KANNUR UNIVERSITY

(Abstract)

M.Sc.Biotechnology Programme-Scheme, Syllabus, Pattern of Question Paper and Model Question paper under Choice Based Credit Semester System (in Outcome Based Education System-OBE) in Affiliated Colleges- Implemented with effect from 2023 Admission--Orders issued.

ACADEMIC C SECTION

ACAD C/ACAD C1/17830/2023 Dated: 11.09.2023

Read:-1. U.O No. Acad C2/429/2017 Dated 08.09.2020

2. U.O.No. Acad C1/21246/2019 Dated 07.12.2020

3. U.O. No. Acad/C1/21246/2019 Dated 16.02.2023.

4. U.O. No. Acad/C1/21246/2019 Dated 20.04.2023

5. Minutes ofthe meeting of the CSMC& Conveners of Ad hoc committee held on 15.06.2023

6. Orders of the Vice Chancellor in the file No. Acad C1/21246/2019 Dated 05.08.2023.

7. U.O. No. Acad/C1/21246/2019 Dated 09.08.2023

8. The Minutes of the meeting of the Ad hoc Committee for M.Sc. Biotechnology Programme held on 22.08.2023

9. Syllabus of M.Sc. Biotechnology Programme submitted by the Convenor, Ad hoc Committee for M.Sc.Biotechnology Programme vide e-mail dated 22.08.2023

ORDER

1. A Curriculum Syllabus Monitoring Committee comprising the members of Syndicate was constituted for the Syllabus revision of U G & P G Programmes in Affiliated Colleges, vide paper read (1) above and as per the recommendation of this Committee in its meeting held on 20.11.2020, constitute a sub Committee to prepare the Regulation for PG programmes in Affiliated Colleges vide paper read (2) above.

2. As the reconstitution of Board of Studies of the University is under the consideration of the Hon'ble Chancellor, and considering the exigency of the matter, Ad hoc Committees were constituted vide paper read (3) above and it has been modified vide paper read (4) above, to revise the Curriculum and Syllabus of PG Programmes in Affiliated Colleges w.e.f 2023-24 academic year.

3. The combined meeting of the Curriculum Syllabus Monitoring Committee & Conveners of Ad hoc committee held on 15.06.2023 at syndicate room discussed in detail the draft Regulation, prepared by the Curriculum Syllabus Monitoring Committee, for the PG programmes under Choice Based Credit and Semester System to be implemented in Affiliated Colleges w.e.f 2023 admission and proposed the different phases of Syllabus revision process such as subject wise workshop, vide the paper read (5) above.

4. The revised Regulations for Post Graduate Programmes under Choice Based Credit and Semester System (In OBE-Out Come Based Education System) was approved by the Vice chancellor on 05.08.2023 and implemented w.e.f 2023 Admission vide Paper read (7) above.

5. Subsequently, as per the paper read (8) above, the Ad hoc Committee for M.Sc. Biotechnology programme finalized the Scheme, Syllabus, Pattern of Question Paper and Model Question paper of M.Sc. Biotechnology programme to be implemented with effect from 2023 Admission

6. As per the read (9) above, the Convenor, Ad hoc Committee for M.Sc. Biotechnology programme submitted the finalized copy of Scheme, Syllabus, Pattern of Question Paper and Model Question Paper of M.Sc. Biotechnology programme for implementation with effect from 2023 Admission.

7. The Vice Chancellor after considering the matter in detail and in exercise of the powers of the Academic Council conferred under section 11(1) Chapter III of Kannur University Act, 1996 and all other enabling provisions read together with ***accorded sanction to implement the scheme, Syllabus, Pattern of Question Paper and Model Question paper of M.Sc Biotechnology programme under Choice Based Credit Semester System (in OBE-Outcome Based Education System) in Affiliated Colleges under the University with effect from 2023 Admission, subject to report to the Academic Council.***

8.The Scheme, Syllabus, Pattern of Question Paper and Model Question paper of M.Sc. Biotechnology programme under Choice Based Credit and Semester System (in OBE- Outcome Based Education System) in Affiliated Colleges under the University with effect from 2023 Admission is uploaded on the University website.

9. Orders are issued accordingly.

Sd/-

Narayanadas K

DEPUTY REGISTRAR (ACAD)

For REGISTRAR

To:
1. Principals of Affiliated Colleges offering M.Sc. Biotechnology Programme
2. Convenor, Curriulum Syllabus Monitoring Committee.
3. Convenor, Ad hoc Committee for Biotechnology Programme.

Copy To:
1. The Examination Branch (Through PA to CE)
2. PS to VC/ PA to PVC/ PA to R/ PA to FO
3. DR/ AR 1(Acad) /Computer Programmer
4. Web Manager (for uploading on the website).
5. EG 1/EX C1(Exam), EP V
6. SF/DF/FC

Forwarded / By Order

SECTION OFFICER

KANNUR UNIVERSITY
CIVIL STATION P.O.
KANNUR
Pin-670 002
* THAVAKKARA *

KANNUR UNIVERSITY

Course Structure and Syllabus

for

M.Sc. Biotechnology Programme

under

Choice Based Credit Semester System

(OBE-Outcome Based Education)

with effect from 2023 admission

(for affiliated colleges)

Introduction

Biotechnology can be termed as technology based on biology. It uses cellular and biomolecular processes to develop products that help to improve the quality of our lives. We have been using microbial based biological processes for thousands of years to make useful food products, such as bread and cheese and beverages. Modern biotechnology provides products and technologies to combat diseases, preserve our environment, feed the hungry, make cleaner energy and more efficient industrial manufacturing processes.

M.Sc. Biotechnology is a two year postgraduate program. The program is run under choice based credit semester system and is a part of the Outcome Based Education adopted in Kannur University. Three types of courses are offered in this programme: core, elective and open elective courses. A number elective courses are offered and hence the students will be able to choose the courses according to their preferences. It is having both theoretical and practical courses. The programme helps the students to apply their knowledge in different fields. It also helps the students to get employment in companies like healthcare and pharmaceuticals. Students are also eligible to pursue their career in research and development and will be able to contribute to science and technology.

Vision:

To establish a teaching, residential and affiliating University and to provide equitable and just access to quality higher education involving the generation, dissemination and a critical application of knowledge with special focus on the development of higher education in Kasargode and Kannur Revenue Districts and the Manandavady Taluk of Wayanad Revenue District.

Mission:

To produce and disseminate new knowledge and to find novel avenues for application of such knowledge.

To adopt critical pedagogic practices which uphold scientific temper, the uncompromised spirit of enquiry and the right to dissent.

To uphold democratic, multicultural, secular, environmental and gender sensitive values as the foundational principles of higher education and to cater to the modern notions of equity, social justice and merit in all educational endeavours.

To affiliate colleges and other institutions of higher learning and to monitor academic, ethical, administrative and infrastructural standards in such institutions.

To build stronger community networks based on the values and principles of higher education and to ensure the region's intellectual integration with national vision and international standards.

To associate with the local self-governing bodies and other statutory as well as non-governmental organizations for continuing education and also for building public awareness on important social, cultural and other policy issues.

The Program Outcomes (POs)

Program outcomes can be defined as the objectives achieved at the end of any specialization or discipline. These attributes are mapped while a student is doing graduation and determined when they get a degree.

PO 1. Advanced Knowledge and Skills: Postgraduate courses aim to provide students with in-depth knowledge and advanced skills related to their chosen field. The best outcome would be to acquire a comprehensive understanding of the subject matter and develop specialized expertise.

PO 2. Research and Analytical Abilities: Postgraduate programs often emphasize research and analytical thinking. The ability to conduct independent research, analyze complex problems, and propose innovative solutions is highly valued.

PO 3. Critical Thinking and Problem-Solving Skills: Developing critical thinking skills is crucial for postgraduate students. Being able to evaluate information critically, identify patterns, and solve problems creatively are important outcomes of these programs.

PO 4. Effective Communication Skills: Strong communication skills, both written and verbal, are essential in various professional settings. Postgraduate programs should focus on enhancing communication abilities to effectively convey ideas, present research findings, and engage in academic discussions.

PO 5. Ethical and Professional Standards: Graduates should uphold ethical and professional standards relevant to their field. Understanding and adhering to professional ethics and practices are important outcomes of postgraduate education.

PO 6. Career Readiness: Postgraduate programs should equip students with the necessary skills and knowledge to succeed in their chosen careers. This includes practical skills, industry-specific knowledge, and an understanding of the job market and its requirements.

PO 7. Networking and Collaboration: Building a professional network and collaborating with peers and experts in the field are valuable outcomes. These connections can lead to opportunities for research collaborations, internships, and employment prospects.

PO 8. Lifelong Learning: Postgraduate education should instill a passion for lifelong learning. The ability to adapt to new developments in the field, pursue further education, and stay updated with emerging trends is a desirable outcome.

Program Specific Outcomes (PSOs):

On successful completion of the M.Sc. Biotechnology program the students will be able to

PSO1: Explain the organization, structure and functions of living cells and cell organelles.

PSO2: Explain the function of genes, heredity and flow of genetic information, genetic modification.

PSO3: Explain the biosynthesis, structure, function of biological macromolecules, metabolism and flow of energy in living system.

PSO4: Explain the structure, physiology, classification and application of microbes.

PSO5: Apply various biophysical techniques and statistical methods to study the biological system.

PSO6: Apply the principles of bioprocess technology for the large scale production of useful products.

PSO7: Explain the principles and mechanisms of the immune system, immune responses, and how it provides protection from infection.

PSO8: Apply plant and animal cell culture methods and tissue culture methods to improve quality and quantity of crops and other useful products.

Scheme of the M.Sc. Biotechnology Programme

SEMESTER I

Sl. No.	Course Code	Name of the course	Credit	Teaching hours per week	CE Mark	ESE Mark
	Core Courses					
1	MSBTC01C01	Biochemistry and Enzymology	4	4	10	40
2	MSBTC01C02	General Microbiology	4	4	10	40
3	MSBTC01C03	Molecular Cell Biology	4	4	10	40
4	MSBTC01C04	Genetics	4	4	10	40
5	MSBTC01C05	Practical I (Biochemistry and Genetics)		5		
6	MSBTC01C06	Practical II (Molecular Cell Biology and General Microbiology)		4		
		Total	16	25	40	160

Note: End semester examinations for practical courses shall be conducted at the end of second semester

SEMESTER II

Sl. No.	Course Code	Name of the course	Credit	Teaching	CE Mark	ESE Mark

				hours per week		
	Core Courses					
7	MSBTC02C07	Immunology	4	5	10	40
8	MSBTC02C08	Molecular Biology	4	4	10	40
9	MSBTC02C09	Bioprocess Technology	4	4	10	40
10	MSBTC01C05	Practical I (Biochemistry and Genetics)	2		10	40
11	MSBTC01C06	Practical II (Molecular Cell Biology and General Microbiology)	2		10	40
12	MSBTC02C10	Practical III (Molecular Biology)	2	4	10	40
13	MSBTC02C11	Practical IV (Immunology and Bioprocess Technology)	2	4	10	40
14	MSBTC02C12	Internship / Field visit/ Minor project within Institution *	1		10	40
	Elective Courses (Students can choose one course from the given courses)					
15	MSBTC02E01	Biophysics	3	4	10	40
16	MSBTC02E02	Bioinstrumentation	3	4	10	40
17	MSBTC02E03	Nano Biotechnology	3	4	10	40
		Total	24	25	90	360

* Internship / mini project of minimum 30 hour duration

SEMESTER III

Sl. No.	Course Code	Name of the course	Credit	Teaching hours per week	CE Mark	ESE Mark

	Core Courses					
18	MSBTC03C13	Recombinant DNA Technology	3	3	10	40
19	MSBTC03C14	Plant Biotechnology and Crop Improvement	3	3	10	40
20	MSBTC03C15	Bioinformatics	3	3	10	40
21	MSBTC03C16	Practical V (Recombinant DNA Technology)		4		
22	MSBTC03C17	Practical VI (Plant Biotechnology and Crop Improvement		4		
	Elective Courses (Students can choose one course from the given courses)					
23	MSBTC03E04	Marine Biotechnology	3	4	10	40
24	MSBTC03E05	Biostatistics	3	4	10	40
25	MSBTC03E06	Bioentrepreneurship	3	4	10	40
	Open Elective Courses (Students can choose one open elective course either from the parent institute or from other institutes)					
26	MSBTC03O01	Intellectual Property Rights	4	4	10	40
27	MSBTC03O02	Food Biotechnology	4	4	10	40
28	MSBTC03O03	Vaccine Biotechnology	4	4	10	40
		Total	16	25	50	200

Note: End semester examinations for practical courses shall be conducted at the end of fourth semester

