



“Education through self-help is our motto.”

Rayat Shikshan Sanstha's

YASHAVANTRAO CHAVAN INSTITUTE OF SCIENCE, SATARA

(An Autonomous College)

Reaccredited by NAAC with 'A+' Grade

Syllabus for Master of Science

Part - I

Biotechnology

To be implemented from June, 2023 onwards

(As Per NEP-2020 Guidelines)

Rayat Shikshan Sanstha's
Yashavantrao Chavan Institute of Science, Satara
Syllabus for Masters of Science Biotechnology

1. **Title:** M.Sc. Biotechnology

2. **Year of Implementation:** 2023-24

3. **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.

4. **General Objectives**

- 1) Construction and designing of the courses to research and industrial needs
- 2) More emphasis on applied aspects of biotechnology
- 3) To develop aptitude of students in the field of research
- 4) Enrichment of basic knowledge in areas of Biotechnology

5. **Program Outcomes:** The students will be ...

- 1) Graduate with proficiency in the biotechnology
- 2) Eligible to continue higher studies in the subject.
- 3) Eligible to peruse higher education in abroad.
- 4) Enable graduate to pursue research career in industry and academia
- 5) Eligible for jobs in industry, research institutes, government sector, NGOs. Etc.
- 6) Able to do advanced scientific research and entrepreneurship

6. **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.

7. Program Specific Outcomes

- 1) Learn, design and perform experiments in the labs to demonstrate the concepts, principles and theories learnt in the classroom
- 2) Develop the ability to apply the knowledge acquired in classroom and laboratories to specific problems in theoretical and experimental biotechnology
- 3) Empower the students to acquire technological knowledge by connecting disciplinary and interdisciplinary aspects of biotechnology
- 4) Identify the area of interest in the academic research and development
- 5) Perform job in various fields like food, pharmaceutical, agriculture, healthcare, public services and business etc.
- 6) Be an entrepreneur with precision, analytical mind, innovative thinking, and clarity of thought, expression and systematic approach

8. **Duration:** One Year

9. **Pattern:** Semester wise

10. **Medium of Instruction:** English

11. **Structure of Course:**

Level	Sem	Major			RM	OJT	RP	Total
		DSC Mandatory		DST Elective				
		T	P	T				
6	I	12 (3 papers)	2	4 (1 paper out of 2)	4	--	--	22
	II	12 (3 papers)	2	4 (1 paper out of 2)	--	--	4	22
6.5	III	12 (3 papers)	2	4 (1 paper out of 2)	--	--	6	22
	IV	12 (3 papers)	--	4 (1 paper out of 2)	--	4	--	22
Total		48	6	16	4	4	10	88
		70			8	10		

Rayat Shikshan Sanstha's

Yashwantrao Chavan Institute of Science, Satara (Autonomous)

Department of Biotechnology "NEP 2020 Implementation"

.....**BIOTECHNOLOGY COURSE TITLES**.....

M. Sc. Part I

Semester I

Nature of course	Course Code	Name of the Course
Theory	MBTT 411	Advances in Cell Biology
	MBTT 412	Advances in Molecular Biology
	MBTT 413	Advances in Biological Chemistry
	MBTT 414 E-I	Advances in Microbiology
	MBTT 414 E-II	Clinical research & Data management
	MBTT 415	Research methodology
Practical	MBTP 416	Exercises in Molecular Biology, Cell Biology and Biological Chemistry

Semester II

Nature of course	Course Code	Name of the Course
Theory	MBTT 421	Genetics
	MBTT 422	Immunology and Virology
	MBTT 423	Plant Biotechnology
	MBTT 424 E-I	Food Biotechnology
	MBTT 424 E-II	Animal Tissue Culture
	MBTP 425	Research Project
Practical	MBTP 426	Laboratory Exercises in Genetics, Immunology and Plant Biotechnology

