



**Karmaveer Bhaurao Patil University, Satara**

**Syllabus for**  
**M. Sc. I (Biotechnology)**

**Under**  
**Faculty of Science and Technology**

**(As per NEP 2020)**

**With effect from Academic Year 2024-2025**

## Syllabus for Masters of Science Part I

**Title:** Biotechnology

**Year of Implementation:** The Syllabus will be implemented from June, 2024 onwards

**Preamble:** As per the NEP 2020 guidelines this updated syllabus is prepared for first year undergraduate students of Biotechnology. At this level, to develop their interest towards Biotechnology as applied science and also to prepare them for the academic and industrial exposure simultaneously. Introduction of life science subjects will help to form a basic foundation of concepts for students. The interdisciplinary approach with vigor and depth is compatible to the syllabi of other universities, at the same time is not rigid for the students at first year of their graduation. The units in the syllabus are well defined with scope and the number of lectures. The references are mentioned with relevance.

### Program Outcomes:

PO No.	PO Statement After completing the Master of Science in Biotechnology students will be able to -
PO -1	Graduate with proficiency in the biotechnology
PO -2	Eligible to continue higher studies in the subject.
PO -3	Eligible to peruse higher education in abroad
PO -4	Enable graduate to pursue research career in industry and academia
PO -5	Eligible for jobs in industry, research institutes, government sector, NGOs. Etc.
PO -6	Able to do advanced scientific research and entrepreneurship

### Program Specific Objectives :

1. The students are expected to understand the knowledge about core areas of biotechnology
2. The practical course is framed in relevance with theory courses to improve understanding of various concepts in biotechnology
3. The students are expected to acquire knowledge, critical thinking skill and experience in conducting cutting edge research
4. It is expected to instill the ability for research and entrepreneurship in the students along with strong ethics and communication skills
5. The students are expected to get equipped and motivated to pursue higher education and research in reputed institutes at national and international level in biotechnology.

## Program Specific Outcomes

PSO No.	PSO Statement
PSO -1	Learn, design and perform experiments in the labs to demonstrate the concepts, principles and theories learnt in the classroom
PSO -2	Develop the ability to apply the knowledge acquired in classroom and laboratories to specific problems in theoretical and experimental biotechnology
PSO -3	Empower the students to acquire technological knowledge by connecting disciplinary and interdisciplinary aspects of biotechnology
PSO -4	Identify the area of interest in the academic research and development
PSO -5	Perform job in various fields like food, pharmaceutical, agriculture, healthcare, public services and business etc.
PSO -6	Be an entrepreneur with precision, analytical mind, innovative thinking, and clarity of thought, expression and systematic approach

**Duration:** One Year Full time

**Pattern:** Semester wise

**Medium of Instruction:** English

**Structure of Course: M. Sc. I Semester I**

Level	Semester	Course Code	Name of the Course	No. of Hours per week	Credits
6	1	MBTT 411	Advances in Cell Biology	4	4
		MBTT 412	Advances in Molecular Biology	4	4
		MBTT 413	Advances in Biological Chemistry	4	4
		MBTT 414 E-I MBTT 414 E-II DSE (Elective any one among two)	Advances in Microbiology /  Clinical Research & Data management	2	2
		MBTT 415	Research Methodology	2	2
		MBTP 415	Research Methodology practicals	4	2
		MBTP 416	Lab I: Laboratory Exercises in Molecular Biology, and Cell Biology	4	2
		MBTP 417	Lab II: Laboratory Exercises in Biological Chemistry and Microbiology	4	2
		Total			

**Structure of Course: M. Sc. I Semester II**

Level	Semester	Course Code	Name of the Course	No. of Hours per week	Credits
6	2	MBTT 421	Genetics	4	4
		MBTT 422	Immunology and Virology	4	4
		MBTT 423	Plant Biotechnology	4	4
		MBTT 424 E-I MBTT 424 E-II DSE (Elective any one among two)	Food Biotechnology/ Animal Tissue Culture	2	2
		MBTP 425	Research Project	4	4
		MBTP 426	Lab III: Laboratory Exercises in Genetics, and Immunology	4	2
		MBTP 427	Lab IV: Laboratory Exercises in Plant Biotechnology and Food Biotechnology	4	2
Total					22

**Master of Science (M. Sc.) Part I**  
**Semester I**  
**MBTT 411: Advances in Cell Biology**

**Course Objectives:** The students should be able to...

1. Learn cell structure with respect to plant, animal and bacteria
2. Study transport of cell membrane
3. Understand cell division theory
4. Learn characteristic of normal and cancerous cell

Unit	Content	No. of hrs. per Unit
<b>I</b>	<b>Cell structure and cytoplasmic membrane system</b>	<b>15</b>
	Structure and functions of organelles (mitochondria, chloroplast, vacuoles, peroxisomes and lysosomes, nucleus and its components), Cell membrane – Plasma membrane types (animal, plant and bacterial) Cell cytoplasmic membrane system- structural and functional organization	
<b>II</b>	<b>Cellular Transport</b>	<b>15</b>
	Transport across plasma membrane and intra-cellular transport (vesicular and membrane transport) at molecular level, Ion channels and aquaporins. Structure of Plant Cell, Plant cell wall - primary and secondary, Plasmodesmata structure and function Plastids - biogenesis, structure and types, Transmembrane Transport, Voltage-Gated Ion Channels and the Propagation of Action Potentials in Nerve Cells	
<b>III</b>	<b>Cell signaling</b>	<b>15</b>
	Communication between cells and environment, Cytoskeleton- Structure- assembly and disassembly of cytoskeletal elements (microtubule, microfilament IF), role in cell division Extracellular matrix and cell junctions- relevance to tissue structure and function Signaling at cell surface, signaling molecules, hormones and receptors signaling pathways that control gene activity, signal transduction and secondary messengers Plant cell communication	
<b>IV</b>	<b>Cell differentiation</b>	<b>15</b>
	Cell Cycle and its regulation, Cell differentiation, Cell death, phenomenon of apoptosis, necrosis, cell transformation, Cell differentiation in plants and animals including terminal cell differentiation, Role of hormones and growth factors	

**Course Outcome:** After completion of syllabus, students will be able to...

1. Explain cell structure with respect to plant, animal and bacteria
2. Determine different types of transport systems across the plasma membrane
3. Discuss protein targeting and vesicular transport
4. Describe and differentiate cancerous and noncancerous cells

**Reference Books:**

1. Alberts B., Johnson A., Heald R., Morgan D., Raff M. (Author), Roberts K., Walter P. (2022)  
Molecular Biology of the Cell, 7th Edition WW Norton & Co

2. Dashek W. V. (2017) Plant Cell Biology - CRC Press
3. Pollard T. D., Earnshaw W. C., Schwartz J. L. (2016), Cell Biology 3<sup>rd</sup> Edition ELSEVIER
4. Stahl P.D., Bradshaw R. A. (2015), Encyclopedia of Cell Biology, Elsevier Science
5. Plopper G. (2014) Principles of Cell Biology 2<sup>nd</sup> Edition Jones & Bartlett Learning
6. Cooper G. M., Hausman R. E. (2013), The Cell: A Molecular Approach, 6<sup>th</sup> edition Sinauer Associates Inc
7. Lodish H., Berk A, Kaiser C., K. Reiger M., Bretscher A., Ploegh H., Angelika A. A., Matthew P. Scott M.P., W.H. Freeman and Co., (2012) Molecular Cell Biology. 7<sup>th</sup> Edition, W.H Freeman and Co. USA
8. Karp G. Cell Biology, 6th edition, (2010) John Wiley & Sons., USA
9. Wilson J. H. (2008) Molecular Biology of the Cell: Problems Book, Garland Science
10. Lewis, Raff M., Roberts K., Walter P. (2006) Molecular Biology of the Cell Garland Science, USA

**Master of Science (M. Sc.) Part I**  
**Semester I**  
**MBTT 412: Advances in Molecular Biology**

**Course Objectives:** The students should be able to...

- a. Learn various advance concepts of Genomic organization.
- b. Know role of DNA in a range of gene expression and regulation.
- c. Study protein synthesis process
- d. Understand molecular biology in relevance to Biotechnology.

