

D.Y. PATIL EDUCATION SOCIETY
[Deemed to be University], Kolhapur
Re-accredited by NAAC with 'A' Grade



Centre for Interdisciplinary Research (CIR)

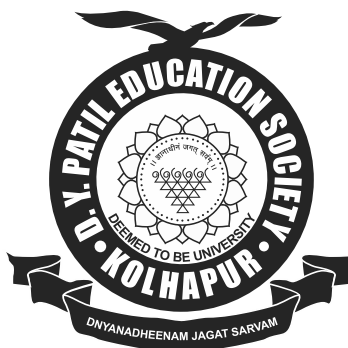
Department of Stem Cell &
Regenerative Medicine and Medical Biotechnology

Syllabus For

M.SC. MEDICAL BIOTECHNOLOGY

Choice Based Credit System

D. Y. PATIL EDUCATION SOCIETY, KOLHAPUR
(DEEMED TO BE UNIVERSITY)



Centre for Interdisciplinary Research (CIR)

Department of Stem Cell & Regenerative Medicine
and
Medical Biotechnology

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M. Sc. Medical Biotechnology
(Choice Based Credit System)

Year of Implementation : 2022-23
Year of Examination : 2023-24

BL-MB-01: Introduction

This course focuses on the Scientific and Industrial application of biotechnology in support of medicine. The course concentrates on various aspects of basic science such as cell and molecular biology, immunology, genetics, microbiology etc. with a special focus on medical biotechnology coupled with biological processes, technologies and skills used in the research and development of pharmaceutical products, vaccines and devices for the application in medical industry.

BL-MB-02: Vision, Mission and Goal**VISION**

M. Sc. Medical Biotechnology is a post graduate biotechnology course in medical field. The vision of the course is to provide the students with knowledge within areas such as medical biotechnology, applied and Industrial biotechnology, Nano biotechnology, molecular diagnostics and therapeutics, Medical Microbiology.

MISSION

- To provide a stepping stone for aspiring students willing to pursue research and
- Employment opportunities in Academic or Industrial Sector.
- To impart hands-on- training in the field of medical biotechnology
- To help students in gaining higher education to fulfill the purpose of research and employment.

GOAL

- To introduce a host of scientific development, legal and ethical issues that shape the
- Public view of the medical biotechnology and its applications.
- To provide students with basic concepts and understanding of how the various
- drivers of medical biotechnology interact with one another and shape this industry and impact the growth of medical biotechnology companies.

OUTCOMES

- Student will have extensive theoretical and practical knowledge on Medical Biotechnology
- Understanding the use of relevant analytical techniques within the field of medical biotechnology.
- Increasing awareness of professional, ethical and social responsibilities with relationship to medical biotechnology.
- Increasing the opportunities to pursue higher studies in foreign countries.

SEMESTER-I

Theory Papers	University Exam marks	Internal marks	Total marks	Credits
(Paper 1) MBT.1.1.1 Biochemistry	80	20	100	4
(Paper 2) MBT.1.1.2 Cell Biology and Developmental Biology	80	20	100	4
(Paper 3) MBT.1.1.3 Genetics and Molecular Biology	80	20	100	4
(Paper 4) MBT.1.1.4 Immunology and Virology	80	20	100	4
Practical				
(Practical 1) MBT.1.1.P.1 Biochemistry	40	-	40	8
(Practical 2) MBT.1.1.P.2 Cell Biology and Developmental Biology	40	-	40	
(Practical 3) MBT.1.1.P.3 Genetics and Molecular biology	40	-	40	
(Practical 4) MBT.1.1.P.4 Immunology and Virology	40	-	40	
(Practical 5) MBT.1.1.P.5 Industry Visit and Report	40	-	40	
Total	520	80	600	24

SEMESTER-II

Theory Papers	University Exam marks	Internal marks	Total marks	Credits
(Paper 5) MBT.1.2.1 Metabolism and Clinical Biochemistry	80	20	100	4
(Paper 6) MBT.1.2.2 Biostatistics and Bioinformatics	80	20	100	4
(Paper 7) MBT.1.2.3 Biomedical Instrumentation a and Nanobiotechnology	80	20	100	4
(Paper 8) MBT.1.2.4 Stem Cell Biology	80	20	100	4
Practical				
(Practical 6) MBT.1.2.P.1 Metabolism and Clinical Biochemistry	40	-	40	8
(Practical 7) MBT.1.2.P.2 Biostatistics and Bioinformatics	40	-	40	
(Practical 8) MBT.1.2.P.3 Biomedical Instrumentation & Nanotechnology	40	-	40	
(Practical 9) MBT.1.2.P.4 Stem Cell Biology	40	-	40	
(Practical 10) MBT.1.2.P.5 Industry visit and report	40	-	40	
Total	520	80	600	24

SEMESTER-III

Theory Papers	University Exam marks	Internal marks	Total marks	Credits
(Paper 9) MBT.2.3.1 Industrial Biotechnology	80	20	100	4
(Paper 10) MBT.2.3.2 Cell Culture and Animal Biotechnology	80	20	100	4
(Paper 11) MBT.2.3.3 Elective I(Choose any one) (A) Medical Microbiology (B) Nanobiotechnology	80	20	100	4
(Paper 12) MBT.2.3.4 Elective II(Choose any one) (A) Molecular Diagnostics and Therapeutics (B) Environmental Sciences and Biodiversity	80	20	100	4
Practical				
(Practical 11) MBT.2.3.P1 Industrial Biotechnology	40	-	40	8
(Practical 12) MBT.2.3.P2 Cell culture and Animal Biotechnology	40	-	40	
(Practical 13) MBT.2.3.P3 Elective I(Choose any one) (A) Medical Microbiology (B) Nanobiotechnology	40	-	40	
(Practical 14) MBT.2.3.P4 Elective II(Choose any one) (A) Molecular Diagnostics and Therapeutics (B) Environmental Sciences and Biodiversity	40	-	40	
(Practical 15) MBT.2.3.P.5 Research Project Synopsis	40	-	40	
Total	520	80	600	24

SEMESTER-IV

	University Exam marks	Internal marks	Total marks	Credits
(Practical 16) MBT.2.4.P.1 Research Project				
Oral / Poster Presentation in conference/ workshop/ any other relevant program	-	100	100	4
Dissertation	200	-	200	8
Viva	200	-	200	8
Industry Visit and Report	100	-	100	4
Total	500	100	600	24

Programme outcome (PO)	
PO1	Knowledge and Skills
PO2	Planning and Problem-solving abilities
PO3	Communication
PO4	Research Aptitude
PO5	Professionalism and Ethics
PO6	Leadership
PO7	Societal Responsibilities
PO8	Environment and Sustainability
PO9	Lifelong Learner

Upon completion of the M. Sc. program, the student will be able to:

PO1:Demonstrate subject knowledge and skill of Medical Biotechnology for appropriate applications in Industry, Medical or hospital related organizations, Regulatory Agencies and Academia.

PO2: Planning and problem solving abilities in molecular biology, rDNA technology, disease diagnosis, handling and maintenance biological instrumentation, analytical methods, problem solving and interpretation of experimental data.

PO3: Develop communication skills to communicate effectively in teaching, research, interviews, healthcare sector, industries, academia for collaborative research by explaining his ideas with good interpersonal and workplace based skills.

PO4:To do research in molecular biology, rDNA technology, disease diagnosis, handling and maintenance biological instrumentation, analytical methods and drug development.

PO5: Develop understanding and implementation of ethics in profession, research, society, animal experiment, workplace, hospital clinical research and human trials.

PO6: Develop leadership skills, logical reasoning, time management, values required for self-directed and lifelong learning, soft skills for professional development and execute their professional roles in society as Medical biotechnology professionals, employers and employees in various industries, regulatory committees, academic institutions and research laboratories.

PO7: Develop character with good moral values, human values, good social behaviour, gratitude, honesty, ethics, safety, hygiene, responsibility, confidence, tolerance and critical thinking.

PO8: To contribute in sustainable development to achieve the national sustainable development goal 3.

PO9: This course is helpful for lifelong learning in Life Science Stream.

Course Outcomes

Paper 1. Biochemistry

At the end of the course, the student will be able to:

CO1: Describe the Structure and properties of biomolecules like Nucleic acids, Proteins amino acids, estimation of biomolecules, Carbohydrates and Proteins and their role in metabolic and cellular pathways.

CO2: Describe the classification and functional properties of enzymes, enzyme kinetics and enzyme inhibition.

CO3: Explain about the role of vitamins and cofactors in enzyme activity.

CO4: Describe the metabolism of carbohydrates.

CO5: Describe the metabolism of lipids.

