Rayat Shikshan Sanstha's

Yashavantrao Chavan Institute of Science, Satara

Syllabus for Master of Science Part I

1. Title: **M.Sc. Biotechnology (Entire)**
2. Year of Implementation: 2020-21
3. Preamble:

   This syllabus is framed to give advanced knowledge of Biotechnology to postgraduate students at first year of two years of M.Sc. degree course. The new syllabus is based on a basic and applied approach with vigor and depth. At the same time precaution is taken to make the syllabus comparable to the syllabi of other universities and the needs of industries and research. The syllabus is prepared after discussion at length with number of faculty members of the subject and experts from industries and research fields. The units of the syllabus are well defined, taking into consideration the level and capacity of students.

4. General Objectives:

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

5. Duration: One Year
6. Pattern: Semester wise
7. Medium of Instruction: English

8. Structure of Course:
    a. Semester I :
        Theory: 04 Papers
        Practical's: 02 Papers
    b. Semester I :
        Theory: 04 Papers
        Practical's: 02 Paper

9. Structure of Course:

COURSE STRUCTURE UNDER CHOICE BASED CREDIT SYSTEM (CBCS)									
M. Sc. BIOTECHNOLOGY (ENTIRE)									
M. Sc. I SEMESTER– I (Duration – 6 Months)									
Sr. No.	**SUBJECT CODE**	**PAPER NO AND TITEL**	**TEACHING SCHEME**						
			Theory			**Practical**			
			No. of lectures	**Hours**	**Credits**	**Subject**	**No. of lectures**	**Hours**	**Credits**
1	MBTT--101	Cell Biology	4	4	4	MBTP--105 : Exercises in Molecular Biology and Cell Biology	8	8	4
2	MBTT--102	Molecular Biology	4	4	4				
3	MBTT--103	Biological Chemistry	4	4	4	MBTP--106 : Exercises in Biological Chemistry & Bacteriology	8	8	4
4	MBTT--104	Basics of Microbiology	4	4	4				
	Total of SEM I		**16**	**16**	**16**		**16**	**16**	**8**

YASHAVANTRAO CHAVAN INSTITUTE OF SCIENCE ,SATARA									
COURSE STRUCTURE UNDER CHOICE BASED CREDIT SYSTEM (CBCS)									
M. Sc. BIOTECHNOLOGY (ENTIRE)									
M. Sc. I SEMESTER– II (Duration – 6 Months)									
Sr. No.	**SUBJECT CODE**	**PAPER NO AND TITEL**	**TEACHING SCHEME**						
			Theory			**Practical**			
			No. of lectures	**Hours**	**Credits**	**Subject**	**No. of lectures**	**Hours**	**Credits**
1	MBTT--201	Genetics	4	4	4	MBTP--206: Laboratory Exercise in Genetics, Immunology & Virology	8	8	4
2	MBTT--202	Immunology and Virology	4	4	4				
3	MBTT--203	Plant Biotechnology	4	4	4	MBTP--207 : Laboratory Exercise in Plant Biotechnology and Environmental Biotechnology	8	8	4
4	MBTT--204	Environmental Biotechnology	4	4	4				
	Total of SEM II		**16**	**16**	**16**		**16**	**16**	**8**

• Student contact hours per week : 30 Hours (Min.)	• Total Marks for M.Sc.-I : 1250
• Theory lectures and practical : 60 Minutes Each	• Total Credits for M.Sc.-I (Semester I & II) : 52
• **MBTE:** M.Sc. Biotechnology (Entire) for Semester IMBTT--101 to MBTE-106 and for semester II MBTT-201 to MBTT-207)	
• Course list as per enclosed Annexure. ***Separate passing is mandatory for Theory, Internal and Practical.***	
• Practical Examination will be conducted at semester end for 100 Marks each paper.	

Other Feature:

A) Library:

Reference and Textbooks, Journals and Periodicals

B) Specific Equipment's:

Computer, LCD Projector, Visualizer, Smart Board

C) Laboratory Equipment's:

Sr No.	**Name of Instrument**
1	Atomic Absorption Spectrometer
2	Autoclave Vertical
3	Bacteriological Incubator
4	Binocular Research Microscope CX 21i
5	BOD Incubator
6	Centrifuge Remi R-4C
9	COD refluxing unit
10	Colorimeter
11	Combined pH and Conductivity Meter
12	Compound Microscope
13	Conductivity Meter
14	Deep freezer
16	Dissection microscope
17	Distillation assembly
18	Flame Photometer
19	Hemocytometer
24	Horizontal Electrophoresis unit
25	Horizontal Laminar Airflow
26	Hot Plate
27	Lux Meter
29	Microcentrifuge
30	Microscope camera device
31	Microwave Oven
32	MiniCentrifuge Remi
33	Mixer
34	pH Meter
35	Refractometer
38	Refrigerator
39	Rotary Shaker
40	Sonicator Waterbath

