CVM UNIVERSITY

MASTER OF SCIENCE

(BIOTECHNOLOGY)

PROGRAMME

Under Choice Based Credit Scheme

Structure with Effect From: 2020-21

M.Sc. Biotechnology Programme Details

Programme Objectives (POs):

At the time of completion of the programme the student will have developed extensive knowledge in various areas of Biotechnology. Through the stimulus of scholarly progression and intellectual development the programme aims to equip students with excellence in education and skills, thus enabling the student to pursue a career of his/her choice. By cultivating talents and promoting all round personality development through multi-dimensional education a spirit of self-confidence and self-reliance will be infused in the student. The student will be instilled with values of professional ethics and be made ready to contribute to society as responsible individuals.

Programme Specific Outcomes (PSOs):

At the end of the two-year programme the student will understand and be able to explain different aspects of Biotechnology. The student will be able to explain about various applications of Biotechnology such as Environmental Biotechnology, Industrial Biotechnology, Food Biotechnology, Medical Biotechnology, Bioinformatics, etc. He/she will be able to design and execute experiments related to Molecular Biology, Recombinant DNA Technology, Immunology, Plant and Animal Biotechnology and Computational Biology. They will be able to execute a short research project incorporating techniques of Biotechnology under supervision. The student will be equipped to take up a suitable position in academia or industry, and to pursue a career in research if so desired.

Programme Structure:

The M.Sc. Biotechnology programme is a two-year course divided into four-semesters. A student is required to complete hundred credits for the completion of course and the award of degree. A student has to accumulate twenty-five credits in each of the four semesters.

PART ONE	FIRST YEAR	SEMESTER I	SEMESTER II
PART TWO	SECOND YEAR	SEMESTER III	SEMESTER IV

Course Credit Scheme

Semester I

Course Type	Course Code	Name of Course	T/P	Credits	Exam Duration (Hrs)	Components of Marks		
						Internal	External	Total
						Total/ Passing	Total/ Passing	Total/ Passing
Core Course	101420101	Molecular Biology	T	4	3	40/16	60/24	100/40
	101420102	Bioanalytical Techniques and Instrumentation	T	4	3	40/16	60/24	100/40
	101420103	Cell Biology	T	4	3	40/16	60/24	100/40
	101420104	Practicals based on 101420101 and 101420102	P	4	3	40/16	60/24	100/40
	101420105	Practicals based on 101420103 and Elective (any one) subject	P	4	3	40/16	60/24	100/40
	101420106	Comprehensive Viva	P	1			50/20	50/20
Elective Course	101420107	Fundamentals of Biochemistry and Bioenergetics	T	4	3	40/16	60/24	100/40
	101420108	Food Biotechnology	T	4	3	40/16	60/24	100/40
	101420109	Marine Biotechnology	T	4	3	40/16	60/24	100/40
	101420110	Virology	T	4	3	40/16	60/24	100/40

Course Wise Content Details for M.Sc. (Biotechnology) Programme

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101420101: Molecular Biology

Course Objectives:

The objectives of this course are to make students understand how molecular machines are constructed and regulated so that they can accurately copy, repair, and interpret genomic information in prokaryotes and eukaryotic cells. Further, to appreciate the subject of molecular biology as a dynamic and ever-changing experimental science.

Course Learning Outcomes:

Unit 1: Students should be able to acquire basic knowledge on DNA structure, different conformations of DNA, supercoiling and DNA-protein interactions.

Unit 2: Students should be clear about organization of prokaryotic and eukaryotic genomes and should learn various molecular events that lead to duplication of DNA.

Unit 3: Students should have understood the process of transcription in prokaryotic and eukaryotic cells. They should have clear understanding of pre and post transcriptional modifications happening in the cells.

Unit 4: Student should have learnt protein synthesis in prokaryotic and eukaryotic cell along with processing of proteome in cell.

Contents:

UNIT -1

DNA structure

Chemistry of DNA, DNA structure, Different conformations of DNA (B, A and Z), Denaturation and Renaturation (Cot curves) of DNA. DNA topology: Supercoiling, Biology of Supercoiled DNA, DNA topoisomerases and their mechanism of action. DNA- protein interactions: General features, Sequence specific DNA binding protein motifs, ssDNA binding proteins.

UNIT –II

Organization of genome and its replication

Packaging of DNA and organization of chromosome in bacterial cells; Packaging of DNA in eukaryotic nucleosome and chromatin condensation, assembly of nucleosomes upon replication, chromatin modification.

Mechanism of DNA polymerase catalyzed synthesis of DNA, Types of DNA polymerases in bacteria, Initiation of DNA replication and its regulation in prokaryotes, assembly of replisome and progress of replication fork, termination of replication. DNA replication in eukaryotes and archaea. Inhibitors of DNA replication.

UNIT -III

Transcription

RNA polymerases, features of prokaryotic and eukaryotic promoters, assembly of transcription initiation complex in prokaryotes and eukaryotes, and its regulation; synthesis and processing of prokaryotic and eukaryotic transcripts.

UNIT-IV

Translation & Processing of proteome

Structure and role of t-RNA in protein synthesis, ribosome structure, basic features of genetic code and its deciphering, translation (initiation, elongation and termination in detail in prokaryotes as well as eukaryotes).

Post-translational processing of proteins (protein folding, processing by proteolytic cleavage, processing by chemical modification, Inteins), Protein degradation.

References:

1. Lewin's Genes X: Jocelyn E. Krebs
2. Molecular Biology of the Gene 6th Edition: Watson et al
3. Molecular Genetic of Bacteria 3rd Edition: Snyder and Champness
4. Molecular Biology: Genes to Proteins, 4th Edition: Burton E Tropp
5. Principles of Genetics 6th Edition: Snustad and Simmons
6. Genomes, 3rd Edition: T.A. Brown

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101420102: Bioanalytical Techniques and Instrumentation

Course Objectives:

The course will enable the students to understand the principle and working of visualization techniques, separation techniques, spectroscopic techniques for analysis of the samples and principles and applications of tracer techniques in biology. Principles and applications of different types of microscopy, principle & application of cytophotometry and flow cytometry, centrifugation, electrophoresis chromatography, spectroscopy, radioactivity, radiation counters, x-ray diffraction will be known to the students.

Course Learning Outcomes:

Unit 1: Deals with the knowledge of different types of microscopes such as Light microscope, Compound microscope, Dark field, Bright field, Stereo microscope, Confocal, Phase contrast microscope, Fluorescent microscope, Transmission Electron Microscopy (TEM) and Scanning Electron Microscopy (SEM). It also deals with the principle and application of cytophotometry and flow cytometry.

Unit 2: Enrich the concept and application for separation of molecules by different types of centrifugation techniques. Knowledge of separation by horizontal and vertical gel electrophoresis is also anticipated. The separation of molecules by different types of chromatographic techniques will be learnt.

Unit 3: Explore the consideration of principle and analysis of samples by different spectroscopic techniques such as UV, Visible, IR (including FTIR and ATR), AAS, NMR, Mass, MALDI-TOF, fluorescence, CD spectroscopy etc. will be learnt.

Unit 4: Gather the concept of radioactivity autoradiography, different types of counters used to trace the radiation will be studied. The principle and application of x-ray diffraction methods to study the structure of biopolymer will be known.

Contents:

Unit I

Visualization techniques:

Principle of working and applications of bright field & dark field microscopy, phase contrast microscopy, fluorescence microscopy, confocal microscopy, scanning and transmission electron

microscopy, scanning tunneling microscopy, atomic force microscopy. Principle and applications of cytophotometry and flow cytometry.

Unit II

Separation techniques:

Basic principle and application of analytical and preparative centrifugation, settling time & velocity, types of rotor, sedimentation coefficient, relative centrifugal force (RCF) differential, density and ultracentrifugation.

Principle and applications agarose and 2D gel electrophoresis. Capillary electrophoresis and its applications. Native-PAGE, SDS-PAGE

Principle, methodology and applications of gel–filtration, ion–exchange and affinity chromatography; Thin layer and High-Performance Thin Layer Chromatography. Gas chromatography, High performance liquid chromatography and FPLC.

Unit III

Spectropscopy

Basic principle of electromagnetic radiation, instrumentation and applications of UV, Visible, IR (including FTIR and ATR), AAS, NMR, Mass, MALDI-TOF, fluorescence and CD spectroscopy.

Unit IV

Principle and applications of tracer technique in biology:

Concept of radioactivity, rate of radioactive decay; units of radioactivity- uses of radioisotopes in life sciences and biotechnology; autoradiography; cerenkov radiation; radiation dosimetry; ionization and scintillation-based detection of radioactivity.

Principle of biophysical methods used for analysis of biopolymer structure: X-ray diffraction.

References:

1. Instrumental method of chemical analysis: Sharma B K
2. Instrumental methods of analysis: D A Skoog
3. An introduction to practical Biochemistry: Plummer
4. Instrumentation: Chatwal and Anand
5. Modern experimental Biology: Boyer
6. Freifelder D. M. Physical Biochemistry- Application to Biochemistry and Molecular Biology, 2nd ed., W.H. Freeman, 1982.
7. Wilson & Walker. Principles and Techniques in Practical Biochemistry. 5th ed. Cambridge Univ. Press, 2000.
8. West & Todd. Biochemistry. 4th ed. Oxford and IBH.
9. Horst Friebolin. Basic One and Two-dimensional spectroscopy. VCH Publ, 1991.
10. Murphy D. B. Fundamental of Light Microscopy & Electron Imaging. 1st ed. Wiley-Liss, 2001.
11. R. Marimuthu – Microscopy and Microtechnique, MJP Publishers, 2015.

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101420103: Cell Biology

Course Objectives:

The major objective of this paper is to develop clear understanding of various aspects of cell biology along with diverse metabolic pathways existing at cellular level in relation to survival and propagation. This course enables the students to understand the structure and function of cell organelles, protein transport mechanism, intracellular signalling mechanism and acquainted with cell cycle, its regulation and apoptosis.

Course Learning Outcomes:

Unit 1: The students will understand the evolution of the cell, Cell as a unit of living organisms. They will learn structural details of prokaryotic and eukaryotic cells, their cell wall, cell membrane and other outer appendages.

Unit 2: The students can gain knowledge for molecular organization of Mitochondria, Chloroplast. Will know the ultrastructure and functions of Nucleus, Endoplasmic reticulum, Golgi complex, Lysosomes and other microbodies. They will also gain the knowledge of Protein sorting: organelle biogenesis and protein secretion, synthesis and its intracellular traffic, vesicular traffic in the secretary pathways.

Unit 3: Will get the information for cytoskeleton topography which include the role of Microtubule and its dynamics, motor proteins, Microfilament and its functions, Intermediate filaments and their functions, Cilia and centrioles.

Unit 4: Will be acquainted with overview of the Cell cycle and its control, the molecular mechanisms for regulating mitotic events, checkpoints in cell cycle regulation and signalling pathways which regulate apoptosis process.

Contents

Unit I

The origin and Evolution of cells: Evolution of metabolism, Diversity of cell size and shapes, Structure of Prokaryotic and Eukaryotic cells, Single cell to multicellular organism

The Structure of cell membrane: The fluid Mosaic Model, Membrane lipids and Proteins, The Glycocalyx, Transport across plasma membrane.

Endocytosis: Phagocytosis and Receptor mediated endocytosis)

Cell walls and extracellular matrix & Cell Matrix Interactions

Cell-Cell interactions: Adhesion protein, Tight junctions, gap junctions and plasmodesmata.

Unit II

Cell Organelles: Molecular organization of Mitochondria, Chloroplast, Ultrastructure and Functions of Nucleus

Molecular Organization and functions of Endoplasmic reticulum, Golgi complex, Lysosomes (Protein sorting and transport, Types of vesicular transport and their functions), Microbodies: Peroxisomes, Ribosomes.

Unit III

The cytoskeleton: The nature of cytoskeleton, Intermediate filaments, Microtubules: Organization of tubules, assembly and organization within the cells, microtubule motors and movements, cilia and flagella: structure and function.

Cell signalling: Signalling molecules and their receptors, Functions of cell surface receptors, pathways of intracellular signal transduction, signal transduction and cytoskeleton.

Unit IV

Cell growth and division: Overview of the Cell cycle and its control, the molecular mechanisms for regulating mitotic events, Cell cycle control in mammalian cells, Checkpoints in cell cycle regulation, regulators of cell cycle progression-MPF, cyclins and CDKs, Inhibitors of cell cycle progression; M-phase and cytokinesis.

Programmed Cell Death: Difference between necrosis, apoptosis and necroptosis, Caspases, Central regulators of apoptosis (Bcl-2 family), signalling pathways that regulate apoptosis.

Reference Books:

- The cell: A molecular approach-Geoffrey M Cooper and Robert E. Hausman
- Cell Biology-Karp
- Molecular Biology of the cell- Alberts
- Molecular Cell Biology-Lodish et al.

101420104 : Practicals based on 101420101 and 101420102

List of Practicals

1. Amino acid titration curve
2. DNA estimation by DPA method and UV absorption
3. RNA estimation by orcinol method
4. Isolation of chromosomal DNA
5. Separation of proteins by PAGE
6. Introduction to pH, buffer preparation, molar, normal and % solutions.
7. Calculations for making stock solution
8. Separation of amino acids by TLC
9. Separation of cells by density gradient centrifugation
10. Determination of partition coefficient

101420105: Practicals based on 101420103 and 101420107(Biochemistry)

List of Practicals

1. Estimation of Reducing Sugar in Jaggery by Cole's Method
2. Estimation of Protein by Folin-Lowry Method
3. Estimation of Reducing Sugar by DNS Method
4. Total Sugar Estimation by Phenol Sulphuric acid method
5. Estimation of RNA by Orcinol Method
6. Localization of Cell Organelle and Determination of Chlorophyll and Carotenoids
7. Estimation of Amino Acid (Proline)
8. Estimation of Amino Acid (Methionine from Food Grains)
9. Study of Cell structure (Eukaryotic & Prokaryotic)
10. Study of Meiosis and Mitosis

101420106: Comprehensive Viva based on theory papers

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101420107: Fundamentals of Biochemistry and Bioenergetics

Course Objectives:

The major objective of this paper is to develop clear understanding of various aspects of biochemistry which includes properties of biomolecules, their metabolism and regulation. This course content enables students to better understand concept of bioenergetics and its importance in cellular metabolism. Moreover, useful to understand key role of water in metabolism which maintain acid base equilibrium at cellular level as well as an importance of physiological buffers.