Unit	Content	No. of hrs. per Unit
<b>I</b>	<b>Genome Structure and Organization</b>	<b>15</b>
	<p>Organization of prokaryotic and eukaryotic genomes, Structure of chromatin, nucleosome, chromatin organization and remodeling, DNA re-association kinetics (Cot curves), repetitive and unique sequences, DNA melting and buoyant density, C value paradox and genome size, satellite DNA,. Gene families, clusters, Pseudogenes, superfamilies, Organelle genomes</p> <p>Mobile DNA elements: Transposable elements in bacteria, IS elements, composite transposons, replicative and non-replicative transposons, Mu transposition, p-elements, Controlling elements in TnA and Tn 10 transposition. SINES and LINES, retrotransposons</p>	
<b>II</b>	<b>DNA damage and Repair</b>	<b>15</b>
	<p>Types of DNA damage, DNA repair mechanisms- nucleotide excision repair, base excision repair, mismatch repair, recombination repair, double strand break repair transcriptional coupled repair.</p> <p>Mutation: Nonsense, missense and point mutations, intragenic and intergenic suppression, frameshift mutations, physical, chemical and biological mutagens.</p> <p>Recombination: Homologous and site-specific recombination, models for homologous recombination- Holliday junction, NHEJ Proteins involved in recombination- RecA, RuvA, B, C, Gene conversion</p>	
<b>III</b>	<b>DNA Replication and Regulation</b>	<b>15</b>
	<p>DNA polymerases and mechanisms of DNA replication in prokaryotes and eukaryotes (initiation, elongation and termination, enzymes and accessory proteins involved in DNA replication), DNA replication models, connection of replication to cell cycle. Gene Expression and Regulation in Prokaryotes and Eukaryotes:</p> <p>Transcription: Basic mechanism in prokaryotes and eukaryotes, RNA Polymerases, pseudo-ORFs Chromatin remodeling in relation to gene expression, DNase hypersensitivity, DNA methylation. Regulation of transcription including transcription factors. Post-transcriptional processing and transport of RNA. Non coding RNAs, Organization and structure-function of ribonucleoproteins (Ribonome concept)</p>	
<b>IV</b>	<b>Protein Synthesis and Regulation</b>	<b>15</b>

	Components of protein synthesis, Genetic code, degeneracy of codons, wobble	
	hypothesis codon usage, Mechanism of protein synthesis (initiation, elongation and termination, Co- and post-translational Modifications), Regulation of protein synthesis, protein turnover and degradation.	

**Course Outcomes: After completion of syllabus, students will be able to...**

1. Explain advance concepts of Genomic organization
2. Describe fundamentals of Molecular Biology.
3. Elaborate concepts of DNA mutation, Gene expression, protein synthesis.
4. Explain process of synthesis of proteins

**Reference Books:**

1. Nadeem A., Hassan F., Javed M. (2021), Introduction to Molecular Genomics, Bentham Science Publishers
2. Craig N., Green R., Greider C., Cohen O. (2014) Molecular Biology Principles of Genome Function 2<sup>nd</sup> Edition, OUP Oxford
3. Lewin B. (2012), Genes XI, 11<sup>th</sup> edition, Publisher - Jones and Barlett Inc. USA
4. Weaver R (2011) Molecular Biology, 5th Edition, McGraw Hill Science. USA
5. Tropp B. E., Jones, Bartlett (2011), Molecular Biology: genes to proteins, 4th edition Learning, USA
6. Wilson K., Walker J. (2010) Principles and Techniques of Biochemistry and Molecular Biology 7<sup>th</sup> Edition Cambridge University Press
7. Pal J.K. and Ghaskadbi S., (2009), Fundamentals of Molecular Biology, Oxford University Press
8. Watson J. D., Baker T., Bell S. P., Gann A., Levine M., Lodwick R. (2008) Molecular Biology of the Gene, 6th Edition,. Pearson Education, Inc. and Dorling Kindersley Publishing, Inc. USA
9. Twyman R. M., W. Wisden (1998) Advanced Molecular Biology: A Concise Reference BIOS Scientific
10. Brown T A (1995) A practical approach, Essential molecular biology, vol. I, IRL press, Oxford.



**Master of Science (M. Sc.) Part I**  
**Semester I**  
**MBTT 413: Advances in Biological Chemistry**

**Course Objectives:** The students should be able to...

1. Learn basic concepts of protein biochemistry.
2. Acquire the knowledge about enzymes their structure, function and kinetics.
3. Know vitamins and their role as coenzymes.
4. Understand the role of enzymes in industry and diagnostics

Unit	SEMESTER I MBTT 413: Advances in Biological Chemistry	No. of hrs. per Unit
I	<b>Protein Biochemistry</b>	15
	Biomolecules of life, Structure of Proteins (Primary, Secondary, Tertiary quaternary), Protein folding mechanisms - Molten globule, energy funnel, chaperon, Protein misfolding and misfolding diseases, Protein Processing- Proteolytic cleavage (Pre, Pro, removal), Protein Modifications – Glycosylation, Phosphorylation, Lipids attachment, Glycolipids, Protein degradation – Lysosomal & proteosomal ubiquitination.	
II	<b>Enzymes &amp; coenzymes</b>	15
	IUB system, rationale, overview and specific example, Concept of prosthetic group, apoenzyme, holoenzyme, Coenzymes: Vitamins as coenzymes: sources, requirements, functions and deficiency symptoms of water soluble vitamins. Structure and biochemical role, Cofactors: Role of trace elements, their bound forms in biological systems and in enzyme structure and function.	
III	<b>Enzymology</b>	15
	Characteristics of enzymes, enzyme substrate complex. Concept of active center, binding sites, stereospecificity and ES complex formation. Enzyme kinetics, Michaelis Menten equation, Effect of temperature, pH and substrate concentration on reaction rate. Activation energy. Transition state theory. Enzyme activity, international units, specific activity, turnover number, factors affecting catalytic efficiency - proximity and orientation effects, distortion or strain, acid - base and nucleophilic catalysis.  Chemical modification of enzymes. Isoenzymes and multiple forms of enzymes.	
IV	<b>Purification &amp; Immobilization of enzymes</b>	15
	<b>Purification-</b> salting out-salting in, Ammonium sulfate precipitation, Dialysis, Gel filtration, IEC, Affinity chromatography, Isoelectrofocussing, Sangers method-Protein sequencing.  <b>Immobilization:</b> Practical and economic advantage of immobilization of enzymes for industrial use, effect of partition on kinetics and performance with emphasis on amino acid charge and hydrophobicity (pH, temperature and Km). Various methods of immobilization of enzymes - ionic bonding, adsorption, covalent bonding (based on R- groups of amino acids), encapsulation and gel entrapment. Immobilized multienzyme complex systems.  <b>Biosensors in diagnosis of diseases-</b> glucose oxidase, cholesterol oxidase, urease and antibodies as biosensors.	