Total credit (Sem I + Sem II) = 22 + 22 = 44

SEMESTER I

MBTT 411: Advances in Cell Biology

Credits 04

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

Credits 04	SEMESTER I MBTT 411: Advances in Cell Biology	No. of hrs. per credit
Unit I	Cell structure and cytoplasmic membrane system	15
	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	
UnitII	Cellular Transport:	15
	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, Plamodesmata structure and function Plastids - biogenesis, structure and types, Transepithelial Transport, Voltage-Gated Ion Channels and the Propagation of Action Potentials in Nerve Cells	
Unit III	Cell signaling	15
	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	
Unit IV	Cell differentiation	15
	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: The students should 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. Explain 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 3rd Edition ELSEVIER
4. Stahl P.D., Bradshaw R. A. (2015), Encyclopedia of Cell Biology, Elsevier Science
5. Plopper G. (2014) Principles of Cell Biology 2nd Edition Jones & Bartlett Learning
6. Cooper G. M., Hausman R. E. (2013), The Cell: A Molecular Approach, 6th 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. 7th 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

MBTT 412: Advances in Molecular Biology**Credits: 04****Learning Objectives:** The students should be able to...

1. Learn various advance concepts of Genomic organization.
2. Know role of DNA in a range of gene expression and regulation.
3. Study protein synthesis process
4. Understand molecular biology in relevance to Biotechnology.

Credits 04	SEMESTER I MBTT 412: Advances in Molecular Biology	No. of hrs. per credit
Unit I	Genome Structure and Organization	15
	<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>	
Unit II	DNA damage and Repair	15
	<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>	
Unit III	DNA Replication and Regulation	15
	<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 (Ribosome concept)</p>	
Unit IV	Protein Synthesis and Regulation	15
	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.	
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Course Outcomes: The 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 2nd Edition, OUP Oxford
3. Lewin B. (2012), Genes XI, 11th 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 7th 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.

MBTT 413: Advances in Biological Chemistry

Credits: 04

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. Understand about vitamins and their role as coenzymes.
4. Understand the role of enzymes in industry and diagnostics

Credits 04	SEMESTER I MBTT 413: Advances in Biological Chemistry	No. of hrs. per credit
Unit I	Protein Biochemistry	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.	
UnitII	Enzymes & coenzymes	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.	
Unit III	Enzymology	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.	
Unit IV	Purification & Immobilization of enzymes	15
	Purification- salting out-salting in, Ammonium sulfate precipitation, Dialysis, Gel filtration, IEC, Affinity chromatography, Isoelectrofocussing, Sangers method-Protein sequencing. Immobilization: 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. Biosensors in diagnosis of diseases- glucose oxidase, cholesterol oxidase,	

Course Outcomes: The 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*, 5th 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*. 5th edition. New York:, W.H. Freeman and company,
6. Satyanarayanan, U. and Chakrapani, U., (2007) *Biochemistry*, 3rd 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*, 2nd edition, USA: Wiley-Blackwell,
9. Plummer D., (2001). *An Introduction to Practical Biochemistry*, 3rd 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

MBTT 414 E I: Advances in Microbiology**Credits: 04****Course Objectives:** The students should be able to...

1. Study 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

Credits04	SEMESTER I MBTT 414 E I: Advances in Microbiology	No. of hrs. per credit
Unit I	Molecular basis of Binary Fission and	15
	Overview with emphasis on: Genetic mechanism determining bacterial shapes, Assembly of Flagella, Motility and Chemotaxis, Cell wall and Cell membrane (Gram Positive , Negative and Archaeobacterial), Protoplast, Spheroplast, L forms, Mycoplasma (taxonomic significance)	
Unit II	Microbial growth kinetics	15
	Growth curve of bacteria, Measurement of microbial growth, The influence of environmental factors in growth, Synchronous growth, Continuous growth, Extremophiles their molecular adaptations and significance.	
Unit III	Bacterial pathogenesis	15
	Entry of Pathogen in the host,colonization, Virulence factors, host factors, Molecular mechanism of pathogenesis of: Mycobacterium tuberculosis, Pathogenic <i>E. coli</i> , <i>Staphylococcus aureus</i> Pathogenicity Islands – Concept with example Molecular and immunological methods for disease diagnosis (of above mentioned pathogens)	
Unit IV	Antibiotics and drug resistance	15
	Types of antimicrobial agents, Classes of antibiotics (β -lactams, tetracyclins, aminoglycosides, macrolids, Polypeptides antibiotics & their mode of action)Antiviral, antifungal, antiprotozoan antibiotics, Development of Multidrug resistance in bacteria (cause and effect), 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: The 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,, 6th 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