Course Learning Outcomes:

Unit 1: Will have learnt carbohydrates, their types and properties. Further, will be acquainted with central metabolic pathways for carbon metabolism in bacteria enlisting differences with eukaryotic systems and their regulation in diverse physiological conditions.

Unit 2: Understands types of amino acids and their properties. Moreover, will have gathered understanding of inorganic and organic nitrogen assimilation and its regulation. Also knows role of glutathione in cellular redox regulation and biochemistry of glutamate overproducing strains. Will understand biochemical basis of nucleotides and its metabolism.

Unit 3: Will understand details of lipid, its metabolism and regulation along with biochemical basis of lipid accumulation at cellular level.

Unit 4: Will have learnt basic concepts of bioenergetics and its importance in cellular metabolism. The students will be aware with different electron carriers compounds and their role in ATP generation. Moreover, gain in depth knowledge of Water and Acid-Base Equilibrium.

Contents:

Unit I

Carbohydrates and Glycobiology: Monosaccharide - structure of aldoses and ketoses, ring structure of sugars, conformations of sugars, mutarotation, anomers, epimers and enantiomers, structure of biologically important sugar derivatives, oxidation of sugars. Formation of disaccharides, reducing and nonreducing disaccharides. Polysaccharides – homo- and heteropolysaccharides, structural and storage polysaccharides. Structure and role of proteoglycans, glycoproteins and glycolipids (gangliosides and lipopolysaccharides).

Carbohydrate metabolism: Glycolysis, Gluconeogenesis, PP Pathway, Citric acid cycle- steps involved, amphibolic nature, anaplerotic reactions, Coordinated regulation of glycolysis and gluconeogenesis, Glycogen synthesis

Unit II

Amino acids: Structure of amino acids, physical, chemical and optical properties of amino acids, Classification of amino acids, Peptides and Proteins, Secondary, tertiary and Quaternary structure of proteins

Protein metabolism: Nitrogen metabolism, Biosynthesis of amino acids, molecules derived from the amino acids, amino acid oxidation and production of urea

Nucleotides and Nucleic acids: Structure of major species of RNA - mRNA, tRNA and rRNA. Nucleic acid chemistry – UV absorption, effect of acid and alkali on DNA.

Nucleotides metabolism: Biosynthesis and Degradation of Nucleotides

Unit III

Lipids - fatty acids, glycerol, ceramide. Storage lipids - triacyl glycerol and waxes, Structural lipids in membranes – glycerophospholipids, galactolipids and sulpholipids, sphingolipids and sterols, structure, distribution and role of membrane lipids, Lipids as signals, cofactors and pigments

Lipid Metabolism: Biosynthesis of fatty acids, Triacylglycerol, membrane lipids and cholesterol, Fatty acid catabolism

Unit IV

Bioenergetics: The laws of thermodynamics, concept of entropy and free energy; ATP synthesis and hydrolysis, Biological oxidation: oxygenases, hydrolases, dehydrogenases, free energy changes and redox potentials, Gibbs energy

The mitochondrial respiratory chain, order and organization of carriers, proton gradient, iron sulphur proteins, cytochromes and their characterization, ATP- synthetase complex, Chemiosmotic theory of Energy Coupling, Inhibitors of ETC

Water and Acid-Base Equilibrium: Ionization of Water, Weak Acids, and Weak Bases, buffering against pH Changes in Biological Systems: Henderson and Hassebach equation, Buffers and their importance, pKa of amino acid and their relevance, Importance of discontinuous buffer system used in SDS PAGE, Water as a Reactant

References:

- Lehninger's Principles of Biochemistry: D. L. Nelson and M. M. Cox, Macmillan, Worth Pub. Inc., NY.
- Chemistry of Biomolecules by S. P. Bhutani, Ane Books Pvt. Ltd. CRC Press
- Biochemistry: Lubert Stryer WH Freeman & Co., NY.
- Harper's Biochemistry: R. K. Murray and others. Appleton and Lange, Stanford.
- Text book of Biochemistry with clinical correlations by Delvin.
- Nptel lectures

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101420108: Food Biotechnology

Course Objectives:

The course will enable students to understand the taxonomical classification, phenotypic and biochemical identification of food associated molds, yeasts, yeast-like fungi and bacteria. The course will teach the strategies to develop fermented and non-fermented milk products, fermented plant-based products, malt beverages, distilled liquors, etc. The role of microbes in food spoilage, preservation and various food borne diseases can be discussed.

Course Learning Outcomes:

Unit 1: Will know about production and evaluation of the quality of starter cultures and fermented milk products. They will understand the role of microbes in food spoilage and how different factors affect this process.

Unit 2: Gathers information regarding microbes causing food intoxications and food-borne infections. The students will learn different diagnostics methods and preventive measures.

Unit 3: Knows traditional food preservation techniques including drying, salting, refrigeration, vacuum packaging, canning/bottling, chemical preservation and irradiation. The students will also learn use of modern techniques viz. high-pressure processing (HHP), bacteriocins, manosonication (MS), etc. They will be aware of fermentation protocols of different food products and understands the use and production of probiotics, prebiotics and nutraceuticals.

Unit 4: Gains knowledge about conventional methods for food quality analysis and is able to use the most recent and non-invasive techniques of quantification and detection of food borne microbes. Understands the relevance of microbial standards for food safety, quality assurance programs that revolutionize food safety.

Contents:

UNIT I:

Scope of food biotechnology

Food as a substrate

Role of Microbes in food Biotechnology – Bacteria, yeasts and moulds

Food Spoilage

a) General principles underlying food spoilage and contamination.

b) Spoilage of canned food, vegetables, fruits, meat and meat products, milk and milk products fish and seafood

UNIT II:

Food poisoning

Food borne pathogens

a) Bacterial food borne infections and intoxications- Brucella, Campylobacter, Clostridium, Escherichia (ETEC/EHEC/EPEC/EAEC), Salmonella, Shigella, Listeria and Vibrio

b) Non- bacterial food borne infections and intoxications- Protozoa, fungi & viruses

UNIT III:

a) **Food preservation**

Principles of food preservation – Physical and chemical preservation methods, Bio preservatives

b) **Starter cultures for dairy & fermented foods**

Oriental fermented foods: Shoyu and Tempeh

Fermented milk products: Yogurt and Kefir

Fermented vegetables – Sauerkraut

UNIT IV:

Genetically modified foods

Food research organizations/institutes in India

Food sanitation – Microbiology of food plant sanitation, water and milk testing

Food laws and quality control – HACCP, Codex Alimentarius, PFA, FPO, MFPO, BIS, AGMARK.

References:

1. Food Microbiology, Frazier and Westhoff
2. Food microbiology, Adam and Moss
3. Dairy Microbiology by Robinson. Volume I and II.
4. Fundamental Food Microbiology, Bibek Ray and Arun Bhuniya

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101420109: Marine Biotechnology

Course Objectives:

The course will enable the students to understand the concept of biology of marine organisms including the concept of lagoons, mangroves, zonation of a sea coast. This course will enable the students in understanding of the concept of plankton, nekton, benthos, oceanic food and feeds, natural products from marine organisms and marine biominerals. Students will also gather the knowledge about the alternative sources of bioenergy from micro- and macro algae. Algal genomics, transcriptomics, metabolomics and omics as an approach for product discovery in marine algae will also be known.

Course Learning Outcomes:

Unit 1: Deals with the concept of sea-estuaries, backwaters, lagoons, mangroves, coastal waters, inshore, offshore and deep sea. It provides the understanding of biodiversity of oceanic flora and fauna, diversity and distribution of flora and fauna in different zones of the sea, marine microorganisms and adaptations in marine environments.

Unit 2: Enrich the knowledge of sources of food and feed from ocean. Importance of marine fishes, need of diversification of mariculture and aquaculture will be learnt.

Unit 3: Explore the consideration of isolation and separation of marine natural products such as alkaloids, terpenoids, steroids nucleosides etc. from marine flora and fauna. The students will also learn the methods and advances in marine natural product discovery, marine biominerals, non-mineriled structures and applications of marine natural products.

Unit 4: Gather the idea of bioenergy technology from algae. Algal species, biomass production, bioenergy production will also be understood. The knowledge by-products from algal biofuel, economic analysis of biofuels and genetic engineering for product discovery in marine algae will be known.

Contents:

Unit 1:

Fundamentals of Marine Biology: Biological divisions of the sea- estuaries and backwaters, lagoons, mangroves, coastal waters, inshore, offshore, deep sea/oceanic; Biodiversity of the oceans; marine flora and fauna; Plankton - diversity and their role in the food chain; Plankton blooms and

impact on fisheries; Harmful algal blooms; Nekton – abundance, distribution, geographic ranges and patterns of migration; diversity and distribution of Marine reptiles, birds and mammals; Benthos – intertidal and subtidal zones; Marine boring and fouling organisms; Marine microorganisms, Microbiome, Adaptations for living in marine environment, Marine ecosystems structuring life on earth

Unit 2:

Ocean as a source of food and feed: Marine food chain and food web, Microbial loop and viral shunt, Ocean as a source of food**,** Fisheries of Indian seas; marine fish production in India; recent developments in survey of marine fishery resources; concept of sustainable fisheries, fisheries of the important species/groups– demersal, pelagic and deep sea; Decline in fisheries and the need for diversification of mariculture and aquaculture.

Unit 3:

Marine natural products: Isolation and separation of marine natural products (MNP) from marine flora and fauna; Diversity of marine derived compounds - Alkaloid, Terpenoids and steroides, nucleoside, amino acids, peptides, depsipeptide, polyketide, Macrolide; Marine Toxins, Marine Enzymes- protease, lipase, chitinase, glucanase Methods and advances in marine natural product discovery. Marine biominerals; Biominerelized structures and Biocomposites-skeletal formations, macro- and microscleres, spicules, spines, bristles, cell walls, cyst walls, loricae; Non-mineralized Structures-bioelastomers like abductin, resilin, gorgonin, spongin; antipathin; Applications of marine natural products.

Unit 4: Algal bioenergy technology and genomics: Bioenergy from micro- and macro-algae, selection of species, biomass processing, bioethanol production, butanol production, Hydrogen production, methane production Biochemical genetic and metabolic engineering of the lipid metabolism; By-products from algal biofuel production; Economic analysis of algal biofuel production; Concept of biorefinery. Marine algal genomics; Algal transcriptomics, Production of transgenic algae: Need for the development of genetic engineering tools for marine algae, Microalgae as gene expression system- production of antibodies, Metabolome and fluxome of algae, 'Omics' approach for product discovery in marine algae. Genetic engineering of macro-algae, Metabolic engineering in algae.

References

1. Pinet P.R. 2000. Invitation to Oceanography. 2nd Edition. Jones and Bartlett Publishers, Sudbury. 555p.
2. Se-Kwon Kim (Ed.), 2013. Marine Biomaterials: Characterization, Isolation and Applications, CRC Press.
3. Se-Kwon Kim (Ed.), 2015. Functional Marine Biomaterials: Properties and Applications, CRC Press.
4. UNEP-WCMC, 2011. Marine and coastal ecosystem services: Valuation methods and their application. UNEP-WCMC Biodiversity Series No. 33. 46 pp.

5. Becker, EW1994. Microalgae: Biotechnology and microbiology. Cambridge University Press.
6. Cohen Z. 1999. Chemicals from microalgae. Taylor and Francis Ltd.
7. Chen F and Jian Y. (Eds) 2001. Algae and their biotechnological Potential. Kluwer Academic Publishers.
8. Faizal Bux, Yusuf Chisti. 2016. Algae Biotechnology: Products and Processes. Springer
9. Navid Reza Moheimani et al., 2015. Biomass and Biofuels from Microalgae: Advances in Engineering and Biology. Springer
10. Rosa León, Aurora Galván Cejudo, Emilio Fernández. 2008. Transgenic Microalgae as Green Cell Factories, Springer Science & Business Media,
11. Charles D. Amsler. 2008. Algal Chemical Ecology. Springer.
12. Debabrata Das. 2015. Algal Biorefinery: An Integrated Approach. Springer
13. Michael A. Borowitzka, Navid Reza Moheimani. 2012. Algae for Biofuels and Energy. Springer Science & Business Media.
14. Clemens Posten, Steven Feng Chen, 2015. Microalgae Biotechnology. Springer.
15. Paul M. Dewick. 2011. Medicinal Natural Products: A Biosynthetic Approach. John Wiley & Sons
16. James W. Lee. 2012. Advanced Biofuels and Bioproducts. Springer Science & Business Media.
17. Se-Kwon Kim, Katarzyna Chojnacka. 2015. Marine Algae Extracts: Processes, Products, and Applications, 2 Volume Set. John Wiley & Sons.
18. Joël Fleurence, Ira Levine. 2016. Seaweed in Health and Disease Prevention.Academic Press.
19. Christian Wiencke, Kai Bischof. 2012. Seaweed Biology: Novel Insights into Ecophysiology, Ecology and Utilization. Springer Science & Business Media.

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101420110: Virology

Course Objectives:

The main objective of the course is to make students to understand the taxonomical classification, phenotypic and biochemical identification of various viruses. The course will teach the strategies to develop isolation and preservation of viruses and their life cycle for development of antiviral compounds for the viral infections and the role of various viruses in the development of vaccines etc.

Course Learning Outcomes:

Unit 1: Student will be able to describe the defining viral attributes, the general properties of viruses, and steps in virus infection cycle. The principle of virus classification, list the virus families, and describe methods of study virus infection. General overview of viral genomes and their types as well as isolation & preservation of viruses.