**Course Outcomes: After completion of syllabus, students will be able to...**

1. Correlate functional relationship of proteins & misfolding diseases.
2. Determine structure function relations of enzymes and coenzymes
3. Perform applications of Immobilization of enzymes in industries.
4. Apply gained knowledge in clinical disease diagnosis

**Reference Books:**

1. Berg J., Stryer L., (2012), Principles of Biochemistry, 7th Edition. New York: W.H. Freeman and company
2. Nicholas C. P. (2009) *Fundamentals of Enzymology: Cell and Molecular Biology of Catalytic Proteins*, Oxford University Press
3. Conn E. & Stumpf P., (2009), *Practical Biochemistry*, 5<sup>th</sup> Edition, USA: John Wiley and Sons
4. Voet D. & Voet J., (2008) *Fundamentals of Biochemistry*, 3rd edition. USA: John Wiley and Sons Inc.,
5. Nelson D. & Cox M. (2008) Lehninger, *Principles of Biochemistry*. 5<sup>th</sup> edition. New York:, W.H. Freeman and company,
6. Satyanarayanan, U. and Chakrapani, U., (2007) *Biochemistry*, 3<sup>rd</sup> edition India: Uppala Author Publisher Interlinks,
7. Reymond, J. L. (2005) Enzyme Assays and Enzyme Profiling: High Throughput Screening, Genetic Selection and Fingerprinting; Wiley VCH
8. Walsch G., (2001). *Proteins: Biotechnology and Biochemistry*, 2<sup>nd</sup> edition, USA: Wiley-Blackwell,
9. Plummer D., (2001). *An Introduction to Practical Biochemistry*, 3<sup>rd</sup> Edition, India: Tata McGraw Hill Edu. Pvt .Ltd.
10. Nicholas C. P. and Stevens L. (2000) *Fundamentals of Enzymology, The Cell and Molecular Biology of Catalytic Proteins*, New York : Oxford University Press

**Master of Science (M. Sc.) Part I**  
**Semester I**  
**MBTT 414 E I: Advances in Microbiology**

**Course Objectives:** The students should be able to...

1. Know micro organisms' cell structure, morphology, taxonomic significance
2. Understand industrial importance of microorganisms, growth kinetics
3. Study staining and sterilization methods
4. Learn bacterial pathogenesis, antimicrobial agents

Unit	Content	No. of hrs. per Unit
<b>I</b>	<b>Molecular basis of Binary Fission</b>	<b>8</b>
	Overview with emphasis on: Genetic mechanism determining bacterial shapes, Cell wall and Cell membrane (Archaeobacterial), Protoplast, Spheroplast, L forms Mycoplasma (taxonomic significance)	
<b>II</b>	<b>Microbial growth kinetics</b>	<b>7</b>
	Measurement of microbial growth, The influence of environmental factors in growth, Synchronous growth, Continuous growth Extremophiles their molecular adaptations and significance.	
<b>III</b>	<b>Bacterial pathogenesis</b>	<b>7</b>
	Pathogenicity Islands – Concept with example Molecular and immunological methods for disease diagnosis, Molecular mechanism of pathogenesis of <i>Mycobacterium tuberculosis</i>	
<b>IV</b>	<b>Antibiotics and drug resistance</b>	<b>8</b>
	Types of antimicrobial agents Classes of antibiotics (tetracyclins, aminoglycosides, macrolids, Polypeptides antibiotics & their mode of action) antiprotozoan antibiotics, Mechanisms of development of drug resistance of Methicillin resistant <i>Staphylococcus aureus</i> (MRSA) Plasmid curing a possible approach for overcoming drug resistance.	

**Course Outcomes: After completion of syllabus, students will be able to...**

1. Explain binary fission, bacterial cell structure, endospore formation
2. Identify metabolic diversity, quorum sensing and biofilm formation
3. Classify microorganisms according to Microbial nutrition
4. Perform types of staining

**Reference Books:**

1. Madigan MT, Martinko J. M. (2006). Brock's Biology of Microorganisms. 11th Edition, Pearson Education Inc. , USA
2. L. M., Harley J.P., and Klein D.A. (2005). Microbiology Prescott,, 6<sup>th</sup> Edition. MacGraw Hill Companies Inc.

3. Ananthnarayana, R. and C.E, Panakar J., (1996), Text book of microbiology 5th edition Orient Longman.
4. Tortora, G.J., Funke B.R., Case C.L, Benjamin, (1992), Microbiology: An introduction, 5th edition Pub.Co. NY
5. Davis B.D., DeBacco, J. B. (1990), Microbiology, 4th edition Lippincott Co. NY, Zinsser,
6. W. K Joklik, 1976, Microbiology 2nd Edition, Zinsser, NY
7. Dey, N.C and Dey, TK., (1988), Medical Bacteriology, 14th edition, Allied Agency, India
8. Stanier R.Y., Adelberg E.A. and Ingraham, J. L (1987), General Microbiology, 5th edition Macmillan Press Ltd.
9. Salle AJ. Tata MacGraw Thomson Brooks / Cole. (1971)Fundamental Principles of Bacteriology. 7th Edition, Tata MacGraw Hill Publishing Co.
10. Ingraham J.L. and Ingraham C.A. (1999) Introduction to Microbiology. 3rd Edition, S. Chand (G/L) & Company Ltd

**Master of Science (M. Sc.) Part I**  
**Semester I**  
**MBTT 414 E II: Clinical Research & Data Management**

**Course Objectives:** The students should be able to...

1. Understand the principles involved in the ethical issues in clinical human subjects research,
2. Know legal, and regulatory issues in clinical human subjects research,
3. Familiar with the basic biostatistical methods involved in conducting clinical research
4. Know the epidemiologic methods involved in conducting clinical research

Unit	Content	No. of hrs. per Unit
<b>I</b>	<b>Introduction to Clinical Research</b>	<b>7</b>
	<b>Brief History of Clinical Research:</b> Sulphanilamide Tragedy, Thalidomide Disaster, Nazi Experiments, Tuskegee Study, Belmont report, Nuremberg code Declaration of Helsinki.  <b>Clinical Pharmacology:</b> Pharmacokinetics, Pharmacodynamics, Pharmacoepidemiology, Bioavailability. Bioequivalence.	
<b>II</b>	<b>Guidelines and process for Drug Development</b>	<b>8</b>
	<b>Drug Development Process:</b> Preclinical trial, Human Pharmacology (Phase-I) Therapeutic Exploratory trail (Phase-II), Therapeutic Confirmatory Trial (Phase-III) and Post marketing surveillance (Phase-IV).  <b>Guidelines in Clinical Research-</b> International Conference on Harmonization (ICH), Guidelines for Good Clinical Practice, ICMR guidelines for Biomedical Research on Human Subjects.	
<b>III</b>	<b>Regulation in Clinical Research</b>	<b>8</b>
	<b>Regulation in Clinical Research-</b> Drug and cosmetic act, FDA, Schedule-Y- Ethics Committee and their responsibilities.  <b>Clinical Research Regulatory Submission &amp; approval Process-</b> IND, NDA and ANDA submission Procedure. DCGI submission procedure. Other Regulatory authorities- EMEA, MHRA, PhRMA.	
<b>IV</b>	<b>Ethics in Clinical Research</b>	<b>7</b>
	<b>Clinical Research Operation, Monitoring and Clinical Evaluation:</b> Protocol in Clinical Research, Informed Consent, Case Report Form, Investigator's Brochure (IB), Inclusion and exclusion criteria, Randomization, Blinding, Ethics and Regulatory submission.	

**Course outcomes:** After completion of syllabus, students will be able to...

- 1) Explain principles involved in the ethical, legal, and regulatory issues in clinical human subject's research, including the role of IRB
- 2) Determine steps involved in developing and funding research studies.
- 3) Gained knowledge about clinical disease diagnosis and drug development process.
- 4) Discuss the importance of good clinical practice and ICMR guidelines.

**Reference Books:**

1. Kubben P., Dumontier M., Dekker A., (2018) Fundamentals of Clinical Data Science, Springer International Publishing
2. Elsley M. (2017), A Guide to GCP for Clinical Data Management , Canary Publications
3. Friedman L. M., Furberg C. D., DeMets D. L., (2015) Fundamentals of Clinical Trials, Springer; Kindle Edition 5<sup>th</sup> edition
4. Dr. Hulley S.B, Cummings S. R. (2013), Designing Clinical Research
5. Ognibene F. P, Gallin J. I. (2011) Principles and Practice of Clinical Research 2<sup>nd</sup> Edition Elsevier Science
6. National Research Council (U.S.). Panel on Handling Missing Data in Clinical Trials, Committee on National Statistics, (2010) The Prevention and Treatment of Missing Data in Clinical Trials National Academies Press
7. Machin D., Day S., Green S. (2007) Textbook of Clinical Trials Wiley
8. Gupta S. K. ( 2007) Basic Principles of Clinical Research and Methodology JPB; Editor First Edition
9. Giovanna I. D., Hayes G., (2001) Principles of Clinical Research Wrightson Biomedical Pub
10. Rondel R. K., VarleyS. A., Webb C. F., (2000), Clinical Data Management 2<sup>nd</sup> Edition, Wiley

## Master of Science (M. Sc.) Part I

### Semester I

#### MBTT 415: Research Methodology

**Course Objectives:** The students should be able to...

1. Know the basics of research
2. Understand the philosophy behind the research
3. Understand how define research problem
4. Learn tools required while doing research.

