MADHYANCHAL
PROFESSIONAL UNIVERSITY

Draft Rules & Syllabus
for the

Master of Science in Biotechnology

(M.Sc. Biotech.) Course

Scheme for M.Sc., CBCS Course

Semester I

S.No.	Subject Code	Subject Name & Title	Maximum Marks Allotted								Hours per week.			Total Credits	Remarks
			Theory				Practical								
			End Sem	Mid Sem. MST	Quiz, Assignment	Total Marks	Lab Work	Assignment /Quiz/Term paper	End Sem	Total Marks	L	T	P		One credit refers to one hour teaching in theory, Tutorial
1	MSc101	Microbiology	60	20	20	100	-	-	-	-	3	1	-	4	
2	MSc 102	Enzyme Technology	60	20	20	100	-	-	-	-	3	1	-	4	
3	MSc 103	Molecular Biology	60	20	20	100	-	-	-	-	3	1	-	4	
4	MSc 104	Biochemistry	60	20	20	100	-	-	-	-	3	1	-	4	
5	MSc 105	Microbiology and Molecular Biology	-	-	-	-	40	20	40	100	-	-	4	2	
6	MSc 106	Biochemistry and Enzyme Technology	-	-	-	-	40	20	40	100	-	-	4	2	
	Total		240	80	80	400	80	40	80	200	12	4	8	20	600

Semester II

S.No.	Subject Code	Subject Name & Title	Maximum Marks Allotted								Hours per week.			Total Credits	Remarks
			Theory				Practical								
			End Sem	Mid Sem. MST	Quiz, Assignment	Total Marks	Lab Work	Assignment /Quiz/Term paper	End Sem	Total Marks	L	T	P		One credit refers to one hour teaching in theory, Tutorial
1	MSc 201	Microbial Biotechnology	60	20	20	100	-	-	-	-	3	1	-	4	
2	MSc 202	Plant Biotechnology	60	20	20	100	-	-	-	-	3	1	-	4	
3	MSc 203	Immunotechnology	60	20	20	100	-	-	-	-	3	1	-	4	
4	MSc 204	Bioinformatics	60	20	20	100	-	-	-	-	3	1	-	4	
5	MSc 205	Microbial Biotechnology and Plant Biotechnology	-	-	-	-	40	20	40	100	-	-	4	2	
6	MSc 206	Immunotechnology and Bioinformatics and Biostatistics	-	-	-	-	40	20	40	100	-	-	4	2	
	Total		240	80	80	400	80	40	80	200	12	4	8	20	600

Chapter II Syllabus

COURSE BT – 101: MICROBIOLOGY

UNIT-1: Methods in Microbiology

- Sterilization Methods, Pure culture technique, Enrichment techniques
- Preservation & Maintenance of culture
- Staining & fixation, Bacterial morphology
- Growth curve of bacteria, Measurement of microbial growth, The influence of environmental factors in growth ,Synchronous growth, Continuous growth
- Sporulation, Spore germination
- Common Nutrient Requirements, Types of media for growth of microorganisms.

UNIT-2: Medical Microbiology and epidemiology

- Pathogenicity and virulence.
- Virulence factors of microorganism.
- Epidemiology
- **UNIT-3: Bacterial Genetics**
- Recombination of bacterial genes, gene targeting
- Gene transfer method- Transformation, Conjugation & Transduction
- Mutation:- Types , causes & effects of mutation

UNIT-4: Viruses & Prions

- General Characteristics of viruses
- Viruses of Bacteria Lytic & Lysogeny cycle (General features, RNA & DNA viruses)
- Viruses of Plants:- Different types of plant, viruses , mechanism of infection
- Animal viruses:- General features of retroviruses, overview of Animal viruses, HIV and AIDS
- Prions & Molecular basis of their pathogenecity

UNIT-5: Antimicrobial agents

- Types of antimicrobial agents
- Classes of antibiotics (β -lactams, tetracyclins, aminoglycosides, macrolids, Polypeptides antibiotics & their mode of action)
- Antiviral, antifungal, antiprotozoan antibiotics
- Development of resistance to antibiotics
- Microbial spoilage and its impact.