42	Spectrophotometer UV-Vis
43	Stabilizer
44	Thermal Cycler
45	Ultra microtome
46	UV transilluminator
47	Vacuum pump
48	Variable type power pack
49	Vertical Electrophoresis Unit
51	Visible Spectrophotometer
52	Water bath
53	Weighing balance

MBTT 101: Cell Biology

Lectures 60 **Credits 04**

Objective:

- To learn cell structure with respect to plant, animal and bacteria
- To understand transport of cell membrane
- To understand cell division theory
- To learn characteristic of normal and cancerous cell

UNIT I **(15)**

Cell structure and cytoplasmic membrane system: 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

UNIT II **(15)**

Cellular Transport: 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

UNIT III **(15)**

Cell signaling: 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 **(15)**

Cell differentiation: 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

Learning Outcome:

The students should acquire the knowledge about:

- Cell differentiation, cell cycle regulation and programmed cell death.
- Hormones and growth factor effects on a cell. Cell transformation and cancer etiology.
- Structure and function of organelles in a cell
- Plant cell communication.
- Different types of transport systems across the plasma membrane
- Protein targeting and vesicular transport

Reference Books:

1. Lodish H., Berk A, Kaiser C., K., Reiger M., Bretscher A., Ploegh H., Angelika Amon A., Matthew P. Scott M.P. *Molecular Cell Biology*, New York: W. H. Freeman and Co., USA; 7th Edition, (2012)
2. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter. *Molecular Biology of the Cell*, New Yorl: Garland Science; 5th edition (2007)
3. Gerald Karp. *Cell Biology*, USA: John Wiley & Sons., 6th edition, (2010).
4. Geoffrey M. Cooper, Robert E. Hausman. *The Cell: A Molecular Approach*, USA: Sinauer Associates, Inc.; 6th edition (2013).

MBTT 102: Molecular Biology

Lectures: 60 **4 Credits**

Objective:

- To make the student aware of advance concepts of Genomic organization.
- The role of DNA in a range of gene expression and regulation.
- To make the student aware of molecular biology in relevance to Biotechnology.

UNIT I **(15)**

Genome Structure and Organization: Organization of prokaryotic and eukaryotic genomes, Structure of chromatin, nucleosome, chromatin organization and remodeling, DNA reassociation 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

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

UNIT II **(15)**

DNA damage and Repair: Types of DNA damage, DNA repair mechanisms- nucleotide excision repair, base excision repair, mismatch repair, recombination repair, double strand break repair, transcriptional coupled repair.

Mutation: Nonsense, missense and point mutations, intragenic and intergenic suppression, frameshift mutations, physical, chemical and biological mutagens.

Recombination: Homologous and site-specific recombination, models for homologous recombination- Holliday junction, NHEJ Proteins involved in recombination- RecA, RuvA, B, C, Gene conversion

UNIT III **(18)**

DNA Replication and Regulation: 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: 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)

UNIT IV **(12)**

Protein Synthesis and Regulation: 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.

Learning outcomes:

Student should be able to

- Understand fundamentals of Molecular Biology.
- Learn advance concepts of DNA mutation, Gene expression, protein synthesis.
- Should be able to relate it to in future research work

REFRENCES:

1. Benjamin Lewin. *Genes XI*, Jones and Barlett Inc. USA, 11th edition (2012).
2. James D. Watson, Tania Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Lodwick. *Molecular Biology of the Gene*, Pearson Education, Inc. and Dorling Kindersley Publishing, Inc. USA, 6th Edition (2008).

3. Weaver R. *Molecular Biology*, USA: McGrew Hill Science. 5th Edition (2011).
4. Pal J.K. and Saroj Ghaskadbi. *Fundamentals of Molecular Biology*, Oxford University Press. India (2009),
5. Burton E Trop. *Molecular Biology: genes to proteins*, Jones & Bartlett Learning, USA, 4th edition (2011).
6. Brown T A. *Essential molecular biology*: *A practical approach*, IRL press, Oxford. vol. I, (1995).
7. James D. Watson, Tania Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Lodwick. *Molecular Biology of the Gene*, Pearson Education, Inc. and Dorling Kindersley Publishing, Inc. USA. 6th Edition (2008).