Unit	SEMESTER I MBTT 415 : Research Methodology	No. of hrs. per Unit
I	<b>Introduction of Research</b>	07
	Introduction: Meaning of Research, Objectives of Research, Types of Research, Research Approaches, Significance of Research, Research Methodology, Research and Scientific Method Defining the Research Problem: What is a Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem.	
II	<b>Scientific Writing</b>	08
	Definition and kinds of scientific documents – research paper, review paper, book reviews, theses, conference and project reports (for the scientific community and for funding agencies). Components of a research paper – the IMRAD system, title, authors and addresses, abstract, acknowledgements, references, tables and illustrations. Dealing with publishers – submission of manuscript, ordering reprints. Oral and poster presentation of research papers in conferences/symposia.	
III	<b>Ethics in Biological science research</b>	08
	Originality, Integrity, Intellectual Property Rights, Patents and Plagiarism in research. Ethical issues and bio-safety regulation: DBT Guidelines for Bio-safety, Institutional Bio-safety committee and its functioning. Ethics in use of Experimental animals: Institutional Animal ethics committee, and Institutional ethical committee, CCSEA and CPCEA guidelines for animal experimentation, ICMR guidelines for experiments involving humans. Biodiversity laws: Guidelines and regulations of Bioresources utilization for commercial and research purpose. The Biological Diversity Act, Wildlife (Protection) Act, Forest (Conservation) Conservation Act.	
IV	<b>Biostatistics in research</b>	07
	Processing of data: Classification and tabulation. Data Analysis: Descriptive- Central measures (mean, medium, mode) Dispersion measures (range, standard deviation), probability co- relation and regression, Binomial position and normal distribution, parametric and non parametric tests t- test, chi-square test, ANOVA. Introduction to computer programs used for biostatistics: MS-Excel, SPSS STATISTICA, PRIMER etc.	

**Course Outcomes: After completion of syllabus, students will be able to...**

1. Discuss the philosophy behind the research
2. Define research problems
3. Discuss the importance of knowing how research is done.
4. Use different tools required while doing research.

**Reference Books:**

1. Tan W. (2017) Research Methods A Practical Guide for Students and Researchers World Scientific
2. Devi P. S. (2017) Research Methodology: A Handbook for Beginners Notion Press
3. Goyal R. C. (2010) Research Methodology for Health Profession, Jaypee Brothers Medical Publishers Pvt. Limited
4. Gupta B. N., Gupta N. (2022) Research Methodology - SBPD Publications
5. Kothari C. R. (2009) "Research Methodology: Methods & Techniques" (Second Revised Edition), New Age International Publishers, New Delhi.
6. Mathur U. C., (2007) Product and Brand Management, Narainaphase I, New Delhi,
7. Mishra S. B., Dr. Alok S. (2017) Handbook of Research Methodology A Compendium for Scholars & Researchers Educreation Publishing
8. Sinha S. C. and Dhiman A. K., (2002) Research Methodology Ess Publications 2 Columes.
9. Trochim W. M. K., (2005) Research Methods: The Concise Knowledge Base Atomic Dog Publishing. 270P Garg, B. L.Karadia R. Agrawal, F. and Agrawal U. K., 2002. An Introduction to Research Methodology, RBSA Publishers
10. Wadehra B. L., (2000) Law Relating to Patents, Trade Marks, Copyright Design and Geographical Indications, Universal Law Publishing.



**Master of Science (M. Sc.) Part I**  
**Semester I**  
**MBTP 415 : Research Methodology Practicals**

**Course Objectives:** The students should be able to...

- 1) become aware writing mini research article
- 2) gain the knowledge about the t-test analysis
- 3) know the One way and Two way Anova for significance analysis
- 4) get the knowledge about writing research article

Sr. No.	Content	No. of hours per unit (60)
1.	Designing a Basic Experimental Layout	3
2.	Framing a Research Problem and Hypothesis	3
3.	Literature Review and Problem Selection	3
4.	Understanding Biodiversity and Bioresource Utilization Laws	3
5.	Review of Institutional Biosafety Guidelines (IBSC)	3
6.	Writing a Mini Research Article Using IMRAD Format	3
7.	Intellectual Property Rights and Patent Search Exercise	3
8.	Creating Scientific Tables and Figures	3
9.	Preparing a Poster Presentation for a Scientific Study	3
10.	Referencing and Citation Management Using Zotero/Mendeley	3
11.	Case Study on Research Misconduct and Plagiarism	3
12.	Preparing an Abstract from a Full Research Paper	3
13.	Study of design research proposal	3
14.	Identification of Sampling and Experimental Units	3
15.	Data Entry and Tabulation Using MS Excel	3
16.	Descriptive Statistical Analysis (Mean, Median, SD)	3
17.	Study of Statistical Analysis using Chi-square/ t-Test	3
18.	Study of Statistical Analysis using ANOVA.	3
19.	Data Visualization: Creating Graphs and Plots	3
20.	Statistical Analysis of a Biotechnology Dataset	3

**Course outcomes:** After completion of syllabus, students will be able to...

1. apply the knowledge for writing research article
2. prepare and publish the research article in journal
3. prepare a poster for presentation
4. apply statistical analysis tools like mean, mode & median

**Reference Book:**

1. Devi P. S. (2017) Research Methodology: A Handbook for Beginners Notion Press
2. Goyal R. C. (2010) Research Methodology for Health Profession, Jaypee Brothers Medical Publishers Pvt. Limited
3. Gupta B. N., Gupta N. (2022) Research Methodology - SBPD Publications
4. Kothari C. R. (2009) "Research Methodology: Methods & Techniques" (Second Revised Edition), New Age International Publishers, New Delhi.

5. Mathur U. C., (2007) Product and Brand Management, Narainaphase I, New Delhi,
6. Mishra S. B., Dr. Alok S. (2017) Handbook of Research Methodology A Compendium for Scholars & Researchers Educreation Publishing
7. Sinha S. C. and Dhiman A. K., (2002) Research Methodology Ess Publications 2 Columes.
8. Trochim W. M. K., (2005) Research Methods: The Concise Knowledge Base Atomic Dog Publishing. 270P Garg, B. L.Karadia R. Agrawal, F. and Agrawal U. K., 2002. An Introduction to Research Methodology, RBSA Publishers
9. Wadehra B. L., (2000) Law Relating to Patents, Trade Marks, Copyright Design and Geographical Indications, Universal Law Publishing.
10. Mathur U. C., (2007) Product and Brand Management, Narainaphase I, New Delhi,

## Master of Science (M. Sc.) Part I

### Semester I

**MBTP 416: Practical** Based on MBTT 411, 412 courses

**Course Objectives:** The students should be able to...

- 5) Become aware of basic techniques in Molecular biology
- 6) Gain hands on skill for handling of genetic material
- 7) Perform skill of measuring the microscopic objects
- 8) Get the practical skills of protein extraction, purification and characterization

Sr. No.	Content	No. of hours per unit (60)
1.	Effect of organic solvents, temperature on membrane permeability.	3
2.	To isolate chloroplasts from plant cells	3
3.	To perform Micrometry: determination of different cell sizes: bacterial	3
4.	To perform Micrometry: determination of different cell sizes: Fungal	3
5.	To perform Micrometry: determination of different cell sizes: Animal Cell	3
6.	To perform Micrometry: determination of different cell sizes: plant cell	3
7.	To isolate mitochondria from plant cells	3
8.	Estimation of amount of chlorophyll present in the leaf tissue	3
9.	Isolation of nuclei from plant cell.	3
10.	Study of Mitosis.	3
11.	Lab safety in molecular biology laboratory	3
12.	Preparation of chemicals, buffers for molecular biology	3
13.	To isolate Eukaryotic DNA from - Plant Material	3
14.	To isolate Eukaryotic DNA from - Animal tissue	3
15.	To isolate Eukaryotic DNA from - Blood sample	3
16.	To isolate bacterial genomic DNA	3
17.	To isolate Plasmid from <i>E.coli</i> .	3
18.	To isolate RNA from plant	3
19.	To isolate RNA from animal	3
20.	To perform Restriction digestion of DNA /Plasmid	3