SEMESTER IV

Sl. No.	Course Code	Name of the course	Credit	Teaching hours per week	CE Mark	ESE Mark

	Core Courses					
29	MSBTC04C18	Animal Cell Biotechnology	3	4	10	40
30	MSBTC04C19	Environmental Biotechnology	3	4	10	40
31	MSBTC04C20	Medical Biotechnology	3	3	10	40
32	MSBTC03C16	Practical V (Recombinant DNA Technology)	2		10	40
33	MSBTC03C17	Practical VI (Plant Biotechnology and Crop Improvement)	2		10	40
34	MSBTC04C21	Practical VII (Environmental Biotechnology)	2	4	10	40
35	MSBTC04C22	Project	6	6	10	40
	Elective Courses (Students can choose one course from the given courses)					
36	MSBTC04E07	Pharmaceutical Biotechnology and Drug Design	3	4	10	40
37	MSBTC04E08	Research Methodology	3	4	10	40
38	MSBTC04E09	Biosafety and Bioethics	3	4	10	40
			24	25	80	320

Syllabus of M.Sc. Biotechnology Programme

SEMESTER I

MSBTC01C01: BIOCHEMISTRY AND ENZYMOLOGY

Course Learning Outcomes:

Upon successfully completing this course, the student will be able to

1. Explain the structure and functions of Carbohydrates and Proteins
2. Explain the structure and functions of Lipids and Nucleic acids
3. Analyze Enzyme Kinetics and Enzyme Mechanisms
4. Interpret Enzyme Inhibition and Enzyme Regulation

Unit I **(12 hrs)**

Carbohydrates: structure and function of monosaccharides, disaccharides, polysaccharides, glycosaminoglycans. Proteins: Amino acids - classification based on structures, properties of amino acids

Unit II **(15 hrs)**

Lipids: Definition and classification, structure, function, physical and chemical properties - cholesterol, ergosterol, phosphatidic acid, lecithin, cephalin, phosphatidyl serine, sphingo lipids, eicosanoids. saponification number, acid number and iodine number of fats. Nucleic acids: Purines and pyrimidines, double helical structure, Watson - Crick Model of DNA . Classification of nucleic acids. Properties of nucleic acid – denaturation, renaturation & melting point. confirmation of nucleic acids

Unit III **(16 hrs)**

Enzymology: Basic definition, classification and nomenclature- classical & EC recommendation. Coenzymes, Active site. Enzyme kinetics- single substrate, M.M equation, determination of Vmax & Km, LB plot. Sequential and ping pong mechanism. Activation energy in enzyme reactions, Equilibrium and steady state kinetics, Turn over number, Kcat, Catalytic efficiency, Enzyme Units and specific activity. Research and Industrial uses of enzymes

Unit IV **(17 hrs)**

Mechanism of enzyme action catalytic strategies with examples- general acid base catalysis. Covalent catalysis, Metal ion catalysis, Catalysis by approximation & orientation. Catalysis by

preferential transition state binding. Enzyme inhibition- Mechanism and rate studies. Reversible and irreversible inhibition. Reversible enzyme inhibition- competitive, non competitive and uncompetitive inhibition. Enzyme regulation- Allosteric regulation, zymogen activation, covalent modification. Cooperatively- MWC and sequential mode of allosteric enzyme.

References:

1. Biochemistry. Jeremy M. Berg John and TymoczkoLubertStryer. W H Freeman & Co. NY 9th edition (1 January 2019).
2. Biochemistry. Jeffery Zubay. Brown (William C.) Co ,U.S.; 4th edition (1 April 1997).
3. Biochemistry. Mathews C K and KE van Holde. Pearson College Div; 4th edition (26 February 2012)..
4. Biochemistry with Clinical Correlation. Thomas M Devlin. John Wiley & Sons; 7th edition (January 19, 2010).
5. Enzymes. M. Dixon, et al, Longmans Group London.
6. Lehninger's Principle of Biochemistry. Nelson L D and M M Cox. W H Freeman & Co; 8th edition (29 January 2021)
7. Biochemistry. Donald Voet, Judith G Voet, Charlottew Pratt. Wiley; 4th edition (16 November 2010).
8. Textbook of Medical Physiology. Guyton & Hall. Elsevier; 14th edition (31 July 2020).
9. Fundamentals of Enzymology. Nicholas C. Price & Lewis Stevens, Oxford University Press (1 January 2009).
10. Enzymes: Biochemistry, Biotechnology, Clinical chemistry. T Palmer. East West (1 January 2008)

MSBTC01C02 : GENERAL MICROBIOLOGY

Course Learning Outcomes:

Upon successfully completing this course, the student will be able to

1. Explain the ultrastructure of bacteria and the basic microbiological classification system.

2. Analyze the microbial growth and understand growth kinetics
3. Describe the diversity of microorganisms as well as different bacteriological techniques involved in microbiology.
4. Evaluate the importance of microorganisms in natural system and artificial system
5. Illustrate the ways to control microbial growth by physical and chemical means.

Unit I **(15 hrs)**

Introduction to microbiology: The importance of microorganisms, Microorganisms and their natural environment.History and scope of microbiology.Major divisions of life: Domains & kingdoms, Principles of bacterial taxonomy- Numerical taxonomy, identifying characters - morphological, physiological, biochemical and molecular characters, Major categories and groups of Eubacteria and Archaebacteria. Morphology and reproduction of algae, and fungi. General properties and classification of viruses.Bacteriophages Viroids and Prions.

Unit II **(15 hrs)**

The study of microbial structure: Microscopy: Bright field, Dark field, fluorescent, phase contrast and electron microscopes. Specimen preparation and staining: Principles and types of staining,Fungal staining, Determination of bacterial motility-Hanging drop method.Controlling microbial growth: Physical control methods, chemical control methods. Evaluation of antimicrobial agent effectiveness. Determination of antibiotic sensitivity.

Unit III **(15 hrs)**

An overview of microbial world: Prokaryotic cell structure and function, Prokaryotic cell organization, prokaryotic cell membranes, intra cytoplasmic membrane, the cytoplasmic matrix,inclusions, bacterial cytoskeleton, the nucleoid, ultra structure of prokaryotic cell wall,Antibiotics inhibiting cell wall synthesis, the outer membrane proteins and antibiotic influx in Gram negative bacteria. Components external to the cell wall (capsule ,slime layer,S layer),bacterial pili, and fimbriae, bacterial flagella, flagellar movement twitching and gliding motility. The bacterial endospore- structure and resistance, sporulation.

Unit IV **(15 hrs)**

Microbial Growth: The growth curve, Measurement of microbial growth:Cell mass and cell numbers.Continuous culture of microorganisms-Chemostat and turbidostat.Influence of environmental factors on microbial growth.Microbial growth in natural environment- cell to cell communication within microbial populations.Microbial nutrition: the nutrient requirements.Isolation of pure cultures-Enrichment culturing,dilution plating,Spread, streak

plate, uptake of nutrients by the cell,passive processes and active processes ,iron uptake, Preservation of microbial cultures-subculturing,Overlaying cultures with mineral oils, lyophilization, storage at low temperatures.

References:

1. Pelczar MJ Jr., Chan ECS and Kreig NR., Microbiology, 5th Edition,(1998) Tata McGraw Hill.
2. Prescott's Microbiology,11th Edition,(2019) Joanne Willey, Kathleen Sandman and Dorothy Wood. Mc Graw-Hill
3. General Microbiology ,5th Edition, Roger Y Stanier
4. Brock biology of Microorganisms,16th Edition, Michael T Madigan, Kelly S. Bender, Daniel H. Buckley, David A. Stahl and Thomas Brock ,Pearson higher Ed,2021
5. Microbiology: An Introduction,13th Edition,(2018) Gerard J Tortora, Berdell R Funke and Christine L. Case, Pearson Benjamin Cummings
6. Textbook of Microbiology 12th Edition, (2022)Ananthanarayan, Paniker, Universities Press

MSBTC01C03 : MOLECULAR CELL BIOLOGY

Course Learning Outcomes:

Upon successfully completing this course, the student will be able to

1. Explain the detailed structure of a cell including its membrane, cytoskeleton, organelles, genetic material etc.
2. Analyze the packaging of genetic material and to understand the structure of chromosomes.
3. Compare cell signaling pathways in various cell types.
4. Interpret cell division and its control mechanisms in somatic and reproductive cells.
5. Outline the role of cell cycle in uncontrolled cell division and the molecular mechanism by which the disease emerges.
6. Examine the therapeutic approaches in cancer prognosis.
7. Illustrate programmed cell death and summarise its role in controlling homeostasis in the body.

UNIT I **(15 hrs)**

Cell membrane molecular structure and function- lipid bilayer and membrane protein diffusion, transport across membranes, electrical properties of membranes.Structure and functions of endoplasmic reticulum, nucleus, golgi complex, ribosomes, lysosomes, peroxisomes (glyoxysomes), plastids, chloroplast, and mitochondria.

UNIT II **(15 hrs)**

Basic elements of the cytoskeleton of a cell -mechanisms of assembly, dynamic structure and regulation. Nature of the genetic material, Proteins associated with nuclei packaging of genetic material: nucleosome model. Organization of chromatin: chromosome structure., unique and repetitive DNA, heterochromatin and euchromatin. Discuss the characteristics of Barr body from human cheek epithelium.

UNIT III **(15 hrs)**

Cell signaling: Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways, bacterial and plant two-component systems, light signaling in plants, bacterial chemotaxis and quorum sensing.

UNIT IV **(15 hrs)**

Cell cycle: Molecular control of cell cycle. Cancer biology: Genetic rearrangements in progenitor cells, oncogenes, tumour suppressor genes, cancer & the cell cycle. Interaction of cancer cells with normal cells, Therapeutic interventions of uncontrolled cell growth. Illustrate mitosis and understand about chromosomal aberrations.

References:

1. Karp's Cell and Molecular Biology (9th edition) Gerald Karp ,Janet Iwasa , Wallace Marshall (2020) Wiley.
2. Molecular Cell Biology (9th edition) Harvey Lodish ,Arnold Berk ,Chris A. Kaiser, Monty Krieger , Anthony Bretscher, Hidde Ploegh, Kelsey C. Martin , Michael Yaffe, Angelika Amon (2021)W. H. Freeman.
3. Lehninger's Principles of Biochemistry (7th edition) David L Nelson and Micheal Cox (2017) WH Freeman & Co.
4. Essential Cell Biology (7th Edition). Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Roff, Keeth Roberts, Peter Walter (2022)W. W. Norton & Company
5. The world of the cell (7th edition).Becker, Wayne M.; Kleinsmith, Lewis J.; Hardin, Jeff; Bertoni, Gregory Paul (2008) Benjamin Cummings.
6. The Cell: A Molecular Approach (9th Edition) Geoffrey M. Cooper and Kenneth W. Adams (2022) Oxford University Press.
7. Cell and molecular biology(8th edition) Eduardo D.P.De Robertis and E.M.P.De Robertis (2017) Lea & Febiger,U.S.
8. Cell Biology (4th edition) Thomas D. Pollard ,William C. Earnshaw, Jennifer Lippincott-Schwartz , Graham Johnson (2023) Elsevier.

MSBTC01C04 : GENETICS

Course Learning Outcomes:

Upon successfully completing this course,the student will be able to do the following-

1. Discuss various Mendelian & Non-Mendelian interactions & their significance in various aspects of life.
2. Explain the chemical basis of heredity across generations.
3. Analyze genetic problems in various living models and to draw conclusions.
4. Evaluate genetic diseases using pedigree and infer appropriate measures significant for clinical counseling to identify and prevent such genetic disorders
5. Explain the role of genetics in shaping evolution of organisms at various level.
6. Demonstrate the practical skill for molecular analysis of gene transmission and describe the methods employed.
7. Construct and work with genetic maps
8. Determine the effect of various types of mutations on organisms and evaluate the consequences.
9. Interpret genetic polymorphisms and variations paving way to variations at the level of population.
10. Discuss epigenetic mechanisms & explain how transgenerational epigenetics can influence the living conditions across generations.

UNIT I **(17 hrs)**

Fundamentals of genetics: Mendelian genetics, Complete, incomplete dominance & codominance. Applying chi square in Mendelian Genetics. Multiple alleles, Lethal alleles, Epistasis. Epigenetics & trans generational epigenetics. Sex determination mechanism & dosage compensation. Sex limited & sex influenced traits. Chromosomal and genic balance theory of sex determination. Extra chromosomal inheritance: Criteria for extra chromosomal inheritance. Maternal Inheritance in humans (mitochondrial inheritance, Leigh syndrome), cytoplasmic inheritance, Maternal effect. Polygenic inheritance.Human genetic pedigree analysis.Perform a pedigree analysis & interpret the result.