Unit 2: Student will be able to receive information regarding various bacteriophages life cycles, which are model viruses for the study. Applications of phages in therapy; Concern over phage contamination in food & fermentation industry.

Unit 3: Students will be able to know various plant and animal viruses and their isolation, preservation and classifications. Student will be able to describe host defense against virus infection and able to describe general characteristics of acute viral infections, pathogenesis of Influenza virus, Polio virus, Measles virus, and Rotavirus infection. Student will be able to describe general characteristics of chronic, persistent, latent infections

Unit 4: Student will be able to describe how different antiviral drugs and their mode of action of viruses, student knows how live viral vaccines are made, how inactivated viral vaccines are made, Polio vaccine and story of polio eradication.

Student is able to describe antiviral drug discovery process, mechanism of drug resistance and use of interferons for viral infections.

Contents:

Unit – I: Prokaryotic Viruses

Discovery of bacteriophages, Structure and composition of bacteriophages, Classification system of Baltimore & ICTV

Phage biodiversity, Genome diversity and host- specific interactions

Isolation and purification by filtration, ultracentrifugation and affinity chromatography

Plaque assays

One step growth, single burst and eclipse experiments

Unit – II:

Life cycle of model bacteriophages infecting *E coli* – λ (lytic lysogenic)

Life cycle of model bacteriophages: ϕ X 174, M13

Life cycle of model bacteriophages: T4, T7

Life cycle of model bacteriophages: Qß, Mu

Applications of phages - therapy; Concern over phage contamination in industry (dairy)

Unit – III : Eukaryotic Viruses

Discovery and classification of plant and animal viruses, structure of viruses, viroids, virusoids

Classification of viruses – ICTV and Baltimore classifications

Host – viruses interactions, permissive/non – permissive hosts; Cytopathic effects

Isolation and purification of viruses, Cultivation and propagation

Assay methods – pock assay, hemagglutination assay, transformation assay.

Structure, Life cycle and Pathogenicity of Gemini virus

Structure, Life cycle and Pathogenicity of TMV

Structure, Life cycle and Pathogenicity of Adenovirus

Structure, Life cycle and Pathogenicity of Rotavirus

Structure, Life cycle and Pathogenicity of Rubella, Influenza and Measles viruses

Structure, Life cycle and Pathogenicity of HIV and Hepatitis B Virus

Unit – IV: Prevention & control of viral diseases

Antiviral compounds and their mode of action

Interferon and their mode of action.

General principles of viral vaccination

Applications of Virology:

Use of viral vectors in cloning and expression, Gene therapy and Phage display

Reference Books:

1. Principles of Virology, (Vol I & II) Flint SJ, Enquist LW, Racaniello VR, Skalka AM, Pub ASN Press
2. Introduction to Modern Virology – Dimmock
3. Basic Virology – Wagner
4. Virology – Saravanan
5. Virology – Maharajan
6. Molecular Virology – A. J. Cann
7. An introduction to Viruses – Biswas

BIOTECHNOLOGY
SEMESTER-II

Course Type	Course Code	Name of Course	T/P	Credits	Exam Duration (Hrs)	Components of Marks		
						Internal	External	Total
						Total/ Passing	Total/ Passing	Total/ Passing
Core Course	101420201	Fermentation Technology	T	4	3	40/16	60/24	100/40
	101420202	Basics of Microbial Genetics	T	4	3	40/16	60/24	100/40
	101420203	Immunology	T	4	3	40/16	60/24	100/40
	101420204	Practicals based on 101420201 and 101420202	P	4	3	40/16	60/24	100/40
	101420205	Practicals based on 101420203 and Elective (any one) subject	P	4	3	40/16	60/24	100/40
	101420206	Comprehensive Viva	P	1			50/20	50/20
Elective Course	101420207	Biostatistics	T	4	3	40/16	60/24	100/40
	101420208	Medical Biotechnology	T	4	3	40/16	60/24	100/40
	101420209	Omics and Computational Biology	T	4	3	40/16	60/24	100/40
	101420210	Medical Microbiology	T	4	3	40/16	60/24	100/40

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101420201: Fermentation Technology

Course Objectives:

The major objective of this paper is to impart knowledge about fermentation processes and its relavent aspects. The course will teach strain improvement strategies, preservation methods, sterilization of media and air. It will be useful to understand various bioreactors and their applications. This course will enable the students to understand aeration-agitation concept, its importance in fermentation process and growth kinetics. Lastly, useful to understand downstream processes of the fermentation process.

Course Learning Outcomes:

Unit 1. Is able to describe the role of microbes in fermentation processes. The students will understand different strategies of strain improvement. It will also useful to understand the role of medium components on product formation.

Unit 2. Understands aseptic environment, sterilization and its various methods. Will know fermenter design, its components and its variable control parameters.

Unit 3. Understands microbial growth, it's kinetics and association of product formation with growth. The students will understand the concept of mass transfer and various methods to determine Kla.

Unit 4. Is able to describe various methods of product recovery. Will know the role of various chromatography in product purification. Moreover, makes the student aware of desalting, drying and crystallization processes.

Contents:

Unit I

Isolation, Screening: Primary and Secondary, Preservation and maintenance of Industrially important microorganisms

Strain Improvement of industrially important microbes: Isolation of mutant producing primary and secondary metabolites, isolation and use of auxotrophic mutants, isolation and use of revertant mutants and use of recombination systems

Media for industrial fermentation processes: Energy sources, antifoam agents and medium optimization

Unit II Sterilization methods and principles: Media sterilization, mathematical modelling of sterilization processes, Arrhenius equation, Del factor, effect of sterilization on media quality and yield coefficients, batch and continuous sterilization, filter and steam sterilization at industrial scale

Design of fermenter and reactors: Basic components of a fermenter, laboratory and industrial scale fermenters, mechanical, Types of fermenter like stirred tank, bubble column, airlift, packed beds, fluidized beds, perfusion cultures, photo-bioreactors and animal cell culture bioreactor, Plug flow reactors, Immobilized enzyme reactors.
Bioprocess Control parameters: Instrumentation for monitoring bioreactor and fermentation processes, Sensors, Controllers, fermentation control systems and architecture, Incubation and sequence control, advanced control Scale up and Scale down and containment

Unit III
Microbial Growth kinetics: Kinetics of growth and substrate utilization in batch, fed batch and continuous systems. Inoculum development, aseptic inoculation and sampling.
Agitation and aeration: Mass transfer of oxygen, Determination of K_La, factors affecting K_La, fluid rheology, newtonian and non-newtonian fluids, bingham plastic, pseudo plastic, power number, Reynolds number.

Unit IV
Recovery and Purification of fermentation Products: Bio separation: filtration, centrifugation, sedimentation, flocculation, cell disruption, liquid-liquid extraction.
Purification by chromatographic techniques, Membrane Processes, drying, crystallization, storage and packaging.
Fermentation Economics

References:

- Principles of Fermentation Technology: Whitekar & Stanbury
- Comprehensive Biotechnology: Murray Moo Young
- Methods in Industrial Microbiology: Sikyta
- Fermentation Microbiology and Biotechnology, El Mansi and Bryc

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101420202: Basics of Microbial Genetics

Course Objectives:

The objectives of this course are to take students through basics of microbial genetics covering different types of mutations, plasmid biology, prokaryotic genetics and agrobacterium genetics. On covering the course the student will be exposed to concepts of mutation, DNA damage and repair, plasmid biology, microbial and phage genetics.

Course Learning Outcomes:

Unit 1: Students will know that genome is transient and mutation keeps on happening. They will know the types mutation and different mechanisms involved in their repair.

Unit 2: Students should be clear about types of plasmids, their compatibility regulation of copy number and segregation. Students will also learn about phage genetics and recombination.

Unit 3: Students should have understood the types and process of transformation, conjugation and transduction at the end of this unit

Unit 4: Here student should have learnt Agrobacterium genetics, types of restriction modification systems and different types of transposable elements.

Contents:

UNIT -1

Mutation, DNA damage and Repair

Spontaneous mutations (Random v/s Adaptive nature of mutation; Mutation rate and its determination, Types of DNA damage and their consequences (spontaneous and chemical induced deamination, radiation induced DNA damage, loss of nitrogen bases, alkylation, intra and inter strand cross linking) , DNA repair pathways (Mis-match repair in prokaryotes and eukaryotes, Nucleotide excision repair in prokaryotes and in eukaryotes, base excision repair, recombinational repair, SOS pathway, specific repair of oxidative DNA damage, repair of pyrimidine dimers, repair of alkylation induced damage and adaptive response and other specific repair mechanisms).

UNIT –II

Plasmid Biology, Phage Genetics & Recombination

Types of plasmids, compatibility, regulation of plasmid copy number & plasmid segregation

T-series, complementation and Fine structure analysis, biology of lambda phages. Types of recombination, Different models of recombination, Molecular mechanism of homologous recombination in eukaryotes, Mating type switching, Site specific recombination and its biological significance.

UNIT -III

Genetic exchange in prokaryotes

Natural transformation in *Bacillus subtilis*, Transformation by inducing artificial competence, Gene linkage and mapping by transformation.

Generalized transduction in T4 bacteriophage, Specialized transduction, homologous recombination with recipient's chromosome, measuring transduction (co-transduction of markers, marker effects, abortive transduction, transduction of plasmids). Applications of transduction.

F-factor mediated Conjugation in *E. coli*, Hfr conjugation and chromosomal transfer, F-prime conjugation and merodiploids, Conjugation of fertility inhibited F-like plasmids, Non conjugative mobilizable plasmids, chromosomal mobilization of non-F plasmids, Interrupted mating and conjugational mapping.

UNIT-IV

Agrobacterium genetics, Restriction Modification Systems, Transposable Elements

Ti plasmid, Interkingdom gene transfer (Key early experiments, vir regulon, protein secretion apparatus, conjugation model of T-DNA transfer, Integration products)

Types of RM systems, Role of RM systems, salient features and insights into evolution of diverse types of Restriction endonucleases and Methyl transferases, Regulation of RM systems.

Types of bacterial transposable elements; Structure, genetic organization and mechanism of transposition of Tn5, Tn3, phage Mu, Tn7, IS911, Integrons, Retrotransposons, conjugative and mobilizable transposons, Assays of transposition.

References:

1. Lewin's Genes X: Jocelyn E. Krebs
2. Molecular Biology of the Gene 6th Edition-Watson et al.
3. Modern Microbial Genetics 2nd Edition-Uldis Streips and Ronald Yasbin
4. Microbial genetics 2nd Edition-Stanley Molay, John Cronan and David Freifelder.
5. Molecular Genetics of Bacteria 3rd Edition-Snyder and Champness.
6. Molecular Genetics: An Introductory Narrative 2nd Edition-Stent and Calender
7. Principles of Genetics 6th Edition- Snustad and Simmons
8. Molecular Biology of the Cell 5th Edition-Alberts et al.

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101420203: Immunology

Course Objectives:

The objective of this course is to understand various components of the host immune system; their structure, organization and role in defence mechanism. The student will gain knowledge to understand the operational mechanisms which underlie the host defence system. It would make them clear to understand genetic organization and expression of receptors to show immune response. They will also learn the role of immune system in health and diseases.

Course Learning Outcomes:

Upon successful completion of the course, the student will learn:

Unit 1: Will be able to understand the types of immunity and basic components of immune system; the role played by complement system as an interface between innate and adaptive immunity.

Unit 2: Will be able to understand the genetic organization of the genes meant for expression of immune cell receptors and the basis of the generation of their diversity. The principle of antigen-antibody interactions and methods to measure them will become clear to students.

Unit 3: Will be able to understand the importance of MHC molecule in an individual's immunity to various antigens, the mechanism of antigen processing and presentation. They will be able to understand the mechanism of B and T cell activation and memory generation.

Unit 4: The students will gain knowledge about the mechanism of cell mediated immunity. They will learn about the cytokines, important biopharmaceuticals and their role in modulation of immune response. The students will also learn how body shows different kinds of immune response to different infections.

Contents:

Unit I

Immunity: Innate and Adaptive, Cells of the Immune system: Haematopoiesis and its regulation
Cells and organs of the immune system: Primary and secondary lymphoid organs
Induced Innate immunity: receptors of the innate immunity (TLR and sensing of PAMPs, CLR,RLR and CLR); Inflammatory responses, Natural Killer cells
Antigens: Immunogenicity versus antigenicity, Epitopes, Haptens.

Complement system: The Major Pathways of Complement Activation: Classical, alternative and lectin complement pathways, functions of complement, regulation of complement, complement deficiencies, microbial complement evasion strategies

Unit II

Antibody: Structure of immunoglobulin; classes of immunoglobulins, Signal transduction pathways emanating from the BCR

The Organization and Expression of Lymphocyte Receptor Genes: Hozumi and Tonegawa's Experiment, Multigene organization of Ig Gene, Mechanism of VDJ recombination, B cell receptor expression: Allelic exclusion, B cell isotype switching and somatic hypermutation; expression of membrane bound and soluble immunoglobulin; T cell receptor genes and expression

Basics of Antigen-antibody interactions: Immunoprecipitation and agglutination based techniques, Methods to determine affinity of antigen-antibody interactions, Immunofluroscence, FACS

Unit III

The Major Histocompatibility Complex and Antigen Presentation: The structure and function of MHC molecules, general organization and inheritance of MHC genes, The role and expression Pattern of MHC, Endogenous and exogenous pathway of antigen processing and presentation; presentation of non-peptide antigens.

B Cell activation: T dependent and T independent B cell responses and memory generation

T Cell activation: Two signal hypothesis, superantigens, activation and differentiation of T cell into effector and memory cells.T_H1 and T_H2 responses.