MBTT 414 E II: Clinical research & Data management

Credit: 04

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

1. Understand the principles involved in the ethical, legal, and regulatory issues in clinical human subjects research, including the role of IRBs.
2. Understand the infrastructure required in performing clinical research and to have
3. Know the steps involved in developing and funding research studies.
4. Familiar with the basic biostatistical and epidemiologic methods involved in conducting clinical research

Credit 04	SEMESTER I MBTT 414 E II : Clinical research & Data management	No. of hrs. per credit
Unit I	Introduction to Clinical Research	15
	<p>Brief History of Clinical Research: Sulphanilamide Tragedy, Thalidomide Disaster, Nazi Experiments, Tuskegee Study, Belmont report, Nuremberg code, Declaration of Helsinki.</p> <p>Clinical Research: An Overview, Historical guidelines in Clinical Research. Different types of Clinical Research.</p> <p>Clinical Pharmacology: Pharmacokinetics, Pharmacodynamics, Pharmacoepidomology, Bioavailability. Bioequivalence, Terminologies and definition in Clinical Research.</p> <p>Drug Development Process: Preclinical trail, Human Pharmacology (Phase-I), Therapeutic Exploratory trail (Phase-II), Therapeutic Confirmatory Trail (Phase-III) and Post marketing surveillance (Phase-IV). Guidelines in Clinical Research-International Conference on Harmonization (ICH), Guidelines for Good Clinical Practice, ICMR guidelines for Biomedical Research on Human Subjects.</p>	
Unit II	Regulation and Ethics in Clinical Research	15
	<p>Regulation in Clinical Research- Drug and cosmetic act, FDA, Schedule-Y- Ethics Committee and their responsibilities.</p> <p>Clinical Research Regulatory Submission & approval Process- IND, NDA and ANDA submission Procedure. DCGI submission procedure. Other Regulatory authorities- EMEA, MHRA, PhRMA.</p>	
Unit III	Clinical Trial Management	15
	<p>Concept of Clinical Trail Management, Stake holders in Clinical Trail project. Responsibility of Sponsors, Study Preparation, Study feasibility, Vendors/Service provider selection, Investigator selection, Budgeting in Clinical trial, Agreement (CTA), Regulatory submission and approval, Sponsors obligation in Good Clinical Practice. Investigators obligation outlined in Good Clinical Practice, Ethics committee submission, adverse event and safety reporting.</p> <p>Service provider- Contract Research Organization (CRO), Site Management Organization (SMO), Central Lab, Clinical Data Management Organization (CDMO), Medical Writing Organization, Pharmacovigilance Organization.</p> <p>Clinical Research Operation, Monitoring and Clinical Evaluation: Protocol</p>	

	in Clinical Research, Informed Consent, Case Report Form, Investigator's Brochure (IB), Inclusion and exclusion criteria, Randomization, Blinding, Ethics and Regulatory submission.	
Unit IV	Clinical Data Management	15
	<p>CDM Systems: Clinical data management systems, , Electronic data capture systems, Choosing vendor products, Implementing new systems, System validation, Test procedures, Coding dictionaries, Migrating and archiving Legacy Data.</p> <p>Clinical Data Management process-Data management Plan, CRF design considerations, Database design considerations, Study setup, Entering Data, Tracking CRF pages, Managing Lab Data, Identifying and Managing the discrepancies, Collecting Adverse Event Data, Coding Reported terms, Creating report and Transferring data, Closing study, SAS in Clinical data analysis, Standard operating procedures and guidelines for data management.</p>	

Course outcomes: The 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) Analyze infrastructure required in performing clinical research
- 3) Determine steps involved in developing and funding research studies.
- 4) Explain data management system

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 5th 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 2nd 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 2nd Edition, Wiley

MBTT 415: Research Methodology**Credit: 04****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.