UNIT II **(13 hrs)**

Linkage and crossing over: Linkage maps, tetrad analysis, Coupling and repulsion hypothesis, theories of crossing over, three point test cross. Recombination: Homologous and non-homologous recombination, transposition and site specific recombination. Bacterial genetics-conjugation, transduction and transformation.

UNIT III **(15 hrs)**

Cytogenetics- Numerical (Euploidy, Aneuploidy) and Structural alterations (deletion, duplication, inversion, translocation, morphological variations) in chromosomes and their genetic implications. Autosomal/sex chromosomal/sex reversal; Mechanisms – mitotic/meiotic nondisjunction/ chromosomal rearrangements; Some examples (Syndromes/Cancer/Infertility) - Gene mutations.

UNIT IV **(15 hrs)**

Population genetics: Populations, gene pool, Allelic frequency, genotypic frequency, Hardy-Weinberg law. Concepts and rate of change in gene frequency through mutation, random genetic drift, migration, inbreeding and natural selection. Molecular evolution: concept of neutral evolution, molecular divergence and molecular clocks .Adaptive radiation; Speciation, Isolating mechanisms; Allopatricity and Sympatricity; Convergent evolution; Origin of new genes and proteins; Gene duplication and divergence.Use of various databases for population genetic studies-European Variation Archive, GWAS, gnomAD, dbSNP.

References:-

1. Introduction to genetic analysis (12th ed.) -Griffiths, University Anthony J F, Wessler, University Susan R, Carroll, D. S. B., & Doebley, J. (2020).W.H. Freeman Co.
2. Principles of Genetics (7th ed.)-D. Peter Snustad, Michael J. Simmons (2015) John Wiley
3. Genetics:A conceptual approach (7th ed.)-Benjamin A Pierce et al.(2019)ΓW H Freeman & Co
4. i Genetics-A molecular approach-Peter J Russell(2015) Pearson education(3rd ed.)Pearson College Div; Solution Manual, Student, Study Guide edition
5. Concepts of genetics (12th ed.) -William Klug,Michael Cummings,Spencer *et al* (2019) Pearson
6. Lewin's Genes XII-Jocelyn E Krebs,Elliott S Goldstein et al (2017) Jones and Bartlett Publishers, Inc
7. Strickberger's Evolution (5th ed.) -Brian K Hall & Benedikt Hallgrimsson (2013) Jones and Bartlett Publishers, In

MSBTC01C05 : PRACTICAL I

Biochemistry and Genetics

Course Learning Outcomes:

Upon successfully completing this course, the students will be able to

1. Analyze carbohydrates and proteins
2. Calculate the level of serum cholesterol
3. Calculate the level of blood glucose
4. Define saponification and calculate the number of lipids
5. Analyze the effect of pH/temperature/time/substrate concentration on enzyme activity
6. Calculate Michaelis-Menten constant on enzyme activity
7. Explain the process of bacterial conjugation experimentally
8. Formulate the protocol for transformation
9. Analyze Barr body

Experiments

1. Qualitative analysis of carbohydrates
2. Qualitative analysis of proteins
3. Quantitative estimation of serum cholesterol
4. Quantitative estimation of protein
5. Quantitative estimation of blood glucose
6. Determination of saponification and iodine number of lipids
7. Assay of Alkaline and Acid Phosphatase in serum samples
8. Assay of Serum amylase
9. Effect of PH on enzyme activity
10. Effect of temperature on enzyme activity
11. Effect of time on enzyme activity
12. Effect of substrate concentration on enzyme activity
13. Determination of Michaelis-Menten constant (Km) of enzyme byLineweaver-Burk method
14. Study of bacterial conjugation
15. Study of transformation.
16. Detection of Barr body.
17. Study of human karyotype
18. Genetic problems

MSBTC01C06 : PRACTICAL II

Molecular Cell Biology and General Microbiology

Course Learning Outcomes:

Upon successfully completing this course, the students will be able to

1. Categorize mitosis and meiosis
2. Create thin sections of tissues and stain with tissue specific stains
3. Calculate the quantity of DNA by Diphenylamine test
4. Calculate the quantity of RNA by Orcinol method
5. Analyze micrometry
6. Formulate the protocol for staining of micro-organisms
7. Define anaerobic cultivation
8. Create protocol for microbial culturing

Experiments:

1. Study of mitosis.
2. Study of meiosis.
3. Study of polytene chromosome.
4. Cell fractionation.
5. Preparation of thin sections of tissues and staining with tissue specific stains (Toluidine blue, Orange G, Safranin etc.)
6. Estimation of DNA by Diphenylamine test.
7. Estimation of RNA by Orcinol method.
8. Micrometry: measurement of microorganisms.
9. Motility determination: hanging drop method.
10. Staining: simple, Gram's, acid-fast, spore, capsule and granular staining.
11. Media preparation: liquid, solid.-Differential,Selective
12. Pure culture techniques: streak plate, pour plate, spread plate.
13. Anaerobic cultivation: RCM, anaerobic jar.
14. Biochemical tests for identification of bacteria.

SEMESTER II

MSBTC02C07 : IMMUNOLOGY

Course Learning Outcomes:

Upon successfully completing this course, the students will be able to

1. Comprehend the fundamentals of immunology, and characterize the structural and functional attributes of the cells, sub populations and organs involved in immune responses.
2. Classify the immune mechanisms responsible in defense of the host against invading microbes.
3. Analyze the molecular mechanism of antibody generation and to differentiate classes and sub types of antibody, their distribution, and function.
4. Illustrate the various aspects of humoral and cell mediated immune responses against infectious agents.
5. Outline antigen immunodetection in cells and tissue by particle labeling and categorize various immunodiagnostic techniques .
6. Evaluate methods and techniques for production, purifying, characterisation of antibodies.
7. Generate awareness on the essentials and outline the immunological requirements of transplantation.
8. To assess the defects in the immune system that could contribute to abnormal immune responses in terms of hypersensitivity and autoimmunity.
9. Evaluate the techniques used for vaccine development to elicit robust immune responses.

UNIT I- Introduction to Immune System: (15 hrs)

Cells, Organs of the immune system, Hematopoiesis-Ontogeny. Types of immunity: Innate, acquired, passive, active immunity, humoral and cellular immunity. Innate immune response: Mechanism, Inflammation, Complement system. Antigens types, haptens, epitopes, adjuvants, Antibodies: Immunoglobulin structure, distribution and function, Immunoglobulin classes and subclasses. Molecular biology of immunoglobulin synthesis, generation of antibody diversity.

UNIT II: Humoral and Cell Mediated Immunity: (15 hrs)

Cytokines & their role in immune regulation. Effector mechanisms in immunity-macrophage activation. Cell mediated cytotoxicity. Cellular interaction in immune response. Antigen recognition, Antigen processing and presentation, T and B cell receptors, Structure & function of

class I and II histocompatibility antigens, MHC restriction. Lymphocyte activation, clonal proliferation, differentiation.

UNIT III: Methods in immunology & Immunodiagnosis (22 hrs)

Immunodetection of antigen in cells and tissues:- Antigen antibody interaction, Immunoelectrophoresis,Chemiluminescence assay, Immunohistochemistry, Immunoprecipitation of antigen complexes, Chromatin immunoprecipitation (ChIP) assays, ChIP on Chip assays. Immunoblotting (western blot analysis), Raising antibodies: by immunization, hybridoma techniques- chimeric and hybrid monoclonal antibodies, Characterizing antibodies, Purifying antibodies, Preparing antibody fragments, Conjugating antibodies. Production of humanized monoclonal antibodies using PCR technology (Single chain fragment variable). Immunotherapy with genetically engineered antibodies. Immune disease models.

UNIT IV: Transplantation Immunology , Immune disorders & Vaccinology (18 hrs)

Transplantation immunology: Immunologic basis of graft rejection, clinical manifestation of graft rejection, transplantation antigens, tissue typing, role of MHC molecules in allograft rejection. Hypersensitive reactions, types, prevention. Autoimmune disorders: organ specific and systemic autoimmune diseases. Vaccines: Active and passive immunization. Live, killed, attenuated, subUNIT vaccine. Vaccine technology- role and properties of adjuvants, recombinant DNA and protein based vaccines, plant based vaccines.

References:

1. Essential Immunology Roitt I. Blackwell Scientific Publications- Oxford 13th Edition 2017
2. Immunology: A short course. Richard Coico , Geoffrey Sunshine Published by Wiley-Blackwell, 7th edition, 2015
3. Understanding Immunology. Peter Wood- Pearson Education 3rd edition, 2011
4. Immunology: A short course. Benjamini E. Geoffrey Sunshine. Wiley Liss 5th edition, 2003.
5. Immunology – an Introduction. Tizard Thomson. Brooks/Cole 4th edition, 2004.
6. Immunology & Immunotechnology. Ashim K Chakravarthy- Oxford University Press, 2006
7. Immunodiagnostics 1st ed.. S C Rastogi-New Age International, 1996
8. Kuby Immunology 8th ed-Jenni Punt,Sharon Stanford et al, 2018- WH Freeman.
9. Immunotechnology: Principles, Concepts and Applications. A. Moran and J .P. Gosling-
10. John Wiley & Sons, 2008
11. Cellular and Molecular Immunology. A. K. Abbas, A.H. Lichtman, and S. Pillai-10 th edition. El Sevier Saunders, 2021.

MSBTC02C08 : MOLECULAR BIOLOGY

Course Learning Outcomes:

Upon successfully completing this course, the students will be able to

1. Elucidate the mechanism of DNA replication and outline various repair mechanism of DNA

2.Illustrate the mechanism of transcript production and to evaluate the various post transcriptional modification procedures for the synthesis of a functional mRNA

3. Analyze the various steps involved in protein synthesis and regulation of gene expression

4. Design experiments for gene expression and characterisation.

Unit I **(15 hrs)**

DNA Replication and Repair: Replication initiation, elongation and termination in prokaryotes and eukaryotes; Enzymes and accessory proteins; Fidelity; Replication of single stranded circular DNA; Gene stability and DNA repair enzymes; Photoreactivation; Nucleotide excision repair; Mismatch correction; Recombinational and SOS repair.

Unit II **(15 hrs)**

Transcription and Post transcriptional modifications: Transcription in prokaryotes and eukaryotes; Initiation, elongation and termination; RNA polymerases and promoters; Transcription factors. Footprinting. Selective inhibition of RNA polymerase by antibiotics. RNA processing: Capping, splicing, polyadenylation and RNA editing biosynthesis of rRNA and tRNA.

Unit III **(15 hrs)**

Translation and regulation of gene expression: Ribosome structure; Genetic code; Aminoacylation of tRNA and formation of initiation complex, initiation factors and elongation factors; Termination; Post translational modification of proteins. Inhibition of protein synthesis by antibiotics. Protein trafficking. Bacterial operons (lac, trp), regulation of phages and viruses, chromatin activity and gene regulation in eukaryotes. Gene functional determination by gene ontology and ontology annotations.

Unit IV **(15 hrs)**

Methods for analysis of gene expression at RNA and protein level: Gene and Whole genome analysis, DNA microarray. Basis of microarray data analysis (heat map and cluster analysis). Genome analysis for global patterns of gene expression using fluorescent labeled cDNA or end labeled RNA probes. Relative and absolute Quantitative analysis by RT PCR. Proteome analysis by 2D, MALDI and mass spectroscopy.

References:

1. Molecular Biology. Robert F Weaver. McGraw Hill Education; 5th Edition 2011
2. Molecular Biology of the Gene. James D Watson, Tania A Baker, Stephen P Bell, Alexander Gann, Michael Levine, Richard Losick. Pearson Education; 5th Edition 2013.
3. Lewin's Genes X. Jocelyn Krebs, Elliot S. Goldstein, Stephen T Kilpatrik. Jones and Bartlett Learning; 10th Edition 2009.
4. Molecular Cell Biology. Harvey Lodish, Arnold Berk, Cris A Kaiser, Monty Krieger, AnthonyBretscher. W H Freeman & Co. New York; 9th Edition 2021.
5. Principles of gene manipulations and Genomics. Sandy B Primrose and Richard Twyman. Wiley-Blackwell, 7th Edition, 2013.

MSBTC02C09 : BIOPROCESS TECHNOLOGY

Course Learning Outcomes:

Upon successfully completing this course, the students will be able to

1.Formulate the bioreactor set up and the types of bioreactors

2.Validate the different types of microbial processes carried out at industrial level

3.Evaluate methods of harnessing superior microorganisms for bioprocess and the technique for selecting and improving the strains for better productivity.

