

SYLLABUS for M. Sc. BIOTECHNOLOGY
Semester Pattern
Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur
Effective from 2012-2013
With Appendix A, B, C&D

- 1) The syllabus is divided into four semesters. In all the semesters there are four theory papers. The first three semesters carry two practical each and Seminar. A project work is required to be completed in the fourth semester. Apart from the project, the student will also have to complete a practical and a seminar in the fourth semester. Each theory paper is divided into four units and all the units carry equal weightage. All papers and practical are compulsory. Each theory paper carries 100 marks. Each practical carries 100 marks. 100 marks are allotted to a project work to be carried out during the fourth semester. The project is compulsory. 25 marks are allotted to the Seminar.
- 2) **Number of theory and practical periods:** The syllabus is based on 18 theory periods and 16 practical periods per week. Candidates are required to pass separately in theory and practical examination.
- 3) **Study tour:** Students of M. Sc. Biotechnology are encouraged to visit some research institutes of national and international repute during the two-year course.
- 4) **Seminars:** In all the semesters every student has to give at least one seminar and submit a written summary of the same.
- 5) **Project work:** In the fourth semester, 100 marks are allotted to the project work. The project is compulsory.
- 6) **Distribution of theory/practical/seminar/project marks:**

M. Sc. Biotechnology
Semester I

Theory		
Paper I	Cell Biology and Enzymology	100 marks/4 Credits
Paper II	Molecular Biology	100 marks/4 Credits
Paper III	Biomolecules	100 marks/4 Credits
Paper IV	Biophysical Technique	100 marks/4 Credits
Practical 1	Cell Biology & Enzymology	100 Marks/4 Credits
Practical 2	Macromolecules & Analytical Techniques	100 Marks/4 Credits
Seminar		25 marks/1 Credit

M. Sc. Biotechnology
Semester II

Theory		
Paper I	Microbiology	100 marks/4 Credits
Paper II	Industrial Biotechnology and Biostatistics	100 marks/4 Credits
Paper III	Immunology	100 marks/4 Credits
Paper IV	Molecular Biology & Bioinformatics	100 marks/4 Credits
Practical 1	Microbiology & Immunology	100 Marks/4 Credits
Practical 2	Molecular Biology & Bioinformatics	100 Marks/4 Credits
Seminar		25 marks/1 Credit

M. Sc. Biotechnology
Semester III

Theory		
Paper I	Animal Biotechnology	100 marks/4 Credits
Paper II	Plant Biotechnology	100 marks/4 Credits
Paper III	Genetic Engineering- I	100 marks/4 Credits
Paper IV	Genetic Engineering- II	100 marks/4 Credits
Practical 1	Animal & Plant Biotechnology	100 Marks/4 Credits
Practical 2	Genetic Engineering	100 Marks/4 Credits
Seminar		25 marks/1 Credit

**M. Sc. Biotechnology
Semester IV**

Theory		
Paper I	Environmental Science & Bioresources	100 marks/4 Credits
Paper II	Applied Environmental Biotechnology	100 marks/4 Credits
Paper III	Environmental Monitoring & Management	100 marks/4 Credits
Paper IV	Ethics, Patenting and Bio-Entrepreneurship	100 marks/4 Credits
Practical	Environmental Biotechnology	100 Marks/4 Credits
Project Work		100 Marks/4 Credits
Seminar		25 marks/1 Credit

**M. Sc. BIOTECHNOLOGY
Semester I
Paper – I
Cell Biology and Enzymology**

Credits: 4

UNIT I:

- a. **Plasma membrane:** Structural models, transport of nutrients, ions and macromolecules. Cellular junctions and adhesions, Plasmodesmata
- b. **Mitochondria:** Electron Transport Chain and Oxidative Phosphorylation.
- c. **Chloroplasts:** Structure-Function relationship
- d. **Organelles:** Golgi complex, Endoplasmic Reticulum, Lysosomes, Peroxisomes (functions); Role of microtubules and microfilaments in cell.

UNIT II:

- a. **Cell signaling:** Extracellular Messengers & their receptors, G-protein- Coupled receptors their second messengers and signal transduction pathway-Specificity of G-protein coupled responses, Regulation of Glucose levels, Role of GPCRs in sensory perceptions.
- b. **Protein Tyrosine Kinases-RTK-** Dimerization, Protein Kinase activation, RTKs activates downstream signaling pathway, signaling by the insulin receptors (RTKs)

UNIT III:

- a. **Calcium as an intracellular messenger:** IP₃ and Voltage-Gated Ca²⁺ Channels, Calcium binding Protein (calmodulin) & its role in signaling Intrinsic pathway of Apoptosis; light induced signal transduction (Plant transduction).
- b. **Cell cycle:** Control mechanisms: Role of cyclins and Cdks, Cell cycle check points, Molecular events in *S. cerevisiae*.

UNIT IV:

- a. **Basic aspects of Enzyme Kinetics:** Michaelis- Menten equation (derivation, significance and transformation). Two substrate kinetics. Modifying factors of enzyme kinetics, enzyme inhibition and types of inhibitors.
 - b. **Concept of multienzyme complexes:** Fatty acid synthase and dehydrogenase complexes.
 - c. **Concept of enzyme regulation:** Allosteric (example ATCase), chemical modification and calmodulin mediated regulation.
 - d. **Enzyme Engineering:** Mechanism of enzyme function and reactions, enzymic bioconversions e.g. Starch and sugar conversion processes etc. Immobilization of Enzymes and their industrial applications.
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M. Sc. BIOTECHNOLOGY
Semester I
Paper – II
Molecular Biology

Credits: 4

UNIT I:

Organization of gene and Chromosomes: Operon (*lac., trp, ara*), Structure of chromatin & chromosomes, Unique & repetitive DNA, Heterochromatin & euchromatin, Cot Curve analysis, Interrupted genes, Transposons.

UNIT II:

- a. **DNA Replication:** Prokaryotic and Eukaryotic DNA replication, mechanisms of DNA replication, fidelity of replication, enzymes and accessory proteins involved in DNA replication.
- b. **Gene mutations:** Types of mutations. Suppression, Transposable Genetic Elements, Ames' test.
- c. **DNA Repair:** Direct repair, Ada protein, NER, BER, MMR, SOS repair, Transcription-repair coupling, repair of double-strand breaks.

UNIT III:

- a) **Prokaryotic Transcription:** RNA Polymerase holoenzyme and apoenzyme, different sigma factors, details of initiation, elongation, termination.
- b) **Eukaryotic Transcription:** Three types of RNA polymerases. Promoter of RNA polymerase II. Enhancers. General and inducible transcription factors.
- c) **Modifications of RNA:** 5' cap formation, polyadenylation, splicing of nuclear pre-mRNA, mRNA stability.

UNIT IV

- a) **Genetic code:** Characteristics, deciphering the code.
- b) **Protein biosynthesis:** Prokaryotic and eukaryotic translation, the translational machinery, mechanism of initiation, elongation and termination.
- a) **c) Regulation of expression in eukaryotes:** Britten-Davidson model. DNA binding and activation domains of transcription factors. Packaging of chromosomes and its relation to transcription regulation. Regulation of translation by 3' and 5' UTR motifs.