Credit 04	SEMESTER I MBTT 415 : Research Methodology	No. of hrs. per credit
Unit I	Introduction of Research	15
	<p>Introduction: Meaning of Research, Objectives of Research, Types of Research, Research Approaches, Significance of Research, Research Methodology, Research and Scientific Method</p> <p>Defining the Research Problem: What is a Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem.</p>	
Unit II	Research Design	15
	<p>Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Basic Principles of Experimental Designs ,Sampling Design ,Census and Sample Survey, Implications of a Sample Design, Steps in Sampling Design, Criteria of Selecting a Sampling Procedure, Characteristics of a Good Sample Design, Different Types of Sample Designs, How to Select a Random Sample, Random Sample from an Infinite Universe</p>	
Unit III	Use of tools / techniques for referencing and writing	15
	<p>Methods to search required information effectively, PubMed, effective literature search using Entrez, Google Scholar. Software for paper formatting like MS Office, software for detection of Plagiarism. Basics of internet and e-mailing.</p> <p>Reporting and Thesis writing - Structure and components of scientific reports - Types of report - Technical reports and thesis - Significance - Different steps in the preparation - Layout, Structure and Language of typical reports - Illustrations and tables –</p> <p>Bibliography, referencing and footnotes - Reproduction of published material - citation and acknowledgement - Oral presentation - Planning - Preparation - Practice - Making presentation - Use of visual aids - Importance of effective communication.</p>	
Unit IV	Application of results and ethics	15
	<p>Environmental impacts - Ethical issues - ethical committees - Commercialization - Copy right - royalty - Intellectual property rights and patent law.</p> <p>Reasoning and Mental ability: Logical reasoning and aptitude, Classification, Series, Coding-Decoding, Direction Sense, Representation Through Venn Diagrams, Mathematical Operations, Arithmetical Reasoning, Inserting the Missing Character, Number, Ranking and Time Sequence Test, Eligibility Test,</p>	

	Representation through Venn diagrams, Number & symbols ordering, Comprehension questions, Statement & assumptions, Statement & conclusions, Statement & actions.	
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Course Outcomes: The 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. Dr. Gupta B. N., , Gupta N. · 2022, Research Methodology - SBPD Publications
2. Dr. Mishra S. B., Dr. Alok S. (2017) Handbook of Research Methodology A Compendium for Scholars & Researchers Educreation Publishing
3. Devi P. S. (2017) Research Methodology: A Handbook for Beginners Notion Press
4. Tan W. (2017) Research Methods A Practical Guide for Students and Researchers World Scientific
5. Goyal R. C. (2010) Research Methodology for Health Profession, Jaypee Brothers Medical Publishers Pvt. Limited
6. Kothari C. R. (2009) "Research Methodology: Methods & Techniques" (Second Revised Edition), New Age International Publishers, New Delhi.
7. Mathur U. C., (2007) Product and Brand Management, Narainaphase I, New Delhi,
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. Sinha S. C. and Dhiman A. K., (2002) Research Methodology Ess Publications 2 Columes.
10. Wadehra B. L., (2000) Law Relating to Patents, Trade Marks, Copyright Design and Geographical Indications, Universal Law Publishing