COURSE BT – 102: ENZYME TECHNOLOGY

UNIT-1: Enzyme – General Account

- Classification of enzymes and enzyme kinetics of single substrate and two substrate catalyzed reactions
- Factors affecting rate of enzymatic reactions: temperature pH modulators etc and significance of activation energy and free energy in biochemical reactions.

UNIT-2: Enzyme Cofactors and Mechanism of Enzyme Catalysis

- Structure and biological function of a variety of enzyme cofactors. Enzyme substrate
- complex concept of ES complex binding sites, active site and type of enzyme specificities.
- Acid Base catalysis, Orientation and Proximity, Covalent Catalysis (Electrophilic and Nucleophilic), Strain and Distortion

UNIT-3: Regulation of Enzyme activity

- Covalent Modification & Allosteric Regulation.
- Isozymes and Abzymes
- Asymmetric catalysis through enzymes.

UNIT-4: Enzyme immobilization and Biotransformation

- Methods and principles, Supporting matrix, advantages, and reactor-design for immobilization of enzymes.
- Biotransformation through enzymes and Microbes
- Non-aqueous enzyme technology

UNIT-5: Enzyme technology for industrial application

- Applications of enzyme technology in environment
- Medical,
- Agricultural,
- Industrial benefit**s**

COURSE BT – 103: MOLECULAR BIOLOGY

UNIT-1: Organization of genetic materials

- Various models to explain the structure of the nucleus and chromosomes, Special type of chromosomes: lamp brush, salivary and B chromosomes.
- Packaging of DNA as nucleosomes in eukaryotes, Chromosomal DNA contents and Cvalue paradox.
- Structural changes in the chromosomes

- Multigene families in eukaryotes
- Genomic organization in prokaryotes and Archaebacteria

UNIT-2: DNA replication and repair

- Enzymes & accessory proteins involved in DNA replication
- Replication process in prokaryotic & Eukaryotic DNA
- Regulations of Eukaryotic replication
- DNA Repair:- Types of DNA Repair, Mechanism of DNA Repair

UNIT-3: Transcription

- Importance of DNA binding Proteins, RNA polymerase
- Mechanism of Transcription in prokaryotes & Eukaryotes
- Processing of RNA:- m-RNA processing, 5' capping, 3' polyadenylation, splicing
- r-RNA & t- RNA processing

UNIT-4: Translation

- The translation machinery, role of t RNA & ribosome
- Mechanism, of translation
- Post translational modification of proteins such as phosphorylation, adenylation, acylation and glycosylation

UNIT-5: Regulation & gene expression in Prokaryotes & eukaryotes

- Operon concept (Lac operon, trp operon, his operon and arabinose operon), Structural basis of DNA-Protein interaction
- Attenuation & termination
- Gene silencing:- DNA methylation,
- Chromatin modification & gene expression. Histone acetylation & deacetylation
- Environmental regulation of gene expression

COURSE BT – 104: BIOCHEMISTRY

UNIT-1: Carbohydrates and Lipids

- **CARBOHYDRATES:** Classification, functions, Monosaccharide, Fischer projection formula, hemiketal and hemiacetal formation, furanoses, pyranoses, anomers, epimers, disaccharides-sucrose, lactose, maltose; polysaccharide (homo and heteropolysaccharides), peptidoglycans, glycoproteins, proteoglycans
- **LIPIDS:** Definition, classification & functions of Lipids. Saturated & unsaturated fatty acids, Essential Fatty acids, Prostagladins Fat:-Hydrolysis, Saponification Value, Rancidity of fat, Biological significance Properties & function of Glycerides, Phospholipids, sphingolipids & glycolipids