Unit IV

Cell mediated effector response (Generation of effector CTL's, Granzyme and Perforin Mediated Cytolysis, Fas-FasL Mediated Cytolysis, NK cell mediated cytolysis

Cytokines: properties, receptors, associated diseases, therapeutic applications, cytokine signalling pathways: JAK-STAT and FAS-FASL signalling pathways

Immune response to infection by viruses, bacteria, fungi and parasite: Mechanism of Immune response and evasion by pathogen

References

1 Owen, J. A., Punt, J., &Stranford, S. A. (2013). *Kuby immunology* (7thEdn). New York: WH Freeman.

2 Murphy, K., & Weaver, C. (2016). *Janeway's immunobiology* (9thEdn) Garland Science.

3 Male, D., Brostoff, J., Roth, D., &Roitt, I. (2012). *Immunology*(8thEdn) *With STUDENT CONSULT Online Access*. Elsevier Health Sciences.

4 Abbas, A. K., Lichtman, A. H., & Pillai, S. (2014). *Cellular and molecular immunology* (6thEdn) Elsevier Health Sciences.

5 Relevant review articles / research papers / handouts of latest development in the subject.

101420204: Practicals based on 101420201 and 101420202

List of Practicals

1. Optimization of centrifugation for separation of cells
2. Measurement of growth by various methods (Absorbance, SPC, Direct count, Wet weight, Dry weight, Indirect method)
3. Determination of KLa by sulfite oxidation method
4. Demonstration of laboratory scale fermenter
5. Production of ethanol by yeast cells
6. Production of penicillin and its recovery
7. Recovery of citric acid
8. Partial purification of proteins by precipitation
9. Conjugation in *E. coli*.
10. Transduction in *E. coli*
11. Transposon assay
12. β-galactosidase induction and assay
13. Isolation and enumeration of bacteriophage
14. Demonstration of Lysogeny

101420205: Practicals based on 101420203 and 101420207 (Biostatistics)

List of Practicals

1. To perform total WBC count using Haemocytometer
2. To Perform Differential Leukocyte count
3. To learn the technique of Ouchterlony Double Diffusion
4. To learn the technique of Radial Immunodiffusion
5. To learn the technique of Immunoelectrophoresis
6. To perform sandwich Dot ELISA test for antigen
7. To learn the technique of latex -agglutination
8. To separate lymphocytes by density gradient method
9. To convert ungrouped data in to grouped data using Sturge's formula.
10. To study representation of data by one dimensional diagram.
11. To study representation of data by two dimensional diagram.
12. To study representation of data by means of graphs. (Histogram & frequency polygon).
13. To study the data representation by graphs (Frequency polygon & frequency curve).
14. To study how to calculate descriptive statistics for the given data. (Mean mode, median, standard deviation and mean deviation).
15. To study the concept of permutation and combination in practical counting problems.
16. To study the concept of normal distribution and apply it to practical problems.
17. To study the concept of estimation (point estimation and interval estimation).
18. To apply the concept of skewness in the field of biosciences.
19. To apply the concept of F- test for biological problems.
20. To apply the concept of χ^2 – test for biological problems.

101420206: Comprehensive Viva based on Theory Papers

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101420207: BIOSTATISTICS

Course Objectives:

The course aims to develop competency and expertise in the application of statistical methods applied to biological data obtained in experimental techniques.

Course Learning Outcomes:

Unit 1: Student will be able to know about basic terms and use in biostatistics. They will understand types of data, their organization and various graphical representation methods to represent data, and will enable students to understand the basic statistics and its importance in research.

Unit 2: Student will be able to calculate various measures of central tendencies, measure of dispersion and measure of kurtosis and skewness and its importance.

Unit 3: To understand the exact method of data analysis for the problem under investigation. Student will be able to perform various hypothesis testing like T-test, F-test, and chi square tests and its application in biological sciences.

Unit 4: Understanding for drawing valid inferences and to plan for future investigations. Student will be able to perform Correlation & regression calculations and its application in Biological sciences. Student will able to perform ANOVA testing.

Contents:

Unit I:

Data Collection and Presentation

Types of Biological Data: Qualitative Data -Nominal, Ordinal, Ranked; Quantitative Data: Discrete and Continuous.

Understanding of Population and sample

Methods of Collection of Data: (i) Experimental Data and (ii) Survey Data- Simple random Sample (with and without replacement), stratified sampling and cluster sampling.

Tables: Frequency Distributions, Relative Frequencies.

Graphical Presentation: Bar charts, Histograms, Frequency Polygons, One way scatter plots, Box plots, two-way scatter plots, line graphs.

Unit II:
Descriptive Statistics
Measures of Central Tendency: Mean, Median and Mode, quartiles, deciles and percentiles (both for raw data and grouped data)
Measures of Dispersion: Range, Interquartile Range, Variance, Standard Deviation and Coefficient of Variation.
Measures of Skewness and Kurtosis.

Unit III:
Statistical hypotheses: Null and Alternative hypotheses.
Statistical Tests: Acceptance region and Rejection Region. Types of errors and power of the test.
Goodness of fit tests.
Random Variables: Discrete and Continuous. Some examples from biological sciences.
Probability Distributions: General Normal Distribution, Standard Normal Distribution ; Sampling Distributions- t, chi-square and F distributions.
Significance Tests for Normal Distribution: One sample tests for mean – z test and t-test.
Two sample tests for normal distributions: Tests for means (i) when variances are known (ii) when variances are unknown. Tests for equality of variances.
Paired t-test for equality of means.
Confidence Intervals

Unit IV:
Correlation: Covariance, Calculation of covariance, correlation analysis and correlation Coefficient calculated from ungrouped data.
Regression: Simple linear regressions analysis, regression coefficients, Linear regression line or equation
Analysis of Variance: Completely Randomized Design, Randomized Block Design

References:

- Fundamentals of statistics by S.C. Gupta
- Principles of Biostatistics by Marcello Pagano and Kimberlee Gaurea
- Biostatistics : A Foundation For Analysis in the Health Sciences by Daniel, Wayne (Seventh Edition), Wiley India Pub.

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101420208: Medical Biotechnology

Course Objectives:

The objective of this course is to provide a medical flavour to biotechnology that the student might have learnt. The students will be exposed to the upcoming medical fields such as vaccinology, stem cell biology, bioengineering and molecular therapeutics. It will showcase a completely different facet of biotechnology to students.

Course Learning Outcomes:

Unit 1: Students should be able to acquire basic knowledge on different types of vaccines and adjuvants and along with few success stories and failures in the field vaccinology to highlight the current challenges.

Unit 2: Students should have basic knowledge of stem cell biology including source and organogenesis. Students should also know the use of embryonic and adult stems for therapy.

Unit 3: Students should have learnt about history and scope of bioengineering. They should also know different biomaterials and strategies to create different scaffolds in tissue engineering.

Unit 4: Student should have learnt different molecular therapeutic methods such as viral mediated gene transfer, liposome mediated transfer, RNAi etc.

Contents:

UNIT I

Vaccinology

Active and passive immunization; live, killed, attenuated, subunit vaccines; vaccine technology- role and properties of adjuvants, recombinant DNA and protein based vaccines, reverse vaccinology; peptide vaccines, conjugate vaccines; antibody genes and antibody engineering- chimeric, hybrid monoclonal antibodies; catalytic antibodies and generation of immunoglobulin gene libraries, idiotypic vaccines and marker vaccines, viral-like particles (VLPs), dendritic cell based vaccines, vaccine against cancer, T-cell based vaccine, edible vaccine and therapeutic vaccine; Success stories in vaccinology *e.g.* Hepatitis, Polio, Small pox, DPT.

UNIT II

Stem Cell Biology

Definition, classification and source of stem cells. Blastocyst and inner cell mass cells; Organogenesis; Mammalian Nuclear Transfer Technology; Stem cell differentiation; Stem cells cryopreservation.

Overview of embryonic and adult stem cells for therapy, Neurodegenerative diseases; Parkinson's, Alzheimer, Spinal Cord injuries and other Brain Syndromes; Tissue systems Failures; Diabetes; Cardiomyopathy; Kidney failure; Liver failure; Cancer; Hemophilia *etc.*

Human stem cells research: Ethical considerations; Stem cell religion consideration; Stem cell based therapies: Pre clinical regulatory consideration and Patient advocacy.

UNIT III

Bioengineering

Historical overview and fundamentals of tissue engineering, tissue dynamics/homeostasis, Introduction to Biomaterials used in tissue engineering, Role of scaffolds and growth factors in tissue engineering; Importance and scope of tissue engineering.

Introduction to biomaterials and scaffolds; Requirement of biomaterials as Tissue Engineering scaffolds, Properties and types of scaffolds, Tissue specific scaffolds; Scaffold Preparation: Different methods employed in synthesis of scaffolds and ways to process them; Cell/Tissue-scaffold interaction: Animal cell culture on scaffolds, consequences, optimization strategies and important considerations.

UNIT IV

Molecular Therapeutics

Overview of inherited and acquired diseases for gene therapy; Retro and adenovirus mediated gene transfer; Liposome and nanoparticles mediated gene delivery; Gene Therapy for Hematopoietic Disorders, Cardiovascular Gene and Cell Therapy, Gene Therapy for Cancer, Molecular Therapy for Type 1 and Type 2 Diabetes, Gene silencing technology; Antisense therapy; siRNA; Tissue and organ transplantation; Transgenics and their uses; Cloning; Ethical issues.

References:

1. Kindt, T. J., Goldsby, R. A., Osborne, B. A., & Kuby, J. (2006). *Kuby Immunology*. New York: W.H. Freeman.
2. Brostoff, J., Seaddin, J. K., Male, D., & Roitt, I. M. (2002). *Clinical Immunology.* London: Gower Medical Pub.
3. Murphy, K., Travers, P., Walport, M., & Janeway, C. (2012). *Janeway's Immunobiology.* New York: Garland Science.
4. Paul, W. E. (1993). *Fundamental Immunology.* New York: Raven Press.

5. Goding, J. W. (1986). *Monoclonal Antibodies: Principles and Practice: Production and Application of Monoclonal Antibodies in Cell Biology, Biochemistry, and Immunology*. London: Academic Press.
6. Parham, P. (2005). *The Immune System*. New York: Garland Science.
7. Brown, T. A. (2006). *Genomes* (3rd ed.). New York: Garland Science Pub
8. S. Primrose, R. Twyman, B. Old, and G. Bertola (2006). *Principles of Gene Manipulation and Genomics*, Blackwell Publishing Limited; 7th Edition
9. Green, M. R., & Sambrook, J. (2012). *Molecular Cloning: A Laboratory Manual*. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
10. Selected papers from Scientific Journals, particularly Nature & Science.
11. Technical Literature from Stratagene, Promega, Novagen, New England Biolab *etc.*
12. Ann A. Kiessling, (2003) *Human Embryonic Stem Cells: an Introduction to the Science and Therapeutic Potential*, Jones and Bartett.
13. Peter J. Quesenberry (1998), *Stem Cell Biology and Gene Therapy*, (1st Edition), Willy-Less.
14. Robert Lanja, (2006) *Essential of Stem Cell Biology*, 2nd Edition, Academic Press.
15. A.D.Ho., R.Hoffiman, (2006) *Stem Cell Transplantation Biology Processes Therapy*, Willy-VCH.
16. C.S.Potten, (2006) *Stem Cells*, Elsevier.
17. Ed. Robert Lanza *et al*.; *Principles of Tissue Engineering*; Academic Press
18. Boer JD *et al*.; *Tissue Engineering*; Academic Press
19. Pallua N, Suschek CV; *Tissue Engineering*: *from Lab to Clinic*; Springer
20. Barnes SJ, Harris LP; *Tissue Engineering: Roles, Materials and Applications*; Nova Science Publishers Inc
21. Minuth WW. Strehl R. Schumacher K; *Tissue Engineering: from Cell Biology to Artificial Organs*; Wiley VCH
22. Lanza R., Atala A.; *Essentials of Stem Cell Biology*; Academic Press
23. Zhao RC; *Stem Cells: Basics and Clinical Translation* (Translational Medicine Research); Springer
24. Knoepfler; *Stem Cells: An Insider's Guide*; World Scientific Publishing Company
25. Harris J. Quigley M. Chan S.; *Stem Cells: New Frontiers in Science & Ethics*; World Scientific Publishing Co Pte Ltd
26. Attala & Lana; *Methods of Tissue Engineering*; Academic Press
27. Lanza, Langer, Vacanti; P*rinciples of Tissue Engineering*; Academic Press
28. Patrick, Mikos, McIntire; *Frontiers in Tissue Engineering*; Pergamon
29. Ratner, Hoffman, Schoen; *Biomaterials Science*; Academic Press
30. Palsson & Bhatia; *Tissue Engineering*; Prentice Hall.
31. Campbell, A. M., & Heyer, L. J. (2006). *Discovering Genomics, Proteomics, and Bioinformatics*. San Francisco: Benjamin Cummings.
32. Brooker, R. J. (2009). *Genetics: Analysis & Principles*. New York, NY: McGraw-Hill.
33. Glick, B. R., Pasternak, J. J., & Patten, C. L. (2010). *Molecular Biotechnology: Principles and Applications of Recombinant DNA*. Washington, DC: ASM Press.
34. Coleman, W. B., & Tsongalis, G. J. (1997). *Molecular Diagnostics: for the Clinical Laboratorian*. Totowa, NJ: Humana Press.

35. Bernhard Palsson and Sangeeta N Bhatia, (2004), *Tissue Engineering,*2nd Edition, Prentice Hall.
36. Pamela Greenwell, Michelle McCulley, (2008), *Molecular Therapeutics:21st century Medicine*, 1st Edition, Springer.
37. New Generation Vaccines, 4th Ed., Myron M. Levine, Informa Healthcare
38. Gene and Cell Therapy- Therapeutic Mechanisms and Strategies, 3rd Ed., Nancy Smyth Templeton, CRC Press

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101420209: Omics and Computational Biology

Course Objectives:

The course will enable the students to understand the concept of genome mapping, genome sequencing, functional genomics, basic concepts of proteomics tools, data mining, basic concepts and tools of lipidomics, glycomics and phosphoproteomics. Storage and retrieval of various types of databases collection and storing of sequence data will be understood by the students. Students will also be able to know the local and global alignment through scoring matrices, gene prediction methods, RNA fold analysis, splice site identification.