M. Sc. Part-I, Sem I
MBTP 416 Practical
(Based on MBTT 411,412,413 courses)

Credit: 02

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

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

Credits 02	MBTP 416 Practical Courses (Lab-I)	No. of Practical hours (60)
	<ol style="list-style-type: none"> 1. To isolate Eukaryotic DNA from - Plant Material 2. To isolate Eukaryotic DNA from - Animal Material 3. To isolate bacterial genomic DNA 4. To isolate Plasmid from <i>E.coli</i>. 5. To isolate RNA from plant 6. To isolate RNA from animal 7. To perform Restriction digestion of DNA /Plasmid 8. To isolate mitochondria and lysosomes by sucrose gradient centrifugation and analysis of fractions by assay of SDH and acid phosphatase activity 9. To isolate chloroplasts / mitochondria from plant cells 10. To perform Micrometry: determination of different cell sizes: bacterial 11. To perform Micrometry: determination of different cell sizes: Fungal 12. To perform Micrometry: determination of different cell sizes: Animal Cell 13. To perform Micrometry: determination of different cell sizes: plant cell 14. To perform Ammonium sulfate precipitation of proteins/ enzymes & dialysis 15. To perform Separation of proteins - Gel filtration chromatography 16. To perform Separation of proteins – Ion exchange chromatography 17. To perform Separation of proteins - Affinity chromatography 18. To perform Quantification and spectral analysis at each step of purification 19. To perform enzyme activity of amylase 20. To perform purification and dialysis of amylase 	

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

1. Apply advanced techniques in molecular biology
2. Perform skillful handling of genetic material
3. Perform measuring the microscopic objects
4. Apply advanced techniques in biological chemistry

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. Sadashivam and Manikam, (2000) *Handbook of biochemistry*, Springer
6. Plummer D., (2001). *An Introduction to Practical Biochemistry*, 3rd Edition, India: Tata McGraw Hill Edu.Pvt.Ltd.,
7. Jayaraman J., (2011) *Laboratory Manual In Biochemistry*, New Age International Private Limited
8. Weaver R. (2011) *Molecular Biology*, 5th Edition, McGraw Hill Science. USA
9. Tropp B. E., Jones & Bartlett (2011), *Molecular Biology: genes to proteins*, 4th edition Learning, USA
10. Wilson K., Walker J. (2010) *Principles and Techniques of Biochemistry and Molecular Biology* 7th Edition Cambridge University Press

SEMESTER II

MBTT 421: Genetics

Credits: 04

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.

Credits 04	SEMESTER-II MBTT 421: Genetics	No. of hrs. per credits
Unit I	Mendelian genetics	15
	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.	
Unit II	Cytogenetics	15
	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.	
Unit III	Human and population genetics	15
	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.	
Unit IV	Microbial genetics and Environment	15
	Microbial genetics: Methods of genetic transfers – transformation, conjugation, transduction and sex-duction. Recombination: Homologous and non-homologous recombination including transposition. Environment and the Genome: (a) Imprinting and Epigenetics (b) Genetics of Cancer (Oncogenes and tumor suppressor genes) (c) Genetics of Ageing.	

Course outcomes: The 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, 8th 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, Fitzgerald,
- 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, 2nd 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, IInd edition, Rastogi publications,
- 10) Sarin C., (1985). Genetics ,Tata McGraw-Hill Publications,

Semester II
MBTT 422: Immunology and Virology

Credits 04

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

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

Credits 04	SEMESTER-II MBTT 422: Immunology and Virology	No. of hrs. per credit
Unit I	Immunology	15
	<p>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.</p> <p>Vaccines – Active and passive immunization, DNA vaccines, multivalent subunit vaccines, synthetic peptide vaccines</p>	
Unit II	Clinical Immunology	15
	<p>Hypersensitivity: Type I, II, III, and IV reactions.</p> <p>Autoimmunity – organ specific and systemic autoimmune diseases, Treatment of autoimmune diseases, molecular mimicry, autoimmune therapy</p> <p>Monoclonal antibodies – Hybridoma technology and various cellular technologies.</p> <p>Transplant immunology: 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</p> <p>Animal Models: 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</p>	
Unit III	Introduction to viruses	15
	<p>Introduction to viruses: General properties of viruses, Morphology and ultrastructure of Viruses Classification of viruses: ICTV system, Baltimore system</p> <p>Replication of viruses: DNA (ds) - Poxvirus , RNA(ss+ve)- Poliovirus, RNA (ss -ve) – Influenza virus and RNA with RT- HIV</p> <p>Viral Diagnosis: Microscopy, Cultivation, Serological and Molecular methods, Infectivity assays, immunodiagnosics</p> <p>Antiviral : Mode of Action of various antiviral drugs with examples and Viral Vaccines</p>	