CO6: Describe the metabolic disorders in human.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	3	1	3	2	3	3	2	2
CO2	3	3	2	2	1	1	2	1	1
CO3	3	2	3	2	1	1	1	1	2
CO4	3	2	2	1	1	1	2	3	1
CO5	3	2	1	3	1	1	1	2	3
CO6	3	2	2	3	2	2	1	1	2

Paper 2. Cell Biology and Developmental Biology

At the end of the course, the student will be able to:

CO1: Know basics concepts of cell biology including structure and function of different organelles.

CO2: Understand the transport mechanisms and Mechanism of cellular recognition and communication.

CO3: Develop the basics understanding of receptor, ligand and different types cell signalling and their mechanisms.

CO4: Explain the importance of development and development process.

CO5: Explain the Growth, Morphogenesis and Genetic assimilation.

CO6: Understand of role of stem cells in development of organisms and developmental anomalies.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	3	1	3	2	3	3	2	2
CO2	3	3	2	2	1	1	2	1	1
CO3	3	1	3	2	1	1	1	1	2
CO4	3	2	1	1	1	1	2	3	1
CO5	3	3	1	3	2	3	1	2	3
CO6	3	1	1	1	1	2	1	1	2

Paper 3. Genetics and Molecular Biology

At the end of the course, the student will be able to:

CO1: Explain the mechanisms of DNA replication and repair, RNA synthesis and processing, and protein synthesis.

CO2: Contribute to the education of peers by actively engaging in small group sessions, and by clearly communicating information in an oral presentation based on a personal literature search on a specific genetic disease.

CO3: Critically evaluate one's performance in the course to identify strengths and personal limitations in either knowledge of molecular cell biology and genetics or study methods; develop learning goals to address any deficiencies and actively seek out assistance from appropriate sources to successfully remediate these deficiencies.

CO4: Explain the mechanisms of gene transcription and its regulation.

CO5: Explain the Gene mutations and human genetic disorders Consequences of mutation, Causes and occurrences.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	3	1	1	1	1	3	2	2
CO2	3	3	2	2	2	2	2	1	1
CO3	2	3	2	2	2	2	1	1	2
CO4	2	2	2	3	3	3	2	3	1
CO5	2	2	2	3	3	3	1	2	3

Paper 4. Immunology and Virology

At the end of the course, the student will be able to:

CO1: Understand the role and importance of innate and adaptive immunity to host defence against micro-organisms and the processes involved in immune cell development.

CO2: Understand the concepts of regulation of Immune responses.

CO3: Understanding of Immunologic basis of graft rejection and immuno therapies.

CO4: Acquire knowledge of viral diseases.

CO5: Understand the development of vaccines.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	3	1	1	1	1	3	2	2
CO2	3	3	2	2	1	2	2	1	1
CO3	3	3	2	2	2	1	1	1	2
CO4	3	2	2	1	1	1	2	3	1
CO5	3	2	2	1	1	2	1	2	3

Paper 5. Metabolism and Clinical Biochemistry

At the end of the course, the student will be able to:

CO1: Understand the concepts of protein metabolism and understand the importance of clinically important enzymes and related pathophysiology.

CO2 : To know about cause of metabolic diseases.

CO3: To learn biochemical methods for diagnosis of metabolic diseases.

CO4: The knowledge of metabolic disorders and organ system function test.

CO5: To get the knowledge metabolic disorders involved in metabolism.

CO6: To understand clinically important Enzymes.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	3	1	1	1	1	3	2	2
CO2	3	3	2	2	1	2	2	1	1
CO3	3	3	2	2	2	1	1	1	2
CO4	3	2	2	1	1	1	2	3	1
CO5	3	3	2	2	1	2	1	2	3
CO6	3	3	2	2	2	1	1	1	2

Paper 6. Biostatistics and Bioinformatics

At the end of the course, the student will be able to :

CO1: Understand the basic concepts of bioinformatics and databases available for Bioinformatics study.

CO2: Apply the knowledge of bioinformatics for getting DNA sequence and protein sequence for desired gene.

CO3: To study the comparison of Nucleotides, Amino acids sequences between various organisms.

CO4: Understand the definition of statistics and its relation with biological sciences.

CO5: Use the knowledge of sampling techniques, probability distributions for research.

CO6: Apply the knowledge of sampling correlation and regression in problem solving.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	2	3	1	2	3	2	3	2	2
CO2	3	3	2	2	1	1	2	1	1
CO3	3	3	2	2	2	1	1	1	2
CO4	3	2	2	1	2	2	2	3	1
CO5	3	3	2	2	2	2	1	2	3
CO6	2	3	2	2	2	1	1	1	2

Paper 7. Biomedical Instrumentation and Nanobiotechnology

At the end of the course, the student will be able to:

CO1: Understand the fundamental principles of Chromatography, electrophoresis, Spectrophotometry etc.

CO2: Development of technical Skills involved in Chromatography, electrophoresis, Spectrophotometry etc.

CO3: To understand principle and Instrumentation involved in PCR and Flow cytometry techniques.

CO4: To understand basic principles in nanobiotechnology.

CO5: Acquire knowledge about techniques used in nanobiotechnology.

CO6: Understand the applications of nanobiotechnology in Tissue engineering.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	3	1	1	1	1	3	2	2
CO2	3	3	3	2	2	2	2	1	1
CO3	3	3	2	2	2	2	1	1	2
CO4	3	2	2	1	1	1	2	3	1
CO5	3	2	2	2	1	1	1	2	3
CO6	3	2	2	1	1	1	1	1	3

Paper 8. Stem Cell Biology

At the end of the course, the student will be able to:

CO1: Explain basic concepts of stem cells, and different types of stem cells.

CO2: Understand the Pluripotent stem cell and molecular mechanism of Self renewal and differentiation.

CO3: Demonstrate methods of isolation of stem cell types.

CO4: Understand the Hematopoietic stem cell, their Characterization, and Differentiation of hematopoietic stem cell lineages.

CO5: Explain basic concepts of endothelial progenitor cells, Multipotent adult progenitor cells.

CO6: Understand the Cancer stem cells and their regulation.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	2	2	2	3	1	3	2	2
CO2	3	3	2	2	1	1	2	1	1
CO3	3	3	2	2	2	2	1	1	2
CO4	3	2	1	1	1	1	2	3	1
CO5	3	3	2	2	1	2	1	2	3
CO6	3	3	2	2	2	1	1	1	2

Paper 9. Industrial Biotechnology

At the end of the course, the student will be able to:

CO1: Explain the concepts of Fermentation process, media Formulation and sterilization.

CO2: Know about bio reactors design and strain improvement.

CO3: Understand preparation of bio fertilizers and Bio pesticides.

CO4: Know Genetic modification of organism for improvement.

CO5: Explain the downstream processing, pollution control, bioremediations.

CO6: Understand the Intellectual property rights.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	3	2	2	2	2	3	2	2
CO2	3	2	2	2	2	2	2	1	1
CO3	3	3	2	2	2	2	1	1	2
CO4	3	1	2	2	3	1	2	3	1
CO5	3	2	2	2	2	1	1	2	3
CO6	2	2	2	2	1	1	1	1	2

Paper 10 Cell Culture and Animal Biotechnology

At the end of the course, the student will be able to:

CO1: Explain the basic concepts of cell culture laboratory, media formulation, procedure for cell culture.

CO2: Demonstrate the techniques involved in animal cell culture for animal biotechnology

CO3: Know applications of animals in *In vivo* studies.

CO4: Understand the application of cell culture technology in production of human and animal viral vaccines.

CO5: Understand the application of cell culture technology in pharmaceutical proteins.

CO6: To understand the concept of cryopreservation.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	3	2	2	2	2	3	2	2
CO2	3	2	2	2	2	2	2	1	1
CO3	3	3	1	2	2	1	1	1	2
CO4	3	1	2	2	3	1	2	3	1
CO5	3	2	2	2	2	1	1	2	3
CO6	3	2	1	3	2	1	1	1	2

Paper 11. (A) Medical Microbiology

At the end of the course, the student will be able to:

CO1: Explain types of fungal diseases and its diagnosis.

CO2: To understand bacterial diseases and its diagnosis.

CO3: to understand the causes of diseases and its diagnosis.

CO4: Demonstrate methods of detection of protozoan and sexually transmitted diseases.

CO5: To know the epidemiology of viral diseases.