**Course outcomes: After completion of syllabus, students will be able to...**

1. Apply advanced techniques in molecular biology
2. Perform skillful handling of genetic material
3. Perform isolation of cell organelles
4. Apply advanced techniques in determination of cell size

### Reference Books:

1. Loose; (2014) Molecular Biology of the Cell 6th edition Leaf Garland Science
2. Loddish W H Freeman; (2016) Molecular Cell Biology 8th edition
3. Lewin's Genes XII, (2017) 12th edition Jones and Bartlett Publishers, Inc;
4. Karp G. (2013) Cell biology – Seventh edition Wiley;
5. Weaver R. (2011) Molecular Biology, 5th Edition, McGraw Hill Science. USA
6. Tropp B. E., Jones & Bartlett (2011), Molecular Biology: genes to proteins, 4th

edition Learning, USA

7. Wilson K., Walker J. (2010) Principles and Techniques of Biochemistry and Molecular Biology 7<sup>th</sup> Edition Cambridge University Press
8. Twyman R. M., W. Wisden (1998) Advanced Molecular Biology: A Concise Reference BIOS Scientific
9. Brown T A (1995) A practical approach, Essential molecular biology, vol. I, IRL press, Oxford.
10. Lanza R., Atala A., [2013], Essentials of stem cell biology, 3<sup>rd</sup> Edition, Academic press

### **Master of Science (M. Sc.) Part I**

#### **Semester I**

#### **MBTP 417 Practical**

**(Based on MBTT 413 and 414 courses)**

**Course Objectives:** The students should be able to...

- 1) Become aware of basic techniques in biological chemistry
- 2) Gain hands on skill for handling of chromatography techniques
- 3) Perform skill of measuring the microscopic objects
- 4) Get the practical skills of protein extraction, purification and characterization

<b>Sr. No.</b>	<b>Content</b>	<b>No. of hours per unit (60)</b>
1.	To perform Ammonium sulfate precipitation of proteins/ enzymes & dialysis	3
2.	To perform Separation of proteins - Gel filtration chromatography	3
3.	To perform Separation of proteins – Ion exchange chromatography	3
4.	To perform Separation of proteins - Affinity chromatography	3
5.	To perform Quantification and spectral analysis at each step of purification	3
6.	To perform enzyme activity of amylase	3
7.	To perform purification and dialysis of amylase	3
8.	Quantitative estimation of protein.	3
9.	Quantitative estimation of carbohydrate	3
10.	Isolation of starch from potatoes/ Isolation of casein from mil	3
<b>Practicals Based on Elective I</b>		
1.	Isolation & maintenance of organism by plating, streaking & serial dilution isolation methods slants & stab culture, storage of microorganisms	3
2.	Isolation, identification of following organisms by morphology, cultural characteristics and biochemical tests: Staphylococcus spp.(for identification use of keys as well as Bergey's Manual is recommended)	3
3.	Effect of environmental parameters on bacterial growth curve and generation time	3
4.	Effect of Environmental Factors on Growth of Bacteria: Salt, Temp, pH.	3
5.	Enrichment and Isolation of: Halophiles	3
6.	Enrichment and Isolation of Psychrophiles	3
7.	Enrichment and Isolation of Antibiotic Producers	3
8.	Effect of Antibiotics on various Gram Positive and Gram Negative bacteria	3
9.	Determination of Minimum Inhibitory Concentration (MIC) and Minimum Bactericidal	3
10.	Concentration (MBC) of various Antibiotics on different Organisms	3

	<b>Practicals Based on Elective II</b>	
1.	Ethical consent form preparation	3
2.	Analysis of demographic parameters from data	3
3.	Design the clinical study for new drug development	3
4.	Data management plan (DMP) development	3
5.	Designing of data Collection Strategy	3
6.	Data collection from the area	3
7.	Assessment of clinical data quality	3
8.	Analysis of clinical data	3
9.	Study the process of Data Transfer	3
10.	Case report form development	3

**Course outcomes: After completion of syllabus, students will be able to...**

1. Apply advanced techniques in biochemistry
2. Perform skillful handling of chromatography techniques
3. Perform measuring the microscopic objects
4. Demonstrate techniques in isolation of different kinds of microorganisms or discuss the clinical data and collection strategy.

**Reference Books:**

1. Sadashivam and Manikam, (2000) Handbook of biochemistry, Springer
2. Plummer D., (2001). *An Introduction to Practical Biochemistry*, 3rd Edition, India: Tata McGraw Hill Edu.Pvt.Ltd.,
3. Jayaraman J., ( 2011) Laboratory Manual In Biochemistry, New Age International Private Limited
4. Wilson K., Walker J. (2010) Principles and Techniques of Biochemistry and Molecular Biology 7<sup>th</sup> Edition Cambridge University Press
5. L. M., Harley J.P., and Klein D.A. (2005). Microbiology Prescott,, 6<sup>th</sup> Edition. MacGraw Hill Companies Inc.
6. Ananthnarayana, R. and C.E, Panakar J., (1996), Text book of microbiology 5th edition Orient Longman.
7. Tortora, G.J., Funke B.R., Case C.L, Benjamin, (1992), Microbiology: An introduction, 5th edition Pub.Co. NY
8. Davis B.D., DeBacco, J. B. (1990), Microbiology, 4th edition Lippincott Co. NY, Zinsser,
9. W. K Joklik, 1976, Microbiology 2nd Edition, Zinsser, NY
10. Dey, N.C and Dey, TK., (1988), Medical Bacteriology, 14th edition, Allied Agency, India
11. Stanier R.Y., Adelberg E.A. and Ingraham, J. L (1987), General Microbiology, 5th edition Macmillan Press Ltd.

## Master of Science (M. Sc.) Part I

### Semester II

#### MBTT 421: Genetics

**Course Objectives:** The students should be able to ...

1. Understand the basics of genetics.
2. Learn principles of Mendelian and Microbial genetics.
3. Know the concept of cytogenetics, human and population genetics.
4. Study the effect of environment on genetics.

Unit	SEMESTER-II MBTT 421: Genetics	No. of hrs. per Units
<b>I</b>	<b>Mendelian genetics</b>	<b>15</b>
	Mendelian principles: Dominance, segregation, independent assortment. Concept of gene: Allele, multiple alleles, pseudoallele, complementation tests. Extensions of Mendelian principles: Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy. Extra chromosomal inheritance: Inheritance of Mitochondrial and chloroplast genes, maternal inheritance.	
<b>II</b>	<b>Cytogenetics</b>	<b>15</b>
	Linkage and crossing over: Linkage – Definition, coupling and repulsion hypothesis, linkage groups. Crossing over- Mechanism and theory. Gene mapping methods : Linkage maps, tetrad analysis, mapping with molecular markers. Chromosomal Aberrations and Syndromes: Changes in chromosomal number: Euploidy, Aneuploidy. Polyploidy, Mosaics, Trisomy and Monosomy. Changes in chromosomal structure: Translocation, inversion, deletion and duplication. Autosomal and sex linked disorders. Abnormal karyotype and its implications. Chromosome abnormalities in cancer.	
<b>III</b>	<b>Human and population genetics</b>	<b>15</b>
	Pedigree Analysis in Humans: Symbols, construction of pedigree, molecular genetic data, significance of pedigrees. Karyotyping: Classical karyotyping (banding techniques). Molecular karyotyping (FISH, M-FISH, SKY, QF-PCR and mBAND). Various karyotyping symbols used in human genetics. Quantitative genetics: Human Population and gene pool concepts, modes of speciation, genotype and allele frequencies, variation. Hardy Weinberg's Law genetic equilibrium. inheritance, heritability and its measurements, QTL mapping.	
<b>IV</b>	<b>Microbial genetics and Environment</b>	<b>15</b>
	Microbial genetics: Methods of genetic transfers – transformation, conjugation transduction and sex-duction. Recombination: Homologous and non-homologous recombination including transposition.  <b>Environment and the Genome:</b> (a) Imprinting and Epigenetics (b) Genetics of Cancer (Oncogenes and tumor suppressor genes) (c) Genetics of Ageing.	

