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	PG01CBIT01	Molecular Biology	T	4	3	30/10	70/28	100/40
	PG01CBIT02	Bioanalytical Techniques and Instrumentation	T	4	3	30/10	70/28	100/40
	PG01CBIT03	Cell Biology	T	4	3	30/10	70/28	100/40
	PG01CBIT04	Practicals based on PG01CBIT01 and PG01CBIT02	P	4	3	30/10	70/28	100/40
	PG01CBIT05	Practicals based on PG01CBIT03 and PG01EBIT0X	P	4	3	30/10	70/28	100/40
	PG01CBIT06	Comprehensive Viva	P	1			50/20	50/20
Elective Course	PG01EBIT01	Fundamentals of Biochemistry and Bioenergetics	T	4	3	30/10	70/28	100/40
	PG01EBIT02	Food Biotechnology	T	4	3	30/10	70/28	100/40
	PG01EBIT03	Marine Biotechnology	T	4	3	30/10	70/28	100/40
	PG01EBIT04	Virology	T	4	3	30/10	70/28	100/40
Total Credit				25				650

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	PG02CBIT01	Fermentation Technology	T	4	3	30/10	70/28	100/40
	PG02CBIT02	Basics of Microbial Genetics	T	4	3	30/10	70/28	100/40
	PG02CBIT03	Immunology	T	4	3	30/10	70/28	100/40
	PG02CBIT04	Practicals based on PG02CBIT01 and PG02CBIT02	P	4	3	30/10	70/28	100/40
	PG02CBIT05	Practicals based on PG02CBIT03 and PG02EBIT0X	P	4	3	30/10	70/28	100/40
	PG02CBIT06	Comprehensive Viva	P	1			50/20	50/20
Elective Course	PG02EBIT01	Biostatistics	T	4	3	30/10	70/28	100/40
	PG02EBIT02	Medical Biotechnology	T	4	3	30/10	70/28	100/40
	PG02EBIT03	Omics and Computational Biology	T	4	3	30/10	70/28	100/40
	PG02EBIT04	Medical Microbiology	T	4	3	30/10	70/28	100/40
Total Credit				25				650

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

CHARUTAR VIDYAMANDAL UNIVERSITY
VALLABH VIDHANAGAR
SEMESTER I
M.Sc BIOTECHNOLOGY
SYLLABUS EFFECTIVE FROM: JUNE-2020-21

PG01CBIT01: 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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SYLLABUS EFFECTIVE FROM: JUNE-2020-21

PG01CBIT02: 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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SYLLABUS EFFECTIVE FROM: JUNE-2020-21

PG01CBIT03: 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.

References:

- 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.

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SYLLABUS EFFECTIVE FROM: JUNE-2020-21

PG01EBIT01: 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.

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SYLLABUS EFFECTIVE FROM: JUNE-2020-21

PG01EBIT02: 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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M.Sc BIOTECHNOLOGY
SYLLABUS EFFECTIVE FROM: JUNE-2020-21

PG01EBIT03: 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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SYLLABUS EFFECTIVE FROM: JUNE-2020-21

PG01EBIT04: 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

References:
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

PG01CBIT04: Practicals based on PG01CBIT01 and PG01CBIT02

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

PG01CBIT05: Practicals based on PG01CBIT03 and PG01EBIT01

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

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PG02CBIT01: 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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PG02CBIT02: 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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PG02CBIT03: 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.

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PG02EBIT01: 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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PG02EBIT02: 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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PG02EMIC03: 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. Introduction to Proteomics -Tools for the New Biology by Daniel C. Liebler, Humana Press.
2. Mass Spectrometry for Biotechnology by Gary Siuzdak, Academic Press.
3. Proteomics for Biological Discovery by Timothy Veenstra and John Yates, Wiley.
4. Metabolomics- Methods and Protocols by Wolfram Weckwerth, Humana Press.
5. Lipidomics- Technologies and Applications by Kim Ekroos, Wiley-VCH.
6. Web/Journal Resources.
7. Transcriptomics: Expression Pattern Analysis, Virendra Gomase, Somnath Tagore; VDM Publishing, 2009 – Science.
8. Current Protocols in Bioinformatics, Edited by A.D. Baxevanis et al, Wiley Publishers. 2005.
9. Bioinformatics by David W. Mount, Cold Spring Harbor Laboratory Press. 2001.

10. Fundamental concepts of Bioinformatics by D.E. Krane and M.L Raymer, Pearson Education. 2003.
11. Bioinformatics and Functional Genomics by Pevsner, J., John Wiley and Sons, New Jersey, USA. 2003
12. Principles of Genome Analysis and Genomics (3rd Ed.) by Primrose, S.B. and Twyman, R.M., Blackwell Publishing Company, Oxford, UK. 2003.
13. Introduction to proteomics – Tools for the new biology (1st Ed.) by Liebler, D.C., 2002, Human Press Inc., New Jersey, USA.
14. Bioinformatics: Sequence and Genome Analysis by Mount, D., Cold Spring Harbor Laboratory Press, New York. 2004.

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PG02EMIC04: 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.

PG02CBIT04: Practicals based on PG02CBIT01and PG02CBIT02

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

PG02CBIT05: Practicals based on PG02CBIT03 and PG02EBIT01

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.