Course Learning Outcomes:

Unit 1: Deals with genome, genomics and transcriptomics. The concept and application of physical map, genetic map, genome sequencing, functional genomics, small or large regulatory RNAs and dark matter will be known.

Unit 2: Gathers information regarding concept of proteomics, metabolomics and lipidomics. The the basic tools of proteomics, metabolomics, lipidomics and their applications will be learnt by the students.

Unit 3: Deals with the primary and secondary databases, collection, storage and retrieval of databases, knowledge of freeware, software and hardware. The sequence databases, sequence format, annotation and archival of databases will be understood.

Unit 4: Accords the sequence alignment and applications. The choice of alignment, local alignment, global alignment scoring matrices, codon usages analysis, RNA fold analysis, splice site identification will also be studied by the students.

Contents

Unit 1

Genome, Genomics & Transcriptomics:

Genome mapping: Physical and Genetic Map, Genome Sequencing, Next generation sequencing methods, Genome Annotation, Functional Genomics. Transcription factor binding sites, RNA-Seq, Microarrays, Regulatory RNAs: small or large, Computational prediction of miRNA target genes, RNA Dark matter.

Unit 2

Proteomics, Metabolomics & Lipidomics:

Basic concepts, Tools of proteomics- SDS PAGE, 2D PAGE, Liquid chromatography, Mass Spectrometry (ESI and MALDI), Protein identification by peptide mass fingerprinting, Applications of proteomics.

Fundamental concept, data integration and data mining; Tools of metabolomics-Capillary electrophoresis, Gas chromatography, Electrochemical detectors.

Basic concepts and tools of lipidomics, glycomics and phosphoproteomics.

Unit 3

Biological Literature Information access, storage and retrieval systems- Primary and secondary databases of genomics, trascriptomics, proteomics and metabolomics. Knowledge on freeware and commercial software. Importance of hardware and software creations.

Collecting and Storing Sequence Data: Sequence assembly; Submission of Sequences; Sequence accuracy; Sequence databases; Sequence formats; Annotation and Archival.

Unit 4

Sequence alignment and applications: Uses: Choice to be made for alignment; Scoring matrices; Homology and related concepts; Dot Matrix methods; Dynamic programming methods for global and local alignments tools- FASTA, BLAST, statistical and Biological significance.

Nucleic acid sequence analysis: Reading frames; Codon Usage analysis; Translational and transcriptional signals; Splice site identification; Gene prediction methods; RNA fold analysis

References:

1. (1st Ed.) by Liebler, D.C., 2002, Human Press Inc., New Jersey, USA.
2. Bioinformatics: Sequence and Genome Analysis Introduction to Proteomics -Tools for the New Biology by Daniel C. Liebler, Humana Press.
3. Mass Spectrometry for Biotechnology by Gary Siuzdak, Academic Press.
4. Proteomics for Biological Discovery by Timothy Veenstra and John Yates, Wiley.
5. Metabolomics- Methods and Protocols by Wolfram Weckwerth, Humana Press.
6. Lipidomics- Technologies and Applications by Kim Ekroos, Wiley-VCH.
7. Web/Journal Resources.
8. Transcriptomics: Expression Pattern Analysis, Virendra Gomase, Somnath Tagore; VDM Publishing, 2009 – Science.
9. Current Protocols in Bioinformatics, Edited by A.D. Baxevanis et al, Wiley Publishers. 2005.
10. Bioinformatics by David W. Mount, Cold Spring Harbor Laboratory Press. 2001.
11. Fundamental concepts of Bioinformatics by D.E. Krane and M.L Raymer, Pearson Education. 2003.

12. Bioinformatics and Functional Genomics by Pevsner, J., John Wiley and Sons, New Jersey, USA. 2003
13. Principles of Genome Analysis and Genomics (3rd Ed.) by Primrose, S.B. and Twyman, R.M., Blackwell Publishing Company, Oxford, UK. 2003.
14. Introduction to proteomics – Tools for the new biology by Mount, D., Cold Spring Harbor Laboratory Press, New York. 2004.

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101420210: Medical Microbiology

Course Objectives:

The objective of this course is to make the students understand various attributes which make the microbes pathogenic or disease-causing, the emergence of newer pathogens with relevance to India and the various tools for their local or global spread. The students would also learn the mechanisms of resistance of bacteria to antibiotics and role of newer vaccines in controlling infectious diseases. The course would also enable students to describe the diagnostic methods and automated equipment which may be used for diagnosis of diseases caused by microorganisms.

Course Learning Outcomes:

Unit 1: Understands infection, its types and various host pathogen interaction. The students will be able to know the operation and the mechanisms which underlie the immune response to understand the phenomena like host defense.
Useful to study various tools available to work on epidemiology.
Unit 2: Will gain in depth knowledge of Morphology, Cultural Characteristics, Antigenic structures, Pathogenesis, Laboratory Diagnosis of certain prominent and newer disease-causing bacteria.
Unit 3: Will get the information of different significant viral diseases, their characteristics, pathogenicity, antigenic properties, diagnosis and its preventive and control measures.
Unit 4: Understands different fungal and protozoal infections, their life cycles, and pathogenesis. Also useful to study and evaluate preventive and control mechanisms.

Contents:

Unit-I Basics in Medical Microbiology

Host pathogen interaction: Definitions - Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Carriers and their types, Opportunistic infections, Nosocomial infections. Transmission of infection, Pathophysiologic effects of LPS

Nonspecific host defences, virulence factors, normal flora and gnotobiology

Epidemiology: Infectious diseases, disease cycle, epidemiological methods, diagnostic principles, control, prevention, antimicrobial therapy.

Unit-II Bacterial Diseases

Morphology, Cultural Characteristics, Antigenic structures, Pathogenesis, Laboratory Diagnosis of following bacteria: *Staphylococcus, Streptococcus including Pneumococcus, Corynebacterium, Clostridium, Mycobacteria, E. coli, Salmonella, Shighella, Spirochaetes, Neisseria*

Unit-III Viral Diseases

The Nature and classification of viruses, Morphology: virus structure and Virus replication.

General properties, diseases caused, lab diagnosis and prevention of Herpes (HSV), Hepatitis (HAV & HAB), Picorna (Polio virus), Orthomyxo (Influenza), Paramyxo (Mumps and Measles), Rabdo (Rabies), Ebola, Zika and HIV virus.

Viral vaccines and antiviral agents

Unit-IV Fungal and Protozoal Diseases

Fungal Morphology, diseases caused and lab diagnosis of:

Opportunistic fungi – *Candida and Aspergillus*

Fungi causing Cutaneous mycoses- *Dermatophytes*

Subcutaneous mycoses - *Mycetoma*

Systemic mycoses- *Histoplasma*

Protozoal Morphology, life cycle, laboratory diagnosis of following parasites

Parasites: *Entamoeba, Giardia, Leishmania, Plasmodium*

References:

1. Textbook of Microbiology by Surinder Kumar
2. Medical Parasitology by R. Karyakarte.
3. P. B. Godkar. Text Books of Medical Laboratory Technology
4. Anathanarayana & Panikar – A Text Book of Medical Microbiology
5. P. Chakraborthy- A Text Book of Microbiology
6. Chatterjee, KD – Parasitology
7. Danial Greenwood et al, Medical Microbiology, A guide to Microbial Infections, Pathogenesis, Immunity, Laboratory Diagnosis and control.
8. Jagdish Chander, Textbook of medical mycology.
9. Teri Shores- Understanding Viruses.
10. Biswas SB and Biswas A: An Introduction to Viruses.

Course Credit Scheme
Semester III

Course Type	Course Code	Name of Course	T/ P	Credits	Exam Duration (Hrs)	Components of Marks		
						Internal	External	Total
						Total/ Passing	Total/ Passing	Total/ Passing
Core Course	101420301	Microbial Biotechnology	T	4	3	40/16	60/24	100/40
	101420302	Gene regulation and Genetic Engineering	T	4	3	40/16	60/24	100/40
	101420303	Enzyme Kinetics and Mechanisms	T	4	3	40/16	60/24	100/40
	101420304	Lab I (Practicals based on 101420301and101420302)	P	4	3	40/16	60/24	100/40
	101420305	Lab II (Practicals based on 101420303 and any one of the Elective)	P	4	3	40/16	60/24	100/40
	101420306	Comprehensive Viva	P	1			50/20	50/20
Elective Course	101420307	Bioinformatics	T	4	3	40/16	60/24	100/40
	101420308	Developmental Biology	T	4	3	40/16	60/24	100/40
	101420309	Micro-techniques	T	4	3	40/16	60/24	100/40
	101420310	Microbial Physiology	T	4	3	40/16	60/24	100/40
Total Credits				25				650

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SYLLABUS EFFECTIVE FROM: JUNE-2020-21

101420301 – MICROBIAL BIOTECHNOLOGY

Course Objectives:
The main aim of course is to make students understand the importance of industrially important organisms and the fermentation processes involved in the production of various microbial products with focus on the current trends in fermentation technology. Students will be to differentiate between batch, fed-batch and continuous cultivation systems and their optimization strategies for the economical production of different fermented products used in various industries like food industry, pharmaceutical applications etc.

Course Learning Outcomes:
Unit 1: Students will be able to know about production of various primary metabolites of economic importance. They will understand the role of microbes in production of these primary metabolites.

Unit 2: Gathers information regarding microbial biotechnology and its application in microbial processes. Understand about strain development and selection of hyper producing industrially relevant strains for production of microbial products like antibiotics, anticancer agents and ergot alkaloids.

Unit 3: Knows the production of various enzymes, amino acids and vitamins production using fermentation processes and their industrial use.

Unit 4: Gains knowledge about production of bioplastics and exopolysaccharides. Students will be able to understand the biotransformation of steroids for therapeutic purposes. Students will be able to understand various bioinsecticides and their production.

Contents:
Unit 1: Microbial production of organic acids, solvents and beverages
Organic acids: citric acid, acetic acid
Industrial Solvents: ethanol, acetone-butanol
Beverages: beer, wine

Unit 2: Microbial production of therapeutic agents
Streptomycin, cephalosporin
Anticancer agents- Anthracyclines
Ergot alkaloids

Unit 3: Microbial production of enzymes, vitamins and amino acids
Enzymes: proteases, amylases and lipases

Vitamins: B_2 and B_{12}
Amino acids: lysine, glutamic acid

Unit 4: Other microbial products
Microbial polysaccharides: Xanthan and Dextran
Steroid biotransformation
Polyhydroxyalkanoates: PHA and PHB

Reference Books:

1. Comprehensive biotechnology. Murray MooYoung, Editor in Chief. Pergamon Press, Oxford, 1985, 4 volume set. Volume 3 — The Practice of Biotechnology: Bulk Commodity Products. Volume Editors - Harvey W. Blanch, Stephen Drew and Daniel I.C. Wang, ISBN 10: 008026204X ISBN 13: 9780080262048
2. Microbial Technology - Second Edition, Volume I - Microbial Processes, Edited by Henry. J. PEPPLER and D. PERLMAN, ACADEMIC PRESS, New York San Francisco London 1979. ISBN 0-12-551501-4
3. Microbial Technology - Second Edition, Volume II - Fermentation Technology, Edited by Henry. J. PEPPLER and D. PERLMAN, ACADEMIC PRESS, New York San Francisco London 1979. ISBN 0-12-551502-2 (v. 2) Hardcover ISBN: 9780125515023, eBook ISBN: 9781483268279, Paperback ISBN: 9781483244693
4. Biotechnology: a multi volume comprehensive treatise edited by H. J. Rehm and G. Reed in cooperation with A. Puhler and P. Stadler. – 2nd edition, completely revised edition. – VCH, (Weinheim) volume 6: Products of Primary metabolism and volume 7: Products of secondary metabolism ISBN 3-527-28310-2
5. Microbiology and Technology of Fermented Foods, 2nd Edition, editor- Robert W. Hutkins, Wiley-Blackwell Publishing, ISBN: 978-1-119-02744-7
6. Modern Industrial Microbiology and Biotechnology, 2nd edition, editors - Nduka Okafor, Benedict C. Okeke (2017), CRC Press, ISBN 9780367781675

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101420302: GENE REGULATION AND GENETIC ENGINEERING

Course Objectives:
The objective of this course is to make students understand the transcriptional, translational and processing level control of gene expression in prokaryotes. This knowledge will then be used to meet the main objective of this course, which is to make the student understand the process of cloning, screening and expression of genes in heterologous systems.

Course Learning Outcomes:
Unit – I: Students should be able to acquire basic knowledge of regulation of prokaryotic gene expression at different levels.

Unit – II: Students should know about different types of enzymes and vectors that are used in recombinant DNA technology.

Unit – III: Students should have understood the process of transferring the cloned DNA in another host by different methods and various screening methods to select the transformed cells from the non-transformed cells.

Unit – IV: Students should have learnt advanced selection and screening techniques including molecular markers, PCR and sequencing.

Contents:
Unit 1: Regulation of gene expression
Regulation of gene expression in prokaryotes: Operon concept, positive and negative regulation. Examples of lac and trp operon regulation; global regulatory responses. Regulation of gene expression in eukaryotes: Transcriptional, translational and processing level control mechanisms.

Unit 2: Restriction enzymes & Vectors
General strategies and Steps involved in gene cloning; Extraction and purification of DNA from bacteria, plant and animal cells.
Restriction enzymes, DNA ligase and other enzymes involved in gene cloning
Cloning and expression vectors- Plasmids, - bacteriophages, M-13 based vectors, Phagemids, Cosmids, YAC, BAC, PAC, HAC/MAC, etc. Expression of cloned gene in heterologous host.

Unit 3: Recombinant selection & screening

Introduction of DNA into host system

Chemical synthesis of DNA, Construction of genomic and cDNA libraries, Recombinant selection and screening, Southern blotting & hybridization, Northern analysis, Western blot analysis, DNA sequencing, Nucleic Acid Microarray

Unit 4: Molecular Markers, PCR & Sequencing

Molecular markers (RFLP, RAPD, AFLP, SSR)

Polymerase chain reaction (PCR), Types of PCR

DNA sequencing and its assembly: Maxam -Gilbert and Sanger's methods, Shot gun sequencing, Next generation sequencing strategies for large genomes.