CO6: To understand transmissibility of pathogenic diseases.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	1	2	1	2	1	3	2	2
CO2	3	2	2	1	2	2	2	1	1
CO3	3	3	2	2	2	2	1	1	2
CO4	3	1	1	2	3	1	2	3	1
CO5	3	2	3	2	2	2	1	2	3
CO6	3	2	1	3	2	1	1	1	2

Paper 11. (B) Nanobiotechnology

At the end of the course, the student will be able to:

CO1: Know Different formats of nanomaterials and applications with example for specific cases

CO2 Acquire knowledge about Cellular Nanostructures; Nanopores; Biomolecular motors; Bio-inspired Nanostructures, Synthesis and characterization of different nanomaterials.

CO3: Synthesize Nanoparticles for drug delivery, concepts, optimization of nanoparticle properties for suitability of administration through various routes of delivery

CO4: Demonstrate the nano Thin films; Colloidal nanostructures; Self Assembly, Nanovesicles; Nanospheres; Nanocapsules and their characterization

CO5: Know the applications of Nanoparticles for diagnostics and imaging (theranostics); concepts of smart stimuli responsive nanoparticles, implications in cancer therapy, nanodevices for biosensor development

CO6: Aware of Safety of nanomaterials, Basics of nanotoxicity, Models and assays for Nanotoxicity assessment; Fate of nanomaterials in different stratas of environment; Ecotoxicity.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	2	3	3	3	3	3	2	2
CO2	2	2	2	3	3	3	2	1	1
CO3	3	2	3	3	3	3	1	1	2
CO4	3	2	3	2	3	2	2	3	1
CO5	3	2	3	3	2	3	1	2	3
CO6	3	2	3	3	3	2	1	1	2

Paper 12.(A) Molecular Diagnostics and Therapeutics

At the end of the course, the student will be able to:

CO1: Explain basic concepts molecular diagnostics.

CO2: To demonstrate the techniques involved in PCR for disease diagnosis.

CO3: To know the concepts of gene therapy.

CO4: To understand the various methods of disease diagnosis.

CO5: To detect recognized genetic aberrations in clinical samples from cancer patients.

CO6: Explain basic concepts oncology.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	3	2	1	1	2	3	2	2
CO2	3	3	2	2	2	2	2	1	1
CO3	3	3	2	2	2	2	1	1	2
CO4	3	2	2	1	1	2	2	3	1
CO5	3	2	2	2	1	2	1	2	3
CO6	3	2	2	1	1	2	1	1	2

Paper 12. (B)Environmental Sciences and Biodiversity

At the end of the course, the student will be able to:

CO1: Know types of pollution methods for management of the pollution, Environmental management, waste water treatment, Solid waste management

CO2: Acquire knowledge of degradation of xenobiotics in Environment, Bioremediation of xenobiotics and heavy metals, Ozone depletion, greenhouse effect and acid rain. Use of genetically modified microbe for reducing the pollution

CO3: Know the Principles and scope of ecology, Human ecology and Human settlement, Evolution, Origin of life and speciation

CO4: Know the Food Chains, Food web, Ecological pyramids. Ecological Succession, Population, Community ecology and Parasitism, Prey predator relationships

CO5: Know the air-borne diseases and allergies. Environmental Biotechnology: Fermentation Technology, Vermiculture technology, Biofertilizer technology

CO6: Know the Biodiversity conservation Act 2002, Wildlife parks, wildlife reserves, privately owned wildlife reserves & Biosphere reserves, Single species / single habitat based conservation programmes (e.g. Project tiger, Valley of flowers), International conventions on conservation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	2	3	3	3	3	3	3	2
CO2	2	2	2	3	3	3	3	3	1
CO3	3	2	3	3	3	3	3	3	2
CO4	3	2	3	2	3	2	3	3	1
CO5	3	2	3	3	2	3	3	3	3
CO6	3	2	3	3	3	2	3	3	2

Semester I

(Paper 1) MBT 1.1.1 Biochemistry (60 h)

Unit I. Amino acids, Proteins and Nucleic acids (15h)

Amino acid: Classification, structure and properties, amphoteric nature, isoelectric point, peptide bond formation. Protein: Classification, properties and biological functions; Protein Structure: primary, secondary, tertiary and quaternary, structure and function of myoglobin, hemoglobin, collagen, Ribonuclease A, chymotrypsine; Protein folding, Chaperones. Structure of nucleoside, nucleotide. De novo and salvage pathways of nucleotide synthesis. Secondary structure of DNA, Watson and Crick model of DNA. A, B and Z forms of DNA, Tm and its relation to GC content Chemical and enzymatic degradation of nucleic acids. RNA-structure and types.

Unit II. Enzymes (15 h)

Enzymes: classification, Factors affecting the enzyme activity- Concentration, pH and temperature. Kinetics of a single-substrate enzyme catalysed reaction, Michealis-Menten Equation, Km, Vmax, L.B Plot, Turnover number, Kcat. Kinetics of Enzyme Inhibition. Kinetics Allosteric enzymes. Immobilization of enzymes, Role of Vitamins and Cofactors in enzyme activity.

Unit III. Carbohydrates (15 h)

h)Carbohydrates: Classification, properties and biological functions of, Monosaccharides: Classification, properties, functions, isomerism, D & L forms, Disaccharides: Glycosidic bond, classification, composition and biological importance. Polysaccharides: Classification, properties and functions; Photosynthesis; aerobic and anaerobic respiration.

Unit IV. Lipids (15 h)

Lipids: Classification, properties and functions; fatty acids: composition, classification, characteristics and functions; Simple lipids, Triglycerides Conjugated lipids, phospholipids and its functions, glycolipids lipoproteins, Cholesterol-structure, properties and functions, Liposomes, lipids, lipoproteins and apolipoproteins.

Books for study and references:

1. Jeremy M. Berg, Lubert Stryer, John L. Tymoczko, Gregory J. Gatto - Biochemistry, 8th edition (2015), WH Freeman publications.
2. Biochemistry by Voet Donald, Voet, Judith G. (2004) 3rd edition (J Wiley and Sons)
3. Lehninger's Principles of Biochemistry by D. L. Nelson and M. M. Cox, CBS Publications, 2000 Biochemistry by Lubert Stryer, 4th Edition.
4. Pharmaceutical Biotechnology (Kindle Edition) by S. P. Vyas, V. K. Dixit, CBS Publishers and distributors.

5. Meeting Educational Needs with “Course” Remodelled Biotech Curricula May, 2017 Copyright © Deptt. of Biotechnology Ministry of Science & Technology Government of India Compiled and Coordinated Ms. Shreya Malik, DM, BCIL Edited Dr. Suman Govil, Adviser, DBT Dr. Purnima Sharma, MD, BCIL.

(Paper 2) MBT.1.1.2 Cell Biology and Developmental Biology (60 h)

Unit I. Work of Cells (15 h)

Membrane structure and function: Lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps; Structural organization and function of intracellular organelles: Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes; structure & function of cytoskeleton and its role in motility; Cell division and cell cycle: Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle

Unit II. Cell communication and Cell Signalling (15 h)

Hormones and their receptors, cell surface receptors, signaling through G-protein coupled receptors, Signal transduction pathways, second messengers, regulation of signaling pathways; General principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, and integrin.

Unit III. Basic concepts of development (15 h)

Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development

Unit IV. Gametogenesis, fertilization and early development (15 h)

Production of gametes, cell surface molecules in sperm-egg recognition in animals; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals.

Books for study and references:

1. Lodish, H. F. (2021). *Molecular Cell Biology*, (9th Edition). New York: W.H. Freeman.
2. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2022).
3. *Molecular Biology of the Cell*, (7th Edition). New York: Garland Science.
4. Gilbert SF., Barresi MJF. (2020) *Developmental Biology*; (12th Edition).; Sinauer Associates Inc.
5. Wolper L., Tickle C; (2019); *Principles of Development* (6th Edition); Oxford University Press, UK

(Paper 3) MBT 1.1.3 Genetics and Molecular Biology**(60 h)****Unit I. Principles of Genetics (15 h)**

Classical genetics: Mendelian laws of Inheritance, Chromosomal basis of inheritance, principles, Gene interaction, Genetic linkage and gene mapping, Yeast genetics and Tetrad analysis, Sex chromosomes and sex determination. General features of chromosomes. General features of Genetic code, Cytogenetics: Human karyotype, Chromosome banding, ploidy, chromosome aberrations and position effect. Population genetics: Calculation of allelic frequencies, Hardy-Weinberg law. Contributions of Thomas Hunt Morgan.

Unit II. Nucleic Acids and Replication (15 h)

Molecular structure of DNA and RNA. Identification of DNA as a genetic material. Hershey and Chase experiments on T₂ phage. Chargaff's experiments. Central Dogma of molecular biology. DNA Replication. A structural Overview. Three different models on DNA replication. Semi-conservative model. Bacterial DNA replication. *In vitro* DNA replication. Eukaryotic DNA replication, Steps and enzymes involved.