4. Determine upstream processes and the downstream processes carried out at large scale production plant

5. Assess the potential of microbes in alternative fuels and energy production and its application in food, health and agriculture industry

6. Apply the technique of immobilization and its advantages in bioprocess

Unit I **(15 hrs)**

Basic principles of bioprocess fermentation - Solid state and submerged fermentation. Isolation and screening, strain improvement and preservation of industrially important microbes. Application of modern biotechnological tools for strain improvement. Synthetic biology approaches in strain improvement, Pathway engineering. Evaluate methods for screening of promising microorganism from soil sample.

Unit II **(15 hrs)**

Bioreactors- design and types, bioprocess control and monitoring- variables (pH, temperature, pressure, Dissolved oxygen). Bioprocess media-formulation and sterilization of media and development of inoculum. Scale up in bioprocess. Downstream processing. Single parameter optimization strategies, Multi-parameter optimization strategies. Growth kinetics.

Unit III **(15 hrs)**

Microbial production of amino acids (glutamic acid, lysine, threonine), vitamin (vit B12, vit A), antibiotics (penicillin, tetracycline, streptomycin), enzymes (amylase, protease), organic acids (citric acid, acetic acid), fermented foods and beverages. Microbes in food and agricultural

Biotechnology: bio-insecticides, biofertilizers, SCP, Probiotics and its application. Formulate method for preparation of biofertilizers and fermented foods on a small scale.

Unit IV **(15 hrs)**

Immobilization of cells and enzymes-Biotransformation. Biofilm formation and challenges associated with biofilm. Biofuels: First generation biofuels, second generation biofuels, third generation biofuels. Production of bioethanol, biogas, biodiesel, lignocellulosic material for ethanol production. Biorefineries. Humulin production process. Viral culturing and vaccine production. Device method for Immobilization of yeast cells and its use in wine production.

References:

1.Microbial Biotechnology. Fundamentals of applied microbiology. Alexander N Glazer, Hiroshi Nikalido(2nd edition) . Cambridge University Press. 2007

2. Principles of fermentation technology.Stanbury PF, A Whitaker and S J Hall. (3rd edition) Elsevier, 2013.

3. Microbial Technology. Fermentation Technology. Peppler Henry J D Perlman, published by Academic Press (An imprint of Elsevier) 2014.

4.Fermentation microbiology and biotechnology. E M T. E I- Mansi, C F A Bryee, A L Demain and A R Allman. CRC press 2018.

5.Industrial microbiology.A H Patel. MacMillian. 2011

6.Bioprocess technology. P T Kalaichelvan, I Arun Pandi. MJP publishers.2019

7.Industrial microbiology. Prescott and Dunn. A V I Publishing Co USA. 2009

8. Cruger's Biotechnology. A textbook of Industrial Microbiology. Crueger, Wulf, and Anneliese Crueger. MEdtech. 2017

9.Industrial Microbiology. L E Casida. New AGE International Publications. 2019

10.Industrial Microbiology: An Introduction. Michael J Waites, Neil L Morgan, John S Rockey, Gary Higton (2nd edition). Blackwell science. 2007

MSBTC02C10-PRACTICAL III

Molecular Biology

Course Learning Outcomes:

Upon successfully completing this course, the student will be able to

1 Design and apply DNA isolation techniques for purification of DNA from various sources
2. Analyze and quantify DNA .
3. Formulate the protocol for the isolation of Plant RNA
4. Formulate protocol for protein isolation and SDS-PAGE
5. Analyze protein fingerprinting in Bacteria
6. Analyze Bacterial gene expression using lac promoter
7. Demonstrate types of blotting techniques

Experiments

1. Isolation of DNA from Bacteria.
2. Isolation of DNA from Plant.
3. Isolation of DNA from animal tissue.
4. Agarose gel electrophoresis of DNA (Spectrophotometry/Fluorometry)
5. Quantitation of DNA.
6. Gel elution of DNA
7. Isolation of RNA from Plant (TRI solution)
8. Quantitation of RNA (U.V Spectrophotometry/Nanodrop Spectrophotometry)
9. Extraction of proteins from serum
10. Extraction of proteins from Bacteria
11. SDS-PAGE of proteins.
12. Silver staining of Proteins
13. Analysis of Proteolytic cleavage
14. Protein fingerprinting (Bacteria/Plant)
15. Bacterial gene expression using Lac promoter.
16. Nucleic acid blotting and hybridization (Southern/Northern)
17. Western Blotting

MSBTC02C11 : PRACTICAL IV

Immunology and Bioprocess Technology

Course Learning Outcomes:

1. Demonstrate Haemagglutination reaction

2. Validate Immunodiffusion techniques

3. Isolate industrially important microorganism from environment, conduct primary and secondary screening techniques to identify important strains

4. Prepare fermented food and beverages like cheese, yogurt, sauerkraut and wine

5. Perform acid and alcohol estimation of wine

6. Perform immobilization techniques to improve fermentation process

7. Screen and isolate amylase producers from environment

8. Identify and characterize microorganism that can be exploited and formulated as bio fertilizer

Experiments:

1. Preparation and identification of lymphocytes from blood and solid lymphoid organs
2. Purification of human immunoglobulins from serum and confirmation of its antigenicity.
3. Haemagglutination reaction.
4. Latex agglutination.
5. Single radial immunodiffusion.
6. Double diffusion in two dimensions.
7. Immunoelectrophoresis.
8. Affinity and ion exchange chromatography
9. Co-immunoprecipitation
10. Immunohistochemistry
11. Clinical diagnosis of viral diseases by ELISA.
12. Screening and isolation of antibiotic and enzyme producers.
13. Production and characterization of wine (estimation of alcohol & acid).
14. Production of immobilized cells
15. Comparison of ethanol production using various organic waste/ raw material (frees cells and immobilized cells).
16. Production of SCP

17. Biogas production.
18. Test for the degradation of aromatic hydrocarbons by bacteria.
19. Isolation of industrially important microorganisms for microbial processes (citric / lactic/ alpha amylase)
20. Production of Cheese
21. Production of Yoghurt
22. Production of Sauerkraut

MSBTC02E01 : BIOPHYSICS

Course learning Outcomes:

Upon successfully completing this course, the student will be able to

1. Explain the laws of thermodynamics, chemical kinetics and its applications in cellular processes

2. Explain the structure and conformation of proteins.

3. Explain the structure and conformation of nucleic acids.

4. Explain the importance of surface tension, adsorption, osmosis, dialysis, colloids, detergents, pH and redox potential in living system

Unit I **(15 hrs)**

Thermodynamics: open, closed and isolated systems, laws of thermodynamics, thermodynamic equilibrium, concept of enthalpy, entropy and free energy. Free energy of ATP hydrolysis. Negative entropy changes in living systems, interpretation of life in terms of non-equilibrium thermodynamics. Chemical kinetics: rate, order and molecularity of a reaction, energy of activation.

Unit II **(15 hrs)**

Basic principles of protein structure: Asymmetric carbon, amino acids and peptides, main chain and side chain torsion angles, cis and trans peptides. Principle and patterns of protein conformation. Ramachandran map. Structure of Lysozyme and rubisco. Protein - protein interaction.

Unit III **(15 hrs)**

Basic principles of nucleic acid structure: conformation of nucleotides, oligonucleotides, DNA supercoiling and t-RNA structure. Protein-Nucleic acid interactions, H-L-H, Zn-finger and Leucine zipper motifs. Histone DNA interaction and ligand protein interaction

Unit IV **(15 hrs)**

Concepts and importance of following in biology: pH, hydrogen bond, water structure, surface tension, adsorption, osmosis, dialysis, colloids, detergents, redox potential. Membrane potential, Donnan equilibrium.

References

1. Biophysical chemistry (9th Ed) - Gurtu, 2015, PragatiPrakasan

2. Biological thermodynamics (2nd Ed)- Donald T. Haynie, 2013, Cambridge University Press,Cambridge.

3. Biophysics (2nd Ed) - VasanthaPattabhi and N. Gautham, 2009, Alpha Science International Ltd.

4. Essentials of Biophysics - P. Narayanan, 2005, New Age International publishers

5. Introduction to Protein Structure - C. Branden and I. Tooz. , 2012, Garland Science

6. Principles of Protein Structure - G.E.Schulz&R.H.Schirmer, 2009, IK books

7. Principles of Nucleic Acid Structure - W. Saenger, Springer

8. Protein Folding (2nd Ed) - B. Noelting, 2005, Springer

9. Structure and Mechanism in Protein Science - Alan Fersht, 2017, World Scientific

10. Biochemical Calculations. Segel Irvin H. John Wiley and Sons, New York.

11. Biochemistry: The Chemical Reactions of Living Cells. Metzler David E. Volume 1 & 2, Academic Press, California.

MSBTC02E02 : BIOINSTRUMENTATION

Course learning Outcomes:

Upon successfully completing this course, the student will be able to

1.Summarize the working principle of instruments most commonly used in Biotechnology research.

2.Interpret concept and working of colorimetry, spectrophotometry and spectroscopy and its types

3.Suggest instrumentation to be used in separation/isolation of DNA, RNA and protein viz, centrifuge, chromatography and electrophoresis.

4. Explain the working principle and application of advanced biotechnological techniques that employs radioisotopes and fluorescence labeling

Unit I **(15 hrs)**

Principle and working of pH meter, laminar-air flow, autoclave, incubators, thermal cyclers, UV transilluminator, Gel Documentation system. Centrifugation: Basic principle and application, Types of centrifuge; preparative and analytical centrifuges, differential centrifugation , density gradient centrifuge, Microcentrifuge, High speed & Ultracentrifuges.

Unit II **(15 hrs)**

Chromatography: Principles, application and classification adsorption, partition, molecular sieve, ion exchange, affinity, GC and HPLC, TLC, HPLC, Electrophoresis: Principle, classification and application viz., moving boundary and zone electrophoresis, native and denaturing PAGE, gradient electrophoresis, isoelectric focusing, 1 D and 2 D electrophoresis

Unit III **(15 hrs)**

Basic principles and application of colorimeter and spectrophotometer, UV-Visible, IR, atomic absorption emission spectrophotometer, CD spectroscopy GS-MS, NMR, ESR, mass spectroscopy, X-ray crystallography. Immunofluorescence microscopy, Confocal microscopy.

Unit IV **(15 hrs)**

Fluorescence & Radioisotope based techniques: Use of radioisotopes in life sciences, detection and measurement of α, β, γ rays using scintillation counters, Geiger-Muller counters, blotting technique, hybridization and autoradiography, radiotracer technique, flow cytometry and fluorescence associated cell sorter.

References:

1.Biophysical chemistry, Avinash Upadhyay, Kakkoli Upadhyay, Nirmalendu Nath, Himalaya Publishing House.2016.

2. Principles and techniques of Biochemistry and Molecular Biology. Keith Wilson and John Walker.Cambridge University Press. 8th edition. 2018

3.The Physical Basis of Biochemistry. Peter R Bergethon. Springer-Verlag. 2010

4.Bioseparations. Principles and techniques. Sivasankar. Prentice- Hall India. First edition 2005

5.Principle of physical chemistry. Puri, Sharma, Pathania.VPC publication. 2008

MSBTC02E03 : NANOBIOTECHNOLOGY

Course Learning Outcomes:

Upon successfully completing this course, the students will be able to

1. Explain the basic concepts and presence of nanomaterials in nature
2. Summarize protein and DNA based nanostructure
3. Outline the use of nanoparticles in medicine, drug delivery, cancer research, stem cell biology, tissue engineering, cardiology etc.
4. Illustrate nanobiotechnology in biochips and disease diagnostics.
5. Illustrate the concepts of nanobiotechnology for environmental pollution detection using biosensors, biofilms, oil recovery and cosmetics.

Unit I **(16 hrs)**

Introduction: Definition, Interdisciplinary nature, and history of Nanobiotechnology. Bionanostructures: Protein based nanostructures, self-assembly engineered nanopores, DNA based nanostructures- DNA-Protein nanostructure, Quantum dots and fullerenes, DNA-templated electronics, DNA nanostructures for mechanics and computing.

Unit II **(14 hrs)**

Nanomedicine - applications in drug solubilization and delivery, medicine and surgery (stem cell biology, Artificial cells, artificial organs, tissue engineering, cardiology and cardiac surgery, organ transplantation). Applications of Nanobiotechnology in Cancer research.

Unit III **(15 hrs)**

Applications of nanoparticles for biological assays: Applications in disease diagnosis: Biochips and Microarrays, Gold nanoparticles for diagnostics. Nanomotors, Nanorobots, Magnetosomes, bacteriorhodopsin and their application. Nanoparticles as non-viral transfection agents.

UNIT IV **(15 hrs)**

Applications of Nanobiotechnology in environment: Silica nanoparticles for analytical microbial biofilms structure and applications. Nutraceuticals enhanced oil recovery, antimicrobial and cosmetic nanoemulsions, food colloids, templating of nanoparticles, Nanobiosensors.