Reference Books :

1. Genetic Engineering by Smita Rastogi and Neelam Pathak, Oxford Higher Education, ISBN 0-19-569657-3
2. Molecular Genetics of Bacteria by Larry Snyder and Wendy Champness, 3rd Edition, ASM Press ISBN :1555813992
3. Genomes by T. A.Brown, 3rd Edition, 2007, Taylor and Francis (New York), ISBN 0815341385
4. Molecular Biotechnology: Principles and Applications of Recombinant DNA by Bernard R. Glick, Jack J. Pasternak and Cheryl L. Patten, 4th Edition, 2010, Wiley Publishers, ISBN 978-1-555-81498-4
5. Principles of Gene Manipulation and Genomics by S. B. Primrose & R. M. Twyman, 7th Edition, 2006, Wiley-Blackwell, ISBN 978-1-405-13544-3
6. Applied Molecular Genetics by Roger L. Miesfeld, 1999, Wiley, ISBN 978-0-471-15676-5
7. Textbook of Biotechnology by H. K. Das 4th Edition, 2010, Wiley ISBN-10 : 8126526513

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SYLLABUS EFFECTIVE FROM: JUNE-2020-21

101420303 - ENZYME KINETICS AND MECHANISMS

Course Objectives:
The course will enable students to understand the Enzyme and their classification, structure of enzyme and their action & purification. The course will teach the enzyme kinetics, mechanisms of enzyme catalysis and Methods to study enzymes and its mechanisms of regulations using suitable examples of enzymes in the cell.

Course Learning Outcomes:

Unit I: Students will be able to know about the introduction of enzyme and its structure. The classification of enzyme and enzyme purification strategies from a variety of sources and to study the purity of enzymes.

Unit II: Students will be able to understand the enzyme kinetics with respect to presence of Substrate, inhibitors and activators and significance of Km, Vmax & Kcat, enzyme efficiency.

Unit III: Students will be able know the mechanisms of different enzyme actions. Mechanism of action allosteric enzymes.

Unit IV: Gains knowledge about conventional methods for enzyme analysis and is able to use the most recent and non-invasive techniques of quantification and detection. Understands the relevance of Isoenzymes and its physiological significance, enzyme immobilization techniques, Enzyme engineering.

Contents:
Unit 1:
Introduction to enzymology and historical developments in enzymology
Protein Structure: Primary, secondary, tertiary and quaternary structure, techniques used in enzyme characterization
Enzyme classification: IUB enzyme classification.
Enzyme Activity: Principle and techniques of enzymatic analysis, factors affecting enzyme Activity, Extraction and Purification of enzyme: Objectives and strategy, separation techniques, test of purity.

Unit 2: Enzyme Kinetics
Chemical reaction kinetics and catalysis
Single substrate kinetics: Equilibrium and Steady state kinetics, significance of Km, Vmax & Kcat, enzyme efficiency

Multisubstrate kinetics: General rate equation, compulsory order, random order and ping-pong mechanisms and their primary and secondary plots.
Enzyme inhibition and its kinetics: Reversible and irreversible inhibition, competitive, noncompetitive and uncompetitive, mixed, partial, substrate and allosteric inhibition.
Thermal kinetics: Effect of temperature on reaction rate, enzyme stability, Arrhenius equation and activation energy.

Unit 3: Mechanism of Enzyme Action
Enzyme mechanisms: Factors affecting catalytic efficiency, Mechanism of Lysozyme, Chymotrypsin, Carboxypeptidase, Restriction endonuclease, Aspartate transcarbamoylase.
Allosteric enzymes and sigmoidal kinetics: Protein ligand binding, Cooperativity, MWC & KNF models, Multienzyme enzyme complexes

Unit 4: Methods to study enzymes and its mechanisms
Enzyme engineering: Chemical modification of enzymes: methods of modification of primary structure, catalytic and allosteric properties, use of group specific reagents.
Enzyme Immobilization
Enzymes in non conventional media, Enzymes as analytical reagents.
Isoenzymes and its physiological significance, Ribozymes and Abzymes

Reference Books:

1. Understanding Enzymes, Third edition, editor - Trevor Palmer, 1st Published by Ellis Horwood ltd., England, 1991, ISBN 0-13-932534-4
2. Enzyme Kinetics - Principles and Methods, 2nd edition Revised, editor- Hans Bisswanger, (Wiley, 2008), Print ISBN:9783527319572, Online ISBN:9783527622023
3. Fundamentals Of Enzymology, 3rd Edition, edited by Nicholes C. Price and Lewis Stevens, Published by Oxford University Press, Incorporated (1989). ISBN 10: 0198552963ISBN 13: 9780198552963
4. Structure and mechanism in protein science: a guide to enzyme catalysis and protein folding, editor Alan Fersht, Published W. H. Freeman and Company, New York (1999), ISBN 0-7167-3268-8
5. Biochemistry, 8th edition editors - Jeremy Mark Berg, Gregory Joseph Gatto, Lubert Stryer, John L Tymoczko] - (2015, W. H. Freeman), ISBN-10: 1-4641-2610-0
6. Proteins: Structures and molecular properties, 2nd edition editor - Thomas E. Creighton, Published by W. H. Freeman, New York, 1992, ISBN 0-7167-7030-X
7. ENZYME KINETICS A Modern Approach by Alejandro G. Marangoni. John Wiley & Sons, Inc., Hoboken, New Jersey
8. Enzyme Technology, edited by Anusha Bhaskar and V.G. Vidhya, MJP Publishers, Chennai, India.
9. Enzymes, 3rd Edition, editors - M. DIXON, E. C. WEBB, C. J. R. THORNE, K. F. TIPTON. Longman Group Ltd. London 1979 ISBN:
10. Biochemistry, Fourth edition, edited by D Voet and J Voet, , published by John Wiley Publishers

101420304 - LAB I (PRACTICALS BASED ON 101430301 AND 101430302)

Practicals:

1. Production of cellulase enzyme by solid state fermentation.
2. Saccharification of agro-waste by cellulase enzyme.
3. Bioassay of antibiotics
4. Production of acetic acid / citric acid by submerged fermentation
5. Production of amylase / protease / Lipase by submerged fermentation
6. Development of Mutants for fermentation using Physical and chemical mutagens
7. Isolation of plasmid DNA by boiling lysis method.
8. Isolation of plasmid DNA by Alkaline lysis method.
9. Large scale preparation of plasmid with chloramphenicol amplification.
10. Preparation of competent cells of *E.coli*
11. Transformation of artificially induced competent cells of *E.coli* by plasmid DNA.
12. Cloning of gene in *E.coli*
13. Expression of cloned gene.
14. Restriction digestion.
15. Demonstration of DNA amplification by PCR

101420305 - LAB II (PRACTICALS BASED ON 101430303 AND 101430307(Bioinformatics)

Practicals

1. Estimation of Reducing Sugar by DNS method
2. Substrate saturation curve
3. Determination pH optimum of invertase enzyme
4. Determination temperature optimum of invertase enzyme
5. Determination time optimum of invertase enzyme
6. Determination of type of inhibition of invertase enzyme
7. Introduction of different database of NCBI
8. Introduction of PIR, ExPasy, EMBL, SCOP,CATH
9. Database introduction- Pfam, Prodom
10. Use of L-ALIGN
11. Clustal-W and Phylogenetic Analysis
12. Protein Sequence Databases and visualization by RASMOL & SPDBV
13. Homology modeling, structure validation and quality of protein structure
14. *In Silico* study of ligand protein interaction
15. Introduction to Reactome and iPath3 (Metabolic Pathway Databases)

101420306-COMPREHENSIVE VIVA (BASED ON ALL THEORY PAPERS)

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101420307 – BIOINFORMATICS

Course Objectives: The course will enable the students to understand the concept of bioinformatics, various types of databases and their importance. This course will enable students to for algorithms and concept of sequence alignments, understanding the phylogenetic relationship among the organisms in evolution. Students will also be able to know the 2D structure and 3D structure of protein which ultimately enable the students to understand the active site prediction, drug design & development.

Course Learning Outcomes:
Unit – I: Envisages about the concept of bioinformatics and its application. It provides the knowledge of various databases, nucleic acid databases, protein sequence databases, formats of various databases and their importance.

Unit – II: Gathers information regarding concept of scoring matrix, search of databases, algorithms of the BLAST and FASTA. The students will learn the basic concepts of pairwise sequence alignment and multiple sequence alignments.

Unit – III: Deals with the pairwise and multiple sequence alignment for analysis of nucleic acid and proteins sequences. The students will also learn to construct the phylogenetic trees, molecular basis of evolution using different methods.

Unit – IV: Accords to gain the knowledge of structure of protein, prediction of 2-dimentional, 3-dimentional structure of protein and their algorithms. Students will be able to predict the active site of protein, folding of protein, protein modeling and drug design using software.

Contents:
Unit 1: Introduction to Bioinformatics
Overview, Internet and bioinformatics, Applications.
Introduction and Bioinformatics Resources:
Knowledge of various databases and bioinformatics tools available at these resources, the major content of the databases, Literature databases:
Nucleic acid sequence databases: GenBank, EMBL, DDBJ
Protein sequence databases: SWISS-PROT, PDB, SCOP, CATH
Genome Databases at NCBI, EBI
Other Databases of Patterns/Motifs/System Biology (Gene and protein network database and resources)
Various file formats for bio-molecular sequences: genbank, fasta, gcg, msf, nbrfpir etc.

Basic concepts of sequence similarity, identity and homology, Definitions of homologues, orthologues, paralogues, xenologus.

Unit 2: Sequence analysis

Scoring matrices: basic concept of a scoring matrix, PAM and BLOSUM series.
Sequence-based Database Searches: what are sequence-based database searches, BLAST and FASTA algorithms, various versions of basic BLAST and FASTA.
Pairwise and Multiple sequence alignments: basic concepts of sequence alignment, Needleman & Wuncsh, Smith & Waterman algorithms for pairwise alignments, Progressive and hierarchical algorithms for MSA.

Unit 3: Functional genomics

Use of pairwise alignments and Multiple sequence alignment for analysis of Nucleic acid and protein sequences and interpretation of results.
Multiple sequence Alignment: CLUSTAL W
Definition and description of phylogenetic trees and various types of trees, Molecular basis of evolution, Method of construction of Phylogenetic trees: Distance based method (UPGMA, NJ), Character Based Method (Maximum Parsimony and Maximum Likelihood method).

Unit 4: Molecular Modeling

Structural classification of proteins, Protein structure analysis, Classes, folds, motif, domain
Secondary structure and evaluation: algorithms of Chou Fasman, GOR methods.
Tertiary Structure: basic principles and protocols, Methods to study 3D structure.
Active site prediction, Protein folding, Protein modeling and drug design.

References Books:

1. Bioinformatics: Sequence and Genome Analysis: Mount DW, (2nd edition) (2004). Cold Spring Harbor Laboratory Press, U.S. ISBN: 978-087969712-9
2. Introduction to Bioinformatics by Arthur Lesk 5th edition (2019), Oxford University Press ISBN: 9780198794141.
3. Bioinformatics: Methods and Applications: (Genomics, Proteomics and Drug Discovery) S. C. Rastogi, Namita Mendiratta, Parag Rastogi, 4th Edition, (2013). ASIN: B015DY3IJW
4. Ghosh Z and Mallick B, Bioinformatics-Principles and Applications, Oxford University. Press (First Print: 2008; Second Print: 2009). ISBN-13: 978-0-19-56-9230-3
5. Proteins: Structures and molecular properties by Thomas Creighton, 2nd edition (1992), W. H. Freeman, New York ISBN: 9780716723172.
6. Leach AR, Molecular Modeling : Principles and Application, (1996), Addison Wesley Longman Limited: Essex, England. **ISBN**-10 : 0582382106
7. Bioinformatics and functional genomics 3rd edition (2015), John Wiley & Sons, Ltd, UK. ISBN 978-1-118-58178-0
8. Computational Molecular Biology: An Algorithmic Approach Pevzner PA (2000), Springer.

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101420308 – DEVELOPMENTAL BIOLOGY

Course Objectives:

The major objective of this paper is to impart knowledge about the process of embryogenesis, organogenesis and role of different stem cells. It covers the role of protooncogenes, effect of oncogenes and aging process. Special emphasis will be given to understand gene expression during mammalian development and different genetic disorders.

Course learning outcomes:

Unit1

The student will know the process of embryogenesis, organogenesis and role of different stem cells.

Unit 2

The student is able to understand classification teratomas and teratogenesis.
They will also know the role of tumor suppressor genes, protooncogenes, oncogenes and even they will learn about how genetic regulation of the aging process occurs.

Unit 3

The student will be able to understand gene expression during mammalian development. They will come to know the functions of different genes, transcriptional factors and their role in human development.

Unit 4

The student will know about different genetic errors that occur at the time of human development. They will know the nature of human syndrome, Gene expression and different human diseases related to Infertility.