Unit IV	Epidemiology	15
	<p>Principles and related terminologies, Current National and Global epidemiology of viral infections (with suitable examples)</p> <p>Oncogenic virus and Cancer Immunology, Immunotherapy, Immunodeficiency (Primary and secondary)</p> <p>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.)</p> <p>Animal and Poultry viruses: Clinical symptoms with examples (FMD, Rinderpest Virus, Avian Influenza, Newcastle Disease etc.), Prevention.</p> <p>Plant viruses: Mode of transmission and Prevention. Replication and Symptoms of TMV. Concept of Biosafety Level and Microbial Containment</p>	

Course Outcomes: The 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 4th Edition Wiley.
2. Gangal S. and Sontakke S. (2013), Textbook of basic and clinical immunology, 1st edition, University Press, India.
3. Kubly Immunology, Owen J., Punt J., Stranford S., 7th 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), 12th edition, Wiley and Black Well.
6. F.H. Khan (2009), The Elements of Immunology. Pearson Education.
7. David M., Brostoff J. (2006) Immunology, 7th edition
8. Fields B. N. (2006) Field's Virology - 2 volumes, 5th edition, , Lippincott and Williams Wilkins, USA
9. Flint J. S., ASM (American Society of Microbiology) (1999), Principles of Virology, 3rd 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

Semester II
MBTT 423: Plant Biotechnology

Credits: 04

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.

Credits 04	SEMESTER-II MBTT 423 : Plant Biotechnology	No. of hrs. per credit
Unit I	Algal and Fungal Biotechnology	15
	<p>Algal Biotechnology-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>Fungal Biotechnology-Study of economically important Mushrooms (<i>Agaricus</i>, <i>Pleurotus</i>, <i>Lentinus</i>), Commercial cultivation of Mushrooms</p>	
Unit II	Secondary metabolites in plants	15
	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.	
Unit III	Transgenic Technology	15
	<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>	
Unit IV	Molecular markers in plants	15
	<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: The 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 3rd 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 21st 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 2nd 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

MBTT 424 E-I: Food Biotechnology**Credits 04****Course Objectives:** The students should be able to...

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

Credits 04	SEMESTER-II MBTT 424 E-I :Food Biotechnology	No. of hrs. per credit
Unit I	Food processing	15
	Starter cultures and their biochemical activities; production of alcoholic beverages; production of Single cell protein and Baker's yeast; Mushroom cultivation Food and dairy products: Cheese, bread and yogurt. Fermented vegetables – Saurkraut; Fermented Meat – Sausages	
Unit II	Food preservation	15
	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, Food preservation by low-temp: Refrigeration, freezing and freeze-drying. Osmotic dehydration, Vacuum drying	
Unit III	Quality assurance	15
	Risk analysis; consumer and industry perceptions. 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, ISO 14000.	
Unit IV	Food laws and legislations	15
	Prevention of food adulteration Act: Food Adulteration: definition, common adulterants in different foods, contamination, methods of detection. 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.
2. Apply 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, 1st 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 5th 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.
11. Krammer A & Twigg B A (1973) Quality Control in Food Industry. Vol. I, II. AVI Publ.

MBTT 424 E -II: Animal Tissue Culture

Credits: 04

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 understanding of different physicochemical requirements.
3. Understanding different types of cell cultures.
4. Know applications of animal tissue culture.