M. Sc. BIOTECHNOLOGY
Semester I
Paper – III
Biomolecules

Credits: 4

UNIT I:

Chemical basis of life; Composition of living matter; Water- properties, pH, ionization and hydrophobicity; Emergent properties of biomolecules in water: Biomolecules in water; Biomolecules hierarchy; Macromolecules; Molecular assemblies; Structure- function relationships. Chemistry of Carbohydrates: Energy storage molecules – starch, glycogen. Building blocks – cellulose, hemicellulose, and chitin. Cell surface molecules – glycolipids, proteoglycans.

UNIT II:

Chemistry of Lipids: Triglycerides, phospholipids, glycolipids, sphingolipids, sterols, terpenes, liposomes lipoproteins, lipids, Lipid micelles & their applications.

UNIT III:

Proteins: Amino acids and peptides. Primary, secondary, tertiary structures, and quaternary structures, Protein sequencing, protease mapping. Ramachandran plot. Collagen structure. Domain structure, models of protein folding, methods of study of protein folding, roles of chaperones and chaperonins.

UNIT IV:

Nucleic acids: Structure of DNA and RNA: A, B, and Z forms of DNA. Novel structures. DNA bending and bendability. Denaturation and renaturation studies and their applications, nucleic acid hybridization.

M. Sc. BIOTECHNOLOGY
Semester I
Paper – IV
Biophysical Techniques

Credits: 4

UNIT I:

Spectroscopy Techniques UV, Visible and Raman Spectroscopy; Theory and application of Circular Dichroism; Fluorescence; NMR, PMR, ESR and Plasma Emission spectroscopy; MALDI-TOF; Mass spectrometry.

UNIT II:

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

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

UNIT III:

Centrifugation: Basic principles; Mathematics & theory (RCF, Sedimentation coefficient etc); Types of centrifuge - Microcentrifuge, 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.

UNIT IV:

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 and Mass spectrometry.

Applications of isotopes in biochemistry, Principles of tracer techniques, Its advantages and limitations, Clinical application. Radioimmunoassay.

M. Sc. BIOTECHNOLOGY
Semester I
LAB I
Cell Biology and Enzymology

Credits: 4

Compulsory Practical

Determination of activity of calcium ATPase of plasma membrane.

Subcellular fractionation and assay of marker enzymes.

Assay of activity of LDH.

Optional Practical

1. Cell motility and flagellar staining.
2. Microscopic studies of cell organelles.

3. Cell types of plants- maceration of various tissue explant and identification of xylem, trachied, stomata, root hair, etc.
4. F-Actin assay by Dnase inhibition method.
5. Determination of activity of sodium/potassium ATPase of plasma membrane.
6. Isolation of neutrophils and demonstration of phagocytosis.
7. Determination of osmotic fragility of RBC membrane.
8. Study of electron micrographs of various organelles.
9. Assay of activity of beta-galactosidase
10. Assay of activity of acid phosphatase,
11. Enzyme purification by crystallization - urease.
12. Immobilization of enzymes (Invertase/ Protease/ Amylase.) by Na alginate method.
13. Whole cell immobilization (Yeast) by Na Alginate and the estimation of alcohol produced.
14. Effect of NaCl on amylase activity
15. Inhibition of alkaline phosphatase activity by EDTA
16. Estimation of lipase activity by titrimetric method
17. Effect of Temperature on activity of Amylase / Alkaline phosphatase and determination of optimum temperature.
18. Effect of Substrate concentration on activity of Amylase / Alkaline phosphatase and determination of optimum substrate concentration.
19. Effect of pH on activity of Amylase / Alkaline phosphatase and determination of optimum pH
20. Isolation of chlorophyll and xanthophyll from spinach leaves.
21. Effect of inhibitors on respiratory chain.
22. Study of Mitosis and Meiosis
23. Study of mutations by Ames Test.
24. Assay of Activity of SGOT & SGPT.
25. Isolation, Purity determination and quantitation of DNA by UV method.

Note: In addition to the compulsory practical, at least 6 practical must be conducted from the optional section within the semester.

M. Sc. BIOTECHNOLOGY
Semester I
LAB II
Macromolecules & Analytical Techniques

Credits: 4

Compulsory Practical

1. Separation of proteins / lipids by ion exchange chromatography
2. Separation of lipids / amino acids by thin layer chromatography
3. Polyacrylamide gel electrophoresis: a) native enzyme preparation, b) SDS-PAGE of proteins.

Optional Practical

1. Introduction to measurements: balance and pipetting, preparation of solutions of given molarity and normality.
2. Measurement of pH: buffering capacity, to determine pKa value and hence the dissociation constant of a given acid using pH meter.
3. Colorimetry: To determine the dissociation constant of a given indicator colorimetrically and to prepare buffer solutions in the pH range 2.2 to 8.0
4. Colorimetry: Assay of DNA by diphenylamine method.
5. Colorimetry: Assay of RNA by orcinol method.
6. Potentiometry: To determine redox potential of Fe⁺⁺ and Fe⁺⁺⁺.
7. Conductometry: to determine cell constant of 0.1 M KCl.
8. Conductometry: Titration of strong acid vs strong base, to find out equivalent conductance of salt formed.
9. Viscometry: Effect of temperature on the viscosity of DNA using Ostwald's viscometer.
10. Viscometry: To determine molecular weight of protein and DNA.

11. Viscometry: To determine changes in the conformation of bovine serum albumin by viscosity measurements, effect of pH on conformation of BSA.
12. Spectrophotometry: To study the absorption spectrum of hemoglobin and NADH
13. Determination of T_m of nucleic acid
14. The validity of beers law for colorimetric estimation of creatinine.
15. The ultraviolet absorption of proteins and amino acids.
16. Estimation of proteins by Lowry's and Bradford method.
17. Estimation of protein by E280/E260 method.
18. Fractionation of proteins: Salt precipitation, solvent precipitation, isoelectric precipitation, dialysis, centrifugation.

Note: In addition to the compulsory practical, at least 6 practical must be conducted from the optional section within the semester.

**M. Sc. Part I, Sem I
Seminar**

Credit: 1

**M. Sc. BIOTECHNOLOGY
Semester II
Paper – I
Microbiology**

Credit: 4

UNIT I:

Microbial Diversity & Systematics Classification of Bacteria according to Bergey's manual; Molecular methods such as Denaturing Gradient Gel Electrophoresis (DGGE), Temperature Gradient Gel Electrophoresis (TGGE), Amplified rDNA Restriction Analysis and Terminal Restriction Fragment Length Polymorphism (T-RFLP) in assessing microbial diversity; 16S rDNA sequencing and Ribosomal Database Project.

UNIT II:

Microbial Physiology: Ultrastructure of Archaea (Methanococcus); Eubacteria (E.coli); Unicellular Eukaryotes (Yeast) and viruses (Bacterial, Plant, Animal and Tumor viruses)

Bacterial genetic system: recombination (transformation, conjugation, transduction and transposition) Plasmids, salient features of the E. coli genetic map.