References:

1. Biomineralization: From Biology to Biotechnology and Medical applications. Edmund Bauerlin. Wiley VCH-Verlag, 2000.
2. Nano and Microelectromechanical systems, Fundamentals of Nano and Micro engineering. Sergey Lyshevski, CRC Press 2nd Edition 2005.
3. Nanostructures and Nanomaterials: Synthesis, properties and applications. Guozhong Cao. Imperial College Press 2004.
4. Nanoscale Technology in Biological systems-Ralph S, Fritz B, lane Smith. Boca Raton, CRC press 1st Edition 2004.

SEMESTER III

MSBTC03C13 : RECOMBINANT DNA TECHNOLOGY

Course Learning Outcomes:

Upon successfully completing this course, the student will be able to do the following

1. Outline the functions of nucleases, ligases, polymerases and other DNA modifying enzymes
2. Formulate new cloning vectors
3. Analyze the process of transformation and transfection
4. Validate gene libraries
5. Illustrate polymerase chain reaction and sequencing
6. Compare the difference between recombinant protein production in prokaryotes and eukaryotes
7. Discuss the mechanism of gene knockout
8. Evaluate recombinant DNA technology and its application in medicine and forensics

Unit I **(10 hrs)**

Enzymes involved in genetic engineering: Nucleases, Ligases and polymerases. Restriction enzymes and restriction digestion. (Restriction digestion mapping with specific restriction enzyme). Blotting and Hybridization techniques; Southern, Northern and Western blotting. Colony hybridization; Fluorescence in situ hybridization

Unit II **(10 hrs)**

Cloning vectors: Plasmid vectors, Phage vectors and Cosmids. Introduction of DNA into living cells: Transformation and transfection, identification of transformants and recombinants. Genomic and cDNA libraries, identification of desired clone.

Unit III **(13 hrs)**

PCR: Primer design with specific example (Design of gene specific primers using PRIMER 3 software and brief discussion about its merits and demerits). Fidelity of thermostable enzymes, types of PCR- Multiplex, Nested, Hot Spot and Real time RT PCR. Applications of PCR. Rapid Amplification of cDNA Ends (RACE). DNA sequencing methods; Sanger Coulson and Maxam Gilbert method. Automated DNA sequencing and Pyrosequencing. Next generation sequencing. Random and site directed mutagenesis. Gene silencing techniques: Antisense RNA technology, introduction to siRNA technology, micro RNA. Applications of gene silencing. Gene targeting and gene knock-out.

Unit IV **(12 hrs)**

Heterologous protein production in prokaryotes-Fusion proteins and recombinant protein purification. Heterologous protein production in eukaryotes - Yeast expression system, mammalian cell expression system. Recombinant DNA in medicine: Recombinant insulin, monoclonal antibodies and vaccines. Gene therapy. DNA based diagnosis of genetic disorders (PCR based diagnosis- case study). Applications of recombinant DNA in Forensic science.

References:

1.Recombinant DNA. James D. Watson, Scientific American books. 2nd edition 1992.

2.Gene Cloning and DNA analysis. TA Brow. Balckwell publishing. 8th edition. 2020

3.Molecular Biotechnology. Bernard R Glick, ASM press. 5th edition 2017.

4.Molecular Cloning Vol 1-3. Sambrook and Russel, CSHL press. 3rd edition. 2017.

5.Recombinant DNA. Genes and Genomes. James D Watson, CSHL press. 3rd edition. 2007.

6.PCR primer- A Laboratory Manual. Carl W Dieffenbach, CSHL Press. 2003

7.Principles of gene manipulations and Genomics. SB Primrose and RM Twyman, Blackwell publishing. 7th edition. 200

MSBTC03C14 : PLANT BIOTECHNOLOGY AND CROP IMPROVEMENT

Course Learning Outcomes:

Upon successfully completing this course, the students will be able to

1. Formulate and optimize the culture media for different culture types.
2. Outline in vitro plant regeneration, micropropagation techniques.
3. Comprehend basic knowledge of disease indexing and eradication.
4. Formulate gene transfer strategies in plants, functional genomics and crop improvement strategies in plants.
5. Assess molecular mapping and marker-assisted breeding techniques.

Unit I **(10 hrs)**

An introduction to plant biotechnology. Plant tissue culture- Plasticity and totipotency, the culture environment, plant cell culture media, plant growth regulators. Culture types – Callus, Cell suspension cultures, Protoplast culture, Root culture, shoot tip and meristem culture, embryo culture and microspore culture. Initiate plant tissue culture using different explants

Unit II **(10 hrs)**

Plant regeneration- Somatic embryogenesis, organogenesis, artificial seed; somaclonal variation and crop improvement. Principles of plant micropropagation, *in vitro* phenomenon in mass propagation like genetic instability, contamination, disease indexing and eradication, hardening of plants. Identify somaclonal variation in tissue cultured plants.

Unit III **(12 hrs)**

Genetic engineering in plants – Gene transfer strategies in plants- direct and indirect methods- biolistics, *Agrobacterium* mediated transformation, Detection of inserted DNA, Cre/loxP system. Isolation and maintenance of *Agrobacterium* in laboratory.

Gene functional validation in plants – Forward and reverse genetic approaches, Gene tagging; Gene trapping; Gene silencing -Virus induced gene silencing (VIGS) technology, Knockout mutants, Fast neutron mutagenesis, TILLING, Genome editing, Omics technology for Crop Improvement

Unit IV **(13 hrs)**

Molecular Mapping and Marker-assisted Breeding -- Marker-assisted plant breeding; Relative advantages/ disadvantages in conventional plant breeding and molecular breeding; Molecular polymorphism; Marker Assisted Selection (MAS) for genes of agronomic importance. Molecular markers in crop improvement.

Applications of Plant Biotechnology - Genetic manipulation of herbicide resistance/pest resistance/plant disease resistance. Strategies for engineering stress tolerance (Production of salt tolerant crops - a discussion on different approaches), plant disease resistance. GM crops. Germplasm storage and cryopreservation. Plants as factories for industrial products, pharmaceuticals and biomaterials.

References:

1. Plant Biotechnology: The genetic manipulation of plants. Adrian Slater, Nigel Scott And Mark Fowler. Oxford University Press 2003.
2. Plant Biotechnology and Agriculture: Prospects for future. Arie Altman, Paul Hasegawa, Academic Press Inc 1st Edition 2011.
3. Biotechnology. Applying the Genetic Revolution: David P Clark and Nanette J Pazdernik. Elsevier Academic Press 2009.
4. An introduction to plant tissue culture. Kalyan Kumar De, New Central Book Agency Pvt. Limited, 2004.
5. Introduction to Plant Tissue Culture. M K Razdan, Science Publishers, Inc. 2nd Edition 2003.

MSBTC03C15 : BIOINFORMATICS

Course Learning Outcomes:

Upon successfully completing this course, the student will be able to do the following

1. Comprehend the fundamentals of bioinformatics, genome information and special features and sequencing of nucleic acids and proteins.

2. Compare biological databases; retrieve information from databases using the bioinformatics tools

3. Analyse genomes from different organisms and generate a phylogenetic tree.

4. Demonstrate the structure visualization tools commonly employed in proteomics.

Unit I **(15 hrs)**

Introduction to Bioinformatics: Scope of Bioinformatics.Genome information and special features, coding sequences (CDS), untranslated regions (UTR's), expressed sequence tags (EST).Databases: Protein sequence data bank: PIR, SWISSPROT, UNIPROT, PROSITE, PFAM. Nucleic acid sequence data bank: Gen bank, EMBL, DDBJ. Structural databases: PDB, CATH, SCOP. Retrieving information from NCBI with Entrez. Choose a gene/ protein with some prior knowledge and extract all the information relevant to this gene/protein in the databases listed.

Unit II **(10 hrs)**

Genomics: Structural genomics - Genome sequencing,Sequencing of DNA & RNA .Analysis of NGS & RNASeq data.Genome annotation. Performing genome annotation studies with RAST. Functional genomics-ESTs, SAGE, Comparative genomics, comparison of genetic sequence of organisms. HGP and it's significance .Transcriptomics-comparative transcriptomic approach to study differential gene expression

Unit III **(10 hrs)**

Measurement of sequence similarity: Sequence alignment - Global and local alignment, pairwise and multiple sequence alignment.Homology and similarity search tool: BLAST and FASTA. Performing Sequence alignment with BLAST. Phylogenetic analysis-elements of phylogeny, methods of phylogenetic analysis, Phylogenetic tree. Phylogenetic analysis tools-Phylip, ClustalW. Constructing phylogenetic trees.

Unit IV **(10 hrs)**

Proteomics: Protein sequence information, sequence to structure relationships. Homology modeling with SWISS MODEL. Bioinformatics tools for analysis of proteomics data (tools available at ExPASy proteomics server). Structure visualization tools: Rasmol, SPDBV.

References:

1. Bioinformatics: A beginner's guide by Jean-Michel Claverie and Gerdic Notredame, 2003, Wiley
2. Introduction to Bioinformatics by Attwood, Parry-Smith,Phukan, 2007, Pearson Education
3. Fundamental concepts of Bioinformatics by Krane D.E and Raymer M.L., 2003, Pearson Education
4. Bioinformatics: Databases and Algorithms by N. Gautham, 2006, Alpha Science International Ltd.
5. Bioinformatics: Sequence and Genome analysis by Mount DW, 2004, Cold Spring Harbour Laboratory Press, New York
6. Bioinformatics (4th Ed) - Baxevanis AD, Bader GD Wishart DS (Eds), 2020, Wiley
7. Bioinformatics: Methods and applications (4thed) by S. C. Rastogi, N. Mendiritta, P. Rastogi, 2013, PHI Learning
8. Essential Bioinformatics by Jin Xiong, 2006, Cambridge University Press
9. Structural Bioinformatics (2nded) Gu and Bourne, 2009, Wiley
10. An introduction to Medicinal Chemistry (7thed) by Patrick G, 2023, Oxford University Press.
11. Pharmacology and Pharmacotherapeutics (25thed) by– Satoskar, Rege, TRipathi and Bhandarkar, 2017, Popular Prakashan.
12. Foye's Principles of Medicinal chemistry (6thed) by Lemke, Williams, Roche and Zito, 2008, Wolters Kluwer, Lippincott Williams & Wilkins

MSBTC03C16 : PRACTICAL V

Recombinant DNA Technology

Course Learning Outcomes:

Upon successfully completing this course, the student will be able to

1. Apply alkaline lysis method for plasmid isolation
2. Formulate the method for the isolation of genomic DNA from Blood
3. Formulate the method for the isolation of RNA from Bacteria
4. Illustrate the Principle of Silver nitrate and Safe Green DNA staining
5. Analyze DNA manipulation tools like restriction digestion and DNA ligation
6. Apply the principle and methodology of Polymerase Chain Reaction (PCR)
7. Formulate the protocol for cDNA synthesis (RT-PCR)
8. Explain gene cloning using Green fluorescent protein marker
9. Compare PCR based and non PCR markers like RAPD, ALP and RFLP
10. Apply recombinant DNA Technology in forensic science

Experiments

1. Isolation of Plasmid DNA.
2. Isolation of DNA from Blood.
3. RNA isolation from Bacteria..
4. Silver nitrate DNA staining
5. Safe green DNA staining
6. Restriction digestion of DNA.
7. DNA Ligation.
8. DNA amplification (PCR).
9. Study of Multiplex PCR
10. Green fluorescent protein cloning
11. Recombinant protein purification
12. RFLP analysis
13. RAPD analysis
14. AFLP analysis
15. Recombinant DNA in forensics (DNA isolation from dried blood, hair, nail, saliva etc.).

MSBTC03C17 : PRACTICAL VI

Plant Biotechnology and Crop Improvement

Course Learning Outcomes:

Upon successfully completing this course, the student will be able to

1. Interpret Murashige-Skoog media preparation
2. Analyze the different types of explants and sterilization methods
3. Compare the role of different hormones in shoot regeneration and root regeneration

Experiments:

1. Preparation of solid and liquid media (Murashige-Skoog).
2. Explant selection, sterilization and inoculation.
3. Role of different hormones and their concentration in inducing shoot generation and root generation in plants.
4. Callus and cell suspension culture.
5. Somatic embryogenesis from callus and cell suspension culture.
6. Plant regeneration by organogenesis.
7. Meristem and shoot tip culture.
8. Anther and pollen culture.
9. Seed and embryo culture.
10. Encapsulation of somatic embryos and artificial seed production
11. Hardening of tissue culture plants
12. Agrobacterium mediated genetic transformation

MSBTC03E04 : MARINE BIOTECHNOLOGY

Course Learning Outcomes:

Upon successfully completing this course,the student will be able to do the following

1. Analyze the functional role of marine ecosystem in shaping biodiversity
2. Categorize the use of marine ecosystem in a sustainable manner keeping in balance with human needs.
3. Evaluate Biotechnological tools for the conservation & maintenance of marine life
4. Examine the methods to explore the hidden realms of aquatic life.
5. Device techniques and scientific perspective to assist the fishing industry .
7. Explain the aquatic environment & apply the knowledge to generate useful products.

