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: 2018-19

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	5	4	MBTP--105 : Exercises in Molecular Biology and Cell Biology	5	5	4
2	MBTT--102	Molecular Biology	4	5	4				
3	MBTT--103	Biological Chemistry	4	5	4	MBTP--106 : Exercises in Biological Chemistry & Bacteriology	5	5	4
4	MBTT--104	Basics of Microbiology	4	5	4				
	Total of SEM I		**16**	**20**	**16**		**10**	**10**	**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	5	5	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	5	5	4
4	MBTT--204	Environmental Biotechnology	4	4	4				
	Total of SEM II		**20**	**20**	**20**		**10**	**10**	**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 I MBTT--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
Overview of Membrane Transport
ATP-Powered Pumps and the Intracellular Ionic Environment, Nongated Ion Channels and the Resting Membrane Potential, Cotransport by Symporters and Antiporters, Movement of Water, Transepithelial Transport, Voltage-Gated Ion Channels and the Propagation of Action Potentials in Nerve Cells, Neurotransmitters and Receptor and Transport Proteins in Signal Transmission at Synapses.

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:

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

Reference Books:

1. Molecular Cell Biology. 7th Edition, (2012) Lodish H., Berk A, Kaiser C., KReiger M., Bretscher A., Ploegh H., Angelika Amon A., Matthew P. Scott M.P., W.H. Freeman and Co., USA

2. Molecular Biology of the Cell, 5th Edition (2007) Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter. Garland Science, USA
3. Cell Biology, 6th edition, (2010) Gerald Karp. John Wiley & Sons., USA
4. The Cell: A Molecular Approach, 6th edition (2013), Geoffrey M. Cooper, Robert E.

MBTT 102- Molecular Biology

Lectures: 60 **4 Credits**

Objective:

1. To make the student aware of advance concepts of Genomic organization.
2. The role of DNA in a range of gene expression and regulation.
3. 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, super-families, 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. Genes XI, 11th edition (2012), Benjamin Lewin, Publisher - Jones and Barlett Inc. USA
2. Molecular Biology of the Gene, 6th Edition (2008), James D. Watson, Tania Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Lodwick. Pearson Education, Inc. and Dorling Kindersley Publishing, Inc. USA
3. Molecular Biology, 5th Edition (2011), Weaver R., McGrew Hill Science. USA
4. Fundamentals of Molecular Biology, (2009), Pal J.K. and SarojGhaskadbi, Oxford University Press. India
5. Molecular Biology: genes to proteins, 4th edition (2011), Burton E Tropp, Jones &Bartlett Learning,USA
6. Essential molecular biology, vol. I, Brown T A (1995) A practical approach, IRL press, Oxford.
7. Genes XI, 11th edition (2012), Benjamin Lewin, Publisher - Jones and Barlett Inc. USA
8. Molecular Biology of the Gene, 6th Edition (2008), James D. Watson, Tania Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Lodwick. Pearson Education, Inc. and Dorling Kindersley Publishing, Inc. USA
9. Molecular Biology, 5th Edition (2011), Weaver R., McGrew Hill Science. USA
10. Fundamentals of Molecular Biology, (2009), Pal J.K. and SarojGhaskadbi, Oxford University Press. India
11. Molecular Biology: genes to proteins, 4th edition (2011), Burton E Tropp, Jones &Bartlett Learning,USA
12. Essential molecular biology, vol. I, Brown T A (1995) A practical approach, IRL press, Oxford.

MBTT 103: Biological Chemistry

Lectures: 60 **Credits: 04**

Objectives:

1. To make students aware of different types of biomolecules and their role
2. To make students aware of basic concepts of protein biochemistry.
3. 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

a. Basic concepts of biochemistry.
b. Properties and role of biomolecules
c. Details of protein biochemistry
d. Enzymes, their structure, function and kinetics.