UNIT III:

Microbial Growth & Nutrition

- a) **Nutrition:** Nutritional classification, behavior, cultivation, isolation, media and their types, maintenance of culture.
- b) **Growth:** Measurement of growth, growth curve, continuous and synchronous culture, factors affecting microbial growth.

UNIT IV:

Microbial Control

- a) **Microbial control:** Methods and dynamics of sterilization, mechanisms of control, biocontrol and preservation.
 - b) **Concept of chemotherapy,** chemotherapeutic agents, mechanisms of action.
 - c) **Drug resistance,** MDR, assessment and management of drug resistance.
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M. Sc. BIOTECHNOLOGY
Semester II
Paper – II
Industrial Biotechnology and Biostatistics

Credit: 4

UNIT I:

Bioreactor technology

- a) **Types of bioreactors:** Plug flow reactors, continuously stirred tank flow reactors, loop reactors, air lift reactors, fed batch reactors, fluidized bed reactors, rotatory disc reactors.
- b) Concept of Batch process, continuous process, recycled and non recycled processes, liquid and solid state fermentations.
- c) Concept of bioreactor designing and process optimization, mass transfer, heat transfer, mixing, rheology of fermentation fluids, mean residence time, substrate utilization rate, oxygenation, oxygen sag, yield co-efficient.

UNIT II:

Bioreactor technology

- a) **Down stream processing:** Bioseparation; filtration, membrane filtration, centrifugation, sedimentation, flocculation, purification, solvent extraction, counter current extraction, ion exchange, affinity techniques, concentration, crystallization, reverse osmosis, ultrafiltration, drying, storage, and packaging.
- b) **Immobilized systems:** Adsorption, covalent bonding, entrapment, encapsulation, cross linking, types of reactors, diffusion characteristics, effective factors, instability factors, deactivation rates, relative length of half life.

UNIT III

Scale up, unit processes, Applications

- a) Concept of control, basic control theory, turbidostatic and chemostatic control.
- b) Basic principles of scale up, working parameters.
- c) UNIT processes- production of amylase, ethanol, penicillin.
- d) Biosensor technology.

UNIT IV

Biostatistics

- a) Measures of central tendency: mean, mode, and median.
- b) Measures of dispersion: range, mean deviation, standard deviation.
- c) Methods of sampling, sampling error, non-sampling errors, standard error.
- d) Chi-square test, meaning of correlation and regression.
- e) Cluster analysis: phylogenetic clustering by simple matching coefficients.
- f) Presentation of statistical data: tabulation (simple tables, frequency distribution table); charts and diagrams (bar charts, histograms, pie charts, dendrogram).
- g) Research designs with basic principles and field layout.

M. Sc. BIOTECHNOLOGY
Semester II
Paper – III
Immunology

Credit: 4

Unit I

Immunology- fundamental concepts and anatomy of the immune system

Components of innate and acquired immunity; Organs and cells of the immune system- primary and secondary lymphoid organs; Lymphatic system;; Mucosal and Cutaneous associated Lymphoid tissue.(MALT&CALT); Mucosal Immunity; Antigens - immunogens, haptens; Major Histocompatibility Complex - MHC genes, HLA typing, flow cytometry, Microarrays.

Unit II**Immune responses generated by B and T lymphocytes**

Immunoglobulins-basic structure, classes & subclasses of immunoglobulins, antigenic determinants; Basis of self —non-self discrimination; B cell maturation, activation and differentiation; Generation of antibody diversity; T-cell maturation, activation and differentiation and T-cell receptors; Cell-mediated immune responses, ADCC; Cytokines-properties, receptors and therapeutic uses, Hapten-carrier system

Unit III

Vaccinology Active and passive immunization; Live, killed, attenuated, sub unit vaccines; Vaccine technology- Role and properties of adjuvants, recombinant DNA and protein based vaccines, plant-based vaccines, reverse vaccinology; Peptide vaccines, conjugate vaccines; Antibody genes and antibody engineering- chimeric and hybrid monoclonal antibodies; Catalytic antibodies and generation of immunoglobulin gene libraries.

Unit IV

Clinical Immunology Hypersensitivity — Type I-IV; Autoimmunity; Types of autoimmune diseases; Mechanism and role of CD4+ T cells; MHC and TCR in autoimmunity; Treatment of autoimmune diseases; immunosuppressive therapy; Cancer immunotherapy. Apoptosis, transgenic mice, Gene knock outs.

M. Sc. BIOTECHNOLOGY**Semester II****Paper – IV****Molecular biology and Bioinformatics****Credit: 4****UNIT I:****Recombination and Genome Mapping,**

- a) **Homologous recombination:** Holiday junction, gene targeting, gene disruption, FLP/FRT and Cre/Lox recombination, RecA and other recombinases.
- b) **Molecular mapping of genome:** Genetic and physical maps, choice of mapping population, southern and fluorescence in situ hybridization for genome analysis, RFLP, RAPD, and AFLP analysis, molecular markers linked to disease resistance genes, application of molecular markers in forensic, disease prognosis, genetic counseling, pedigree etc.

UNIT II:**Antisense, Ribozymes and Epigenetics**

- a) **Antisense and ribozyme technology:** Molecular mechanism of antisense molecule, biochemistry of ribozyme, hammerhead ribozymes, applications of antisense and ribozyme technologies.
- b) **Epigenetics:** chromatin marking systems, Direct chemical modification of DNA, Basic concepts of RNAi.

UNIT III:**Cancer Biology**

- a) **Methods to study cancer:** Animal models. Role of tissue culture in study of cancer. Combination of tissue culture and animal models.
- b) **DNA Viruses and cancer:** Polyoma virus, SV40, adenovirus
- c) **Genetics of Cancer:** Oncogenes (ras, myc), suppressor genes (p53, Rb).
- d) **Angiogenesis:** positive and negative factors affecting angiogenesis. Metastasis, biochemical parameters acquired by metastatic cells.
- e) **Cancer stem cells.**

UNIT IV:**Bioinformatics**

- a) **Computer concept:** computer organization, hardware, software, operating system (windows, unix, brief list of computer languages).
- b) **Concept of networking:** internet, internet concepts, web browsing, public domain resources in biology.

- c) **Concept of database management:** brief idea of data types, data structures, searching, sorting, designing a database, genomic, proteomic, and metabolic pathways databases.
- d) **Computer analysis of genetic sequences:** general concepts of sequence analysis, identification of functional sequences, homology, brief idea of BLAST, ENTREZ, and PubMed.
- e) **Proteomics:** basic issues and concepts, protein sequences and alignment, protein structure prediction.
- f) **Bioinformatics tools in drug design.**

M. Sc. BIOTECHNOLOGY
Semester II
LAB I
Microbiology & Immunology

Credit: 4

Compulsory Practical

1. Western blotting.
2. Production of microbial products in bioreactors/fermentors.
3. Immobilization of cells/enzymes.

Optional Practical

4. Cleanliness, media preparation, sterilization, culturing methods, dilution techniques.
5. Staining techniques in microbiology; simple staining, gram staining, spore staining capsule staining, flagella staining.
6. Isolation of pure culture by different techniques.
7. Replica plating technique.
8. Propagation of viruses.
9. Assay of viruses.
10. Purification of immunoglobulins, qualitative assessment.
11. Demonstration of immunochemical reactions (blood group, Widal, VDRL, pregnancy, ELISA)
12. Blood film preparation and identification of cells.
13. Ouchterlonyimmunodiffusion,
14. Determination of albumin by radial immunodiffusion.
15. Biochemical tests for identification of Bacteria – Oxidase, catalase, IMViC test, etc.
16. Isolation of antibiotic resistant bacteria from waste / sewage water.
17. Motility of bacteria by hanging drop method.
18. Assay of antibiotics by disc diffusion method.