Credits 04	SEMESTER-II MBTT 424 B :Animal Tissue Culture	No. of hrs. per credit
Unit I	History and Introduction of Animal Cell culture:	15
	<p>Requirements of Animal cell culture- substrate for cell growth, Equipment's required for animal cell culture (Laminar air flow, CO₂incubator, Centrifuge, Inverted microscope),</p> <p>Sterilization of Glassware's, Equipment's& culture media - Glassware sterilization, reagent and media sterilization, sterility testing.</p> <p>Culture media- Natural media, synthetic media (serum containing media, serum free media, balanced salt solution, media constituent, complete culture media, physicochemical properties of Media).</p>	
Unit II	Characterization of cultured cells:	15
	<p>Cultured cells- Biology and Characterization- Characteristics of cultured cells, cell adhesion, cell proliferation, cell differentiation.</p> <p>Characterization of cultured cells- Morphology of cells, species of origin of cells, Identification of tissue of origin, transformed cells, Identification of specific cell lines.</p> <p>Measurement of growth parameters of cultured cells- Growth cycle of cultured cells, plating efficiency of cultured cells.</p> <p>Cell synchronization- Cell separation by physical means, cell separation by chemical blockade</p> <p>Senescence and apoptosis- Cellular senescence, Measurement of senescence. Apoptosis, Measurement of apoptosis</p>	
Unit III	Cell culture and scale up	15
	<p>Basic technique of mammalian cell culture- Isolation of tissue, disaggregation of tissue, measurement of viability, primary cell culture, Cell lines, Maintenance of cell culture, Subculture.</p> <p>Scale up of Animal cell culture-Scale up in suspension-stirrer culture, continuous flow culture, Airlift fermenter culture Scale up in monolayer- Roller bottle culture, multi surface culture, multiarray disks, and tubes, Micro carrier culture, Immobilized cell culture</p>	
Unit IV	Applications of Animal Cell culture	15
	Organ and Histotypic culture-Types and maintenance of organ culture, Histotypic	

	<p>culture, Stem cell cultures.</p> <p>Cell storage and distribution: a. Cryopreservation b. Cell repositories.</p> <p>Applications of cell culture-In transplantation, and tissue engineering, monoclonal antibodies production, ethics and morality.</p>	
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Course Outcomes: The students will be able to...

1. Apply basic knowledge of animal tissue culture.
2. Determine laboratory organization and safety.
3. Prepare various Animal Tissue Culture media used for culturing in laboratory.
4. Discuss various applications of Animal Tissue 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, 7th 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- 3rd 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

MBTP 425: Research Project

Lectures: 60

Credits: 04

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

M. Sc. Part I Semester – II

MBTP 426 Practical

(Laboratory Exercises in Genetics, Immunology and Plant Biotechnology)

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

Credit 02	MBTP 426 Practical Course (Lab II)	No. of practical hours (60)
	<ol style="list-style-type: none">1. To Determination of mitotic index2. To analyse Karyotype of <i>Allium cepa</i>3. To solve Problems based on Mendelian genetics, linkage and crossing over4. To solve Problem based on pedigree and population genetics5. To perform Bacterial transformation6. To perform Bacterial conjugation7. To perform ELISA and Widal Test8. To perform Immunodiffusion9. To perform Immuno-electrophoresis and Rocket immune-electrophoresis10. To perform Western blotting11. To study Routes of virus inoculation in embryonated eggs12. To study Cultivation and biochemical analysis of <i>Spirulina Spp.</i> And <i>Chlorella Spp.</i>13. To study Cultivation of biochemical analysis of Mushroom14. To study Polymorphic DNA by Molecular marker-RAPD15. To perform Callus Culture Technique.	

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

1. Solve problems on Mendelian genetics & Problems based on linkage and crossing over
2. Perform various immunological techniques
3. Perform cultivation and biochemical analysis methods of *Spirulina Spp.* & *Chlorella Spp.*
4. Analyse DNA by using Molecular marker-Random Amplification Polymorphic DNA

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