MBTT 103: Biological Chemistry

Lectures: 60 **Credits: 04**

Objectives:

- To make students aware of different types of biomolecules and their role
- To make students aware of basic concepts of protein biochemistry.
- To acquire the knowledge about enzymes their structure, function and kinetics.

UNIT I **(15)**

Biomolecules structure & function:

Carbohydrate: Classification, Characteristic Reactions, Physical and Chemical Properties, D & L Glyceraldehydes, structure of Monosaccharide, Disaccharides, and Polysaccharides. Isomers of Monosaccharides, Chemical/Physical Properties of Carbohydrate

Protein: Classification of amino acids based on Properties, Structure of Proteins (Primary, Secondary, Tertiary, quaternary), Ramchandran Plot, Titration Curve of Amino Acids, Concept of Isoelectric pH, Zwitter ion. Protein folding mechanisms - Molten globule, energy funnel, chaperon, Protein Misfolding and misfolding diseases, Denaturation of protein Structure of Peptides

Lipid: Classification of Lipids, Properties of Saturated, Unsaturated Fatty Acids, Rancidity, and Hydrogenation of Oils

Nucleic Acid: Nucleosides & Nucleotides, purines & pyrimidines, Double helical model of DNA structure and Types A, B & Z – DNA, denaturation and renaturation of DNA

UNIT II **(15)**

Protein Biochemistry: 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, Phophorylation, Lipids attachment, Glycolipids

Protein degradation – Lysosomal &proteosomal ubiquitination

UNIT III **(15)**

Enzymology

Classification - IUB system, overview and specific examples, Characteristics of enzymes, enzyme substrate complex. Enzymes–Activity, Regulation, Kinetics Michaelis – Menten Equation - form and derivation, steady state enzyme kinetics, Significance of Vmax and Km., Types of inhibitors - competitive, non-competitive and uncompetitive.

UNIT IV **(15)**

Concept of prosthetic group, apoenzyme, holoenzyme, enzyme. Coenzyme: 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.

Learning outcomes:

Students should be able to understand

- Basic concepts of biochemistry.
- Properties and role of biomolecules
- Details of protein biochemistry
- Enzymes, their structure, function and kinetics.

References:

1. Donald Voet & Judith Voet *Fundamentals of Biochemistry*, USA: JohnWiley and Sons Inc., 3rd edition (2008).
2. David Nelson & Michael Cox. *Lehninger, Principles of Biochemistry.* New York: W.H. Freeman and company, 5th Edition (2008).
3. Jeremy Berg, Lubert Stryer, New York: W.H.Freeman andcompany, 7th Edition (2012).
4. Erice Conn & Paul Stumpf, *Practical Biochemistry*, USA: John Wiley and Sons, 5th Edition, (2009),
5. Gary Walsch, *Proteins: Biotechnology and Biochemistry*, USA: Wiley- Blackwell, 2nd edition (2001).

6. David Plummer, *An Introduction to Practical Biochemistry*, India: TataMcGraw Hill Edu.Pvt.Ltd. 3rd Edition, (2001).
7. Satyanarayanan, U. and Chakrapani, U., *Biochemistry*, India: Uppala Author Publisher Interlinks, 3rd edition (2007).

MBTT 104: BASICS OF MICROBIOLOGY

Lectures 60 **Credits: 04**

Objective:

- To study micro organisms' cell structure, morphology, taxonomic significance
- To study nutritional requirements of micro organisms
- To understand industrial importance of micro organisms, growth kinetics
- To study staining and sterilization methods
- To learn bacterial pathogenesis, antimicrobial agents

UNIT I **(15)**

Molecular basis of Binary Fission, Cell Structure – Overview with emphasis on: Genetic mechanism determining bacterial shapes, Assembly of Flagella, Motility and Chemotaxis, Cell wall and Cell membrane (Gram Positive , Negative and Archaebacterial), Protoplast, Spheroplast, Lforms, Mycoplasma (taxonomic significance), Endospore formation(mechanism describing role of sensor kinases) Sporulation, Spore and Germination, Inclusion bodies, metachromatic granules in detail, cytoskeleton in prokaryotes. Include BGA – heterocyst formation ,Stalk formation, Trichrome formation ,Mycoplasma wrt taxonomic significance, Inclusion bodies, metachromatic granules (to be taught in detail)

UNIT II **(14)**

Common Nutrient Requirements, Types of media for growth of microorganisms, Nutritional Classification and Metabolic diversity of bacteria with specific examples, Quorum Sensing in Bacteria, Biofilm formation and Significance.