Note: In addition to the compulsory practical, at least 6 practical must be conducted from the optional section within the semester.

M. Sc. BIOTECHNOLOGY
Semester II
LAB II
Molecular Biology & Bioinformatics

Credit: 4

Compulsory Practical

1. Induction of β -galactosidase in strains of E. coli (I^+ and I^-).
2. Southern blotting.
3. Isolation of genomic DNA.
4. Endonuclease digestion of DNA and analysis of DNA fragments by agarose electrophoresis.

Optional Practical

5. Isolation of RNA.
6. Restriction fragment length polymorphism.
7. Ames test.
8. Calculation of mean, mode, and median.
9. Calculation of standard deviation and standard error.
10. Using computer in single user and multiple user environment.

11. Designing and management of databases.
12. Computer aided statistical analysis.
13. Computer presentation of statistical data, charts and diagrams.
14. Computer aided visualization of amino acid sequence of protein and its 3D structure.
15. Retrieving metabolic pathway using internet.
16. Homology searching using BLAST.
17. Base sequence analysis of gene / protein sequence.
18. Computer aided survey of scientific literature.
19. Field layout based on statistical research designs.
20. Determination of rheological constant.
21. Determination of oxygen transfer rate, volumetric transfer coefficient.
22. Microbial production of citric acid / alcohol / antibiotics.
23. Preparation and formulation of microbial biopesticides / biofertilizers.

Note: In addition to the compulsory practical, at least 6 practical must be conducted from the optional section within the semester.

M. Sc. Part I, Sem II
Seminar

Credit: 1

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M. Sc. BIOTECHNOLOGY
Semester III
Paper – I
Animal Biotechnology

Credit: 4

UNIT I:

- a) **Animal Cell Culture:** Equipments and materials for animal cell culture technology. Various systems of tissue culture, their distinguishing features, advantages and limitations.
- b) **Culture medium:** natural media, synthetic media, sera. Introduction to 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 di oxide, serum and supplements.
- c) **Characteristics of cells in culture:** Contact inhibition, anchorage dependence, cell-cell communication etc.; Cell senescence; cell and tissue response to trophic factors.

UNIT II:

- a) **Primary Culture:** Behavior of cells, properties, utility. Explant culture; suspension culture.
- b) **Established cell line cultures:** Definition of cell lines, maintenance and management; cell adaptation.
- c) **Measurement of viability and cytotoxicity.** Cell cloning, cell synchronization and cell manipulation. Various methods of separation of cell types, advantages and limitations; flow cytometry.

UNIT III:

- a) **Scaling up of animal cell culture.** Cell transformation.
- b) **Stem cell cultures, embryonic stem cells and their applications.** Somatic cell genetics.
- c) **Apoptosis: Measurement of cell death.** Apoptosis (death domain, role of cytochrome C)

UNIT IV:

Commercial applications of cell culture: Tissue culture as a screening system; cytotoxicity and diagnostic tests. Mass production of biologically important compounds (e.g. Vaccines). Harvesting of products, purification, and assays.

Three dimensional cultures and tissue engineering.

M. Sc. BIOTECHNOLOGY
Semester III
Paper – II
Plant Biotechnology

Credit: 4

UNIT I:

- a) **Conventional plant breeding** (introductory).
- b) **Introduction to cell and Tissue culture.** Tissue culture as a technique to produce novel plants and hybrids.
- c) **Tissue culture media** (composition and preparation)
- d) **Callus and suspension cultures:** initiation and maintenance of callus and suspension cultures; single cell clones.
- e) **Organogenesis.** Embryogenesis; transfer and establishment of whole plants in soil.

UNIT II:

- a) **Shoot tip culture:** rapid clonal propagation and production of virus free plants.
- b) **Embryo culture and embryo rescue.**
- c) **Hybrid plants:** protoplast isolation, culture and fusion, selection of hybrid cells and regeneration of hybrid plants, symmetric and asymmetric hybrid, cybrid.
- d) **Production of haploid plants:** anther, pollen and ovary cultures for production of haploid plants and homozygous lines.
- e) **Germplasm conservation:** cryopreservation, slow growth cultures and DNA banking for germplasm conservation.

UNIT III:

Applications of plant transformation for productivity and performance

Herbicide resistance, phosphinothricine glyphosate, sulfonyl urea, atrazin, insect resistance, Bt genes, non-Bt-like protease inhibitor, virus resistance, coat protein mediated nucleocapsid gene, disease resistance, chitinase, 1-3 beta glucanase, RIP,

antifungal proteins, thionins, PR proteins, nematode resistance, abiotic stress, post harvest losses, long shelf life of fruits and flowers, use of ACC synthase, polygalacturanase, ACC oxidase, male sterile lines, bar and barnase systems, carbohydrate composition and storage, ADP glucose pyrophosphatase.

UNIT IV:

- a) **Plant metabolic engineering and industrial products:** plant secondary metabolites, control mechanisms and manipulation of phenylpropanoid pathway, shikimate pathway, alkaloids, industrial enzymes, biodegradable plastics, polyhydroxybutyrate, therapeutic proteins, lysosomal enzymes, antibodies, edible vaccines, purification strategies, oleosin partitioning technology.
- b) **Molecular marker aided breeding:** RFLP maps, linkage analysis, RAPD markers, STS, microsatellite, SCAR (sequence characterized amplified regions), SSCP (single strand conformational polymorphism), QTL, map based cloning, molecular marker assisted selection.
- c) **Green House Technology**

M. Sc. BIOTECHNOLOGY
Semester III
Paper – III
Genetic Engineering- I

Credit: 4

UNIT I:

- a) **Restriction endonucleases and modification methylases**
- b) **Other enzymes needed in genetic engineering:** exonucleases and endonucleases, ligases, polymerases, DNA modification enzymes and topoisomerases.
- c) **Gene isolation and purification:** general methods (shotgun method for producing gene library, cloning specific genes by hybridization and reverse transcriptase methods, direct selection of a gene)

UNIT II:

- a) **Construction of Genomic DNA library and its applications**
- b) **Construction of cDNA Library:** Method, problems to be addressed, advantages and disadvantages compared to the genomic DNA library, uses
- c) **Screening of recombinants:** Screening by complementation, southern hybridization, northern hybridization, colony lift, western blotting, immunoprecipitation, south-western screening. Synthesis and labeling of probes.
- d) **DNA sequencing:** Sanger-Coulson dideoxynucleotide method, Maxam-Gilbert chemical cleavage method, multiplex DNA sequencing, automated DNA sequencing. Basic idea of oligonucleotide synthesis.