**Course outcomes:** After completion of syllabus, students will be able to...

1. Describe cytogenetics with linkage, crossing over and chromosomal aberration.
2. Explain concepts of human and population genetics
3. Analyse pedigrees

4. Discuss the basics of microbial genetics

**Reference Books:**

- 1) Strickberger M W, (2006) Genetics, Prentice Hall-India,
- 2) Gardner, Simmons M.J., Snustad D.P. (2006) Principles of genetics, 8<sup>th</sup> edition. Wiley
- 3) Hartl DL, Jones EW, (2004) Genetics: analysis of genes and genomes, Jones and Bartlett, Massachusetts
- 4) Pasternak, (2000) An Introduction to Molecular Human Genetics, Fritzgerald,
- 5) Gersen & Keagle, (1999) The Principles of Clinical Cytogenetics, Humana,
- 6) Strachan & Read, Human (1999) Molecular Genetics, Wiley,
- 7) David F. & Maloy S., John Cr onan (1994). Microbial Genetics, Jones and Bartlett Publishers, 2<sup>nd</sup> edition.
- 8) Stanier R. Y., Ingraham J. L., Mark, Wheelis L. , Rage R. (1992). General Microbiology, 5th Edition, Mcmillan publications
- 9) Gupta P. K. (1990). Genetics -A Text-book for University students, II<sup>nd</sup> edition, Rastogi publications,
- 10) Sarin C., (1985). Genetics ,Tata McGraw-Hill Publications,

**Master of Science (M. Sc.) Part I****Semester II****MBTT 422: Immunology and Virology**

**Course Objectives:** The students should be able to...

1. Learn Human Immune system.
2. Understand transplantation technology to cure diseases.
3. Know experimental model organisms for research.
4. Understand properties of viruses.

Unit	SEMESTER-II MBTT 422: Immunology and Virology	No. of hrs. per Unit
<b>I</b>	<b>Immunology</b>	<b>15</b>
	Fundamentals and anatomy of immune system, Immunity – Innate and acquired immunity. Components of innate and acquired immunity. Antigen, Haptens, adjuvants, mitogens. Antibodies – structure, functions. Regulation of immune response – Humoral and Cell mediated response. Immunity to infection, Antigen processing and presentation, MHC, complement system.  Vaccines – Active and passive immunization, DNA vaccines, multivalent subunit vaccines, synthetic peptide vaccines	
<b>II</b>	<b>Clinical Immunology</b>	<b>15</b>
	<b>Hypersensitivity:</b> Type I, II, III, and IV reactions.  Autoimmunity – organ specific and systemic autoimmune diseases, Treatment of autoimmune diseases, molecular mimicry, autoimmune therapy  Monoclonal antibodies – Hybridoma technology and various cellular technologies.  <b>Transplant immunology:</b> Classification of Grafts, Immunological basis of acceptance of autografts and rejection of allograft, Acute, Hyper-acute and Chronic rejections of transplant, Xenotransplantation and its clinical future. GVHD and Immunosuppressive therapy  <b>Animal Models:</b> Nude mouse, SCID mouse, NOD mouse, Obese-strain chicken, NZB and NZW mice Knock – out mouse etc. Animal models for autoimmunity and their use in immunological studies	
<b>III</b>	<b>Introduction to viruses</b>	<b>15</b>
	Introduction to viruses: General properties of viruses, Morphology and ultrastructure of Viruses Classification of viruses: ICTV system, Baltimore system  Replication of viruses: DNA (ds) - Poxvirus , RNA( ss+ve)- Poliovirus, RNA (ss - ve ) – Influenza virus and RNA with RT- HIV  Viral Diagnosis: Microscopy, Cultivation, Serological and Molecular methods, Infectivity assays, immunodiagnostics  Antiviral : Mode of Action of various antiviral drugs with examples and Viral Vaccines	
<b>IV</b>	<b>Epidemiology</b>	<b>15</b>
	Principles and related terminologies, Current National and Global epidemiology	



	of viral infections (with suitable examples) Oncogenic virus and Cancer Immunology, Immunotherapy, Immunodeficiency (Primary and secondary) Emerging viral diseases: Re-emerging and New emerging viral diseases with example. (H1N1, SARS, Nipah , Marburg , Hendra virus , Ebola , H5N1, Dengue yellow fever, West Nile Zika virus etc.) Animal and Poultry viruses: Clinical symptoms with examples (FMD, Rinderpest Virus, Avian Influenza, Newcastle Disease etc.), Prevention. Plant viruses: Mode of transmission and Prevention. Replication and Symptoms of TMV. Concept of Biosafety Level and Microbial Containment	
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**Course Outcomes: After completion of syllabus, students will be able to...**

1. Discuss antigen antibody reactions.
2. Describe techniques used in clinical transplantation.
3. Identify autoimmunity and strategies for treating autoimmune diseases.
4. Describe different types of viruses

**Reference Books:**

1. S. Jane Flint, Vincent R. Racaniello, Glenn F. Rall · 2015 Principles of Virology 4<sup>th</sup> Edition Wiley.
2. Gangal S. and Sontakke S. (2013), Textbook of basic and clinical immunology, 1<sup>st</sup> edition, University Press, India.
3. Kubly Immunology, Owen J., Punt J., Stranford S., 7<sup>th</sup> edition (2012), Freeman and Co.
4. Reddy S. M., Reddy R., Reddy S.M. 2012 Essentials of Virology Scientific Publishers JOU.
5. Roitt D. R. and Mosby, USA. Roitt's Essential Immunology (2011), 12<sup>th</sup> edition, Wiley and Black Well.
6. F.H. Khan (2009), The Elements of Immunology. Pearson Education.
7. David M., Brostoff J. (2006) Immunology, 7<sup>th</sup> edition
8. Fields B. N. (2006) Field's Virology - 2 volumes, 5<sup>th</sup> edition, , Lippincott and Williams Wilkins, USA
9. Flint J. S., ASM (American Society of Microbiology) (1999), Principles of Virology, 3<sup>rd</sup> edition Press Publisher, 2 volumes, USA.
10. S. N. J. Korsman, G. V. Zyl, Preiser W., Nutt L., Andersson M. I. 2012 Virology E-Book An Illustrated Colour Text Elsevier Health Sciences

**Master of Science (M. Sc.) Part I**  
**Semester II**

**MBTT 423: Plant Biotechnology**

**Course Objectives:** The students should be able to...

1. Understand economic importance and cultivation of algae and mushroom.
2. Know transgenic methods to improve plant productivity.
3. Learn importance of secondary metabolites in plants.
4. Know molecular approaches used for plant breeding and trait selection.