UNIT-2: Proteins

- Structure of all 20 amino acids, Essential & Non essential amino acids
- Classification of Proteins based on Function & Solubility
- Primary, Secondary, tertiary & Quaternary structure of proteins, Ramchandran Plot
- Structure and Function of Fibrous proteins (Keratin, Collagen & Elastin), Globular proteins (Hemoglobins , Myoglobins), Lipoprotein, Metalloproteins & nucleoproteins

UNIT-3: Nucleic acids

- Structure of DNA & RNA, Different Conformations of DNA
- Denaturation & annealing of DNA Physical properties of DNA such as bending, super coiling and sequence dependent changes in DNA melting, renaturation properties
- Structure & different types of RNA
- Structure of genomic and organellar DNA in eukaryotes

UNIT-4: Photosynthesis & Nitrogen fixation

- Photosynthesis and respiration. Photosynthetic electron transport and respiratory electron transport and their coupling with energetic.
- Biological nitrogen fixation, Biofertilizers, symbiotic and non-symbiotic nitrogen fixation.
- Mechanism of protection of nitrogenase from molecular oxygen. Nitrate assimilation.

M.Sc. Biotechnology Semester-I

P1: Microbiology and Molecular Biology

1. Isolation & maintenance of organism by plating, streaking & serial isolation methods slants & stab culture, storage of microorganism

2. Microscopic observation - Gram staining, Capsule & Spore Staining

3. Growth cure – Diauxic

4. Effect of Environmental Factors on Growth of Bacteria: Salt, Temp, pH.

5. Viable count of bacteria from soil sample (Dilution Plating Method)

6. Biochemical characterization of selected Microbes

7. Isolation of bacteriophages from sewage sample

8. Enrichment and Isolation of:

a) Halophiles b) Acidophiles c) Phenol Degraders

d) Nitrogen Fixers e) Antibiotic Producers f) Acid Producers

9. Alcohol Fermentation

10. Comparative studies of ethanol production using different substrates

11. Immobilization of Whole Cells

12. Effect of Antibiotics on various Gram Positive and Gram Negative bacteria

13. Determination of Minimum Inhibitory Concentration (MIC) and Minimum

14. Bactericidal Concentration (MBC) of various Antibiotics on different Organisms.

P2: Biochemistry and Enzymology

1. Method of Protein Estimation

i) Estimation of Protein by Biuret methods

ii) Estimation of Protein by Folin Lowry methods

iii) Estimation of Protein by Bradford method

iv) Estimation of Protein by UV Absorption.

2. Method of Carbohydrate Estimation

i) Estimation of reducing sugar by DNSA method.

ii) Estimation of Carbohydrate by Nelson-somogys method

iii) Estimation of Carbohydrate by GOD/POD method.

iv) Estimation of Carbohydrate by Phenol Sulphuric acid Method.

3. Nucleic acid Estimation

i) Estimation of DNA by DPA method

ii) Estimation of RNA by orcinol method /modified orcinol

iii) Estimation of total lipids in seeds

4. Analysis of oils, iodine numbers, saponification value, acid number

5. Enzyme assay, Enzyme Kinetics, specific activity, Determination of Km & Vmax, Optimum pH, Optimum Temperature of Amylase/Alkaline phosphatase /protease/ cellulase

6. Studying comparative effect of Inhibitors on enzyme activity of Amylase/Alkaline phosphatase/protease/cellulose. Alkaline Phosphatase i.e, a) Competitive Inhibition (NaH_2PO_4, PNP)

   b)Uncompetitive Inhibition (L – Phenylalanine)