UNIT I **(16 hrs)**

Marine natural products: Marine organisms-An alternative source of potentially valuable natural products-Pharmaceuticals from marine organisms-anti cancer, diagnostic and therapeutic, bioadhesives and thermostable enzymes. Marine Microbiology: marine polysaccharides-biomedical and Biotechnological applications; molecular pathogenicity of aquacultural pathogens; Biochemistry, gene regulation and molecular biology of marine hyperthermophiles

UNIT II **(14 hrs)**

Aquatic biotechnology: Introduction to aquatic biotechnology. Aquaculture: increasing world's food supply through biotechnology - Molecular genetics of aquatic organisms - Medical applications of aquatic biotechnology - Non medical products. Use of aquatic resources to create renewable energy

UNIT III **(16 hrs)**

Bioremediation: Marine pollution; Aerobic and anaerobic bioremediation in the marine environment. Marine microorganisms capable of degrading and detoxifying chlorinated hydrocarbons and other pollutants. Genetic engineering and ploidy manipulation to enhance growth. Reproduction and development of disease resistance in agricultural species crustaceans, molluscs, fin fishes and algae

UNIT IV **(14 hrs)**

Biofouling and control technology: Biofouling organisms-problems due to Biofouling-Antifouling paints and its environmental pollution. Biotechnological approach to Biofouling control. Environmental applications of aquatic biotechnology. Cause of Marine Pollution & biotechnological remedial solutions

References:

1. Environmental Biotechnology, principles and applications by Bruce E Rittman and Perry L McCarthy. McGraw Hill 2020
2. Environmental Biotechnology 2nd ed ; Alan Scragg; Oxford University Press.2005
3. Blue Biotechnology 1st ed edited by Stephane La Barre & Stephen Bates Wiley VCH 2018
4. Essentials of marine biotechnology Se Kwon Kim Springer 2019
5. Marine Biology 11th ed Peter Castro Michael E Huber McGraw-Hill College 2018

MSBTC03E05 : BIOSTATISTICS

Course learning Outcomes:

Upon successfully completing this course, the student will be able to

1. Demonstrate the classification of statistical data, data presentation, concept of population and sample and various approaches used in sampling.
2. Apply numerical, tabular, and graphical descriptive techniques commonly used to characterize and summarize statistical data.
3. Explain the types of correlation between variables, concept of regression and probability
4. Apply the tests of significance.
5. Explain the basic principles of experimental design and ANOVA.

Unit I **(17 hrs)**

Data:Population and sample, sampling theory, methods of sampling - random sampling and non-random sampling. Different types of numerical data - primary and secondary data, qualitative and quantitative data, ranked data, discrete and continuous data. Presentation of data. Frequency distribution tables: Relative and cumulative frequency distributions, Graphical representation of data: line charts, bar charts, pie chart, pictograms, histograms, frequency polygon, frequency curve, ogives.

Unit II **(15 hrs)**

Measures of central tendency: arithmetic mean, median, mode, geometric mean and harmonic mean. Measures of dispersion: range, interquartile range, variance and standard deviation, coefficient of variation. Correlation and regression: types of correlation between variables, scatter diagram, correlation coefficient, regression coefficient, regression line. Normal distribution curve - symmetric and asymmetric, kurtosis and skewness.

Unit III **(13 hrs)**

Probability: Definition of probability, Permutation and combination, random experiment, sample space, event, types of events. Conditional probability. Addition and multiplication theorems of probability.

Unit IV **(15 hrs)**

Tests of significance - Estimation, confidence limit, degrees of freedom, level of significance, standard error, p - value, testing of hypothesis - Student's t-test, z-test, chi-square test.Principles of experimental designs: completely randomized, randomized complete block design. Latin square designs, augmented block design, simple bacterial experiments, analysis of variance (ANOVA).

References:

1. Principles of Biostatistics. Pagano M. & Kimberlee G. Duxbury Press. 3rd edition. 2022.
2. Biostatistical analysis. Zar, JH. Pearson Education. 5th edition. 2010
3. Fundamentals of Biostatistics. Khan and Khanum; Ukaas publications. 6th edition 2020
4. Biostatistics-How it works. Steve Selvin; Pearson Education. 2003
5. An Introduction to Biostatistics. N. Gurumani.
6. Probability and Statistical Inference. Hogg R. V. Tanis E. A., Prentice Hall, New Jersey.
7. Experimental Design Data Analysis for Biologists. Quinn G. P. & Keogh M. J. Cambridge University Press.
8. Statistical Methods in Biology. Bailey NTJ, Cambridge University Press.
9. Biostatistics for the Biological and Health Sciences. Marc Triola, Mario Triola. Pearson.

MSBTC03E06 : BIOENTREPRENEURSHIP

Course Learning outcomes:

Upon successfully completing this course,the student will be able to do the following

1. Interpret Biotechnology business and marketing
2. Apply Biotechnology in start-up business and to understand its scope and challenges
3. Analyze the different bio businesses in agriculture and industrial sector
4. Integrate the bio-business regulatory frameworks and evaluate ethical concerns

Unit I

Introduction to business and marketing **(13 hrs)**

Taking decision on starting a venture, making a business proposal, legal requirements for starting a company, budget planning, assessment of market demand for potential product(s) of interest, identifying needs of customers including gaps in market, packaging and distribution channels; pricing and commercialization

Unit II

Bio business- the basics **(15 hrs)**

Business opportunity in biotechnology; essential requirement and infrastructure, biological license application, technology development, Research and Development and quality control. Challenges and scope of bio business. Strategy and operations of Biosector firms. Factors shaping opportunities for innovation and entrepreneurship in bio-sectors and the business implications of those opportunities, Alternatives faced by emerging bio-firms and the relevant tools for strategic decision, Entrepreneurship development programmes of public and private agencies (MSME, DBT, BIRAC, Make In India), strategic dimensions of patenting and commercialization strategies

Unit III

Business opportunity in agricultural and industrial biotechnology: **(17 hrs)**

Herbal drug production, Nutraceuticals. Tissue culture and micro-propagation, value added herbal products. Bioethanol production from agricultural sources. Algal biodiesel. Biosensor development in Agri management. Pollution monitoring and Bioremediation. Microbe enriched compost production. Biopesticide/insecticide production. Fermented products-probiotic and prebiotics, single cell protein. Stem cell production, stem cell bank. Production of monoclonal/polyclonal antibody, hormones

Unit IV

Concerns of Bio business: **(13 hrs)**

Technology management: assessment, Development and up gradation, Managing Technology transfer, Quality control and transfer of foreign technologies, Knowledge centers and Technology transfer agencies. Understanding regulatory compliances and procedures. Ethical concerns of Biotechnology innovation and business. Bio business-regulatory bodies; eg.FDA, DSIR, AYUSH, FSSAI etc. The Cartagena protocol on biosafety, Patent and market exclusivity

References:

1. Saxena, A., Biotechnology Business - Concept to Delivery. 2020
2. Craig D Shimasaki - Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies. 2014
3. Coe, J.M - The fundamentals of business to business sales and marketing. New York, NY: McGraw-Hill.2004
4. Syed Imtiaz Haider and Anika Ashok-Biotechnology-A Comprehensive training Guide for the Biotechnology Industry-CRC Press.
5. Craig D Shimaski -The Business of Bioscience- Springer

MSBTC03O01 : INTELLECTUAL PROPERTY RIGHTS

Course Learning Outcomes:

Upon successfully completing this course, the student will be able to

1. Summarize the fundamental legal principles relating to copyright, patents, designs, trademarks.
2. Identify, apply and assess principles of law relating to each of these areas of intellectual property
3. Outline the legal and practical steps needed to ensure that intellectual property rights remain valid and enforceable
4. Discuss the treaties, patents acts and agreements related to international trade.
5. Evaluate the current and emerging issues relating to the intellectual property protection, including those relating to traditional knowledge, biotechnology and international trade
6. Analyze the procedure of patenting plants, animals and other life forms.

Unit I **(15 hrs)**

Intellectual Property Rights: Introduction to IPR, Types of IP - Patents, Trademarks, Trade secrets, Copyright & Related Rights, Industrial Design, Traditional Knowledge and geographical Indications. Importance of IPR – patentable and non patentable matters, patenting life,

Unit II **(15 hrs)**

Agreements and Treaties : History of GATT & TRIPS Agreement; Madrid Agreement; WIPO Treaties; Budapest Treaty; PCT; Indian Patent Act 1970 & recent amendments. IPR and WTO regime - Consumer protection and plant genetic resources. Transfer of technology and patent sharing.

Unit III **(16 hrs)**

Patents and Patent Laws: Objectives of the patent system - Basic, principles and general requirements of patent law. Biotechnological inventions and patent law - Legal development - Patentable subjects and protection in Biotechnology. patentability of microorganisms, plant patent, animal patent, patentability of genes and vectors – FDA. Legal protection for plants and other higher organisms. plant breeders' rights and farmers' rights. Sui-generis plant variety protection

Unit IV **(14 hrs)**

Patent Filing Procedures : National & PCT filing procedure, Time frame and cost, Status of the patent applications, Precautions while patenting, disclosure/ nondisclosure, financial assistance for patenting, introduction to existing schemes. Patent licensing and agreement. Patent infringement - meaning, scope, litigation, case studies.

References:

1. Intellectual Property laws: containing Acts, rules & regulations. Universal Law Publishing Co. 2012
2. Intellectual Property. The law of Trademarks, Copyrights, Patents and Trade Secrets. Third edition. Deborah E. Bouchoux. 2012
3. Intellectual Property law. A Chandrashekaran, C Sitaraman and Co Pvt. Ltd. 2009
4. Intellectual Property Protection and Sustainable Development, Philippe Culle
5. Intellectual Property laws: containing Acts, Rules & Regulations 2008; Universal Law Publishing Co
6. Intellectual Property and Patent in Stem Cell Research Era. Special article. Sorapop Kiatpongsan. Faculty of medicine, Chulalongkorn University. 2006;89(11):1984-6.
7. Intellectual Property rights. Neeraj Pandey, Khushdeep Dharni. PHI Learning private limited. 2014.
8. IPR, Biosafety and Bioethics. Deepa Goel , Shomini Parashar.Pearson 2013
9. Managing Intellectual Property The Strategic Imperative. Vinod V Sople. 4th edition PHI Learning private limited. 2014.
10. Indian Patents Law. Legal and Business Implications. Ajith Parulekar, Sarita D' Souza. Macmillan Publishers India Ltd. 2009
11. Intellectual Property Rights in the Emerging Business Environment. Bharti Thakar. The ICFAI university press, 2006
12. https://ipindia.gov.in (Manual of Patent office Practice and Procedure)

MSBTC03O02 : FOOD BIOTECHNOLOGY

Course outcomes:

Upon successfully completing this course, the student will be able to

1. Apply Biotechnology in food processing.
2. Analysis of food constituents and food supplements.
3. Illustrate food fermentation technology and R&D innovations.
4. Develop novel food ingredients and to analyze their safety evaluation.
5. Outline the production of fermented beverages and foods.
6. Summarize the principle of food spoilage and food preservation techniques.
7. Discuss about food and water borne diseases.
8. Justify the importance of food packaging and dispensing devices.
9. Evaluate food quality and outline policies devised by control agencies (HACCP and FSSAI).

UNIT I **(15 hrs)**

Introduction to food technology and food chemistry – application of biotechnology in food processing, Constituents of food and dietary source of food – carbohydrates, lipids, proteins, water, vitamins and minerals. Low calorie sweeteners, naturally produced flavour modifiers, Food supplements, Nutraceuticals, Water binding agents.

UNIT II **(15 hrs)**

Food Fermentation Technology: Origin, Scope, and development of fermented products, Fermented food and microbial starters, commercial potential, Food fermentation industries, their magnitude, Research & Development innovations. Development of Novel Food and food ingredients, Safety evaluation of novel food products.

UNIT III **(15 hrs)**

Food Spoilage and Preservation: General principle of spoilage, Microbial toxins (endotoxins and exotoxins), Food contamination, Methods and principles of food preservation (Thermal processing, Cold preservation, Chemical and bio preservatives, food dehydration, Food irradiation, Biological control). Food and water borne diseases.