Unit III. Gene transcription and Translation (15 h)

Transcription in prokaryotes and eukaryotes. RNA modification. Types of RNA. Transcriptional regulation in prokaryotes and eukaryotes. Translation of mRNA. The genetic basis of protein synthesis. The structure and function of t RNA. Ribosome structure and assembly. Translation in prokaryotes and eukaryotes. Gene regulation in prokaryotes and eukaryotes. Chromatin remodeling. Histone modification. DNA methylation. Regulation of RNA processing, Gene silencing, siRNA, micro RNA, Gene editing Crispr-Cas system.

Unit IV. Gene mutations and human genetic disorders (15 h)

Consequences of mutation. Causes and occurrences of mutations. Repair of DNA: various mechanisms. Genetic recombination: Homologous recombination. Site specific recombination, Transposons, Discovery and molecular identification of transposons in various life forms. Introduction to Human Genetic Diseases: Cystic Fibrosis, Duchenne muscular dystrophy, Thalassemia, sickle cell anaemia, SCID, Downs syndrome.

Books for study and references:

1. Robert J Brooker, Genetics : Analysis and Principles. Mc Graw Hill Publications .New York, USA. International student's edition. 2012.
2. Jocelyn E.Krebs, Elliot S. Goldstein and Stephen T.Kilpatrick . Lewin s: Genes XI .Jones & Bartlett student edition. 2014
3. Mathew R.Walker with Ralph Rapley: Route Maps in Gene Technology. Blackwell Science.Mass.USA.1997.
4. Robert F.Weaver : Molecular Biology Fifth edition. McGRAW Hill International Edition. 2008.
5. Brown TA: Gene Cloning and DNA Analysis. Willey Blackwell.2010.West Sussex.UK

6. Meeting Educational Needs with “Course” Remodelled Biotech Curricula May, 2017
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(Paper 4) MBT.1.1.4 Immunology and Virology (60 h)

Unit I. Introduction to immune system (15 h)

Introduction and history; Primary and secondary organs of the immune system, Cells of the immune system. Innate immune response & inflammation, complement system. 3. Hapten/antigen; antibody, structure & function, Immunoglobulin classes. Antigen & antibody interaction, Antibody diversity.

Unit II. Generation and regulation of immune responses (15 h)

Major histocompatibility complex, Polymorphism, Human leukocyte antigen association with disease, Ontogeny, Positive and negative selection. Antigen processing and presentation, Co-stimulation, T and B cell stimulation, Cytokines & Chemokines.

Unit III. Transplantation Immunology (15 h)

Immunologic basis of graft rejection, clinical manifestation of graft rejection, immunosuppressive therapy; applications of monoclonal antibodies, single chain and humanised antibodies.

Unit IV. Virology (15 h)

Immune response to infectious diseases Concept of immunotherapy; Vaccines (Recombinant, DNA, live and attenuated, subunit); Herd immunity; Success stories in vaccinology e.g. small pox, polio, Hepatitis, DPT.

Books for study and references:

1. Kuby, RA Goldsby, Thomas J. Kindt, Barbara, A. Osborne, (2002), *Immunology*, 6th Edition, Freeman
 2. Brostoff J, Seaddin JK, Male D, Roitt IM., (2002), *Clinical Immunology*, 6th Edition, Gower Medical Publishing
 3. Janeway *et al.*, *Immunobiology*, (1999), 4th Edition, Current Biology publications
 4. Peakman, M and Vergani D, (2009), *Basic and Clinical Immunology*, 2nd Edition.
 5. MacLachlan, NJ and Dubovi, EJ. (2011). *Fenner's Veterinary Virology*, 4th edition. Elsevier Inc.
 6. Mahy BWJ & Kangaro HO. (1996). *Virology Methods Manual*. Academic Press.
- Meeting Educational Needs with “Course” Remodelled Biotech Curricula Cellular and Molecular Immunology, 10th Ed, South Asia Edition Paperback – 1 January 2021.

Practical

(Practical 1) MBT.1.1.P.1 Biochemistry (15 h)

Paper chromatography technique for amino acid separation.

1. Estimation of Protein by Lowry's method and Bradford's method.
2. Determination of isoelectric pH of Casein.
3. Estimation of DNA by DPA Method.
4. Estimation of RNA by Orcinol method.
5. Estimation of Free Fatty acids.
6. Determination of saponification value of fatty acids.

(Practical 2) MBT.1.1.P.2 Cell Biology and Developmental Biology (15 h)

1. Preparation of temporary stained mount of human cheek cells.
2. Preparation of temporary mount of onion peel to observe and study epidermal cells.
3. Demonstration of osmosis by potato osmometer.
4. Lysosome Isolation in Isotonic Sucrose from Rat liver cells.
5. Isolation of Mitochondria from Rat liver cells.

(Practical 3) MBT.1.1.P.3 Genetics and Molecular Biology(15 h)

1. Isolation of total DNA from bacteria.
2. Preparation of plasmid from *bacteria*.
3. Separation of DNA by Agarose gel electrophoresis
4. Purification of DNA from agarose gel.
5. Restriction Digestion of DNA.
6. DNA / RNA quantification by UV spectrophotometer.

(Practical 4) MBT.1.1.P.4 Immunology and Virology (15 h)

1. Double Diffusion immune precipitation assay
2. Sodium Dodecyl Sulphate Polyacryamide gel electrophoresis of Protein
3. Detection of serum antibodies by WIDAL test.
4. RNA extraction of given biological sample
5. Detection of Viral disease by RTPCR

(Practical 5) MBT.1.1.P.5 Industry visit and report

Semester II

(Paper 5) MBT.1.2.1 Metabolism and Clinical Biochemistry (60 h)

Unit I. Carbohydrate Metabolism

(15 h)

Brief account of Glycogen Metabolism, Fructose Metabolism, Galactose Metabolism and Uronic acid pathway. Inborn errors associated with carbohydrate metabolism – Glycogen storage diseases, Fructosuria, Fructose intolerance, Pentosuria, Galactosuria. Blood glucose regulation (fasting/pp/random)–hormones influencing carbohydrate utilization, Insulin, glucagon, glucocorticoids, epinephrine, growth hormone. Hyperglycaemia, Diabetes Mellitus, Hypoglycaemia.

Unit II. Lipid Metabolism

(15 h)

Digestion of Lipids, Biosynthesis of cholesterol, Regulation of Cholesterol synthesis, Fate of Cholesterol, Cholesterol transport, Atherosclerosis, Hypercholesterolemia. Hyper- and Hypoproteinemia, Fatty Liver, Brief account of Ketone body metabolism, Ketosis. Complete Lipid profile.

Unit III. Amino acid, Protein, Nucleic acid Metabolism (15 h)

Body amino acid pool, Aminoacidopathies, Amino Acid Analysis, Proteins – Catabolism and Nitrogen Balance, Dynamic state of body proteins; Plasma proteins – Prealbumin (Transthyretin), Albumin, Globulins; Total Protein abnormalities– Hypoproteinaemia, Hyperproteinaemia; Methods of analysis– Total nitrogen, Total proteins, Fractionation, Identification and Quantification of specific proteins, Brief account of Metabolism of Glycine, Phenyl alanine, Tyrosine and Sulphur containing amino acids. Glutathione, Formation of Taurene, Hyperglycinaemia's, Homocystinuria, Cystinuria and Cystinosis, Phenyl ketonuria and Alkaptonuria, Albinism, Tyrosinemia, Brief account of Purine and Pyrimidine metabolism including Purine Salvage Pathways. Disorders of Purine Pyrimidine Metabolism such as Gout, LeschNyhan Syndrome and Orotic aciduria.

Unit IV. Clinical Enzymology, Plasma Proteins and NPN compounds (15 h)

Part A: Enzymes of clinical significance – Creatine Kinase, Lactate Dehydrogenase, Aspartate Aminotransferase, Alanine Aminotransferase, Alkaline Phosphatase, Acid Phosphatase, Glutamyl transferase, Amylase, Lipase, Glucose-6-Phosphate Dehydrogenase, Drug – Metabolizing Enzymes, Tumour markers, Bone markers, Cardiac markers, liver markers. Clinical Isoenzymology.

Part B: Serum protein electrophoresis, High-resolution protein electrophoresis, Immunochemical methods; Proteins in other body fluids – Urinary proteins and Cerebrospinal fluid proteins; Non – protein nitrogen compounds (Physiology, clinical application, methods, and pathophysiology) – Urea, Uric acid, Creatine, Creatinine, Ammonia, Synthesis of thyroid hormones, Synthesis and catabolism of catecholamines.