Methods in Microbiology: Sterilization Methods, Pure culture technique, Enrichment techniques, Preservation & Maintenance of culture, Staining & fixation (Monochrome staining and Negative staining ,Differential staining - Gram staining and Acid fast staining, Special staining techniques – Spore ,Capsule, Cell wall staining)

UNIT III **(15)**

Microbial Growth Kinetics

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 V **(15)**

Bacterial Pathogenesis: Entry of Pathogen in the host, colonization, Virulence factors, host factors, Molecular mechanism of pathogenesis of: *Mycobacterium tuberculosis*, Pathogenic *E. coli, Staphylococcus aureus* Pathogenicity Islands – Concept with example Molecular and immunological methods for disease diagnosis (of above mentioned pathogens) 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 *Staphylococcus aureus* (MRSA) Plasmid curing a possible approach for overcoming drug resistance.

Learning Outcome:

The students should acquire the knowledge about:

- Microbial evolution and systematic
- Molecular basis of binary fission, bacterial cell structure, endospore formation
- Metabolic diversity, quorum sensing and biofilm formation
- Class of microorganisms according to Microbial nutrition
- Nutritional requirement of micro organism, Basic components of Nutrient medium and their role
- Principles of sterilization, various agents of sterilization
- Types of staining. The Principles and procedures of staining microorganism
- Microbial growth kinetics, molecular adaptations of extremophiles
- Bacterial pathogenesis of various pathogens, antibacterial agents, multidrug resistance and plasmid curing.

Reference Books:

1. Ingraham JL and Ingraham CA. *Introduction to Microbiology*. Thomson Brooks / Cole. 3rd Edition, (2004).
2. Madigan MT, Martinko JM. *Brock's Biology of Microorganisms.* Pearson Education Inc. USA 11th Edition, (2006).
3. Salle AJ. *Fundamental Principles of Bacteriology*. Tata MacGraw Publishing Co. India 7th Edition, (1971).
4. Tortora, G.J., Funke B.R., Case C.L. *Microbiology: An introduction*, Benjamin Pub.Co. New York, 5th edition, (1992).
5. Davis B.D., Debacco, J.B. *Microbiology*, Lippincott Co. NY. 4th edition (1990).
6. Dey, N.C and Dey, TK. *Medical Bacteriology*, Allied Agency, India, 14th edition, (1988).
7. Ananthnarayana, R. and C.E, Jayaram Panakar. *Text book of microbiology*, Orient Longman. 5th edition (1996).
8. Stanier R.Y., Adelberg E.A. and Ingraham J.L. *General Microbiology*, Macmillan Press Ltd. 5th edition (1987).
9. Prescott L.M., Harley J.P., and Klein D.A. *Microbiology*, MacGraw Hill Companies Inc. 6th edition, (2005).

MBTP 105: Exercises in Molecular Biology and Cell Biology

Credits: 04

Molecular Biology

1. Eukaryotic DNA Isolation from - Plant Material / Animal Material 02
2. Genomic DNA isolation from bacteria 01
3. Plasmid isolation from *E.coli.* 02
4. Restriction digestion of DNA /Plasmid 01
5. Isolation of RNA 02

Cell Biology

1. Isolation of mitochondria and lysosomes by sucrose gradient centrifugation and analysis of fractions by assay of SDH and acid phosphatase activity respectively. 02
2. Isolation of chloroplasts / mitochondria from plant cells 02
3. Micrometry: determination of different cell sizes: bacterial / fungal / plant / animal cells 04

References:-

1. Lodish H., Berk A, Kaiser C., K., Reiger M., Bretscher A., Ploegh H., Angelika Amon A., Matthew P. Scott M.P. *Molecular Cell Biology*, New York: W. H. Freeman and Co., USA; 7th Edition, (2012).
2. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter. *Molecular Biology of the Cell*, New York: Garland Science; 5th edition (2007).
3. Gerald Karp. *Cell Biology*, USA: John Wiley & Sons, 6th edition, (2010).
4. Benjamin Lewin. *Genes XI,* Jones and Barlett Inc. USA. 11th edition (2012).