7. Separation of plant pigments by paper chromatography

8. Separation of Amino acids by thin layer chromatography

SEMESTER II

201 MICROBIAL BIOTECHNOLOGY

UNIT I

Microbial products: Microbial Biomass, Primary metabolites, secondary metabolites microbial enzymes, transformed products. Gene cloning in microorganisms other than *E. coli* (*Salmonella, Rhizobium, Agrobacterium, Bacillus subtilis, Streptomycetes, Aspergillus niger*). Microbial primary and secondary metabolites: Amino acids (Glutamic acid, L-lysine), Vitamins and hormones (vitamin B12, vitamin A, riboflavin, gibberellins). Organic acids and other industrial chemicals (Lactic acid, citric acid, alcohol, acetic acid, glycerol, acetone). Antibiotics (Penicillin, streptomycin, tetracycline), peptide antibiotics (lantibiotics)

UNIT II

Microbial Enzymes: Microbial production of enzymes (Protease, amylase, invertase, pectinase, xylanase) substrate, production, purification of enzymes, immobilization, their application in food and other industries. Microbial exopolysaccharides (EPS), classification and applications (health, industrial, pharmaceutical and food): Alginate, Cellulose, Hyaluronic acid, Xanthan, Dextran, Gellan, Pullulan, Curdlan, polysaccharides of lactic acid bacteria; Chitin, chitosan and chitin derivatives.

UNIT III

Microbial beverages and food: Production of wine, beer, and vinegar. Microbial food: Oriental foods, Baker's yeast, cheese, SCP, SCO (PUFA), mushroom cultivation, sauerkraut, silage, probiotics. Nutraceuticals. Bioconversion, biofuels, biogas. Waste utilization to generate biofuels.

UNIT IV

Biofertilizers: *Rhizobium, Azotobacter, Azospirillum,* Cyanobacteria, *Mycorrhiza*, phosphate solubilizers, *Frankia.* Biopesticides: *Bacillus thuringiensis, Bacillus popillae, Trichoderma*, Baculoviruses. Plant growth promoting Rhizobacteria (PGPR)

References

1. Comprehensive Biotechnology. Vol. 1, 2, 3 & 4. Moo-Young, M., Pergamon Press, 2011
2. Fundamentals of Biotechnology. Prave,P.et al., Wiley-Blackwell Pub., 1987

3. Industrial Microbiology. Cassida, L.E., John Wiley & Sons, 1968
4. Industrial Biotechnology. Crueger, W.&Crueger,A., Sinauer Associates Inc., 1990
5. Industrial Biotechnology. Demain, A.L., American Society for Microbiology, 1986
6. Microbial Biotechnology. Glazer, A.G., WH Freeman and Company, 1994
7. Microbial Technology. Peppler, H.J., Vol. 1 & 2. Academic Press, 1979

202 PLANT BIOTECHNOLOGY

UNIT I

Plant genome structure, gene families in plants, organization of chloroplast genome, mitochondrial genome and their interaction with nuclear genome, RNA editing in plant mitochondria. Mitochondrial DNA and Cytoplasmic male sterility. Plant breeding mechanism: types and applications**.** Biological oxidation: Electron transport chain, chemiosmotic hypothesis, ATP synthesis, oxidative phosphorylation, substrate level phosphorylation, uncouplers and inhibiters of respiration. Photosynthesis, regulation, Calvin cycle, C3-C4 plants

UNIT II

Regulation of gene expression in plant development: Germination, apical meristem, floral development, leaf development, seed development and seed storage proteins. Plant hormones (auxins, cytokinins and gibberellins, IBA, NAA, 2-4-D, TD2). Plant tissue culture, history, laboratory design, aseptic conditions, methodology, media, techniques of callus cultures, meristem cultures, anther culture, embryo culture, micropropagation, protoplast culture, somaclonal variation, synthetic seeds; Methods of plant tissue preservation and applications (cryopreservation).

UNIT III

Cell suspension cultures and bioreactor technology, plant biosynthesis and production, regulation, commercial importance of secondary metabolites by tissue culture. Plant-derived vaccines, plantibodies and pharmacognosy.

Gene rearrangement. Nitrogen fixation by symbiotic and non-symbiotic microbes. *nif* and *nod* genes.