UNIT IV **(15 hrs)**

Food packaging technology: Role, functions, need and requirements of food packaging. Food packaging materials (Glass, Metal, Plastics, Molded Pulp and Aluminium foil), Dispensing devices. Monitoring of food quality. Food sanitation, food control agencies and their regulations (HACCP and FSSAI)

References:

1. Food Processing Technology.Principles and Practice (5th edition) .P.J. Fellows (2022) Woodhead Publishing
2. Food Safety And Standards : Laws, Tools And Management Systems (2022 edition) Vijayalakshmi D., Barbhai Mrunal D.New India Publishing Agency
3. The Chemistry of Food Additives and Preservatives (1st edition) .Titus A. M. Msagati (2012) John Wiley and Sons Ltd
4. Food microbiology (5th edition)William C Frazier (2017) McGraw Hill Education India.
5. Handbook of Food and Beverage Fermentation Technology (1st edition) Edited By Y. H. Hui, Lisbeth Meunier-Goddik, JytteJosephsen, Wai-Kit Nip, Peggy S. Stanfield (2004) Taylor and Francis Inc.
6. Food-The Chemistry of its Components (6th edition) Tom Coultate (2015) Royal society of Chemistry.

MSBTC03O03 : VACCINE BIOTECHNOLOGY

Course outcomes:

Upon successfully completing this course, the student will be able to

1. Differentiate immune responses in relation to infection and vaccination

2. Explain the requirement and designing of different types of Vaccines

3. Comprehend importance of conventional and new emerging Vaccine technologies

Unit I **(17 hours)**

Immune response to infection: Protective immune response in bacterial, viral and parasitic infections; primary and secondary immune responses during infection; Antigen presentation and role of antigen presenting cell: Dendritic cells in immune response; innate immune response; Humoral (antibody mediated) response; cell mediated response: role of CD4+ and CD8+ T cells; Memory responses: Memory and effector T and B cells, Generation, maintenance of T and B cells

Unit II **(15 hours)**

Immune response to vaccination: Vaccination and Immune response; adjuvants in vaccination; modulation of immune responses: Induction of Th1and Th2 responses by using appropriate adjuvants and antigen delivery systems-Microbial adjuvants, Liposomal and Macroparticles as delivery systems; Chemokines and cytokines; Role of soluble mediators in vaccination; Oral immunization and Mucosal Immunity.

Unit III **(13 hours)**

Vaccine type and design: History of vaccines, conventional vaccines; Bacterial vaccines; Viral Vaccines; Vaccines based on routes of administration: parenteral, oral, mucosal; Live attenuated and inactivated vaccines; subunit vaccines and Toxoids; Peptide vaccine

Unit IV **(15 hours)**

Vaccine Technologies: New vaccine Technologies; Rationally designed vaccines; DNA Vaccination; Mucosal vaccination; New approaches for vaccine delivery; Engineering virus vectors for vaccination; Vaccine for targeted delivery (Vaccine Delivery systems); Disease specific vaccine design: Tuberculosis Vaccine; Malaria Vaccine; HIV/AIDS Vaccine; New emerging diseases and Vaccine needs (Ebola/Zika/Corona).

References:

Janeway, C.A., Travers, p., Walport, M., and Shlomchik, M.J. (2005). Immuno Biology: the Immune System in Health and Disease. USA: Garland Science Pub.

Kindt, T.J., Osborne, B.A., Goldsby, R.A., Kuby, J. (2013). Kuby Immunology. Newyork: W.H. Freeman

Kaufmann S.H. (2004). Novel Vaccination Strategies. Weinheim: Wiley-VCH

Journal articles (relevant issues) from: Annual review of Immunology, Annual review of Microbiology, Current opinion in Immunology, Nature Immunology, Expert review of Vaccines

SEMESTER IV

MSBTC04C18 : ANIMAL CELL BIOTECHNOLOGY

Course Learning Outcomes:

Upon successfully completing this course, the students will be able to

1. Explain the process of successfully establishing,monitoring and maintaining animal cell culture.

2. Formulate the procedure of cell line characterization.

3.Explain stem cell properties and culture.

Comprehend stem cell research techniques.

4. Describe 3D culture and tissue engineering.

5. Comprehend the process of transgenesis and applications of transgenic animals.

6. Analyze the technique of animal cloning and its importance.

7. Interpret the applications of animal cell culture in medicine and research.

UNIT I **(15 hrs)**

Animal Cell Culture: Introduction, Culture & maintenance of primary & established cell lines. Biology of cultured cells- culture environment, cell-adhesion, cell proliferation & differentiation. Characterization of cultured cells, viability, cytotoxicity, cell death & apoptosis. Cell synchronisation- cell cloning & cell transformation. Cell separation, Scaling up of animal cell culture.

UNIT II **(15 hrs)**

Stem cells & Tissue engineering: Scope, embryonic & adult stem cells, properties, identification, stem cells culture & techniques. Isolation characterization and maintenance of stem cells, stem cell labeling, molecular imaging techniques in stem cell research, stem cell cryopreservation.Tissue engineering, biomaterials used in tissue engineering, three dimensional culture & transplantation of engineered cells. Tissue engineering-skin, bone & neuronal tissues.

UNIT III **(15 hrs)**

Transgenic Animals & Animal Cloning: Methods involved in the production of transgenic animals, importance & applications of transgenic animals (transgenic animal models, animal pharming & industrialization of transgenic animals). Improvement of biomass, disease resistant, recombinant vaccines for poultry, live-stock pharming products. (Write a review on major vaccines developed against SARS-CoV-2 virus). Animal cloning methods & their importance, IVF technology for livestock and humans.

UNIT IV **(15 hrs)**

Applications of Animal Biotechnology: Pharmaceutical products produced by mammalian cells- plasminogen activator, erythropoietin, blood clotting factors, glycoprotein hormones, interleukins, interferons. (Prepare a summary of mammalian cell lines commonly used for biopharmaceutical production).Use of cell cultures as alternative for animal models for research, testing of drugs on human volunteers, use of animals for research & testing; animal & animal cloning- ethical & social issues.

References:

1. R. Ian. Freshney, Culture of Animal Cells: A manual of Basic Technique & Specialized Applications, 5th edition (2005), John Wiley & Sons. Inc., Publication.
2. John Davis, Animal cell culture: Essential Methods, 1st edition (2011), Wiley Blackwell & Sons publisher.
3. Shantharam D., Jane F., Jane F Montgomery, Biotechnology, Biosafety & Biodiversity: Scientific & Ethical issues for Sustainable development. Science Pub Inc, (1999)
4. Shaleeshn, Bioethics, Wisdom Education Services.
5. Recombinant DNA Safety guidelines, 1999 Department of Biotechnology, Ministry of Science & Technology, Govt. Of India.
6. Slack, J.M., 2018. *The Science of Stem Cells*. John Wiley & Sons.
7. Robert Lanza, John Gearhart, Brigid Hogan, and others eds. .Essentials of Stem Cell Biology . San Diego, Calif., Elsevier Academic Press, 2006.

MSBTC04C19 : ENVIRONMENTAL BIOTECHNOLOGY

Course Learning Outcomes:

Upon successfully completing this course,the student will be able to do the following

1. Compare & contrast the impact of various types of pollution on the environment and to provide keen insight on the anthropogenic effect on proliferating the effect.
2. Employ biotechnological innovations to provide permanent solutions for environmental problems
3. Realize the significance of environmental resources and its need for conservation.
4. Explore and comprehend the significance of indigenous knowledge & apply the information for sustainable human development.
5. To evaluate potential capacity of microbes & plants in degradation of pollutants and to develop innovative Research and Development solutions to improve the capacity of these organisms.
6. Use Biotechnological tools for disaster management.
7. Employ novel Biotechnological tools in sustainable utilization of environmental resources.
8. Combine the knowledge of nanotechnology for environmental protection.

UNIT I **(15 hours)**

Environmental pollution: Air pollution, Water pollution-cause, consequence and remedial measures using recent biotechnological tools. Impact of light pollution on animal communication. **Ocean acidification** and Global warming- **novel technologies on carbon sequestration**. Disaster Management: Disaster – classification, causes and impacts. Stages in disaster management. Disaster risk reduction (DRR). Exploring databases for Disaster Management-Database for Emergency Management by ISRO,NDEM (National Database for Emergency Management by ISRO), NDMA India, EM-DAT

UNIT II **(15 hours)**

Biotechnological methods of pollution detection-bioindicators and biosensors for detection of pollution. Remote sensing. Exploring BIS by Indian Institute of Remote sensing. Environmental Nano Remediation Technology - Thermal, Physico-Chemical, and Biological Methods. Nano

Filtration for the Treatment of Wastes, Removal of Organics, Inorganics and Pathogens. Nanotechnology for Water Purification.

UNIT III **(15 hours)**

Biogeotechnology: Bioleaching (recovery of metals), oil recovery (microbially enhanced oil recovery). Bioremediation, Phytoremediation, technologies for removal of radioactive waste, oil spills and heavy metal pollution. Application of Genetically Modified Organisms in remediation. Metagenomic applications in environmental monitoring and bioremediation & use of NGS in Metagenomics studies

UNIT IV **(15 hours)**

Biodiversity and Conservation Biotechnology: Types of Biodiversity- Genetic, species and ecosystem diversity. Loss of biodiversity, Conservation of biodiversity- ex situ and in situ. Ex situ ,Biodiversity documentation, Biotechnological role in conservation, Bioprospecting and indigenous knowledge system. Exploring biodiversity databases-GBIF, ERA Biodiversity Database, IBIS, India Biodiversity Portal.

References:

1. Textbook of biodiversity 1st ed -K V Krishnamurthy- CRC Press 2003

2. Environmental pollution control-Jingling Liu, Lulu Zhang, Zhijie Liu, China Environment China Environment Publishing Group, Jingling Liu, Lulu Zhang, Zhijie Liu, and China Environment China Environment Publishing Group

3. Disaster Management 2019 S.C. Sharma Khanna Book Publishing Co Ltd.

4. Remote Sensing 1st ed Siamak Khorram, Stacy A.C. Nelson, Frank H. Koch, Cynthia F. van der Wiele Springer New York, NY 2012

5.Environmental Science Earth as a Living Planet 8th ed Daniel B. Botkin Edward A. Keller JOHN WILEY & SONS, INC 2005

6.Environmental Science Towards a sustainable future 13th ed Richard T. Wright Dorothy F. Boorse PEARSON 2017

7.Bioremediation and Sustainability : Research and Applications Romeela Mohee and Ackmez Mudhoo Hoboken, New Jersey : Salem, Massachusetts : John Wiley & Sons, Inc. ; Scrivener Publishing LLC, c2012.

MSBTC04C20 : MEDICAL BIOTECHNOLOGY

Course Learning Outcomes:

Upon successfully completing this course, the students will be able to

1. Comprehend the different types of genetic diseases and clinical cytogenetics.
2. Apply their knowledge of various molecular technologies for detection of genetic disorders.
3. Hypothesize the molecular pathologies of single gene disorders and complex traits.
4. Apply their knowledge of these genetic disorders for genetic counseling, preventive measures and apply gene therapy trials.
5. Analyze biomedical applications of stem cells.

UNIT I **(10 hrs)**

Classification of Genetic diseases: Chromosomal disorders, single gene disorders and complex traits; karyotype analysis. G banding, in situ hybridisation (FISH) and comparative genome hybridisation (CGH).

UNIT II **(10 hrs)**

DNA diagnostics: PCR based diagnostics, Ligation chain reaction, Mutation detection, Southern blot diagnostics, array-based diagnostics, DNA sequencing, genetic profiling and single nucleotide polymorphism.

UNIT III **(12 hrs)**

Molecular pathology of single gene disorders: Hemoglobinopathies, Skeletal disorders. Retinopathies. Diseases of skin. Immunodeficiencies. Molecular pathology of complex traits: Diabetes mellitus, Atherosclerosis and Coronary artery disease, Neurogenetic and neuropsychiatric disorders, Cancer (Mutation detection using PCR/Southern Blotting- case study).