MBTP 106: Exercises in Biological Chemistry & Bacteriology

Credits: 04

Biological Chemistry

1. Extraction, purification and characterization of protein: Ammonium sulphate precipitation, 01
   a. Dialysis, 01
   b. Column Chromatography- Gel filtration, Ion exchange, Affinity 03
   c. Native PAGE and activity staining, SDS PAGE, 02
   d. Quantification and spectral analysis at each step of purification 01

2. Effect of pH, Temperature, time, varying Substrate concentration, inhibition on enzyme activity, Km and Vmax 02

Bacteriology

1. Isolation & maintenance of organism by plating, streaking & serial dilution isolation methods slants & stab culture, storage of microorganism 01
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 02
3. Effect of environmental parameters on bacterial growth curve and generation time 01
4. Effect of Environmental Factors on Growth of Bacteria: Salt, Temp, pH. 01
5. Enrichment and Isolation of: a) Halophiles b) Acidophiles c) Antibiotic Producers 03
6. Effect of Antibiotics on various Gram Positive and Gram Negative bacteria 01
7. Determination of Minimum Inhibitory Concentration (MIC) and Minimum Bactericidal Concentration (MBC) of various Antibiotics on different Organisms 02

Reference Books:

1. Ingraham JL and Ingraham CA. *Introduction to Microbiology*. Thomson Brooks / Cole. 3rd Edition, (2004).
2. Bergey's manual
3. D. K. Maheshwari and R. C. Dubey. *Practical Microbiology*, S. Chand Publishing, India. 2012.

MBTT 201: Genetics

Lectures 60 **Credits: 04**

Objective:

- To learn basics of genetics
- To understand principles of Mendelian and Microbial genetics
- To study the concept of cytogenetics, human and population genetics
- To study the effect of environment on genetics.

Unit I: Mendelian genetics (14)

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 (16)

Linkage and crossing over: Linkage – Defination, 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 (16)

Pedigree Analysis in Humans: Symbols, construction of pedigree, molecular genetic data, significance of pedigrees. Karyotyping: Classical karyotiping (banding techniques). Molecular karyotyping (FISH, M-FISH, SKY, QF-PCR and mBAND). Various karyotyping symbols used n human genetics. Quantitative genetics : Human Population and gene pool concepts, modes of speciation, genotype and allele frequencies, variation. Hardy Weinberg's Law, genetic equilibrium. Polygenic inheritance, heritability and its measurements, QTL mapping.

Unit IV: Microbial genetics and Environment (14)

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.

Expected outcomes:-

- The students should be acquainted with concepts in Mendelian, human and microbial genetics and its current applications.
- Students should be acquainted with general Mendelian genetics with its extensions and extra chromosomal inheritances.
- Students should be gaining the knowledge of cytogenetics with linkage, crossing over and chromosomal aberration.
- Students should be gaining the knowledge of human and population genetics with pedigree, karyotyping and quantitative genetics
- The students should be acquainted with concept of microbial genetics with transformation, conjugation, transduction and sex-duction and mutations.

References:-

1. Pasternak, *An Introduction to Molecular Human Genetics*, Fritzgerald, 2000
2. Gersen & Keagle, *The Principles of Clinical Cytogenetics*, Humana, 1999
3. Strachan & Read, *Human Molecular Genetics*, Wiley, 1999
4. Strickberger MW, *Genetics*, Prentice Hall-India,2006
5. Hartl DL, Jones EW, *Genetics: analysis of genes and genomes*, Jones and Bartlett, Massachusetts
6. David Freifelder, Stanley Maloy, John Cronan- *Microbial Genetics*, Jones and Bartlett Publishers, IInd edition (1994).
7. Roger Y Stanier, John Lingraham, Mark L Wheelis, Rage R Painter. *General microbiology*, Mcmillan publications, 5th Edition (1992).
8. Gardner, M. Jsimmons, D. P. Snustad. *Principles of genetics*, 8th edition (2006).

9. P. K. Gupta – *Genetics- A Text-book for University students*, Rastogi publications, IInd edition, 1990.
10. C. Sarin, *Genetics*, Tata McGraw-Hill Publications, 1985.

MBTT 202: Immunology and Virology

Lectures 60 **Credits 04**

Objective:

- To learn Human Immune system
- To understand transplantation technology to cure diseases
- To understand experimental model organism for research

Unit I **(15)**

Immunology – Fundamentals and anatomy of immune system, Immunity – Innate and acquired immunity. Components of innate and acquired immunity. Antigen, Haptens, adjuvants, mitogens. Antibodies – structure, functions. The anatomy of the immune response: - Cells and organs of immune system. 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.

Vaccine development (Live attenuated, killed and Recombinant Vaccines). Important criteria for designing an effective vaccine.

Unit II **(15)**

Clinical Immunology

Hypersensitivity: - 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.

Transplant immunology: Classification of Grafts, Immunological basis of acceptance of autografts and rejection of allografts, Acute, Hyperacute and Chronic rejections of transplant, Xenotransplantation and its clinical future, GVHD and Immunosuppressive therapy

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.