References:

1. Fundamentals of Biochemistry. 3rd Edition (2008), Donald Voet & Judith Voet , John Wiley and Sons, Inc. USA
2. Lehninger, Principles of Biochemistry. 5th Edition (2008), David Nelson & Michael Cox, W.H. Freeman and company, NY.
3. Biochemistry: 7th Edition, (2012), Jeremy Berg, LubertStryer, W.H.Freeman and company, NY
4. Outlines of Biochemistry: 5th Edition, (2009), Erice Conn & Paul Stumpf ; John Wiley and Sons, USA
5. Proteins: biotechnologyand biochemistry, 1st edition (2001), Gary Walsch, Wiley, USA
6. An Introduction to Practical Biochemistry.3rd Edition, (2001), David Plummer, Tata McGraw Hill Edu.Pvt.Ltd. India
7. U. Satyanarayanan, Biochemistry: Uppala Author Publisher Interlinks, 3rd Ed.(Unit I, III,IV)

MBTT 104: FUNDAMENTALS 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 microorganisms, growth kinetics
- To study staining and sterilization methods
- To learn bacterial pathogenesis, antimicrobial agents

UNIT I **(15L)**

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 **(15L)**

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 **(15L)**

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 **(15L)**

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. Introduction to Microbiology. 3rd Edition, (2004), Ingraham JL and Ingraham CA. Thomson Brooks / Cole.
1. Brock's Biology of Microorganisms. 11th Edition, (2006). Madigan MT, Martinko JM. Pearson Education Inc. , USA
2. Fundamental Principles of Bacteriology. 7th Edition, (1971) Salle AJ. Tata MacGraw Publishing Co. India
3. Microbiology: An introduction, 5th edition,(1992), Tortora, G.J., Funke B.R., Case C.L, Benjamin Pub.Co. NY
4. Microbiology, 4th edition (1990), Davis B.D. ,Debacco, J.B. Lippincott Co. NY, Zinsser, W , 1976, Microbiology Edition, W .K Joklik, NY
5. Medical Bacteriology, 14th edition, (1988), Dey, N.C and Dey, TK., Allied Agency, India
6. Text book of microbiology 5th edition (1996), Ananthnarayana, R. and C.E, Jayaram Panakar, Orient Longman.
7. General Microbiology, 5th edition (1987), Stanier R.Y., Adelberg E.A. and Ingraham J.L..Macmillan Press Ltd.
8. Prescott L.M., Harley J.P., and Klein D.A. (2005). Microbiology, 6thEdition. MacGraw Hill Companies Inc.

MBTP--105: Exercises in Molecular Biology and Cell Biology

Credits: 04

Learning Objectives:

- To make students aware of basic techniques in Molecular biology
- To provide hands on skill for handling of genetic material
- To provide basic knowledge of isolation techniques
- To impart skill of measuring the microscopic objects

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)

Learning Outcomes:

- Students will acquire knowledge of basic techniques in Molecular biology
- Students will get hands on skill for handling of genetic material
- Students will understand basic knowledge of isolation techniques
- Students will learn skill of measuring the microscopic objects

References:-

1. Molecular biology of Cell-Albert
2. Molecular biology & cell biology – Loddish et al
3. Genes- Lewin.
4. Cell biology –Geral karp

MBTP--106: Exercises in Biological Chemistry & Bacteriology

Credits: 04

Learning Objectives:

- To provide the practical skills of protein extraction, purification and characterization
- To provide practical knowledge of enzyme assays.
- To provide knowledge about basic microbial techniques

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 V_{max} 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

Learning Outcomes:

- Students will acquire the practical skills of protein extraction, purification and characterization

- Students will get practical knowledge of enzyme assays.
- Students will get knowledge about basic microbial techniques

Reference Books:

1. Introduction to Microbiology. 3rd Edition, (2004), Ingraham JL and Ingraham CA. Thomson Brooks / Cole.
2. Bergey's manual
3. Practical Microbiology by D.K.Maheshwari and R.C.Dubey
4. Practical Biochemistry - J. Jayaraman
5. Practical Biochemistry - David Plummer

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 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, and significance of pedigrees.Karyotyping**:** Classical karyotiping (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. Polygenic 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.