Unit	SEMESTER-II MBTT 423 : Plant Biotechnology	No. of hrs. per Unit
<b>I</b>	<b>Algal and Fungal Biotechnology</b>	<b>15</b>
	<p><b>Algal Biotechnology</b>-Study of economically important algae like <i>Spirulina</i>, <i>Dunaliella</i>, <i>Chlorella</i>, seaweeds and their cultivation, Applications- Single Cell Proteins, Biofuels, Pigments and phycocolloids, Algal Transgenics</p> <p><b>Fungal Biotechnology</b>-Study of economically important Mushrooms (<i>Agaricus</i>, <i>Pleurotus</i>, <i>Lentinus</i>), Commercial cultivation of Mushrooms</p>	
<b>II</b>	<b>Secondary metabolites in plants</b>	<b>15</b>
	Introduction and concept: Phytochemicals- Glycosides and Flavonoids, Anthocyanins and Coumarins, Lignans, Terpenes, Volatile oils and Saponins, Carotenoids and Alkaloids: biogenesis, therapeutic applications, Biochemistry, physiology and ecological functions of secondary metabolites, Biotechnology for the production of plant secondary metabolites, Secondary metabolites in plant defence mechanisms, Plant cell cultures: chemical factories of secondary metabolites.	
<b>III</b>	<b>Transgenic Technology</b>	<b>15</b>
	<p>Introduction, Methods of Transgenesis (Vector mediated and non-vector based gene transfer) Transgenic plants for biotic stress tolerance (Fungi, bacteria, viruses, Insects, weeds)</p> <p>Transgenic plants for abiotic stress tolerance (Drought, Salt, Temperature)</p> <p>Transgenic plants for production of Secondary metabolites. Increase in productivity by manipulation of Photosynthesis and Nitrogen fixation.</p>	
<b>IV</b>	<b>Molecular markers in plants</b>	<b>15</b>
	<p>RAPD, AFLP, ISSR, SSR markers, marker based applications- trait selection, eco-TILLING</p> <p>Molecular Farming- Improvement in Carbohydrates, Proteins, Lipids, Plantibodies, Edible vaccines.</p>	

**Course Outcomes:** After completion of syllabus, students will be able to...

1. Apply knowledge in cultivation of algae and mushroom.
2. Analyze different transgenic methods to improve plant productivity.
3. Analyze importance of secondary metabolites in plants.
4. Discuss molecular approaches used for plant breeding and trait selection.

**Reference Books:**

1. Chawla, H. C. (2020) Introduction to Plant Biotechnology 3<sup>rd</sup> Edition Oxford & IBH Publishing
2. Bagyanarayana B, Bhadraiah B, et al. 2018 Mycology, Plant Pathology, & Microbial Biotechnology BS Publications
3. C.M. Govil, Aggarwal A. and Sharma J., Aggarwal A., Sharma J. (2017), Plant Biotechnology and Genetic Engineering, Prentice Hall India Pvt., Limited
4. Prasad B. D., Kumar P., Sahni S. (2017), Plant Biotechnology, Transgenics, Stress Management, and Biosafety Issues, Volume 2 Apple Academic Press
5. Altman, A and Hasegawa P M (2012) – Plant Biotechnology and Agriculture Prospects for the 21<sup>st</sup> Century Academic Press Inc
6. Rai, M (2009) Fungal Biotechnology I K International
7. Slater A., Scott N. W. & Fowler M R (2008) – Plant Biotechnology: Genetic manipulation of plants 2<sup>nd</sup> Edition, Oxford;
8. Davies, K. (2004) Plant Pigments and their manipulation-Annual plant reviews-Vol 14 Wiley-Blackwell;
9. Bhojwani, S. S. and Razdan M.K.(1996) Plant Tissue Culture: Theory and Practices Elsevier Science
10. Vasil K., & Thorpe, T A. (1994) Plant cell and Tissue Culture Spring

**Master of Science (M. Sc.) Part I**  
**Semester II**  
**MBTT 424 E-I :Food Biotechnology**

**Course Objectives:** The students should be able to...

1. Become Aware about different methods of food processing
2. Become Aware about different methods of food preservation techniques.
3. Understand different quality control aspects and.
4. Learn the food standards and laws

Unit	SEMESTER-II	No. of hrs. per Unit
<b>I</b>	<b>Food processing</b>	<b>6</b>
	Starter cultures and their biochemical activities; Food and dairy products: Cheese, bread and yogurt. Fermented vegetables – Saurkraut; Fermented Meat – Sausages	
<b>II</b>	<b>Food preservation</b>	<b>8</b>
	Food preservation by heating: drying, osmotic dehydration, blanching, canning, pasteurization, sterilization, extrusion cooking Non-thermal preservation: Hydrostatic pressure, microwave processing, hurdle technology, Retort packaging technology, Vacuum drying Food preservation by low-temp: Refrigeration, freezing and freeze-drying. Osmotic dehydration,	
<b>III</b>	<b>Quality assurance in food sector</b>	<b>8</b>
	Microbiological quality standards of food, FDA, EPA, ISI National – Introduction of BIS/IS, Food Safety and standards – Food Safety and standard regulation, FPO, MPO, MMPO, Agmark. International – Concept of Codex Alimentarius, HACCP, GMP, GHP, USFDA, ISO 9000, ISO 22000	
<b>IV</b>	<b>Food laws and legislations</b>	<b>8</b>
	Prevention of food adulteration Act, Food additives and legislation; coloring matter, preservatives, poisonous metals, antioxidants and emulsifying and stabilizing agents, insecticides and pesticides. PFA specification for food products, Nutritional labeling.	

**Course Outcomes:** The students will be able to...

1. Discuss different methods of food processing and
2. Discuss different various food preservation techniques.
3. Determine different quality control aspects
4. Describe Food laws and legislations

**Reference Books:**

1. Archer D. B. (2008) Food Biotechnology, Springer Berlin Heidelberg
2. Casida L. E. (2005), Industrial Microbiology, 1<sup>st</sup> Ed. Wiley Eastern Ltd.
3. Singh R. P., Heldman D. R. (2001) Introduction to Food Processing. Prentice Hall, Reston Virginia, USA.
4. Frazier W. C., Westhoff D. C. (2000) Food Microbiology 5<sup>th</sup> Ed – Frazier McGraw-Hill Companies
5. Early R. (1995) Guide to Quality Management Systems for Food Industries. Blackie Academic.

6. Fellows P. and Ellis H. (1990) Food Processing and Nutrition. Academic Press, London.
7. Lewis, M. J. (1990) Physical Properties of Food and Food Processing Systems. Woodhead, UK.
8. Potter, N.N. (1986) Food Dehydration and Concentration. In: Food Science. Springer, Dordrecht.
9. Jelen, P. (1985) Food Processing Technology: Principles and Practice, New York.
10. Arsdel W.B., Copley, M.J. and Morgen, A.I. (1978) Food Dehydration, 2nd Edn. (2 vol. Set). AVI, Westport. Bender, A.E.

**Master of Science (M. Sc.) Part I**  
**Semester II**  
**MBTT 424 E -II: Animal Tissue Culture**

**Course Objectives:** The students should be able to ...

1. Know about organization of animal tissue culture laboratory
2. Learn the basic concepts in animal tissue culture with
3. Understand different physicochemical requirements
4. Know applications of animal tissue culture

<b>Credits</b> <b>02</b>	<b>SEMESTER-II</b> <b>MBTT 424 B :Animal Tissue Culture</b>	<b>No. of hrs.</b> <b>per Unit</b>
<b>I</b>	<b>History and Introduction of Animal Cell culture:</b>	<b>8</b>
	Requirements of Animal cell culture- substrate for cell growth, Equipment's required for animal cell culture (Laminar air flow, CO2 incubator, Centrifuge, Inverted microscope), Sterilization of Glassware's, Equipment's & culture media - Glassware sterilization, reagent and media sterilization, sterility testing.	
<b>II</b>	<b>Culture media for animal cell culture</b>	<b>7</b>
	Culture media- Natural media, synthetic media (serum containing media, serum free media, balanced salt solution, media constituent, complete culture media, physicochemical properties of Media).	
<b>III</b>	<b>Characterization of cultured cell</b>	<b>7</b>
	<b>Cultured cells-</b> Biology and Characterization- Characteristics of cultured cells, cell adhesion, cell proliferation, cell differentiation. <b>Measurement of growth parameters of cultured cells-</b> Growth cycle of cultured cells, plating efficiency of cultured cells.	
<b>IV</b>	<b>Types and application of animal cell culture</b>	<b>8</b>
	<b>Cell synchronization-</b> Cell separation by physical means, cell separation by chemical blockade Organ and Histotypic culture-Types and maintenance of organ culture, Histotypic culture, Stem cell cultures. Applications of cell culture-In transplantation, and tissue engineering, monoclonal antibodies production, ethics and morality.	