VIROLOGY

UNIT III **(15)**

Introduction to viruses:

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, immunodiagnosis

Antiviral: Mode of Action of various antiviral drugs with examples and Viral Vaccines.

UNIT IV **(15)**

Epidemiology:

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, Westnile 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

Learning outcome:

Students are expected to learn the following:

- Concept of Antigen antibody reactions.
- An Understanding of clinical transplantation.
- Autoimmunity and strategies for treating autoimmune diseases.
- Properties of viruses and their replication cycle.
- Mode of action of antiviral drugs and viral vaccines.

- Contribution of epidemiology in relation to public health.
- Concept of oncogenic virus and cancer immunology.

Reference Books:

1. Judy Owen, Jenni Punt, Sharon Stranford, *Kuby Immunology*, Freeman and Co., NY, 7th edition (2012).
2. Sudha Gangal and Shubhangi Sontakke, *Textbook of basic and clinical immunology*, University Press, India, 1st edition (2013).
3. David Male, Jonathan Brostoff, David Roth, *Immunology*, Roitt and Mosby, USA. 7th edition (2006).
4. F.H. Khan. *The Elements of Immunology*. Pearson Education (2009).
5. Flint Jane. S., ASM. *Principles of Virology,* (American Society of Microbiology) Press Publisher, 2 volumes, USA. 3rd edition, (1999).
6. Bernard. N. Fields, Lippincott and Williams. *Field's Virology* - Wilkins, USA, 5th edition, (2006).

MBTT 203: Plant Biotechnology

Lectures 60 **Credits: 04**

Objectives

- Economic importance and cultivation of Algae and Mushroom
- Transgenic methods to improve plant productivity
- Importance of secondary metabolites in plants
- Molecular approaches used for plant breeding and trait selection

Unit I **(15)**

Algal Biotechnology- Study of economically important algae like Spirulina, Dunaliella, Chlorella, seaweeds and their cultivation, Applications- Single Cell Proteins, Biofuels, Pigments and phycocolloids, Algal Transgenics Fungal Biotechnology-Study of economically important Mushrooms (Agaricus, Pleurotus, Lentinus), Commercial cultivation of Mushrooms

Unit II **(15)**

Secondary metabolites in plants- 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)**

Introduction, Methods of Transgenesis (Vector mediated and non-vector based gene transfer) Transgenic plants for biotic stress tolerance (Fungi, bacteria, viruses, Insects, weeds)

Transgenic plants for abiotic stress tolerance (Drought, Salt, Temperature) Transgenic plants for production of Secondary metabolites

Increase in productivity by manipulation of Photosynthesis and Nitrogen fixation.

Unit IV **(15)**

Molecular markers in plants: RAPD, AFLP, ISSR, SSR markers, marker based applications trait selection, eco-TILLING Molecular Farming- Improvement in Carbohydrates, Proteins, Lipids, Plantibodies, Edible vaccines

Expected Outcomes:

Students should understand:

- Importance of algal biotechnology.
- Molecular markers and their applications.
- Plant vectors for transformation and mechanism.

Reference books:

1. Chawla, H. C. *Introduction to Plant Biotechnology*. Oxford & IBH publishing, 3rd edition (2004).
2. Davies K–*Plant Pigments and their manipulation*-Annual plant reviews- Blackwell Publishing, Oxford, UK. Vol 14 (2004).
3. Altman, A and Hasegawa P M– *Plant Biotechnology and Agriculture Prospects for the 21st century*, Amsterdam [Netherlands]: Academic Press, Boston, Massachusetts. (2012).
4. Bhojwani,S S and Razdan M.K. *Plant Tissue Culture: Theory and Practices.* Elsevier Science. 1st edition (1996).
5. Slater A, Scott, N W, Fowler, M R–*Plant Biotechnology: Genetic manipulation of Plants.* OUP Oxford, 2nd edition (2008).
6. Rai, M. *Fungal Biotechnology.* IK Intrernational (2009).
7. Vasil K., Thorpe T A. *Plant cell and Tissue Culture*. Springer (1994).
8. Becker E. W. *Microalgae: Biotechnology and Microbiology*. Cambridge University Press, Medical. (1994)
9. Chang Shu-ting, Hayes W. A. The Biology and Cultivation of Edible Mushrooms. Academic Press, - Technology & Engineering - (1978).

MBTT 204: Environmental Biotechnology

Lectures 45 **Credits: 03**

Objective

- To understand Global and regional threats to the environment.
- To understand Role of Biotechnology in effluent treatment.
- To understand the environmental laws.