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 L ingraham, Mark L Wheelis,Rage R Painter General microbiology,5th Edition, Mcmillan publications,1992.
8) Gardner ,M.Jsimmons,D.P Snustad-Principles of genetics , 8th edition.
9) Larry syndeer wendy champness,"Molecular genetics of Bacteria".
10) P.K.Gupta – Genetics -A Text-book for University students, IInd edition ,Rastogi publications ,1990.
11) 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, WestnileZika 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. Kuby Immunology, Judy Owen , Jenni Punt , Sharon Stranford., 7th edition (2012), Freeman and Co., NY
1. Textbook of basic and clinical immunology, 1st edition (2013), SudhaGangal and ShubhangiSontakke, University Press, India.
2. Immunology, 7th edition (2006), David Male, Jonathan Brostoff, David Roth Roitt and Mosby, USA. Roitt's Essential Immunology (2011), 12th edition, Wiley and Black Well.
3. The Elements of Immunology. F.H. Khan (2009), Pearson Education.
4. Principles of Virology 3rd edition, (1999), Flint Jane. S., ASM (American Society of Microbiology) Press Publisher, 2 volumes, USA.
5. Field's Virology - 2 volumes, 5th edition, (2006), Bernard.N. Fields, Lippincott and Williams Wilkins, USA

MBTT 203: Plant Biotechnology (4C)

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,

Reference books:

1. Chawla, H. C. (2004) Introduction to Plant Biotechnology
2. Davies K (2004) –Plant Pigments and their manipulation-Annual plant reviews-Vol 14
3. Altman,A and Hasegawa P M (2012) – Plant Biotechnology and Agriculture Prospects for the 21st century
4. Bhojwani,S S and Razdan M.K.(1996) Plant Tissue Culture: Theory and Practices
5. Slater A, Scott,N W, Fowler, M R(2008) –Plant Biotechnology: Genetic manipulation of plants
6. Rai, M (2009) Fungal Biotechnology (IK Intrernational)
7. Vasil K., Thorpe T A.(1994) Plant cell and Tissue Culture
8. Becker E. W. (1994) Microalgae: Biotechnology and Microbiology (Cambridge University Press, - Medical - 293 pages)
9. Chang Shu-ting, Hayes W. A. (1978) The Biology and Cultivation of Edible Mushrooms Academic Press, - Technology & Engineering - 819 pages

MBTT 204: Environmental Biotechnology

Lectures 60 **Credits: 04**

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 **15**

Global and regional threats to the environment:, Green House Effect & Global Warming, Sources of greenhouse gases, Effect Measurement & control of greenhouse effect, problem of ozone, ozone hole, effect of ozone depletion, measurement & control, Development of acid rain, effects, measurement & control. Environmental sustainability & Biotechnology.

Unit II **15**

Environmental pollution, general, source and nature, 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. 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 **15**

Biotechnological methods for management of pollution, atmosheric Co_2 reduction, management of metal pollution, immobilized cells in management of pollution , 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 Phytoremediation Metal remediation Biofiltration Bioaugmentation, Biostimulation. Agricultural bioremediation: Microbial composting, biogas

Unit IV **15**

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 (2006) Environmental Biotechnology: Basic Concepts and Applications, I. K. International Pvt Ltd, 2006 (Unit III , Unit II)
2. Gareth M. Evans and Judith C. Furlong (2003) Environmental Biotechnology Theory and Application, John Wiley & Sons Inc (Unit I Unit II).