**Course Outcomes:** The students will be able to...

1. Apply basic knowledge of animal tissue culture.
2. Characterize cultured cell.
3. Dictate laboratory organization and safety.
4. Discuss applications of animal cell culture

**Reference Books:**

1. Carter M., Hunt J., 2020 Animal Cell Culture, Ed Tech press
2. Aruni A. W., Ramadass P 2019 Animal Tissue Culture, MJP Publisher
3. Freshney, I.; 2015 Culture of Animal Cells, 7<sup>th</sup> Edition, Wiley & Sons, Inc., USA.
4. Gangal, S. 2007 Principles and Practice of Animal Tissue Culture, 2nd Edition, University Press, India
5. Ranga M. M. 2007 Animal biotechnology University Press, India
6. Babiuk L. A., Phillips J. P., et al. 2013 Animal Biotechnology: Comprehensive Biotechnology, First Supplement Pergamon
7. Masters R. W.; 2000 Animal cell culture- 3<sup>rd</sup> edition , by Oxford University Press, USA
8. Masters, J.; 2000 Animal Cell Culture- Practical Approach, 3rd Edition, Oxford University Press, USA
9. Baserga R., 1989. Cell Growth and Division: A Practical Approach (The Practical Approach Series, 47)
10. Clynes M.; 1998 Animal cell culture technique 2nd edition, Springer

**Master of Science (M. Sc.) Part I**  
**Semester II**  
**MBTP 425: Research Project**

**Course Objectives:** The students should be able to ...

1. Get the practical knowledge of experiment designing
2. Learn search literature for the topic
3. Know optimization of the experiment
4. To make students capable of writing research proposal and projects

**Course outcomes:** The students will be able to...

1. Acquire the practical knowledge of experiment designing.
2. Perform different experiments for the concerned topic.
3. Review available literature on a particular topic.
4. Capable of writing research proposal and projects



**Master of Science (M. Sc.) Part I**  
**Semester II**  
**MBTP 426 Practical**  
**(Laboratory Exercises in Genetics, Immunology)**

Credits: 02

**Course Objectives:** The students should be able to...

1. Understand the Mendelian genetics & Problems based on linkage and crossing over
2. Know ELISA, Immuno electrophoresis, Immuno diffusion techniques; Rocket immuno electrophoresis Western blotting
3. Understand Molecular marker-Random Amplification Polymorphic DNA
4. Learn callus culture technique and cultivation of algae

Sr. No.	MBTP 426 Practical Course (Lab III)	No. of practical hours (60)
1.	Determination of mitotic index	3
2.	To analyse Karyotype of <i>Allium cepa</i>	3
3.	To solve Problems based on Mendelian genetics,	3
4.	To solve Problem based on linkage and crossing over	3
5.	To solve Problem based on pedigree	3
6.	To solve Problem based on gene frequency	3
7.	To solve Problem based on genotype frequency	3
8.	To solve problem based on chi square test.	3
9.	To perform Bacterial transformation	3
10.	To perform Bacterial conjugation	3
11.	To perform blood grouping	3
12.	To perform rapid plasma reagin (RPR) test	3
13.	To perform ELISA	3
14.	To perform widal test	3
15.	To perform Immunodiffusion	3
16.	To perform Immuno-electrophoresis	3
17.	To perform rocket immune-electrophoresis	3
18.	To perform western blotting	3
19.	To study Routes of virus inoculation in embryonated eggs	3
20.	To perform phage assay	3

**Course Outcomes:** The students will be able to...

1. Solve problems on Mendelian genetics &
2. Solve problems based on linkage and crossing over
3. Perform various immunological techniques
4. Demonstrate routes of virus inoculation in embryonated eggs

**Reference Books:**

1. Fraiss and Fiona, (2016) Practical Biochemistry : An Introductory Course University Park Press

2. S. Jayaraman., (2011) Laboratory Manual in Biochemistry New Age International Private Limited
3. S.Sadasivam and A. Manickam., (2007), Biochemical Methods 2nd Ed. Springer
4. Vasil K., & Thorpe, T A. (1994) Plant cell and Tissue Culture Spring
5. Becker E. W. (1994) Microalgae: Biotechnology and Microbiology, Cambridge University Press
6. R. R. Alexander and J. M. Griffith, (1993) Basic Biochemical Methods 2nd ed Wiley–Blackwell
7. R. A Crowther, (1955) Methods in Enzymology Vol. 579 Academic Press Inc
8. David Plummer. (1987) Textbook of Practical Biochemistry McGraw Hill Education
9. Chang Shu-ting, Hayes W. A. (1978) The Biology and Cultivation of Edible Mushrooms  
Academic Press, - Technology & Engineering.
10. Bhojwani, S. S. and Razdan M.K.(1996) Plant Tissue Culture: Theory and Practices Elsevier  
Science

**Master of Science (M. Sc.) Part I****Semester II****MBTP 427 Practical****(Laboratory Exercises in Plant Biotechnology and Food Biotechnology)**

**Course Objectives:** The students should be able to...

1. Understand the isolation and culturing of *Chlorella* spp. and *spirulina* spp.
2. Understand Molecular marker-Random Amplification Polymorphic DNA
3. Learn preservation techniques.
4. Know different food legislations

<b>Credit 02</b>	<b>MBTP 427 Practical Course (Lab IV)</b>	<b>No. of practical hours (60)</b>
1.	To study isolation, culturing and study of growth curves on <i>Chlorella</i> Spp.	
2.	Cultivation and biochemical analysis of <i>Spirulina</i> Spp.	
3.	To study Cultivation of Mushrooms.	
4.	To study biochemical analysis of Mushroom	
5.	To study Polymorphic DNA by Molecular marker-RAPD	
6.	To perform Callus Culture Technique.	
7.	To perform Anther Culture Technique.	
8.	Study of various phytochemical analysis of plants.	
9.	To study effect of salt stress on plants	
10.	To study effect of drought stress on plants	
	<b>Practical based on Elective 1</b>	
11.	Preservation of fruits by drying method.	
12. s	Preservation of vegetables by drying methods	
13.	To study production of paneer.	
14.	Quantitative analysis of milk by standard plate count method	
15.	Enzymatic test of milk by MBRT method	
16.	Detection of Bacteria in spoiled food	
17.	Determination of phosphatase activity of milk.	
18.	Microbial production of curd	
19.	Detection of pathogens in food and feed	
20.	To study different food legislations	
21.	Visit to Food industry	
<b>Practical Based on Elective II</b>		
1.	To study the various routes of drug inoculation on CAM membrane	
2.	Sterilization Techniques	
3.	Preparation of Media	
4.	Preparation of Sera	
5.	Preparation of established Cell lines	
6.	Cell Counting and Viability	
7.	Staining of Animal Cells	
8.	Preservation of Cells	
9.	Cell viability test using trypan blue exclusion method.	
10.	MTTS assay.	

**Course Outcomes:** The students will be able to...

1. Discuss the isolation and culturing of *Chlorella* spp. and *spirulina* spp.
2. Demonstrate Molecular marker-Random Amplification Polymorphic DNA
3. Perform preservation techniques. or perform various assays
4. Discuss different food legislations or demonstrate different techniques of animal Biotechnology

**Reference Books:**

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4. R. A Crowther, (1955) Methods in Enzymology Vol. 579 Academic Press Inc
5. David Plummer. (1987) Textbook of Practical Biochemistry McGraw Hill Education
6. Chang Shu-ting, Hayes W. A. (1978) The Biology and Cultivation of Edible Mushrooms Academic Press, - Technology & Engineering.
7. Bhojwani, S. S. and Razdan M.K.(1996) Plant Tissue Culture: Theory and Practices Elsevier Science
8. P.J. Fellows, (2009) Food Processing Technology Principles and Practice, Elsevier Science
9. D.K.Maheshwari (2002) Practical Microbiology, S. Chand Limited
10. Photis Papademas (2014) Dairy Microbiology A Practical Approach, Taylor & Francis
11. REF book for Animal cell culture

Chairman  
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