Books for study and references:

1. Michael L. Bishop, Edward P. Fody and Larry E. Schoeff; (2013). *Basic Principles and Practice of Clinical Chemistry*, (7th Ed). Lippincott Williams and Wilkins.
2. Stryer, L. (2002). *Biochemistry*, (8th Ed). Freeman.
3. D.M. Vasudevan and Sreekumari, S, (2010). *Textbook of Biochemistry for Medical Students*, (6th Ed). Jaypee Brothers Medical Publishers, New Delhi.
4. Sucheta Dandekar; (2010). *Concise Medical Biochemistry*, (3rd ed), Elsevier Health.
5. Satyanarayana and Chakrapani, (2013), *Biochemistry*; (4th Ed). Elsevier.
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(Paper 6) MBT.1.2.2. Biostatistics and Bioinformatics (60 h)

Unit I. Basic concepts in biostatistics and Descriptive Statistics (15 h)

Definition – Biostatistics, Variable: Quantitative and Qualitative Variable, Applications of statistics in Biology with Examples.

Sampling: Definitions, Population Sample, Advantages of Sample Studies. Types of Samples. Methods of Sampling- Simple random sampling, stratified random sampling, systematic sampling, cluster sampling, multistage sampling, multiphase sampling, Sampling error.

Descriptive statistics: Types of data - Qualitative, Quantitative, Categorical, Raw and grouped data.

Graphical Presentation of data - Pie chart, Bar diagram, Histogram, Frequency polygon, Frequency Curve.

Averages - Arithmetic mean, Median, Mode (Calculations, merits, demerits and uses).

Measures of dispersion - Range, standard deviation, Coefficient of Variation (Computation, merits, demerits and application).

Correlation and Regression: Dependent Variable, Independent variable, Definition and properties of simple Pearsons correlation co-efficient, concept of simple linear regression, scatter graph with regression line.

Unit II. Probability distributions, Testing of significance (15 h)

Definition of probability - Classical relative frequency. Conditional probability. Addition theorem, Multiplication theorem (only statements)

Discrete probability Distributions-Binomial and Poisson (concept and list of applications).

Continuous probability Distribution-Normal distribution concept, properties and applications.

Tests of significance: Null hypothesis, Alternate hypothesis, Type I error, Type II error, Level of significance, p-value, Power of the test, Concept of test of significance. Chi-Square test, Normal test, Student's t-test (paired and unpaired). One-way analysis of variance (only introduction), Test of significance of correlation co-efficient.

Unit III. Bioinformatics basics

(15h)

Bioinformatics basics: Computers in biology and medicine; Database concepts; Protein and nucleic acid databases. Primary and secondary data bases, Structural databases; Databases and search tools. Biological background for sequence analysis; Identification of protein sequence from DNA sequence. Searching of databases for similar sequences. NCBI; Entrez, publicly available tools; resources at EBI; resources on web; database mining tools.

Unit IV. Bioinformatics analysis

(15h)

DNA sequence analysis: gene bank sequence database. Submitting DNA sequences to databases and database searching. Sequence alignment. Pairwise alignment techniques. Multiple sequence alignment. Motif discovery and gene prediction. Genomics, Whole genome sequencing. Human genome sequencing. Saccharomyces genome data base. Assembly of data from genome sequencing. Protein database, Proteomics. Sequence alignment programs, BLAST Searches, Gene expression analysis using microarray, RNA sequencing, Transcriptomics. Biochemical pathway database (KEGG).

Books for study and references:

1. Wayne W. Daniel, Chad L. Cross- Biostatistics: A foundation for analysis in the health science, 10th edition (2013), John Wiley & sons
2. Richard J. Sundar P. S. Rao S. Introduction to Biostatistics and Research Methods, 4th edition (2006), Prentice-Hall of India Pvt. Ltd. publication
3. Armitage P and Berry G - Statistical methods in medical Research, 4th edition (2008), Oxford Blackwell scientific publication
4. Sokal P R and Rohlf F. R.-Biometry: The principles and practice of statistics in Biological, 3rd edition (1981), Freeman and company Sanfransisco
4. Lesk, A. M. (2002). *Introduction to Bioinformatics*. Oxford: Oxford University Press.
5. Mount, D. W. (2001). *Bioinformatics: Sequence and Genome Analysis*. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
6. Baxevanis, A. D., & Ouellette, B. F. (2001). *Bioinformatics: a Practical Guide to the Analysis of Genes and Proteins*. New York: Wiley-Interscience.
7. Pevsner, J. (2015). *Bioinformatics and Functional Genomics*. Hoboken, NJ.: Wiley-Blackwell.
8. Bourne, P. E., & Gu, J. (2009). *Structural Bioinformatics*. Hoboken, NJ: Wiley-Liss.
9. Lesk, A. M. (2004). *Introduction to Protein Science: Architecture, Function, and Genomics*. Oxford: Oxford University Press.
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11. Jaype Brothers, (2011), *Methods in Biostatistics for Medical Students and Research Workers (English)*, 7th Edition. Edited Dr. Suman Govil, Adviser, DBT Dr. Purnima Sharma, MD, BCIL

(Paper 7) MBT.1.2.3 Biomedical instrumentation and Nanobiotechnology (60 h)

Unit I. Biomedical Instrumentation I (15 h)

Chromatography: Paper, TLC, Gel filtration, Ion exchange chromatography, Gas Chromatography, HPLC, HPTLC, affinity chromatography, UV-Visible Spectroscopy, Mass Spectrometry, Nuclear Magnetic resonance, Infrared spectroscopy, Circular Dichroism.

Unit II. Biomedical Instrumentation -II (15 h)

Electrophoresis: Principle and types, Agarose gel Electrophoresis, pulse field gel electrophoresis, SDS-PAGE, 2D Gel Electrophoresis, Iso-Electric Focusing, Capillary electrophoresis, PCR, RTPCR, Flow Cytometry, Microscopy- SEM, TEM, Confocal, X-ray crystallography, ECG, MRI, PET, EEG and CT.

Unit III. Principles of Nanobiotechnology (15 h)

Biological Nanostructures and natural biological assemblies at nanoscale: Bacterial S layers, phospholipid membranes, viruses, Nucleic acids, Oligosaccharides, polysaccharides, biological polymers, Proteins. Biological nanomotors, protein assemblies: Kinesin and dynein, cilia. Bacterial flagella: structure and function; nanomotor. Ion channels: nanopores of high specificity. Bioinspired nanomaterials: DNA and peptide based. Interaction between biomolecules and nanoparticle surfaces. Self-Assembly, Self-Organization, Molecular Recognition.

Unit IV. Biomedical applications of Nanobiotechnology (15 h)

Diagnosis: Bio MEMS, Nanochips-Gene chip and Protein chip, Ultrasensitive biobarcode, Nanobiosensors. Therapeutics: Nanobiotechnology in imaging, Woundcare products, Implantable materials and bionics for medical application, Implantable materials for orthopedics and dentistry. Nanorobotics, Nanotechnology based chemotherapy.

Books for study and references:

1. David Friefelder, (1983), *Physical Biochemistry*, 2nd edition, W.H. Freeman and Co., USA.
2. G.H. Jeffery, J. Bassett. J. Mendham, R.C. Denney, (1991), *Vogel's Textbook of Quantitative Chemical Analysis*, 5th Edition, ELBS, England.
3. P.W. Atkins, (1996), *The Elements of Physical Chemistry*, Oxford University Press.
4. Jack A. Tuszynski Michal Kurzynski, *Introduction to Molecular Biophysics*, CRC Press. 370 | Remodelled Biotech Curricula
5. R.A. Day, A.L. Underwood, *Quantitative Analysis*, 1999, 6th Edition; Prentice-Hall of India Pvt. Ltd., New Delhi.
6. Plummer, 2002. *An Introduction to Practical Biochemistry*, 3rd edition, Tata Mc Graw Hill.
7. K Wilson and J Walker (eds.), 1999. *Principles and Techniques of Practical Biochemistry*, 4th edition, Cambridge Univ. Press.

8. GeroDecher, Joseph B. Schlenoff, (2003); Multilayer Thin Films: Sequential Assembly of Nanocomposite Materials, Wiley-VCH Verlag GmbH & Co. KGaA
9. David S. Goodsell, (2004); Bionanotechnology: Lessons from Nature, Wiley-Liss
10. Neelina H. Malsch, Biomedical Nanotechnology, CRC Press Greg T. Hermanson, (2013); Bioconjugate Techniques, (3rd Edition); Elsevier Recent review papers in the area of Nanomedicine.
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(Paper 8) MBT.1.2.4 Stem Cell Biology(60 h)

Unit I. Introduction and basic biology of stem cells (15 h)

History of stem cell research, Stemness, Type of stem cells, Stem cell markers, Types of adult stem cells: Bone marrow, adipose tissue, cord blood, placenta etc, Differentiation and trans-differentiation of stem cells, Stem cell niches and regulation of stem cell niche in different adult tissues.