3. Alan H. Scragg (2006) Environmental Biotechnology , 1st edition , Oxford University Press (Unit IV)
4. S.K. Agarwal (2007) Environmental Biotechnology , APH Publishing Co-operation , New Delhi(Unit II)
5. Alexander N. Glazer and Hiroshi Nikaido (2010) Microbial Biotechnology, 2nd edition, Cambridge University press.(Unit II Unit III)
6. A.G. Murugesan and C. Rajakumari (2006) Environmental Science and Biotechnology Theory and techniques MJP Publishers , Chennai (Unit II)
7. Gwendolyn Holmes Bruce et al, (2000), Handbook of Environmental management and technology, Wiley Intersciences Publishers(Unit II)
8. Advanced Renewable Energy Sources (2012) GopalNathTiwari and R K Mishra, RSC Publishing, London Unit I Unit I Unit IV)
9. Agenda 21: Guidelines for Stakeholders Patwardhan&Gunale, Pune.(Unit II)
10. Air Pollution (2004) HVN Rao and M N RaoTata McGraw-Hill, , New Delhi
11. Air Pollution Control CP Mahajan, Capital Publishing Co, New Delhi(Unit IV)
12. Air Pollution Engineering Manual (2000) Wayne T Davis (editor), Air and Waste Management Association, Wiley Interscience,, New Jersey(Unit III)
13. An Introduction To Geographic Information Technology (2009) Suchandra Choudhury I K International Pvt Ltd., New Delhi(Unit III)
14. Bioremediation (1994) Baker, K.H and Herson, D.S.McGraw Hill, Inc. New York
15. Biotreatment of Industrial & Hazardous Waste (1993) M.V.Levin and Gealt, M.A. McGraw Hill. Inc, New York
16. Concepts and Techniques of Geographic Information Systems (2009) C.P.Lo.Albert and K.W.Yeung 2nd edition, Prentice Hall, Inc., New Jersey
17. Ecology and environmental biology (2011) Saha T K Books & Allied (p) Ltd, Delhi
18. Environment Problems & Solutions (2001) Asthana&AsthanaS. Chand Limited, New Delhi (Unit IV)

MBTP- 206: Laboratory Exercises in Genetics, Immunology and Virology

Credits: 04

Learning objectives:

- To teach students problems based on Mendelian genetics
- To provide practical knowledge of bacterial genetics
- To provide hands on skill for immunological assays
- To impart skill of virus inoculation and screening techniques

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 and Virology

1. ELISA 01
2. Immunodiffusion 01
3. Immunoelectrophoresis 01
4. Rocket immunoelectrophoresis 01
5. Western blotting 01
6. Widal Test 01
7. Routes of virus inoculation in embryonated eggs. 02
8. Phage Assay 02

Learning outcome:

- Students will be able to solve problems based on Mendelian genetics
- Students will get practical knowledge of bacterial genetics
- Student is expected to know simple applied immunology and virology techniques.
- Models should bring clarity in concepts of antigen antibody interaction.

Reference:

1. Practical Biochemistry: An Introductory Course by Fiona Frais.
2. Methods in Enzymology Vol. I by S.P.Colowick and N.O.Kaplan eds.
3. Basic Biochemical Methods 2nd ed by R.R.Alexander and J.M.Griffith
4. Biochemical Methods 2nd ed. by S.Sadasivam and A. Manickam.
5. Hawk's Physiological Chemistry ed. by Bernard L Oser.
6. A Textbook of Practical Biochemistry by David Plummer.
7. Laboratory Manual in Biochemistry by S. Jayaraman.

MBTP 207: Laboratory Exercise in Plant Biotechnology and Environmental Biotechnology

Credits: 04

Objectives:

- To provide students with the knowledge of techniques in plant biotechnology
- To impart skill of algae and plant cultures.
- To provide students practical knowledge about environmental pollution assessment methods.

Plant Biotechnology

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

Environmental Biotechnology

7. Isolation of microorganism from polluted soil. 2
8. Genotoxicity assay of polluted water on Onion root tip and pollen germination assay. 2
9. Bioremediation of heavy metals 2
10. Estimation of TSS, DO, BOD and COD of waste water. 3
11. Acquisition of "Google Earth" images for the known and unknown area for land use - land cover mapping. 1

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:

- Practical Biochemistry (Principle and protocols) – 2nd edition – Hrudayanath Thatoi , Supriya Dash
- Environmental Science - A practical Manual –G. Swarajya Lakshmi
- Plant tissue culture-Theory & practice-S.S.Bhojwani & M.K. Razdan, Elsevier Science; 1 edition (1996)
- Plant Cell, Tissue and Organ Culture: Fundamental Methods-GamborgO. L. and Phillips G. C., Springer; 1 edition (1995)