UNIT III:**Cloning vectors**

- a) **Plasmids as vectors**, general characteristics of plasmids, bacterial vector plasmids, yeast vector plasmids,
- b) **Yeast artificial chromosomes BACs**
- c) **Phage Vectors (PUC19), p Blue script vector**
- d) **Cosmid vectors.**
- e) **Animal virus derived vectors** – SV 40 and retroviral vectors
- f) **Expression vector:** pMal; GST; PET- based Vectors, Histag, GST tag, MBP-tag.

UNIT IV:

- a) **Insertion of DNA and ligation:** Berg's terminal transferase method (dA:dT joints); Boyer-Cohen-Chang experiment (cohesive ends), Butt joints (T4 DNA ligase); current ligation techniques (blunt-end ligation, complementary end ligation, linkers, adaptors, homopolymer tailing.
- b) **Biosafety Regulation:** Physical and Biological Containment

M. Sc. BIOTECHNOLOGY
Semester III
Paper – IV
Genetic Engineering- II

Credit: 4

UNIT I:

- a) **Transformation:** DNA uptake by bacterial cells.
- b) **Transfection:** Chemical and physical methods, Viral vectors. Polyethylene glycol, DEAE-dextran, calcium phosphate coprecipitation, dimethyl sulfoxide, liposomes, microinjection, macroinjection, electroporation, biolistics, somatic cell fusion, gene transfer by pronuclear microinjection
- c) **Amplification of DNA:** Polymerase chain reaction.

UNIT II:

Plant transformation technology: Basis of tumor formation, hairy root, features of Ti and Ri plasmids, mechanism of DNA transfer, role of virulence genes, use of Ti and Ri as vectors, binary vectors, use of 35S and other promoters, genetic markers, use of reporter genes, use of scaffold attachment regions, methods of nuclear transformation, viral vectors and their application, Biological and physical transformation methods. Chloroplast transformation.

UNIT III:

- a) **Expression of heterologous genes:** expression of eukaryotic genes in bacteria, expression of heterologous genes in yeast, insect and mammalian cells.
- b) **Salient features of expression vectors.**
- c) **Processing of recombinant proteins:** Refolding and stabilization.
- d) **Industrial Products of Protein engineering**

UNIT IV:

- a) **Phage Display:** Production of monoclonal bodies by phage display technique using filamentous phage vectors.
- b) **Gene Therapy:** somatic and germline, gene replacement, *in vivo* and *ex vivo* gene delivery, retrovirus gene transfer system, advantages and disadvantages of adenovirus, adeno-associated virus, herpes virus vectors, gene correction, replacement/augmentation, editing, regulation and silencing. Gene therapy of human diseases
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M. Sc. BIOTECHNOLOGY
Semester III
LAB I
Animal & Plant Biotechnology

Credit: 4

Compulsory Practical

1. Callus propagation, organogenesis, transfer of plants to soil.
2. Development of primary cell lines/maintenance of established cell lines.

Optional Practical

1. Preparation of animal cell culture media.
2. Sterility test of media and serum.
3. Media storage, serum inactivation.
4. Initiation of Primary Culture from Chick Embryo
5. Preparation of single cell suspension from spleen / liver / thymus.
6. Cell counting and cell viability.
7. Trypsinization of monolayer and subculturing.
8. Preparation of metaphase chromosomes from cultured cells.
9. Isolation of DNA and demonstration of apoptosis of DNA laddering,
10. MTT assay for cell viability and growth.
11. Cell fusion with PEG.
12. Cell transformation by viruses.
13. Macrophage monolayer from PEC and measurement of phagocytic activity.
14. Staining of the monolayer cells with Giemsa stain.
15. Preparation of plant tissue culture media.
16. Surface sterilization.
17. Organ culture.
18. Protoplast isolation and culture.
19. Anther culture: production of haploids.
20. Cytological examination of regenerated plants.
21. Filter sterilization and sterility test.
22. Lyophilization of local germplasma.
23. Micropropagation of banana, citrus Papaya, Sugarcane etc.
24. Cell suspension culture from different tissues.
25. Embryo culture and embryo rescue of different plant species
26. Effect of various growth hormones on cell divisions and cell proliferation
27. Isolation, purification and culture of protoplast
28. Artificial seed preparation
29. Cytological examination of regenerated plants
30. *Agrobacterium* culture and selection of transformants.
31. Selection of salt tolerance, amino acids analogous resistance through cell cultures.
32. Hardening of tissue culture raised plants.
33. Transfer of plants to soil.
34. Cell types of plants – TS / LS of various tissue explants and identification of Xylem, trachea, stomata, root hair etc.

Note: In addition to the compulsory practical, at least 6 optional must be conducted within the semester.

M. Sc. BIOTECHNOLOGY
Semester III
PRACTICAL II
Genetic Engineering

Credit: 4

Compulsory Practical

1. Isolation of plasmid DNA (miniprep and alkaline bulk method)
2. Recombinant DNA technology: *in vitro* DNA ligation and transformation of *E. coli*.
3. Isolation of genomic DNA

Optional Practical

1. Western Blotting
2. Recombinant DNA technology: characterization of transformants.
3. Southern blotting
4. Isolation of RNA
5. Isolation of polyA + RNA
6. Northern blotting
7. Preparation of probes
8. Isolation of Lambda phage DNA.
9. Agarose gel electrophoresis and restriction mapping of DNA.
10. Construction of restriction map of plasmid DNA
11. Cloning in plasmid/phagemid vectors.
12. DNA sequencing.
13. Gene expression in *E coli* and analysis of gene product
14. Demonstration of technique of PCR
15. Demonstration of technique of RT-PCR
16. Replica plating technique.
17. Propagation of viruses.
18. Assay of viruses.
19. Induction of β -galactosidase in strains of *E. coli* (I^+ and I^-).
20. Endonuclease digestion of DNA and analysis of DNA fragments by agarose electrophoresis.
21. Restriction fragment length polymorphism.
22. Ames test.
23. Quantitation of DNA by various methods.

Note: In addition to the compulsory practical, at least 6 optional must be conducted within the semester.

M. Sc. Part II, Sem III
Seminar

Credit: 1

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M. Sc. BIOTECHNOLOGY
Semester IV
Paper – I
Environmental Science & Bioresources

Credit: 4

UNIT I:

Introduction to environmental Science: Environmental ethics: Environmentalism, Environment & Religion, Environmental education, Need for environmental education.

Environmental Pollution: Classification of pollutants, Air pollution and their properties, Gaseous pollutants, water pollutants and their properties. Noise pollution, Soil pollution, thermal pollution, marine pollution, solid water pollution.

UNIT II:

Ecosystem structure and functions, abiotic and biotic component, Energy flow, food chain, food web, Ecological Pyramids-types, biogeochemical cycles, ecological succession, Ecads and ecotypes.
Biotechnological processes: Bioconversion, Bioaccumulation, Bioconcentration, Biomagnification, Biodegradation.