UNIT IV **(13 hrs)**

Prevention of genetic diseases, Risk assessment and genetic counseling; Prenatal diagnosis and screening; Personalized health care.Treatment of Genetic Diseases: Gene therapy- Ex-vivo, In-vivo and In-situ gene therapy. Vectors used in gene therapy. Gene therapy trials- Familial hypercholesterolemia, Cystic fibrosis, Cancer, Cardiovascular diseases and AIDS. Stem cell gene therapy, stem cells for therapy for Neurodegenerative diseases, muscular dystrophy, Tissue systems Failures, Diabetes, Kidney failure; Liver failure; Cancer; Hemophilia

References:

1. Genetics for clinicians- Shubha R.Phadke; PRISM BOOKS, (2006)
2. An introduction to Recombinant DNA in medicine- Alan EH. Emery; 2nd edition (1995) Wiley and sons.
3. Human Molecular Genetics- T. Strachan and Andrew Read; 4th edition (2011), Garland Science.
4. Molecular Diagnosis of Infectious Diseases (Methods in Molecular Medicine)- Jochen Decker, U. Reischl; 2nd edition (2004), Humana Press.
5. Thompson and Thompson Genetics in Medicine- Robert Nussbaum, Roderick McInnes, H Willard; 8th edition (2015) Elsevier.
6. Quesenberry, P.J., Stein, G.S., Forget, B.G. and Weissman, S.M. eds., 1998. *Stem cell biology and gene therapy*. John Wiley & Sons.

MSBTC04C21 : PRACTICAL VII

Environmental Biotechnology

Course Learning Outcomes:

Upon successfully completing this course, the student will be able to

1. Perform different techniques for water quality analysis.
2. Perform soil analysis to determine the different constituents.
3. Isolate different microorganism from their natural environment- nitrogen fixers from legume, of *Thiobacillus* from metal suphides and rocks, halophites from seawater.
4. Identify and characterize microorganisms from environment.

Experiments:

1. Analysis of sewage water-Analysis of chemical characteristics and constituents (pH, alkalinity, acidity, total hardness, solids)
2. Analysis of organic constituents- Dissolved oxygen, BOD, COD and ammonical nitrogen
3. Analysis of inorganic constituents- Sulphate, flouride, phosphate etc
4. Analysis of metallic constituents- zinc, nickel etc
5. Analysis of soil: Determination of total phosphorous, calcium, magnesium, total nitrogen, heavy metals etc.
6. Microbial analysis of water, waste water and soil
7. Isolation of Rhizobium from legume root
8. Antifungal and antibacterial activity of medicinal plant
9. Survey of degradative plasmids in microbes growing in polluted environment
10. Studies on halophiles from seawater (pigmentation and salt tolerance)
11. Isolation of *Thiobacillus ferrooxxidans* and T*hiobacillus thiooxidans* from metal sulphides, rock and acidmine water
12. Induction of crown gall using Agrobacterium.

MSBTC04E07 : PHARMACEUTICAL BIOTECHNOLOGY AND DRUG DESIGN

Course Learning outcomes:

Upon successfully completing this course, the students will be able to

1. Critically evaluate the drug discovery process.
2. Compare and analyze the common natural sources of drugs and contemporary approaches to drug design and development
3. Demonstrate an understanding of the timelines and resources required to discover and develop new drugs in a preclinical setting
4. Evaluate the place and importance of Computer Methods in Pharmaceutical and Medicinal Chemistry in drug design.
5. Describe and compare computerized methods in pharmaceutical and medicinal chemistry.
6. Explain the concepts of molecular dynamics, molecular mechanics, energy minimization and solvent simulation.
7. Comprehend the concept of intrinsic activity, efficacy and stimulus-response relationships and the effect of solvent on drug receptor interactions.

Unit I **(15 hours)**

Basic principles of drug design, Structural fragments of drug molecules - pharmacophore, toxicophore, metabophore and biosteres. Pharmacophore - SAR and QSAR. Phases of drug action - pharmaceutical, pharmacokinetic and pharmacodynamic phases. Pharmacokinetics - ADME properties.

Unit II **(15 hours)**

Aims of Drug design, steps in drug design. Computer aided drug design (CADD). Drug targets - enzymes, receptors, nucleic acids, carrier proteins, structural proteins etc. Ion-channels. Agonist and antagonist - biological activity, intrinsic activity & efficacy. Stimulus-response relationships. Drug Receptor interaction.

Unit III **(15 hours)**

Drug Discovery - Target Identification and validation, homology modeling and protein folding. The lead compound, sources of lead compounds, approaches to lead optimization, high throughput screening (HTS), preclinical trials, pro-drugs. Drug docking - Introduction to docking methods to generate new structure; tools and molecular docking programs - AutoDock, DOCK (Molecular docking using specific programmes and discussion).

Unit IV **(15 hours)**

Effect of solvent on drug receptor interactions - Solvent simulation. Energy changes during drug binding, Stability of drug-receptor complex. Molecular mechanics - Introduction, force field, potential energy functions (Molecular simulation studies using suitable programmes). Energy minimization, local and global minima, saddle point. Molecular dynamics - free energy methods, conformational energy searching, Monte Carlo stochastic simulation.

References:

1. An Introduction to Medicinal Chemistry; Graham L. Patrick; Oxford University Press. 5th edition. 2017
2. Molecular Modelling - Principles and Applications; Andrew Leach; Prentice Hall. second edition. 2001
3. Medicinal Chemistry - A Molecular and Biochemical Approach; Thomas Nogardy, Donald F. Weaver; Oxford University Press. 3rd edition.2005.
4. Molecular Modelling and Simulation - An Interdisciplinary Guide; Tamar Schlick. Second edition. 2010

MSBTC04E08 : RESEARCH METHODOLOGY

Course Learning outcomes:

Upon successfully completing this course, the students will be able to

1. Explain different methods of research.
2. Explain the different steps to followed in research.
3. Explain the method of scientific writing and the presentation of data.
4. Explain the importance of ethics in research.
5. Explain the intellectual property rights and its importance in research.

UNIT I **(15 hours)**

Science and Research- definition – history – evolution of scientific enquiry – objectivity, facts, hypothesis, theory and concept. Methods of research – scientific method versus arbitrary method - logical scientific methods – deductive and inductive methods.Various types of Research – descriptive, analytical, fundamental, applied, qualitative, quantitative, conceptual, empirical, surveys, correlations, experimental and quasi-experimental ex-post facto research, critical and action-oriented research, biographical,phenomenological, ethnographical, case studies.

UNIT II **(15 hours)**

Steps in doing research: Review of literature, primary and secondary sources, national institutes useful in literature search – NISCAIR; Library resources – Journals/periodicals, reviews, abstracts, treatise, monographs, searching of web resources, electronic databases, critical review of literature, identification of research gaps, defining or selection or identification of a research topic or problem, formulation of a hypothesis, the significance of hypothesis, types of hypothesis, relevance and assumptions in research, developing a research plan, execution of research work

UNIT III **(15 hours)**

Scientific writing and presentation of scientific data: Research proposals, research papers, research reports, dissertation and thesis. Style of scientific writing – structure and language, "Title" rules, preparation of "Abstracts", "Introduction" rules. Rules for presenting "Materials and Methods", rules for presenting "Results", the concept of "Discussion" method of "Conclusion", , Reference styles,Bibliometrics, Citation,. Presentation of Tables and Figures, visual organization of data/observations, peer review, editing the final drafts, manuscript submission Presentation Tools- creating and customizing presentations, oral and poster presentations, MS / open office ppt and pdf slides.

UNIT IV **(15 hours)**

Impact factor., Journal selection,Scientific writing and ethics, Introduction to copyright - academic misconduct/plagiarism.Funding agencies: National and international funding agencies for R & D projects. Preparation of R & D projects for funding. Biosafety and ethical issues, IPR, Patents and patent filing, Patent specifications and application, characteristics of the disclosure for a biotechnology invention, marketing of biotechnological invention

References:

1. Dawson, C. (2002). Practical research methods.UBS Publishers, New Delhi. 19

2. Stapleton, P., Yondeowei, A., Mukanyange, J., Houten, H. (1995). Scientific writing for agricultural research scientists – a training reference manual. West Africa Rice Development Association, Hong Kong.

3.Panneerselvam R (2004) Research Methodology, Prentice Hall of India, New Delhi

.4.Katz, M. J. (2009). From research to manuscript: a guide to scientific writing. Springer Science & Business 3 Media.

5. Holmes, D. , Moody, P., Dine, D. and Trueman, L. (2016). Research Methods for the Biosciences. Oxford University Press

MSBTC04E09 : BIOSAFETY AND BIOETHICS

Course learning Outcomes:

Upon successfully completing this course, the student will be able to

1. Outline Biosafety and bioethics in the context of modern biotechnology.
2. Analyze and manage the potential bio risks associated with biotechnology and molecular genetics research.
3. Infer the basic ethical principles which guide bioscience research.
4. Apply the basic concepts of biosecurity and Bioethics on real life issues.
5. Implement biosafety guidelines and identify the various hazards related to environmental release.
6. Conduct environmental assessments and apply these guidelines for any rDNA related activities.
7. Interpret the social and ethical issues related to plant and animal biotechnology.

Unit I **(13 hrs)**

Introduction to Biosafety : Objectives of biosafety, biosafety issues in biotechnology. Biological Safety Cabinets, Primary Containment for Biohazards. Biosafety Levels - Levels of Specific Microorganisms, Infectious Agents and Infected Animals. Biological containments and physical containments.

Unit II **(15 hrs)**

Biosafety Guidelines: Guidelines and regulations (National and International including Cartagena Protocol) – operation of biosafety guidelines and regulations of Government of India; Definition of GMOs & LMOs. Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture. Environmental release of GMOs - Risk - Analysis, Assessment, management and communication.

Unit III **(15 hrs)**

Guidelines for rDNA research activities: large scale experiments, release to environment, import and shipment, mechanism of implementation of biosafety guidelines. Quality control of biologicals produced by rDNA technology. Revised guidelines for research in transgenic plants.

Unit IV **(17 hrs)**

Bioethics: Introduction to ethics and bioethics, framework for ethical decision making. Ethical, legal and socio-economic aspects of gene therapy, germ line, somatic, embryonic and adult stem cell research. Ethical implications of GM crops, GMO's, human genome project, human cloning, designer babies, biopiracy and biowarfare. Eugenics and its possible approaches. Animal right activities - Blue cross in India- society for prevention of cruelty against animals. Ethical limits of Animal use. Greenpeace - Human Rights and Responsibilities.

References:

1. CRC Handbook of Laboratory Safety. A Keith Furr, CRC Press
2. Recombinant DNA Safety Guidelines.1990. Department of Biotechnology, Ministry of
3. Science and Technology, Govt. of India
4. Bioethics. Ben Mepham , Oxford university press, 2nd edition, 2008
5. Bioethics and Biosafety. M K Sateesh. I K international Publishing House Pvt ltd, 2008
6. Biosafety and Bioethics. Rajmohan Joshi, Ishabooks, 2006
7. IPR, Biosafety and Bioethics. Deepa Goel , Shomini Parashar.Pearson 2013
8. Biological Safety Principles and Practices, Dawn Wooley and Karen Byers, Wiley publishers , 5th edition, 2017
9. Introduction to Bioethics, John A Bryant , Linda la Velle. Wiley Black well, 2nd edition, 2019

Pattern of Question Papers

First Semester M.Sc. Degree Examination November 2023
MSBTC00C00 : Name of the Paper

Time: 3 Hrs. Max. Marks: 40

Section A
Answer any five questions. Each question carries 2 marks
(Revised Bloom's Taxonomy level 1,2)

1.
2.
3.
4.
5.
6.

(5 x 2 = 10 Marks)

Section B
Answer any three questions. Each question carries 4 marks
(Revised Bloom's Taxonomy level 6)

7.
8.
9.
10.
11.

(3 x 4 = 12 Marks)

Section C
Answer any three questions. Each question carries 6 Marks
(Revised Bloom's Taxonomy level 3,4,5)

12.
13.
14.
15.
16.

Model Question Paper

First Semester M.Sc. Degree Examination November 2023
MSBTC01C03 : MOLECULAR CELL BIOLOGY

Time: 3 Hrs. Max. Marks: 40

Section A
Answer any five questions. Each question carries 2 marks

1. Recall what signal recognition particles are?
2. Where do you find the 9+2 arrangement of the microtubules?
3. What is the role of occludin and claudin protein
4. What is the importance of the targeting sequences in transfer of proteins into organelles?
5. Outline the role of the MAP proteins on the microtubules
6. What are the contributions of Schleiden and Schwann?

(5 x 2 = 10 Marks)

Section B
Answer any three questions. Each question carries 4 marks

7. Outline the Ras-MapK pathway.
8. Summarize the mechanism of export of materials into nucleus.
9. Outline the cell cycle check- points, and their significance.
10. Distinguish between FRAP and FRET.
11. Explain how genetic material is accommodated inside the nucleus.

(3 x 4 = 12 Marks)

Section C
Answer any three questions. Each question carries 6 Marks

12. Justify the statement that cancer is a multifactorial disease
13. Describe the different apoptotic pathways. Add a note on the role of Bcl2 family.
14. Compare and contrast between a prokaryote and a eukaryote
15. Describe the heterochromatinization in the context of histone tail modification
16. What is the significance of extra cellular matrix components in cell migration?

(3 x 6 = 18 Mark)