Unit II. Pluripotent stem cell and molecular mechanism of Self renewal and differentiation (15h)

Pluripotent stem cells, Isolation and maintenance of embryonic stem cell isolated from: Mouse, Human, Extracellular signaling involved in embryonic vs adult stem cells, induced Pluripotent stem cells (iPSCs) and their characterization, Telomerase and its regulation, Symmetric and asymmetric division.

Unit III. Hematopoietic stem cells and their differentiation (15h)

Bone marrow microenvironment, Hematopoietic stem cell mobilization, Isolation of Hematopoietic stem cells, Ex vivo expansion, Characterization of Hematopoietic stem cells, Transcriptional regulation of Hematopoietic stem cells, Side population phenotypes, endothelial progenitor cells, Multipotent adult progenitor cells, Differentiation of stem cells *in-vivo* and *ex-vivo*, Differentiation of hematopoietic stem cell lineages.

Unit IV. Cancer stem cells and their regulation (15h)

Introduction to cancer, Stem cell origin of cancer, Cancer stem cells, Isolation and characterization of Cancer stem cells, Pathways involved in cancer stem cells and their tumor progression, Pericytes and tumor angiogenesis.

Books for study and references:

1. Khawaja H. Haider (2021) Stem Cells: Latest Advances (1st Edition), Springer, Cham
2. Khalid Al-Anazi (2020) Update on Mesenchymal and Induced Pluripotent Stem Cells. IntechOpen
3. Jonathan M. W. Slack (2017) The Science of Stem Cells, John Wiley & Sons, Inc.
4. RoberLanza (2014) Hand book of Stem Cells" (3rd Edition), Elsevier, Academic Press
5. Stewart Sell, (2013) Stem Cells Handbook (2nd Edition), Human Press

Practicals**(Practical 6) MBT. 1.2.P.1 Metabolism and Clinical Biochemistry (15 h)**

1. Estimation of Sugar in given sample of blood.
2. Blood Cell counting.
3. Kidney function test.
4. Liver function test.
5. Cholesterol estimation / lipid profile of blood.

(Practical 7) MBT. 1.2.P.2 Biostatistics and Bioinformatics (15 h)

1. Use of Statistical methods for data analysis.
2. PCR Primer designing by using primer designing tools.
3. Similarity search of DNA sequence using BLAST and interpretation of results.
4. Similarity search of protein sequence using BLAST and interpretation of results.
5. Multiple sequence alignment using ClustalW.
6. Homology modeling of proteins.

(Practical 8) MBT. 1.2.P.3 Biomedical instrumentation and Nanobiotechnology (15 h)

1. Synthesis of Nanoparticles by chemical method.
2. Synthesis of Nanoparticles by biological method.
3. Characterization of Nanoparticles.
4. Preparation of Alginate nanobeads for drug delivery.
5. Separation of Protein by Column chromatography.

(Practical 9) MBT. 1.2.P.4 Stem Cell Biology (15 h)

1. Isolation of stem cells from cord blood.
2. Isolation of stem cells from bone marrow.
3. Isolation of stem cells from cord tissue.
4. Isolation of stem cells from Placenta.
5. Stem cell counting and viability checking.
6. Cell proliferation assay.
7. Characterization of Stem cells by immune histochemistry.

(Practical 10) MBT. 1.2.P.5 Industry Visit and Report

Semester III

Paper 9. MBT.2.3.1 Industrial Biotechnology(60 h)

Unit I. Bioreactor and Fermentation (15 h)

Bioreactors Design, Batch and continuous fermenters; chemostat with recycle, multistage chemostat systems, fed-batch operations; immobilized cell systems; fermentation; Isolation of microorganisms of potential industrial interest; strain improvement; media; sterilization, heating and cooling; aeration and agitation; Production of Beer, wine, Acetone, Vinegar, Amino acids, antibiotics, bacteriocins, Cheese, yoghurt and other fermented food. upstream processing: media formulation and optimization; sterilization; aeration, agitation and heat transfer in bioprocess; scaleup and scale down; measurement and control of bioprocess parameters.

Unit II. Downstream processing and Pollution control (15 h)

Separation of insoluble products- filtration, centrifugation, sedimentation, flocculation; Cell disruption; separation of soluble products: liquid-liquid extraction, precipitation, chromatographic techniques, reverse osmosis, ultra and micro filtration, electrophoresis; final purification: drying; crystallization; storage and packaging.

Pollution management methods, industrial effluent treatment, waste water treatment, degradation of xenobiotics in Environment, Bioremediation of xenobiotics and heavy metals, Ozone depletion, greenhouse effect and acid rains and their impact and biotechnological approaches of management. Use of microbes: Mineral beneficiation and oil recovery.

Unit III. Biofertilizers and Biopesticides (15 h)

Biofertilizers; Azospirillum, Azolla, Rhizobium, Frankia, VAM. Biofuels, Petrocrops, Single cell proteins (SCP), aquaculture. Improvement of nutritional value of seed storage proteins. Genetic engineering of plant for virus, pest and herbicide resistance, Biopesticide.

Unit IV. Intellectual property rights (15 h)

Introduction to intellectual property rights; Intellectual property laws; Trade Related Aspects of Intellectual Property Rights. Forms of IPR like patent, design and copyright trademark, IPR Laws. Bioethics: Necessity of bioethics, different paradigms of bioethics national and international, Ethical issues against molecular technologies.

Books for study and references:

1. M.T. Madigan and J.M. Martinko, (2006), *Brock Biology of Microorganisms*, 11th Ed, Pearson Prentice-Hall.
2. J. M. Willey, L. Sherwood, C.J. Woolverton, L.M. Prescott, (2011), *Prescott's Microbiology*, McGraw Hill, New-york.
3. A.L. Demain and J. Davies, (2004), *Manual of Industrial Microbiology and Biotechnology*, 2nd Ed.ASM Press.

4. Introduction to Bio manufacturing, by Mark Witcher. In Encyclopedia of Industrial Biotechnology
5. Shuler, M. L., & Kargi, F. (2002). *Bioprocess Engineering: Basic Concepts*. Upper Saddle River, NJ: Prentice Hall.
6. Stanbury, P. F., & Whitaker, A. (1984). *Principles of Fermentation Technology*. Oxford: Pergamon Press.
7. Blanch, H. W., & Clark, D. S. (1997). *Biochemical Engineering*. New York: M. Dekker.
8. Bailey, J. E., & Ollis, D. F. (1986). *Biochemical Engineering Fundamentals*. New York: McGraw-Hill.
9. El-Mansi, M., & Bryce, C. F. (2007). *Fermentation Microbiology and Biotechnology*. Boca Raton: CRC/Taylor & Francis.
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11. Law and Strategy of biotechnological patents by Sibley. Butterworth publication. (2007) ISBN: 075069440, 9780750694445.
12. Intellectual property rights- Ganguli-Tat McGrawhill. (2001) ISBN-10: 0074638602,
13. Intellectual Property Right- Wattal- Oxford Publication House. (1997) ISBN:0195905024.

Paper 10 MBT.2.3.2 Cell culture and Animal Biotechnology

(60 h)

Unit I. Cell culture laboratory design and equipments (15 h)

Planning, construction and services; Layout; Sterile handling area; Incubation; Hot room; Air circulation; CO₂ incubator; Inverted stage microscope; Liquid nitrogen freezers; Slow cooling system for cell freezing; Fluid handling systems and other equipment; Washing, packing and sterilization of different materials used in animal cell culture; Aseptic concepts; Maintenance of sterility; Cell culture vessels.

Unit II. Cell Culture Media, reagents and aseptic techniques (15 h)

Types of cell culture media; Ingredients of media; Physiochemical properties; CO₂ and bicarbonates; Buffers; Oxygen; Osmolarity; Temperature; Surface tension and foaming; Balance salt solutions; Antibiotics, growth supplements; Foetal bovine serum; Serum free media; Trypsin in solution; Selection of medium and serum; Conditioned media; Other cell culture reagents; Preparation and sterilization of cell culture media, serum and other reagents. Common cell culture contaminants.

Unit III. Different types of cell cultures (15 h)

Different tissue culture techniques; Types of primary culture; Chicken embryo fibroblast culture; Chicken liver and kidney culture; Secondary culture; Trypsinization; Cell separation; Continuous cell lines; Organotypic culture, histotypic culture; Cell counting, cell Proliferation, growth cycle and phases of growth cycle, Plating efficiency; Development of cell lines; Maintenance of cell lines and Cryopreservation; ISO Cleanroom classification.