UNIT III:

Energy & Biofuels: Non conventional or renewable sources of energy, Energy from Biomass, Biofertilizers, Biosensors and biochips, Biofilters, Biofuel cells,

UNIT IV:

Biofertilizers, Biopesticides and Integrated pest management: Bacterial biofertilizers, algal biofertilizers, Aquatic ferns as biofertilizers, Fungi as biofertilizers, earthworm as biofertilizers, biopesticides, Integrated pest management.

M. Sc. BIOTECHNOLOGY
Semester IV
Paper – II
Applied Environmental Biotechnology

Credit: 4

UNIT I:

Bioremediation & Phytoremediation: Biofeasibility, applications of bioremediation, Bioreduction, Phytoremediation.

UNIT II:

Bioabsorption and Bioleaching of heavy metals: Cadmium, Lead, Mercury, Metal binding targets and organisms, Bioabsorption, Metal microbial interaction, Biomethylation of elements (Methylation of mercury and arsenic), Commercial biosorbants, bioleaching, metal precipitation, advantages and disadvantages of bioleaching.

UNIT III:

Waste water Treatment: Biological treatment system (Oxidative ponds, aerobic and anaerobic ponds, facultative ponds, aerated ponds), Biological waster treatment, activated sludge treatment, microbial pollution in activated sludge, percolating filters, waster water treatment by biofilms. Treatment scheme of Dairy, Distillery, Tannery, Sugar, Fertilizers, Refinery, Chemical and Antibiotic waste.

UNIT IV:

Solid waste pollution and its management: Current practice of solid waste management, composting systems, vermicomposting, sewage treatment.

M. Sc. BIOTECHNOLOGY
Semester IV
Paper – III
Environmental Monitoring & Management

Credit: 4

UNIT I:

Biomedical waste management: Current status of biomedical waste management.
Biodegradation of pollutants by microorganisms: Persistent organic pollutants, non biological degradation of pollutants,

UNIT II:

Xenobiotics in environment: Biodegradation of Hydrocarbons, Substituted hydrocarbons, Surfactant, Pesticides, Lignin, Tannin, Synthetic dyes,
Biotransformation: Oxidation reactions: Cytochrome P450 monooxygenase system, Alcohol and aldehyde dehydrogenases, Peroxidases. Reduction reactions: Cytochrome P450 and flavin dependent reactions.

Hydrolysis reactions: Carboxyl esterases. Conjugation reactions: Gluthione S transferases. Regulation of biotransformation.

UNIT III:

Biodiversity and biotechnology: Classification of biodiversity, Value, loss and conservation of Biodiversity. Biotechnological methods of conservation: Crypreservation and micropropagation.

UNIT IV:

Environmental Monitoring and Impact Assessment: Biological monitoring program, bioindicators and environmental monitoring, environmental impact assessment, environmental management.

Environmental Laws: Problems in making and implementing environmental laws, Indian environmental laws, national environmental policy (draft) 2004.

M. Sc. BIOTECHNOLOGY
Semester IV
Paper – IV
Ethics, Patenting and Bio-Entrepreneurship

Credit: 4

UNIT I:

Ethics: Benefits of biotechnology, ELSI of biotechnology, recombinant therapeutic products for human health care, genetic modifications and food consumption, release of genetically engineered organisms, applications of human genetic rDNA research, human embryonic stem cell research.

UNIT II:

Patenting: Patent and Trademark, Biotechnology products and processes, Intellectual property rights, Plant breeders rights, biotechnology in developing countries. Biosafety and its implementation, Quality control in Biotechnology.

UNIT III:

Entrepreneurship definition, factors necessary for entrepreneurship, desirables in a startup, mistakes to be avoided, pillars of bio-entrepreneurship, promoting bio-entrepreneurship, biotech company roadmap, legal, regulatory and other business factors

UNIT IV:

Funding of biotech business(Financing alternatives, VC funding, funding for biotech in India, Exit strategy, licensing strategies, valuation), support mechanisms for entrepreneurship (Bio-entrepreneurship efforts in India, difficulties in India experienced, organizations supporting biotech growth, areas of scope, funding agencies in India, biotech policy initiatives), Role of knowledge centers and R&D (knowledge centers like universities and research institutions, role of technology and upgradation)

M. Sc. BIOTECHNOLOGY
Semester IV
Practical
Environmental Biotechnology

Credit: 4

1. Detection of coliforms for determination of the purity of potable water.
2. Determination of total dissolved solids of water
3. Determination of Hardness and alkalinity of water sample.
4. Determination of dissolved oxygen concentration of water sample
5. Determination of biological oxygen demand of sewage sample
6. Determination of chemical oxygen demand (COD) of sewage sample.
7. Analysis of oligodynamic action.
8. Determine the efficiency of removal of air pollutant using fibrous air filter.
9. Isolation of xenobiotic degrading bacteria by selective enrichment technique

10. Test for the degradation of aromatic hydrocarbons by bacteria
11. Survey of degradative plasmids in microbes growing in polluted environment
12. Effect of Sulphur dioxide on crop plants
13. Estimation of heavy metals in water/soil by Atomic absorption spectrophotometry,
14. Estimation of nitrate in drinking water.
15. Role of microorganisms in elevation of heavy metal induced stress in plants.
16. Preparation and formulation of microbial biopesticide (bacteria, fungi and viruses)
17. In vitro evaluation of medicinal plants against pathogenic microbes.
18. Effect of mycorrhizal fungi on growth promotion of plants.
19. Production of microbial fertilizers (Rhizobium, Azotobacter and AMF).
20. Study of patenting procedure
21. Preparation of proposal for patenting.
22. Study of RFLP, VNTRs, SNPs

Note: At least 6 practical must be conducted within the semester.

**M. Sc. Part II, Sem IV
Project
EXPERIMENTAL PROJECT WORK**

Credit: 4

Project Work Scheme / Guidelines for the Students, Supervisors and Examiners

Every student is required to carry out **Experimental / Field Based Project Work** (this is in lieu of practical II of semester IV) on a related research topic of the subject /course. It must be an original work and will be evaluated by the examiner on the strength of experimental Project work. On the basis of this work, student must submit the Project Report (typed and properly bound) in two copies at least one month prior to commencement of the final Practical/lab Examination of Semester IV. The project report shall comprise of Introduction, Material and Methods, Results, Discussion, Summary, Conclusions and, References along with the declaration by the candidate that the work is original and not submitted to any University or Organization for award of the degree and certificate by the supervisor and forwarded through Head/Course-coordinator/Director of the Department/Centre or the Principal of the College.

The supervisors for the Experimental Project Work shall be from the following.

A person, selected by the duly constituted Selection Committee of the university and approved by the University, exclusively for P.G. course in Life sciences.

OR

A person, selected by the duly constituted Selection Committee of the University, approved by the University and appointed as a full time regular teacher at U.G. level in the Life Sciences and having at least 15 years teaching experience.

OR

A person, selected by duly constituted Selection Committee of R.T.M. Nagpur University, approved by the University and appointed as full time regular teacher at UG level having M. Phil degree with 10 years teaching experience at UG level, or a person who has Ph.D. Degree, with 5 years teaching experience in Life Sciences.

OR

Scientists of National Laboratories/ Regional Research Laboratories who are approved by dint of their appointments in such facilities by the Union Government / the State Government / Nagpur University / Other Universities recognized by UGC with at least in the Grade Pay of Rs.8000/-.