UNIT IV

Development of transgenic plants for virus, bacteria, fungi, insect resistance. Transgenic crops for improved quality (Bt cotton, Bt brinjal, golden rice), herbicide tolerant, stress resistant plants, delayed fruit ripening, terminator seed technology, GM foods and human health. Molecular diagnosis of plant diseases.

References

1. Biotechnology in Agriculture and Forestry. Bajaj, Y.P.S., Springer, 2007.
2. Biotechnology of Higher Plants. Russell, G.E. Intercept Pub., 1988
3. Plant Cell and Tissue Culture. A Lab manual. Reinert, J.& Yeoman, M.M., Springer, 1982
4. Plant Biotechnology. Mantell, S.H. & Smith, H. Cambridge University Press, 1983
5. Introduction to Plant Biotechnology. Chawla, H.S. Science Publ. Inc., 2002

203 IMMUNOTECHNOLOGY

UNIT I

History and scope of immunology. Types of immunity – humoral and cell-mediated. Innate and adaptive immunity. Specificity and memory. Primary and secondary lymphoid organs; immunization. Cells involved in immune response-T-cells, B-cells. Clonal selection theory. Lymphocyte activation, clonal proliferation, differentiation. Effector mechanisms in immunity-macrophage activation. Lymphokines – Interleukins and their role in immune regulation. Toxin and Toxin resistance.

UNIT II

Antigens and haptens, determinants; types of immunoglobulins: structure, distribution and function. Antigen-antibody reactions – Antigen equilibrium, dialysis, precipitation reactions, immunodiffusion. Affinity and Avidity. Immunization and antibody response. Antibody diversity - V, D, J, gene segments and DNA rearrangements, molecular biology of antibody synthesis. Complement system. Human and mouse, MHC, Transplantation immunology. HLA in human health and disease HLA tissue typing. Immune-suppression in transplantation.

UNIT III

Hypersensitivity reaction, treatment approaches. Immunological tolerance. Autoimmune diseases. Thyrotoxicosis, Systemic Lupus Erythematosus, Antinuclear antibodies. Tumor immunology – tumor antigens, immuno-surveillance, immunological escape. Immune deficiency diseases – AIDS; Immunological tolerance. Production, purification and characterization of monoclonal antibodies. Polyclonal antibodies versus monoclonal antibodies. T-cell cloning and their applications. ELISA, RIA, Western blotting, Fluorescent techniques, Fluorescent activated cell sorter (FACS). Concepts in vaccine development. Types of vaccines. Immunotherapeutic approaches to disease treatment- immunotoxins, Lymphokine-activated killer cells.

References

1. Cellular and Molecular Immunology. Abbas, A.K. et al., Elsevier Saunders Co., 2015
2. Essential Immunology. Riott, I.M., Blackwell Scientific Publications, 1994
3. Handbook of Experiments in Immunology, Vol. 1 & 2, Weir D.M., Wiley, 1997
4. Kuby Immunology. Kindt T.J. et at., W.H. Freeman & Co. 2007
5. Immunology. Riott, I.M., BrostoffJ., Male, D. Mosby Pub., 2001
6. Immunobiology. Janeway C.A. and Travers, P. Churchill Livingstone Pub., 1996
7. Practical Immunology. Hudson L. and Hay F.C., Blackwell Scientific Pub., 1989

204 BIOINFORMATICS

UNIT I

Introduction to Bioinformatics. Basics of UNIX OS and PERL Programming. Biological databases: Nucleotide and protein sequence and structure (primary and secondary) databases, File formats, Molecular visualization softwares. Sequence analysis. Sequence Alignment: Gap penalties, scoring matrices, Alignment algorithms - Global and Local alignments, Dynamic programming and Heuristic methods (BLAST, FASTA). Multiple Sequence Alignment: Tree alignment, Star alignment, Progressive alignment methods and tools. Stand alone packages for sequence alignment: GCG Wisconsin and EMBOSS package.