Unit IV. Applications of Animal Biotechnology(15 h)

Cell cloning and selection; transformation and immortalization of cells; Commercial scale production of animal cells, Scale-up in suspension; Scale and complexity; Mixing and aeration; Rotating chambers; Perfused suspension cultures; Fluidized bed reactors for suspension culture; Scale-up in monolayers; Multisurface propagators; Multiarray disks, spirals and tubes; Roller culture; Microcarriers; Perfused monolayer cultures; Membrane perfusion; Hollow fibre perfusion; Matrix perfusion; Microencapsulation; Application of animal cell culture for *in vitro* testing of drugs; Testing of toxicity of environmental pollutants in cell culture; Application of cell culture technology in production of human viral vaccines.

Books for study and references:

1. Amanda Capes-Davis, R. Ian Freshney (2021), *Culture of Animal Cells*, 8th Edition, Wiley-Blackwell
2. Ed. John R.W. Masters, (2000), *Animal Cell Culture - Practical Approach*, 3rd Edition, Oxford University Press.
3. Michael Aschner, Cristina Suñol, Anna Bal-Price (2011), *Animal Cell Culture Techniques*. Springer.
4. Ashish Verma, Anchal Singh (2020) *Animal Biotechnology*, 2nd Edition, Academic Press
5. N. Arumugam, V. Kumaresan (2019) *Animal Biotechnology*, 4th edition, Saras Publication

(Paper 11) MBT.2.3.3 Elective I (Chose any one of the following)

(A) Medical Microbiology (60 h)

Unit I. Bacterial diseases

(15 h)

Normal microflora (microbiome) of human body and its role – Skin, mouth and respiratory tract, intestinal tract, urogenital tract; Pathogenesis and virulence factors - Koch's postulates, Adherence and invasion, Toxins, Enzymes, Antiphagocytic factors, Antigenic heterogeneity, Iron acquisition; *Bacillus anthracis*, *Clostridium* spp., *Corynebacterium diphtheriae*; *E. coli*, *Vibrio cholerae*, *Helicobacter pylori*, *Salmonella typhi* and *paratyphi*, *Shigella dysenteriae*; *Listeria monocytogenes*, *Mycobacterium* spp., Rickettsial diseases; *Haemophilus influenzae*, *Bordetella pertussis*, Brucellosis, Streptococcal and Staphylococcal infections; Antibacterial chemotherapy (with examples of antibiotics), Drug Resistance.

Unit II. Viral diseases**(15 h)**

Viral Pathogenesis - Routes of entry, Viral spread (local and systemic infection), Viral persistence (chronic and latent infection); Polio, Chicken pox, Mumps, Measles, Rubella; Viral hemorrhagic fever, viral encephalitis, Dengue and Yellow fever; Influenza virus infection (emphasis on Avian and swine flu), Rabies and Prion diseases; Hepatitis and Human Cancer viruses; Emerging viral diseases – Ebola, Marburg, SARS COV 2, Hanta, Chikungunya, Zika, Chandipura; Antiviral chemotherapy and Viral vaccines; Nucleotide and nucleoside analogs, Reverse transcriptase inhibitor, protease inhibitor, fusion inhibitor *etc.*, Interferons, Killed and attenuated vaccines.

Unit III. Fungal and protozoan infections**(15 h)**

Types of Mycoses (with specific example of causative fungi) – Superficial, Cutaneous, Sub-cutaneous; Types of Mycoses (with specific example of causative fungi) – Endemic and Opportunistic; Mycotoxins and Antifungal chemotherapy, Aflatoxins, classes of currently available drugs and new inhibitors in the pipeline; Protozoan diseases - Giardiasis, Amoebiasis; Leishmaniasis, African sleeping sickness; Malaria, Cryptosporidiosis; Infection by Helminths – Nematodes, Trematodes, Cestodes.

Unit IV. Sexually transmitted diseases and Host-pathogen interaction**(15 h)**

Syphilis and Gonorrheal infections; AIDS and Lentiviral infection; Herpes infections; Chlamydial infections (*Chlamydia trachomatis*); Mycoplasma and Ureaplasma infection Toxoplasmosis; Congenital viral infections – Cytomegalovirus, Varicella zoster, HBV, Enterovirus, Parvovirus B19 *etc.* Intracellular and extracellular pathogens, Principles of microbial pathogenesis, host damage, inflammatory responses, adaptation strategies of pathogen- impact of host and pathogen metabolism on immunity and pathogen survival; Chronic pathogens and mechanisms of persistence; Evasion mechanisms of pathogens; Bacterial – host interaction- *Mycobacterium tuberculosis*, *Borrelia burgdorferi*; Viruses – host interaction: HIV, Influenza; Protozoan – host interaction: *Plasmodium* spp., *Leishmania major*.

Books for study and references:

1. KC Carroll, SA Morse, T Mietzner, S Miller. (2016) Jawetz, Melnick and Adelbergs's *Medical Microbiology* 27th edition, McGraw Hill.
2. J Owen, J Punt and Sharon Stranford, (2012), *Kuby Immunology*; 7th edition, W.H. Freeman and Co.
3. IT Kudva, NA. Cornick, PJ Plummer, Q Zhang, TL Nicholson, JP Bannantine and BH Bellaire. *Virulence Mechanisms of Bacterial Pathogens*, (2016). 5th edition, ASM Press.
4. V Kumar, AK. Abbas and JC Aster, (2015), *Robbins & Cotran Pathologic Basis of Disease*. 9th Edition, Elsevier.
5. K Murphy and K Weaver, (2016), *Janeway's Immunobiology*, 9th Edition, Garland Science.
6. AK Abbas, (2015), *Cellular and Molecular Immunology*. 8th Edition, Elsevier.
7. Ananthanarayan and Paniker, *Textbook of Microbiology*, 8th Edition.

8. Baveja CP, (2001) *Textbook of Microbiology*. 5th Ed., Mc graw Hill Education.
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Paper 11 (B) Nanobiotechnology

(60 h)

Unit I. Introduction to nanobiotechnology

(15 h)

Introduction to Nanobiotechnology; Concepts, historical perspective; Different formats of nanomaterials and applications with example for specific cases; Cellular Nanostructures; Nanopores; Biomolecular motors; Bio-inspired Nanostructures, Synthesis and characterization of different nanomaterials.

Unit II. Nano Particles and Nano Films

(15 h)

Nanoparticles for drug delivery, concepts, optimization of nanoparticles properties for suitability of administration through various routes of delivery, advantages, strategies for cellular internalization and long circulation, strategies for enhanced permeation through various anatomical barriers. Thin films; Colloidal nanostructures; Self Assembly, Nanovesicles; Nanospheres; Nanocapsules and their characterisation.

Unit III. Applications of Nano Particles

(15 h)

Nanoparticles for diagnostics and imaging (theranostics); concepts of smart stimuli responsive nanoparticles, implications in cancer therapy, nanodevices for biosensor development. Nanomaterials for catalysis, development and characterization of nanobiocatalysts, application of nanoscaffolds in sythesis, applications of nanobiocatalysis in the production of drugs and drug intermediates.

Unit IV. Nanotoxicity

(15 h)

Introduction to Safety of nanomaterials, Basics of nanotoxicity, Models and assays for Nanotoxicity assessment; Fate of nanomaterials in different stratas of environment; Ecotoxicity models and assays; Life cycle assessment, containment.

Books for study and references:

1. GeroDecher, Joseph B. Schlenoff, (2003); *Multilayer Thin Films: Sequential Assembly of Nanocomposite Materials*, Wiley-VCH Verlag GmbH & Co. KGaA
2. David S. Goodsell, (2004); *Bionanotechnology: Lessons from Nature*, Wiley-Liss
3. Neelina H. Malsch, *Biomedical Nanotechnology*, CRC Press
4. Greg T. Hermanson, (2013); *Bioconjugate Techniques*, (3rd Edition); Elsevier
5. Recent review papers in the area of Nanomedicine.
6. Meeting Educational Needs with "Course" Remodelled Biotech Curricula
7. May, 2017 Copyright © Deptt. of Biotechnology Ministry of Science & Technology Government of India Compiled and Coordinated Ms. Shreya Malik, DM, BCIL Edited Dr. Suman Govil, Adviser, DBT Dr. Purnima Sharma, MD, BCIL

(Paper 12) MBT.2.3.4 Elective II(Choose Any one of the following)**Paper 12 (A) Molecular Diagnostics and Therapeutics(60 h)****Unit I. Genome: resolution, detection & analysis****(15 h)**

DNA polymorphism; Nucleic acid sequencing, Microarray chips; EST; SAGE; microarray data normalization & analysis; molecular markers: 16S rRNA typing; Diagnostic proteomics.