The topic for the project work will be assigned to the student by supervisor at the beginning of third semester. The topic will be forwarded to the controller of examination by the head of the department. The Project Work will carry total 100 marks and will be evaluated by both external and internal examiner in the respective Department / Center / Affiliated College. The examiner will evaluate the Experimental Project Work taking into account the 1) Coverage of subject matter, 2) Arrangement and presentation, 3) References and 4) Critical application and original experimental contribution of the candidate.

For written Project work : 80 Marks

For Viva-Voce : 20 Marks

Total : 100 Marks

M. Sc. Part II, Sem IV
Seminar

Credit: 1

APPENDIX A
MASTER OF SCIENCE (BIOTECHNOLOGY)
TWO YEAR (FOUR SEMESTER) DEGREE COURSE
EXAMINATION & TEACHING SCHEME

Sr. No	Semester	Th. / Pr. / Seminar	Course code	Title of paper	Teaching scheme (hrs/week)			Credits	Examination Scheme					
					Th	Pr	Total		Duration (Hrs)	Max. Marks		Total Marks	Min. Passing Marks	
										External Marks	Internal Marks		Th	Pr
1	I	I	BT1T01	Cell Biology and Enzymology	4		4	4	3	100		100	40	
2	I	II	BT1T02	Molecular Biology	4		4	4	3	100		100	40	
3	I	III	BT1T03	Biomolecules	4		4	4	3	100		100	40	
4	I	IV	BT1T04	Biophysical Technique	4		4	4	3	100		100	40	
5	I	Pr. I	BT1L1	Cell Biology & Enzymology		8	8	4	3-8*	80	20	100		40
6	I	Pr. II	BT1L2	Macromolecules & Analytical Techniques		8	8	4	3-8*	80	20	100		40
7	I	S	BT1INT1	Seminar	2		2	1	--	--	25	25	10	
8				Total	18	16	34	25				625	170	80
9	II	I	BT2T05	Microbiology	4		4	4	3	100		100	40	
10	II	II	BT2T06	Industrial Biotechnology and Biostatistics	4		4	4	3	100		100	40	
11	II	III	BT2T07	Immunology	4		4	4	3	100		100	40	
12	II	IV	BT2T08	Molecular Biology & Bioinformatics	4		4	4	3	100		100	40	

13	II	Pr. I	BT2L3	Microbiology & Immunology		8	8	4	3-8*	80	20	100		40
14	II	Pr. II	BT2L4	Molecular Biology & Bioinformatics		8	8	4	3-8*	80	20	100		40
15	II	S	BT2INT2	Seminar	2		2	1	--	--	25	25	10	
16				Total	16	18	34	25				625	170	80
17	III	I	BT3T09	Animal Biotechnology	4		4	4	3	100		100	40	
18	III	II	BT3T10	Plant Biotechnology	4		4	4	3	100		100	40	
19	III	III	BT3T11	Genetic Engineering- I	4		4	4	3	100		100	40	
20	III	IV	BT3T12	Genetic Engineering- II	4		4	4	3	100		100	40	
21	III	Pr. I	BT3L5	Animal & Plant Biotechnology		8	8	4	3-8*	80	20	100		40
22	III	Pr. II	BT3L6	Genetic Engineering		8	8	4	3-8*	80	20	100		40
23	III	S	BT3INT3	Seminar	2		2	1	--	--	25	25	10	
24				Total	16	18	34	25				625	170	80
25	IV	I	BT4T13	Environmental Science & Bioresources	4		4	4	3	100		100	40	
26	IV	II	BT4T14	Applied Environmental Biotechnology	4		4	4	3	100		100	40	
27	IV	III	BT4T15	Environmental Monitoring & Management	4		4	4	3	100		100	40	
28	IV	IV	BT4T16	Ethics, Patenting and Bio-Entrepreneurship	4		4	4	3	100		100	40	
29	IV	Pr. I	BT4L7	Environmental Biotechnology		8	8	4	3-8*	80	20	100		40
30	IV	Project	BT4PRO	Project Work		8	8	4	3-8*	80	20	100		40
31	IV	S	BT4INT4	Seminar	2		2	1	--	--	25	25	10	
32				Total	16	18	34	25				625	170	80

Note: Th= Theory; Pr= Practical, S= Seminar, * = If required, for two days.

APPENDIX B
MASTER OF SCIENCE (BIOTECHNOLOGY)
TWO YEAR (FOUR SEMESTER) DEGREE COURSE
GENERAL RULES & REGULATIONS

A) Pattern of Question Paper

2. There will be four units in each paper.
3. Question paper will consist of five questions.
4. Four questions will be on four units with internal choice (One question on each unit).
5. Fifth question will be compulsory with questions from each of the four units having equal weightage and there will be no internal choice.
6. Maximum marks of each paper will be 100.
7. Each paper will be of 3 hours duration.
8. Projects shall be evaluated by both internal and external examiners.
9. Practical/laboratory examination of 100 marks. Distribution of marks shall be 20 internal and 80 external.
10. Minimum passing marks in each head (theory, practical & internal assessment) will be 40%.

B) Absorption scheme:

- 1) While switching over to semester pattern, the failure students of annual pattern will be given three chances to clear the examination.
- 2) The candidates who have cleared first year annual pattern examination in the subject shall get admission to third semester directly by matchable scheme. However, candidates who are allowed to keep term will not be eligible for admission to third semester unless they clear all the papers and practicals of first year annual pattern examination.
- 3) The unsuccessful students of old course shall be permitted to appear for higher class as per the new course examination of the post graduate programme (semester, credit and grade system) provided that they submit a certificate from the Head of Department / Principal of the College stating that they have satisfactorily undergone a course of study in all the subjects of the new course as per the absorption scheme of a particular post graduate programme.
- 4) The absorption scheme of the post graduate programme will be effective till the introduction of new syllabus with the new absorption scheme.

C) Grade Point Average (GPA) and Cumulative Grade Point Average (CGPA)

1. On clearing a paper, based on the cumulative score (out of 100) in that paper, a student will be given **Grade Point Average (GPA)** (Maximum of 10, and minimum of 4) for that paper on the following basis.

The description for each of the grades are as follows:

Grade Proposed Norms O: Outstanding: Excellent analysis of the topic, (85% and above)

Accurate knowledge of the primary material, wide range of reading, logical development of ideas, originality in approaching the subject, neat and systematic organization of content, elegant and lucid style;

A: Very Good: Excellent analysis of the topic (70 to 84% and above)

Accurate knowledge of the primary material, acquaintance with seminal publications, logical development of ideas, neat and systematic organization of content, effective and clear expression;

B: Good: Good analysis and treatment of the topic (60 to 69%)

Basic knowledge of the primary material, logical development of ideas, neat and systematic organization of content, effective and clear expression;

C: Average: Some important points covered (55 to 59%)

SCORE (out of 100)	Grade	GRADE POINT AVERAGE (out of 10)
100 to 85	O: Outstanding	10
84 to 70	A: Very Good	09
69 to 60	B: Good	08
59 to 55	C: Average	07
54 to 50	D: Satisfactory	06
49 to 40	E: Pass	05
Below 40	F: Fail	00 or fail

Basic knowledge of the primary material, logical development of ideas, neat and systematic organization of content, good language or expression;

D: Satisfactory: Some points discussed (50 to 54%)

Basic knowledge of the primary material, some organization, acceptable language or expression; **E: Pass:** Any two of the above (40 to 49%)

F: Fail: None of the above (Below 40%)

2. On clearing all the papers in a semester, a student will be allotted a **Semester Grade Point Average (SGPA)** for that particular semester. As the pattern given above does not have differential weights for papers, the SGPA of a student for a particular semester will be the average of the GPA's for all the papers.