Contents:

Unit: 1 Overview of embryogenesis in mammals

Structures of spermatozoa and ovum Fertilization, Cleavage and blastulation, Gastrulation Organogenesis and Stem cells
Sex determination in mammals Types and functions of stem cells
Development of human brain Epidermis and the origin of cutaneous structures

Unit: 2 Teratogenesis and Aging

Teratogenic agents, Classification of teratomas, Tumerogenesis

Overview of tumor suppressor genes, protooncogenes and oncogenes Causes and genetic regulation of aging, Promoting longevity

Unit: 3 Gene expression during Developmental

Differential gene expression during development
RNA localization techniques
Determination of functions of genes
Overview of transcriptional factors and human development

Unit: 4 Medical implications of Developmental biology

Genetic errors of human development, Identification of defective genes Nature of human syndromes, Gene expression and human diseases Infertility

Reference Books:

- Scott F Gilbert, Developmental Biology, 8th edition, Sinauer Associates Inc., USA. ISBN 0-87893-250-X
- Shastry and Shukal, Developmental Biology, Rastogi Publications, ISBN 81-7133-734-1
- Klug W. S. & Cummings M. R. Concepts of Genetics. Seventh edition. Pearson Education. ISBN 81-317-0811-X
- Fundamentals of Genetics by B D Singh.
- P. K. Gupta, Genetics. Rastogi Publications, Meerut, India, ISBN: 81-7133-842-9.
- Gardner E. J., Simmons M. J. & Snustad D. P. Principles of Genetics. Eighth edition. John Wiley & Sons Inc. ISBN 9971-51-346-3.
- Elements of Breeding and breeds of cattle and Buffalo- P Kanakraj, Jaypee Brothers Medical, ISBN:978-8180618420
- Nptel lecture series

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101420309 – MICROTECHNIQUES

Course Objectives:
The course will enable the students to understand the principle of microscopy types of microscopy used to explore the knowledge of microtechniques. The measurement of size of microorganisms, sanctioning of the bigger specimens by using microtome, preparation of temporary and permanent slides of the specimen will be known.

Course Learning Outcomes:
Unit 1: Deals with the concept and principle of microscopy. It provides the understanding of different optical components of microscopy.

Unit 2: Enrich the knowledge of different types of microscopes such as Light microscope, Compound microscope, Dark field, Bright field, Stereo microscope, Confocal, Phase contrast microscope, Fluorescent microscope, Transmission Electron Microscopy (TEM) and Scanning Electron Microscopy (SEM).

Unit 3: Explore the need and methods of measurement of microorganisms by micrometry. The calibration and working with the stage and ocular micrometer. Illustrations and concept of photomicrography will also be known.

Unit 4: The concept of killing and fixation agents, dehydration of the specimens, embedding of specimens in paraffin wax, free hand sanctioning, mounting of sanctioned specimen on slide, staining of specimens and different types of staining will be known.

Contents:
Unit 1
Principles of microscopy – eyepiece lens and objective lenses; Magnification, Resolving power, numerical aperture. Mechanical components: base, pillar, stage, sub stage, body tube, focusing knobs, nose pieces. Optical components: mirror, objectives, ocular lens, condenser, Focussing slides under low/ high power and oil immersion.

Unit 2
Types of microscopes: Light microscope, Compound microscope, Dark field, Bright field, Interference microscope (Stereo microscope), Confocal, Inverted microscope, Phase contrast microscope, Fluorescent microscope, Electron microscope: Transmission Electron Microscopy (TEM) and Scanning Electron Microscopy (SEM).

Unit 3

Measurement of Microorganisms- Micrometry – Stage micrometer, Ocular micrometer, Calibration and working. Preparation of illustrations using camera lucida, digital camera and photomicrography.

Unit 4

Killing and fixation agents - carnoy's formula, F. A. A.
Dehydration– general account of dehydration (Ethanol, Isopropyl alcohol, Acetone, Glycerine).
Ethanol – Xylene series and Tertiary Butyl Alcohol Series
Infiltration – paraffin wax method, Embedding
Free hand sectioning- Microtome (Rotary and sledge) serial sectioning and its significance.
Mounting- A brief account on whole mounting, maceration, smears and squash preparation, application of permanent whole mounts, permanent sections.
Staining- Classification: natural dyes, coal tar dyes, double staining, vital staining; simple, Gram staining, negative staining, capsule staining, spore staining, flagellar staining, nuclear staining and acid-fast staining, stains: saffranin, hematoxylin, acetocarmine

References:

1. Plant Microtechnique, Johansen D. A. 1940, McGraw – Hill Book Company, Inc. New York.
2. Manual of Microbiology – Tools and Techniques, Kanika S. 2007, Ane's student edition.
3. Botanical Microtechnique; principles and Practice, Khasim S.K., 2002, Capital Publishing Company New Delhi.
4. Essentials of botanical microtechnique, Toji T. (2004), Apex Infotec Publ.
5. Fundamental of Light Microscopy & Electron Imaging, Murphy D. B. (2001) 1st eds. Wiley-Liss, 2001.
6. Microscopy and Microtechnique by R. Marimuthu (2015), MJP Publishers.

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SYLLABUS EFFECTIVE FROM: JUNE-2020-21

101420310 – MICROBIAL PHYSIOLOGY

Course Objectives:

The major objective of this paper is to develop a clear understanding of various aspects of microbial physiology along with diverse metabolic pathways existing in bacteria in relation to its survival and propagation. This course enables the students to understand stress responses, intracellular signaling mechanisms and be acquainted with different protective resistance microbial responses.

Course Learning Outcomes:

Unit 1: The students will understand the structural details of cell wall, cell membrane and other outer appendages. Will have gained an in-depth knowledge of primary, secondary and group translocation transport systems existing in bacteria, simultaneously learning membrane transport proteins and kinetics of solute transport. Moreover, it will be useful to understand motility types and mechanism of microbial cells.

Unit 2: Will be acquainted with methods of measuring microbial growth, calculating growth kinetic parameters with understanding of steady state and continuous growth. Understands various microbial stress mechanisms and responses.

Unit 3: Is conversant with intracellular signaling in bacteria in response to various nutritional and physiological stresses. Helpful to understand the role of signaling compounds, its regulation and its response for quorum sensing, biofilm formation and bioluminescence process.

Unit 4: Will be acquainted with different mechanisms of drug resistance, various protective mechanisms of microbes upon infections. Moreover, make the students well aware with bacterial immune system, CRISPR/Cas

Contents:

Unit-1

Bacterial Cell Structure and its type, Bacterial Cell wall structure function and synthesis Membrane transport in prokaryotes-simple, group translocation, ABC transporters, Protein export in bacteria– Type 1,2,3,4, Protein export pathways. 2. Permeation- Primary Active transport, secondary active transport, Co transport

Transport of ions across the membrane V-type, F-type and p-type ATPases

Bacterial organs for locomotion: Flagella: structure, synthesis, function and mechanism of locomotion, Swarming motility, Motility in spirochetes, Gliding motility, Twitching.

Chemotaxis: Molecular mechanism and physiological significance.

Two component signal transduction in prokaryotes

Unit-2

Bacterial cell division: molecular mechanisms involved in formation of Z-ring, Cell division machinery.

Bacterial differentiation: endospore formation, physiological and genetic aspects of sporulation, Sporulation inducing signals & events in sporulation

Microbial stress responses: Heat shock, pH, aerobic-anaerobic shifts- Arc and Fnr system, Oxygen toxicity: Mechanism of oxygen toxicity and its mechanism to overcome toxicity-catalase, peroxidase and superoxide dismutase, Osmotic pressure, Osmolarity regulation in *E.coli* (Omp system), Phosphate assimilation in *E.coli* (Pho system).

Unit-3

Quorum sensing process in microorganisms

Bioluminescence process, biochemistry, genetics and significance

Bacterial biofilms formation steps, dispersion and control strategies

Siderophores; structure, function and significance

Microbial fuel cells: Energy generation principle and application. Production of Hydrogen.

Unit-4

Mechanism of drug resistance

Bacteriocins: Structure, Classification and physiological significance of it.

Host Parasite interactions: Structures and functions involved in Host-parasite interactions, Bacterial damages to host upon infection. Structure and Mechanism of Endotoxin, Exotoxin and Exoenzymes formed by bacteria.

The prokaryotic "immune system", CRISPR/Cas

References:

- Microbial Physiology by A.G. Moat, J. W. Foster, M. P. Spector. 3rd Edition. John Wiley & Sons. 2002
- The Physiology and Biochemistry of prokaryotes by David White
- Bacterial signaling by Kramar and Jung
- Bacterial physiology: A molecular approach by W. E. Sharoud
- Topic related review articles

Course Credit Scheme

Semester IV

Course Type	Course Code	Name of Course	T/P	Credits	Exam Duration (Hrs)	Components of Marks		
						Internal	External	Total
						Total/ Passing	Total/ Passing	Total/ Passing
Core Course	101420401	Plant and Animal Biotechnology	T	4	3	40/16	60/24	100/40
	101420402	Environmental Biotechnology	T	4	3	40/16	60/24	100/40
	101420403	Lab I (Practicals based on 101420402 and101420403)	P	4	3	40/16	60/24	100/40
	101420404	Comprehensive Viva	P	1			50/20	50/20
Elective Course	101420405	Dissertation	P	12			300/120	300/120
	OR							
	101420406	Advanced Immunology	T	4	3	40/16	60/24	100/40
	101420407	IPR and Biosafety	T	4	3	40/16	60/24	100/40
	101420408	Lab II (Practicals based on 101420406 and 101420407)	P	4	3	40/16	60/24	100/40
Total Credits				25				650

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M.Sc MICROBIOLOGY
SEMESTER – IV
SYLLABUS EFFECTIVE FROM: JUNE-2020-21

101420401: PLANT AND ANIMAL BIOTECHNOLOGY

Course Objectives:
The major objective of this paper is to impart knowledge about plant and animal tissue culture techniques. It covers media preparation, its types, its constitutional details, etc. Special emphasis is given to cytotoxicity analysis and role of plant secondary metabolites. It also covers genetically engineered plants developments in regards to microbial or pest control, in terms of stress resistant or high productivity generation.

Course Learning Outcomes:
Unit 1: The students will be able to understand basic requirements for animal tissue culture technique. They will come to know various types of media, its components, its role and different sterilization techniques.

Unit 2: Understands the basic techniques of animal cell culture, Primary cell line development , sub culture and types cell lines. The students will learn about Organ culture, Cell viability and Cytotoxicity assays and they will be also aware regarding the basics of stem cells.

Unit 3: The students will learn about cell & tissue culture in plants; callus cultures; *in-vitro* morphogenesis-organogenesis, somatic embryogenesis, etc. The content will make the students aware for Micropropagation, anther or pollen cultures and embryo cultures development. They will also know about protoplast fusion, somatic hybridization, Somaclonal variation, etc.

Unit 4: The students will learn about sources, types, pathways and role of various secondary metabolites. They will also learn about development of various transgenic plants in terms of stress resistance, pest resistance, microbial resistance, high productivity and some novel variety generation. The students will also know about DNA barcoding technology.

Contents:
Unit 1:
Basic requirements for animal tissue culture: Infrastructure, necessary equipments and accessories for animal tissue culture lab.
Culture Media: Different types of media-Natural media, Defined media, Serum free media
Chemical, physical and metabolic functions of different constituents of culture media.
Role of serum in tissue culture media
Sterilization techniques

Unit 2:
Basic techniques of animal cell culture
Biology and characterization of cultured cells
Primary culture techniques
Enzymatic and mechanical disaggregation techniques
Sub culture and types cell lines
Explant culture, Organ culture – 3D culture
Cell viability
Cytotoxicity assays
Basics of stem cells

Unit -3
Cell & tissue culture in plants; callus cultures; *in-vitro* morphogenesis-organogenesis and somatic embryogenesis; Artificial Seeds, Micropropagation (Clonal propagation); Haploidy- anther and pollen cultures, Embryo cultures; Protoplast isolation, culture and protoplast fusion and somatic hybridization, Cybrids, Somaclonal Variation; Virus elimination, Cryopreservation.

Unit- 4
Applications of secondary metabolites - Sources of plant secondary metabolites; Basic biosynthetic pathways, Drug development, Biopesticides, Biofertilizers. Transgenic plants production through *Agrobacterim tumefaciens* and *A. rhizogenes.* Genetic engineering of plants for bacteria, fungi, virus, pest and herbicide resistance. Production of antibodies, viral antigens and peptide hormones in plants, biodegradable plastics in plants. Molecular plant pathology: Mechanisms of disease resistance in plants against pathogens.DNA barcoding technology.

Reference Books:

- Culture of animal cells: A manual of basic technique- R. Ian Freshney, Wiley Publication.- 978-0-470-52812-9
- Principles and Practice of Animal Tissue Culture- Sudha Gangal- Universities Press 978-8173715785
- Biotechnology- U.Styanarayan- Books and Allied (P) Ltd. Kolkata 81-87134-90-9
- Methods in Cell Biology Vol-5: Animal Cell Culture Methods- Jennie P.Mather and David Barnes, Academic Press. 978-81-312-0658-4
- Animal cell culture & technology-M. Butler. Bio Scientific Publishers. Tayler & Francis Group. 1-85996-049-9
- Animal Biotechnology- M. M. Ranga. Agrobios (India). 81-7754-309-1.
- Animal biotechnology – Ramadas MJP Publishers Chennai. 978-81-8094-042-2
- Plant tissue culture, Theory and Practices-S.S. Bhojwani and M. K. Razdan (1996) Elsevier, Amsterdam. ISBN: 9780444540591
- An introduction to plant tissue culture – M K Razdan, Science Publisher, Inc. ISBN-13 : 978-8120417939
- Introduction to plant biotechnology – H S Chawla, Oxford & IBH Publishing Co Pvt.Ltd. ISBN: 9788120417328
- Plant propagation by tissue culture (Vols. 1 & 2) – Edwin F George, Michel A.and Geert-Jan De Klerk, Springer. ISBN 978-1-4020-5004-6

- Applied and fundamental aspects of plant cell tissue and organ culture edited by Reinert Bajaj Y P S, Springer Verlag. ISBN 978-3-662-02279-5
- Practical application of plant molecular biology – R J Henry, Chapman & Hall. ISBN 13: 9780412732201.
- Plant cell and tissue culture – S Narayanswamy, Tata Mc Graw Hill Co. ISBN: 0074602772
- Nptel lecture serie

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SYLLABUS EFFECTIVE FROM: JUNE-2020-21

101420402: ENVIRONMENTAL BIOTECHNOLOGY

Course Objectives:
The major objective of this paper is to impart knowledge about waste water management. Different aerobic and anaerobic wastewater treatment plants are discussed. It covers different aspects of bioremediation in terms of various kinds of pollutants. Special emphasis is given on the role of microbes and their enzymes in toxicity analysis and role of GMOs.