UNIT II

Phylogenetics. Representation of phylogeny. Methods of phylogeny: Maximum Parsimony, Maximum Likelihood, Distance method, UPGMA. Softwares for phylogenetic analysis: PHYLIP, CLUSTAL, Tree viewing and editing softwares. Nucleotide sequence and structure prediction methods and tools: Promoter Scan, Gen Scan, CENSOR, Repeat Masker. Whole genome analysis. Genome sequencing strategies, Restriction mapping, Primer designing. Gene Expression analysis - microarray techniques. Protein sequence and structure prediction, Molecular modeling softwares and servers, Protein folding, Threading. Computer-aided Drug Designing: Molecular Docking. Distributed computing approach: Genome@home, Folding@home.

UNIT III

Statistics – Definition, Application of statistics in Bioscience, Classification and tabulation, Graphical representation of data, Histogram, frequency polygon, frequency curve. Measures of central tendency, Measures of dispersion. Normal distribution, Binomial, Poisson, Probability, non-parametric statistics, Correlation and regression; Sign test, Rank sum test, Rank correlation. Testing of hypothesis: Significance of t-test and ANOVA, Multiple range test, Chi-square test. Experimental designs. Diversity measures and evenness (e.g. Simpson and Shannon). Statistical packages.

References

1. Beginning Perl for Bioinformatics. Tisdall, J.D., San Val Pub., 2001
2. Bioinformatics: Sequence and Genome Analysis. Mount, D.W., CSHL Press, 2004
3. Bioinformatics: Methods and protocols. Misener, S., &Krawetz,S. A., Humana Press, 2000
4. Fundamental Concepts of Bioinformatics. Krane, D.E.& Raymer, M.L., Pearson Ed., 2002
5. Introduction to Protein Structure. Branden,C.-I. & Tooze,J., Garland Pub., 1999
6. Introduction to Bioinformatics. Attwood, T.& Parry-Smith, D., Prentice Hall Pub., 1999
7. Introductory Statistics for Biology. Parker, R.E., Hodder Arnold Pub., 1979
8. Statistics for Biological Sciences. Schefler,W. C., Addison Wesley Pub., 1979
9. Biostatistical Analysis. Zar, J. H. Prentice Hall, 2010

10. Biostatistics. Lewis,A. E.. Prentice Hall, 2010

MICROBIAL BIOTECHNOLOGY

- Submerged and solid state fermentation Estimation of microbial biomass
- Estimation of microbial enzymes, mycotoxins, organic acids and antibiotics Microbiological assays (antibiotics, amino acids and vitamins)
- Properties of microbial exopolysaccharides (e.g. cell immobilization) Uses of Chitin and its derivatives
- Pilot scale production of alcoholic beverages
- Microbial interactions with plants (rhizobia, mycorrhizas) and plant production Assessment of nitrogen fixation (acetylene reduction test)
- Phosphate solubilization in bacteria, fungi and actinomycetes Qualities of biofuels (e.g. biodiesel, biogas)

PLANT BIOTECHNOLOGY

- Estimation of plant hormones (e.g. auxins, gibberellins) Plant tissue culture methods
- Callus culture (compact and friable) Ovule and anther culture
- Cell suspension cultures Embryogenesis Synthetic seeds Protoplast preparation
- Protoplast fusion techniques Plant cell immobilization
- Methods of inducing resistance through tissue culture

IMMUNOTECHNOLOGY

- Study of immune system in rats
- Blood film preparation and study of immune cells Histology of organs of immune system
- Study of insect hemocytes Production of antiserum Isolation of lymphocytes
- Antigen-antigen reactions (*in vitro*) Phagocytosis (*in vitro*)
- Immunodot technique Immunodiffusion technique
- Immunological diagnosis of pregnancy and infection Demonstration of ELISA technique

BIOINFORMATICS

- Biological databases - BLAST, FASTA Restriction mapping
- Mean SEM, Histogram Student's t-test ANOVA