3. A student will be allotted a **Cumulative Grade Point Average (CGPA)** after clearing all the four semesters. Again as there is no differential weight system for semesters, the CGPA of a student will be the average of the four SGPA's of that student.

The CGPA can be converted to the usual / conventional divisions in the following way→.

CGPA	Final Grade	Equivalent class/division
9.00 to 10.00	O	First class (outstanding)
8.00 to 8.99	A	First class (excellent)
7.00 to 7.99	B	First class with distinction
6.00 to 6.99	C	First class
5.00 to 5.99	D	Second class
4.00 to 4.99	E	Pass class
Below 4.00	F	Fail

a. A student failed to score minimum 40% marks in each head of passing and in aggregate shall be given F grade.

b. Student with F grade in a course would be granted credit for that course but not the grade for that course.

c. Grade points earned in each paper shall be calculated as – Grade points obtained (vide above table) x Credits for the paper.

d. The formula for GPA will be based on Weighted Average. The final GPA will not be printed unless a student passes courses equivalent to minimum 100 Credits.

4. While declaring the result, the existing relevant ordinances are applicable. For verification and revaluation existing rules will be applicable.

5. The candidate may take all the examinations as per the provisions of ATKT simultaneously but his result of final semester shall not be declared unless he is declared successful at lower examinations.

6. If an examinee failed to pass the post graduate programme within five successive years (for four semesters degree) and within six successive years (for six semesters degree) from the date of his / her first admission to particular post graduate programme he/ she shall be declared as “Not Fit for the Course (NFC)” and he/ she will not be allowed to appear further for any previous examination of the course.

7. The computation of Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA) of an examinee shall be given below:

a. The marks will be given in all examinations which will include the college assessment marks, and the total marks for each Theory/ Practical shall be converted into Grades as per above table. SGPA shall be calculated based on Grade Points corresponding to Grade as given in above table and the credits allotted to respective Theory / Practical shown in the scheme for respective semester.

b. SGPA shall be computed for every semester and CGPA shall be computed only in IV semester (for four semester degree) and VI semester (for sixth semester degree). The CGPA of IV / VI semester shall be calculated based on SGPA of all four semesters / six semesters as per following computation:

$$SGPA = \frac{C_1 \times G_1 + C_2 \times G_2 + \dots + C_n \times G_n}{C_1 + C_2 + \dots + C_n}$$

Where C1 = Credit of individual Theory / Practical G1 = Corresponding Grade Point obtained in the Respective Theory/ Practical

$$CGPA = \frac{(SGPA) I \times (Cr) I + (SGPA) II \times (Cr) II + (SGPA) III \times (Cr) III + (SGPA) IV \times (Cr) IV}{(Cr) I + (Cr) II + (Cr) III + (Cr) IV}$$

Where, (SGPA) I = SGPA of I Semester; (Cr) I = Total Credits for I Semester;
 (SGPA) II = SGPA of II Semester; (Cr) II = Total Credits for II Semester;
 (SGPA) III = SGPA of III Semester; (Cr) III = Total Credits for III Semester;
 (SGPA) IV = SGPA of IV Semester; (Cr) IV = Total Credits for IV Semester

APPENDIX –C
MASTER OF SCIENCE (BIOTECHNOLOGY)
TWO YEAR (FOUR SEMESTERS) DEGREE COURSE
PROJECT WORK
M. Sc. Part II, Sem IV
Project
EXPERIMENTAL PROJECT WORK

Credit: 4

Project Work Scheme / Guidelines for the Students, Supervisors and Examiners

Every student is required to carry out **Experimental / Field Based Project Work** (this is in lieu of practical II of semester IV) on a related research topic of the subject /course. It must be an original work and will be evaluated by the examiner on the strength of experimental Project work. On the basis of this work, student must submit the Project Report (typed and properly bound) in two copies at least one month prior to commencement of the final Practical/lab Examination of Semester IV. The project report shall comprise of Introduction, Material and Methods, Results, Discussion, Summary, Conclusions and, References along with the declaration by the candidate that the work is original and not submitted to any University or Organization for award of the degree and certificate by the supervisor and forwarded through Head/Course-coordinator/Director of the Department/Centre or the Principal of the College.

The supervisors for the Experimental Project Work shall be from the following.

A person, selected by the duly constituted Selection Committee of the university and approved by the University, exclusively for P.G. course in Life sciences.

OR

A person, selected by the duly constituted Selection Committee of the University, approved by the University and appointed as a full time regular teacher at U.G. level in the Life Sciences and having atleast 15 years teaching experience.

OR

A person, selected by duly constituted Selection Committee of R.T.M. Nagpur University, approved by the University and appointed as full time regular teacher at UG level having M. Phil degree with 10 years teaching experience at UG level, or a person who has Ph.D. Degree, with 5 years teaching experience in Life Sciences.

OR

Scientists of National Laboratories/ Regional Research Laboratories who are approved by dint of their appointments in such facilities by the Union Government / the State Government / Nagpur University / Other Universities recognized by UGC with at least in the Grade Pay of Rs.8000/-.

The topic for the project work will be assigned to the student by supervisor at the beginning of third semester. The topic will be forwarded to the controller of examination by the head of the department. The Project Work will carry total 100 marks and will be evaluated by both external and internal examiner in the respective Department / Center / Affiliated College. The examiner will evaluate the Experimental Project Work taking into account the 1) Coverage of subject matter, 2) Arrangement and presentation, 3) References and 4) Critical application and original experimental contribution of the candidate.

For written Project work : 80 Marks

For Viva-Voce : 20 Marks

 Total : 100 Marks

APPENDIX – D
MASTER OF SCIENCE (BIOTECHNOLOGY)
TWO YEAR (FOUR SEMESTERS) DEGREE COURSE
SEMINAR

Seminar Guidelines for Students, Supervisors and Examiners Any semester student will have to deliver seminar on any topic relevant to the syllabus with emphasis in the recent trends and develop in that field. The topic of the seminar will be decided at the beginning of the each semester in consultation with the supervisory teacher. Head of the Department will distribute the students among the faculty members. The student has to deliver the seminar which will be followed by discussion. The seminar will be open to all the teachers of the department, invitees and students. The students should submit the seminar report typed and properly bound in two copies to the head of the department. The said shall be evaluated by the concerned supervisor and head of the department. The average marks shall be considered for the final result. The marks of the seminar shall be forwarded to the university within due period through head of the Department. The record of the seminar should be preserved till the declaration of the final result.