Unit I **(11)**

Global and regional threats to the environment: Air, water and soil Pollution: Types, sources and impacts, Solid waste: Sources and types, Impact on land of solid waste disposal, Recycle Reuse and Recovery.

Unit II **(12)**

Biotechnology and environmental pollution control (waste water and air), Biotechnology in control of Industrial pollution and safe disposal of industrial effluents (with 2-3 examples of Industrial effluent types and treatment) Hospital waste management

Unit III **(12)**

Biodegradation: Biodegradation of xenobiotic compounds: Priority pollutants and their health effects, Microbial basis of biodegradation Biopesticides, Microbial plastics. Bioremediation: Meaning, Types, Process with examples, bioremediation of waste water (MSW, BSW, ISW), activated sludge process Phytoremedaition Metal remediation Biofiltration Bioaugmentation, Biostimulation. Agricultural bioremediation: Microbial composting, biogas

Unit IV **(10)**

Environmental management: Problems and need Environmental management Plan: scope, EMP preparation , Need of EMP Environmental Impact Assessment: Objectives of EIA, EIA and International organizations Stages of EIA process EIA in India: Process Stages of Environmental clearance process, ISO 14000 Environmental audits and ethics Environmental Laws and Policies

Learning Outcome:

The students should acquire the knowledge about:

- Global and regional threats to the environment; Air, water and soil pollution.
- Role of Biotechnology in effluent treatment, biodegradation, bioremediation, bioaugmentation with examples.
- Concept of EIA and environmental laws.

Reference Books:

1. Indu Shekhar Thakur. *Environmental Biotechnology: Basic Concepts and Applications,* I. K. International Pvt Ltd, (2006).
2. Gareth M. Evans and Judith C. Furlong. *Environmental Biotechnology Theory and Application*, John Wiley & Sons Inc (2003).
3. Alan H. Scragg. *Environmental Biotechnology*, Oxford University Press. 1st edition (2006).
4. S.K. Agarwal. *Environmental Biotechnology*, APH Publishing Co-operation, New Delhi (2007)
5. Alexander N. Glazer and Hiroshi Nikaido. *Microbial Biotechnology*, Cambridge University press. 2nd edition, (2010).
6. A.G. Murugesan and C. Rajakumari. *Environmental Science and Biotechnology Theory and techniques.* MJP Publishers, Chennai (2006).
7. Holmes, G; Singh, B R; Theodore, L. *Handbook of Environmental management and technology*, USA: Wiley Intersciences Publishers (2000).
8. Gopal Nath Tiwari and R K Mishra. *Advanced Renewable Energy Sources.* RSC Publishing, London (2012).
9. HVN Rao and M N Rao Tata. *Air Pollution.* McGraw-Hill, New Delhi (2004).
10. CP Mahajan. *Air Pollution Control*, Capital Publishing Co, New Delhi.
11. Wayne T Davis. *Air Pollution Engineering Manual*. Air and Waste Management Association, Wiley Interscience, New Jersey (2000).
12. Suchandra Choudhury. *An Introduction To Geographic Information Technology*. IK International Pvt Ltd., New Delhi (2009).
13. Baker, K.H and Herson, D.S. *Bioremediation*. McGraw Hill, Inc. New York, (1994).

14. M.V.Levin and Gealt, M.A. *Biotreatment of Industrial & Hazardous Waste*. McGraw Hill. Inc, New York (1993).
15. C.P.L. Albert and K.W. Yeung. *Concepts and Techniques of Geographic Information Systems.* Prentice Hall, Inc., New Jersey. 2nd edition, (2009).
16. Saha T K. *Ecology and environmental biology.* Books & Allied (p) Ltd, Delhi (2011).
17. Asthana & Asthana. *Environment Problems & Solutions.* S. Chand Limited, New Delhi (2001).

MBTT 205: Bio-entrepreneurship

Lectures: 30 **Credits: 02**

Objectives:

- Understanding the dynamic role of entrepreneurship and small businesses
- Organizing and Managing a Small Business
- Financial Planning and Control
- Forms of Ownership for Small Business
- Strategic Marketing Planning
- New Product or Service Development
- Business Plan Creation

UNIT I **(15)**

An Overview of Entrepreneurs and Entrepreneurship: definition, Basic principles and practices of management- Definition, concepts and application; Organization types, coordination, control and decision making in management Characteristics for being an entrepreneur in biotechnology, Case studies of successful and unsuccessful bio-entrepreneurs

Core concept of Market: Identification and evaluation of market potential of various bioentrepreneur sectors.