Course Learning Outcomes:
Unit 1 Is able to describe the role of microbes in solid and liquid waste management, gaining knowledge of various methods employed in sewage treatment. Also knows about potability of water and its quality control.

Unit 2 Understands the role of anaerobic microbes in management of wastewater treatment plants. It will be helpful to apply knowledge in designing microbe-based processes for preparation of compost or manure. The content becomes useful under the role of microbes or its enzymes in toxicity analysis.

Unit 3 Understands the role of microbes in bioremediation of environmental pollutants like aliphatic, aromatic, polyaromatic hydrocarbons, pesticides, dyes etc.

Unit 4 Understands various bioremediation approaches, use of GMO in bioremediation. The content will make the students aware for the role of plants in heavy metal removal and how microbes can be useful for the treatment of waste gases.

Contents:
Unit 1
Wastewater treatment- Physical, Chemical and Biological characterization of Waste water and its significance: Temperature, pH, Solids, Inorganic constituents, BOD, COD, TOC, TOD, biological components. Critical operating parameters like DO, hydraulic retention time,
mean cell residence time, F/M ratio etc
Wastewater treatment processes: Primary, secondary and tertiary treatment of waste water.
Suspended growth processes:
Activated sludge process: Biology of activated sludge, flocculation and sludge settling, problems of sludge settling, modified processes for inorganic nitrogen and phosphorous removal, Oxidation ditches and Waste stabilization ponds.
Fixed film processes: Biofilm formation, Trickling filters, Rotating biological contactors, fluidized bed and submerged aerated filters.

Unit 2

Anaerobic digestion: Microbial and Biochemical fundamentals of anaerobic digestion process, factors influencing anaerobic digestion.

Anaerobic wastewater treatments: Anaerobic Digesters, Up Flow Anaerobic Sludge Blanket (UASB), Rotating Biological Contactors (RBCs), anaerobic filters. Merits and demerits of anaerobic treatment of waste

Composting: Objectives, fundamentals, microbiology, factors influencing composting, composting systems, Compost quality and uses, Vermicomposting

Toxicity testing in wastewater treatment plants using microorganisms

Unit 3

Biodegradation of organic pollutants: Xenobiotic and recalcitrant organic compounds, mechanisms of biodegradation, factors affecting biodegradation, Acclimation phase in biodegradation.

Biodegradation of simple aliphatic, aromatic, polycyclic aromatic hydrocarbons, halogenated hydrocarbons

Microbial degradation of azo dyes and lignin

Unit 4

Bioremediation approaches: Intrinsic bioremediation, Biostimulation, Bioaugmentation: Use of Genetically Modified Organisms (GMOs). *In situ* and *ex situ* bioremediation technologies with examples

Bioremediation of heavy metal pollution, Phytoremediation

Biological treatment of waste gas (polluted air): biofilters, bio scrubbers, bio trickling filters

Reference Books:

- Wastewater microbiology by Gabriel Bitton, 3rd Edition, Wiley & Sons INC Publication, ISBN- 0-471-65071-4
- Biotechnology: Environmental Processes I, by H. J Rehm and G. Reed, Volume 11, Second Edition, Wiley & Sons INC Publication
- Environmental Biotechnology: Concepts and Applications by Hans-Joachim Jördening and Josef Winter, Wiley & Sons INC Publication
- Waste water treatment for pollution control by Soli J. Arceivala, 2nd edition.TataMcGrawHill Publishing Company Limited, ISBN: 0-07-463002-4.
- Handbook of water and wastewater Microbiology by Doncan Mara and Nigel Horan, 1st Edition, Elsevier Publication
- Topic related review articles

101420403: LAB I (PRACTICALS BASED ON 101420401 AND 101420402)

Practicals:

1. Introduction of animal tissue culture laboratory with necessary equipments and accessories.
2. Preparation of culture media (Hank's balanced salt solution).
3. Filter sterilization of culture medium.
4. Preparation of sterility test medium and check the sterility of culture media.
5. Establishment of primary culture from CHICK EMBRYO.
6. Cell Viability Count.
7. Calculate the seeding concentration of cells.
8. Preparation of MS media for inoculation
9. Micropropogation through nodal explants
10. Callus induction
11. Mass multiplication of banana
12. Protoplast isolation
13. Embryo dissection and culture
14. Alkalinity and Acidity
15. Estimation of Dissolved Oxygen (DO)
16. Determination of BOD of sewage
17. Determination of COD sewage
18. Estimation of Total Solids (TS)
19. Estimation of Total Suspended Solids (TSS)
20. Estimation of Total Dissolved Solids (TDS)
21. Estimation of available phosphorous by Stannous chloride method.
22. Estimation of Nitrate-Nitrogen (NO_3-N) by Brucine Sulfate method.
23. Estimation of Nitrite-Nitrogen (NO_2-N) by colorimetric method.
24. Estimation of Ammonia (NH_4^+ -N) by Nitroprusside Method.
25. Estimation of sulphate (SO_4^{-2}) by turbidometric method.
26. Isolation of metal (Chromium) detoxifying microorganisms.

101420404: COMPREHENSIVE VIVA BASED ON ALL THEORY PAPERS

101420405: DISSERTATION

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SYLLABUS EFFECTIVE FROM: JUNE-2020-21

101420406 - ADVANCED IMMUNOLOGY

Course Objectives:
The objective of the course is to give an extension to the basic knowledge of immunology acquired by students earlier as a core subject with emphasis on the applied aspect of the subject. The course provides an insight into the developments in the diagnostic field based on antigen-antibody reaction; the role of the immune system in transplantation and disease development including cancer and autoimmunity and immunodeficiency.

Course Learning Outcomes:

Unit I: The students will learn about the various methods for antibody production and antibody engineering, which can be then used for diagnostic or treatment purposes. The laboratory/diagnostics techniques based on antigen-antibody reaction, methods to determine antibody affinity etc. The students will also learn about the basis of vaccination and developments in the vaccine production.

Unit II: The students will learn about the development, differentiation and maturation of B and T lymphocytes, positive and negative selection to rule out self- reactive lymphocytes and memory generation.

Unit III: The students will learn about the types of the hypersensitivity reactions, factors triggering them and the consequences. They will also learn about the role of the immune system in acceptance or rejection of a graft, in particular MHC and different immunotherapies available to extend the life of a graft.

Unit IV: The students will learn about the types of immunodeficiency and the specific defect in the immune system causing a particular immunodeficiency. The students will also learn about the selection of self-tolerant cells and development of autoimmune diseases due to breakdown of tolerance.

Contents:
Unit I
Experimental systems and methods for diagnostics and therapy: Antibody production (polyclonal, monoclonal), Methods to Determine the Affinity (Equilibrium dialysis, surface Plasmon resonance), Microscopic visualization of cells and subcellular structures (Immunocytochemistry, Immunohistochemistry, Immunoelectron microscopy), Immunofluorescence-Based Imaging Techniques of Antigen-Antibody Interactions (Flow cytometry, Magnetic activated cell sorting, cell cycle analysis, assays of cell death)

Antibody Engineering: Chimeric and hybrid monoclonal antibodies, Construction of monoclonal antibodies from Ig-gene libraries
Vaccines: Active and passive immunization, conjugate or multivalent vaccines, DNA vaccines, vaccines under development – malaria and cancer

Unit II
T cell Development: Early Thymocyte Development, Positive and Negative Selection, Lineage Commitment, Exit from the Thymus and Final Maturation, Other Mechanisms That Maintain Self-Tolerance, Apoptosis
B cell Development: The Site of Hematopoiesis, B-Cell Development in the Bone Marrow, The Development of B-1 and Marginal-Zone B Cells, Comparison of B- and T-Cell Development
T-Cell Activation, Differentiation, and Memory: T-Cell Activation and the Two Signal Hypothesis, T-Cell Differentiation, T-Cell Memory
B-Cell Activation, Differentiation, and Memory generation: T-Dependent B-Cell Responses, T-Independent B Cell Responses, Negative Regulation of B Cells

Unit III
Allergy, Hypersensitivity and Chronic inflammation: Allergy: A Type I Hypersensitivity Reaction, Antibody-Mediated (Type II) Hypersensitivity Reactions, Immune Complex-Mediated (Type III) Hypersensitivity, Delayed-Type (Type IV) Hypersensitivity (DTH), Chronic Inflammation
Transplantation immunology: Immunological principles of graft rejection, Role of T cells in graft rejection, Role of Blood Group and MHC Antigens in Graft Tolerance, Predictable clinical course of graft rejection, General and target specific immunosuppressive therapy

Unit IV
Immunodeficiency disorders: Primary and secondary immunodeficiencies
Tolerance and autoimmunity: Establishment and maintenance of tolerance (antigen sequestration, central tolerance, peripheral tolerance), Autoimmunity (Organ specific autoimmune disease, systemic autoimmune disease, intrinsic and extrinsic factors that can favor susceptibility to autoimmune disease, proposed mechanisms for induction of autoimmunity, treatment of autoimmune diseases).
Cancer and immune system: Terminology and Common types of cancer, malignant transformation of cells, Tumor antigens, The Immune Response to Cancer, Cancer immunotherapy.

Reference Books:

1. Owen, J. A., Punt, J., & Stranford, S. A. (2013). Kuby immunology (7^{th} Edn). New York: WH Freeman.
2. I. Kannan (2007), Immunology. MJP Publisher, Chennai.
3. Murphy, K., & Weaver, C. (2016). Janeway's immunobiology (9^{th} Ed) Garland Science.
4. Male, D., Brostoff, J., Roth, D., & Roitt, I. (2012). Immunology (8^{th} Ed) With STUDENT CONSULT Online Access. Elsevier Health Sciences.
5. Abbas, A. K., Lichtman, A. H., & Pillai, S. (2014). Cellular and molecular immunology (6^{th} Ed) Elsevier Health Sciences.
6. Relevant review articles / research papers / handouts of latest development in the subject.

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101420407 – IPR AND BIOSAFETY

Course Objectives:

The objectives of this course are to provide basic knowledge on intellectual property rights and their implications in biological research and product development. This course enables the student to become familiar with India's IPR Policy to learn biosafety and risk assessment of products derived from biotechnology and regulation of such products.

Course Learning Outcomes:

Unit – I: Students should know the origin of IPR and its relevant history along with different organizations which led to the current state of IPR in order to better appreciate it.

Unit – II: Students should be able to understand the IPR, its types and the type of legal rights it provides to the owner.

Unit – III: Students should know about different types of Patents, procedure for filing a patent, their rights and different organizations across the globe who accepts patents.

Unit – IV: Students should have understood the concept of Biosafety, Biological and Physical level of containment, Risk assessment, GLP, GMP etc.

Contents

UNIT – I

Need for Intellectual Property Rights

Introduction to history of ITO, GATT, WTO, WIPO and TRIPS; plant variety protection and farmer's rights act; concept of 'prior art': invention in context of "prior art"; patent databases - country-wise patent searches (USPTO, EPO, India); analysis and report formation.

UNIT – II

Intellectual Property Rights & Its Types

Introduction to intellectual property; types of IP: patents, trademarks, copyright & related rights, industrial design, traditional knowledge, geographical indications, protection of new GMOs; International framework for the protection of IP.

UNIT – III

Patenting

Basics of patents: types of patents; Indian Patent Act 1970; recent amendments; WIPO Treaties; Budapest Treaty; Patent Cooperation Treaty (PCT) and implications; procedure for filing a PCT application; role of a Country Patent Office; filing of a patent application; precautions before patenting - disclosure/non-disclosure - patent application - forms and guidelines including those of National Bio-diversity Authority (NBA) and other regulatory bodies, fee structure, time frames; types of patent applications: provisional and complete specifications; PCT and conventional patent applications; international patenting-requirement, procedures and costs; financial assistance for Patenting introduction to existing schemes.

UNIT – IV

Biosafety

Biosafety and Biosecurity - introduction; historical background; introduction to biological safety cabinets; primary containment for biohazards; biosafety levels; GRAS organisms, biosafety levels of specific microorganisms; recommended biosafety levels for infectious agents and infected animals; definition of GMOs & LMOs; principles of safety assessment of transgenic plants – sequential steps in risk assessment; concepts of familiarity and substantial equivalence; risk – environmental risk assessment and food and feed safety assessment; problem formulation – protection goals, compilation of relevant information, risk characterization and development of analysis plan; risk assessment of transgenic crops.

References:

1. Bioethics and Biosafety, M.K. Sateesh. I.K. International Pvt. Ltd., ISBN 8190675702
2. Bioethic and Biosafety in Biotechnology by V. Sree Krishna. New Age International Publishers, ISBN (10): 81-224-2248-9.
3. IPR, Biosafety and Bioethics by Deepa Goel, Shomini Parashar
4. Biotechnology IPRs Biodiversity by Manjula Guru, M. B. Rao. Pearson Longman, ISBN 9788131701355.
5. Patent, Copyright Trademark An Intellectual Property Desk Reference by Richard Stim Attorney 9th Ed Nolo Publishers
6. The Patents Act 1970
7. WIPO Intellectual Property Handbook: Policy, Law and Use by World Intellectual Property Organization. WIPO 2004 2nd Ed, ISBN 92-805-1291-7
8. An Introduction to Ethical, Safety and Intellectual Property Rights Issues in Biotechnology by Padma Nambisan, Academic Press, ISBN: 978-0-12-809231-6
9. Intellectual Property Rights: Text and Cases by Dr. R Radhakrishnan and Dr. S Balasubramanian, Excel Books.
10. WTO and Intellectual Property Rights by Talwar Sabanna, Serials Publications.

101420408: LAB II (PRACTICALS BASED ON 101420406 AND 101420407)

Practical:

1. Quantitative precipitin reaction.
2. Isolation of lymphocytes and Lymphocyte culture
3. Purification of Immunoglobulin from serum:
   (i) Ammonium sulfate precipitation
   (ii) Ion-exchange chromatography
   (iii) Gel exclusion chromatography
4. Design of r-DNA laboratory
5. Various methods to discard the bio-hazardous waste
6. Steps in filing patent, filling patent forms
7. Methods to handle the recombinants
8. Patent case study