Marketing, Marketing research- concept and techniques

UNIT II **(15)**

Types of Enterprises and Ownership Structure: small scale, medium scale and large scale enterprises, role of small enterprises in economic development; proprietorship, partnership, Ltd. companies and co-operatives: their formation, capital structure and source of finance.

Projects: identification and selection of projects; project report: contents and formulation, concept of project evaluation, methods of project evaluation: internal rate of return method and net present value method.

Role of government and schemes, financial institutions in fostering bioentrepreneurship

Factors affecting biotech business: (finance, infrastructure, equipment, manpower, resources, project location, end product, quality issues, etc)

Outcomes:

- Students can able to develop the business plan.
- Students can understand fundamentals of Management and Administration.
- Students will understand Legal forms of the business for registration of the small scale industries, agencies for the registration of the companies.

References:

1. S N Jogdand. *Entrepreneurship And Business Of Biotechnology*, Himalaya Publisher (2007).
2. S Anil Kumar. *Entrepreneurship Development*, New Age International (P) Ltd. Publishers (2003).
3. Robert Mellor. *Entrepreneurship for Everyone: A Student Textbook*, Sage Publication Ltd1. (2009).
4. Richard Blundel & Nigel Lockett. *Exploring Entrepreneurship: Practices and Perspective*. Oxford University Press (2011).
5. Shreefal S. Mehta. *Commercializing Successful Biomedical Technologies*. Cambridge University Press, (2008).
6. Patzelt, Holger, Brenner, Thomas. *Handbook of Bioentrepreneurship*. Springer (2008).

MBTP 206: Laboratory Exercises in Genetics, Immunology and Virology

Credits: 04

Genetics

1. Determination of mitotic index	01
2. Karyotype analysis of Allium cepa	01
3. Problems based on Mendelian genetics	03
4. Problems based on linkage and crossing over	02
5. Bacterial transformation	02
6. Bacterial conjugation	01

Immunology

1. ELISA	01
2. Immunodiffusion	01
3. Immunoelectrophoresis	01
4. Rocket immunoelectrophoresis	01
5. Western blotting	01
6. Widal Test	01

Virology

1. Routes of virus inoculation in embryonated eggs.	02
2. Phage Assay	02

Learning outcome:

- Student is expected to know simple applied immunology and virological techniques.
- Models should bring clarity in concepts of antigen antibody interaction.

Reference:

1. Practical Biochemistry: An Introductory Course by Fiona Frais. University park press, (2016).
2. S.P.Colowick and N.O.Kaplan. *Methods in Enzymology* Vol. I
3. R.R.Alexander and J.M.Griffith. *Basic Biochemical Methods*. John Wiley & Sons, Chichester 2nd edition (1985).
4. S.Sadasivam and A. Manickam. *Biochemical Methods.* New Age International Publication. 2nd edition (2005).

5. Bernard L Oser. *Hawk's Physiological Chemistry* (1966).
6. David Plummer. *A Textbook of Practical Biochemistry*. McGraw Hill Education. 3rd edition (2017).

MBTP 207: Laboratory Exercise in Plant Biotechnology and Environmental Biotechnology

Credits: 04

Plant Biotechnology

1. Spirulina/ Chlorella culture or Pleurotus cultivation and biochemical analysis 01
2. Molecular markers used in plant trait selection 03
3. Protoplast isolation 01
4. In vitro production of secondary metabolites 02
5. Initiation of hairy root culture / Anther culture 01
6. Cell suspension culture and growth analysis 02

Environmental Biotechnology

7. Isolation of microorganism from polluted soil. 02
8. Genotoxicity assay of polluted water on Onion root tip and pollen germination assay. 02
9. Bioremediation of heavy metals 02
10. Estimation of TSS, DO, BOD and COD of waste water. 03
11. Acquisition of "Google Earth" images for the known and unknown area for land use land cover mapping. 01

Learning Outcomes:

- Students will acquire the knowledge of techniques in plant biotechnology
- Students will get skill of algae and plant cultures.
- Students will gain practical knowledge about environmental pollution assessment methods.

References:

1. Hrudayanath Thatoi, Supriya Dash. *Practical Biochemistry (Principle and protocols)* – Dreamtech Press, 2nd edition (2020).
2. G. Swarajya Lakshmi. *Environmental Science - A practical Manual* – BS Publications (2018).
3. S. S. Bhojwani & M. K. Razdan. *Plant tissue culture-Theory & practice.* Elsevier Science; 1st edition (1996).

4. Gamborg O. L. and Phillips G. C. *Plant Cell, Tissue and Organ Culture: Fundamental Methods*- Springer; 1st edition (1995).