Unit II. Detection of diseases (15 h)

Detection of inherited diseases: Exemplified by two inherited diseases for which molecular diagnosis has provided a dramatic improvement of quality of medical care: Fragile X Syndrome: Paradigm of the new mutational mechanism of the unstable triplet repeats, von-Hippel Lindau disease: recent acquisition in growing number of familial cancer syndromes, SARS CoV 2 detection.

Unit III. Molecular oncology (15 h)

Detection of recognized genetic aberrations in clinical samples from cancer patients; types of cancer-causing alterations revealed by next-generation sequencing of clinical isolates; predictive biomarkers for chronic myeloid leukemia, colon, breast, lung cancer and melanoma.

Unit IV. Molecular Therapeutics (15 h)

Gene therapy; Vector mediated gene transfer; Liposome and nanoparticles mediated gene delivery. Advantages and disadvantages of gene therapy. Ethical issues in gene therapy. Clinical applications of recombinant technology; Types of recombinant vaccines and clinical applications; Gene silencing technology; SiRNA, Micro RNA, Crispr CAS 9.

Paper 12 (B) Environmental Sciences and Biodiversity (60 h)

Unit I. Environmental Pollution (15h)

types of pollution methods for management of the pollution, Environmental management, waste water treatment, Solid waste management, degradation of xenobiotics in Environment, Bioremediation of xenobiotics and heavy metals, Ozone depletion, greenhouse effect and acid rains and their impact and biotechnological approaches of management. Use of microbes: Mineral beneficiation and oil recovery.

Unit II. Ecosystem (15h)

Definition, Principles and scope of ecology, Human ecology and Human settlement, Evolution, Origin of life and speciation. Ecosystem : Structure and functions, Abiotic and Biotic components, energy flows, Food Chains, Food web, Ecological pyramids. Ecological Succession, Population, Community ecology and Parasitism, Prey-predator relationships. Common flora and fauna in India Aquatic : Phytoplankton, Zooplankton and Macrophytes.

Unit III. Biodiversity (15h)

Terrestrial : Forests Endangered and Threatened Species Biodiversity and its conservation : Definition, 'Hotspots' of Biodiversity, Strategies for Biodiversity conservation. National Parks and Sanctuaries. Gene pool. Microflora of Atmosphere : Air Sampling techniques, Identification of aeroallergens. Air-borne diseases and allergies. Environmental Biotechnology: Fermentation Technology, Vermiculture technology, Biofertilizer technology.

Unit IV. Biodiversity Conservation (15h)

Biodiversity conservation Act 2002, Wildlife parks, wildlife reserves, privately owned wildlife reserves & Biosphere reserves , Single species / single habitat based conservation programmes (e.g. Project tiger, Valley of flowers), International conventions on conservation, Important International conventions & treaties on nature & conservation India's role & contribution (including VISION 2040) Ex- situ & in-situ conservation, Conservation Breeding (e.g. Vulture, Pygmy hog, Gharial etc.)

Books for study and references:

1. The primary readings will be from Fundamentals of Conservation Biology. Hunter M.L. and Gibbs J.P. Third Edition.
2. A Text Book of Environmental Science Vidya Thakur (2016) – 307.
3. Biodiversity: Law, Policy and Governance Usha Tandon, ,Mohan Parasaran Sidharth 2017 · Luthra

(Practical 11) MBT.2.3.P.1 Industrial Biotechnology

1. Determination of Quality of milk by MBRT.
2. Bacteriological analysis of food sample.
3. Immobilization of yeast cells by sodium alginate beads.
4. Isolation of Rhizobium bacteria from root nodules.
5. Isolation of amylase producing bacteria from soil.

(Practical 12) MBT.2.3.P.2 Cell culture and Animal Biotechnology

1. Quantification of cells by trypan blue exclusion dye.
2. Isolation of lymphocytes and cultivation of lymphocytes
3. Cryopreservation of primary cell cultures and cell lines
4. Cultivation of cell lines
5. Study of toxicity of carcinogens on cell lines

(Practical 13) MBT.2.3.P.3 Elective I (Chose any one of the following)

(A) Medical Microbiology

1. Determination of MIC of antibiotics.
2. Determination of MIC of antifungal drugs.
3. Antibiotic sensitivity test by using disc diffusion test.
4. Bacterial analysis of urine sample.
5. Kill curve assay of antifungal drugs.

(B) Nanobiotechnology

1. Synthesis of Iron oxide nanoparticles by wet chemical method.
2. Synthesis of Gold Nanoparticles by biogenic methods.
3. Synthesis of Silver Nanoparticles by biogenic methods.
4. Isolation of enzymes involved in biosynthesis of nanomaterials.
5. To identify and analyse the given nanomaterial by FTIR spectroscopy.

(Practical 14) MBT.2.3.P.4 Elective II (Chose any one of the following)

(A) Molecular Diagnostics & Therapeutics

1. Karyo typing of human genetic diseases.
2. Pedigree analysis of human genetic diseases.
3. Random Amplified Polymorphic DNA analysis.
4. Restriction Fragment Length Polymorphism analysis of DNA.
5. Analysis of DNA by Southern Blot technique.

(B) Environmental Sciences and Biodiversity

1. Determination of total organic matter in soil.
2. Determination of pH value of different types of soil.
3. Determination of water holding capacity of soil.
4. Prepare a map of India, showing bio-geographical zones and expanse of territorial waters.
5. Identification and description of plant species.
6. To plot biosphere reserve on a map of India.
7. Prepare a document of endemic and exotic species of plants and animals for a selected PAN.

(Practical 15) MBT.2.3.P.5 Research Project Synopsis

Semester IV

Theory Papers	University Exam Marks	Internal marks	Total marks	Credits
(Practical 16) MBT.2.4.P.1 Research Project				
Oral / Poster Presentation in conference/ workshop/ any other relevant program	-	100	100	4
Dissertation	200	-	200	8
Viva	200	-	200	8
Industry Visit and Report	100	-	100	4
Total	500	100	600	24

Standard of Passing

1. All external examinations will be held at the end of year and will be conducted by the University as per the existing norms.
2. Internal assessment- IA (20%) and University examination (80%) - shall have separate heads of passing (i.e. 8 Marks out of 20 for passing internal assessment and 32 Marks out of 80 for passing in University examination).
3. To pass, a student has to obtain minimum grade point E, and above separately in the IA and external examinations.
4. The candidate shall prepare and submit for the practical examination a certified journal based on the practical course carried out under the guidance of a faculty member with minimum number of experiments as specified in the syllabus for each group.
5. The candidate shall prepare the dissertation based on the Research Project for the fulfillment of degree.
6. As per ordinances and regulations prescribed by the University grading system.
7. The candidate shall have attendance record of not less than 75 % in theory class and not less than 80 % in practical work.
8. Standard point scale for grading:

Marks Grade Points and Class:

Grade	Marks	Class
O	70 and above	First class with Distinction
A	60 -69.99	First class
B	55-59.99	Second class
C	50 -54.99	Pass class
D	45-49.99	Pass class
E	40-44.99	Pass class
F	Fail 39.99 and below	Fail

Cumulative Grade Point Average (GPA) calculation:

The Final remark will be decided on the basis of Cumulative Grade Point Average (CGPA) which is weighted average of the grade point obtained in all the exams including repeat exams.

$\sum_{i=1} C_i p_i$	C_i = The number of credits earned in the i^{th} course of a semester.
SGPA = $\frac{\sum_{i=1} C_i p_i}{\sum_{i=1} C_i}$	p_i = Grade point earned in the i^{th} course
	$i = 1, 2, \dots, n$ represents number of courses for which the student is registered.

M. Sc. Sem.-..... - Examination, 202__
(Stem Cells & Regenerative Medicine)

Paper No-_____ Paper Name:_____

Total Duration: Section A+B = 3 Hours

Total Marks (A+B): 80

Time: - 30 Minutes

Date:-

SECTION – A
(MCQ)

Instructions:

1. *Darken the appropriate circle against the question number once only.*
2. *Use Blue/Black ball point pen only.*
3. *Each questions carries one mark.*
4. *A student will not be allotted any marks if he/she overwrites, strikes out or puts*
5. *White ink on the circle once marked.*
6. *Do not write anything on the **blank portion of question paper.** If written anything, such type of act will be considered as an attempt to resort to unfair means.*

Q.1) Multiple Choice Questions

16×1=16

- | | | |
|----|----|----|
| 1. | a. | b. |
| | c. | d. |
| 2. | a. | b. |
| | c. | d. |
| 3. | a. | b. |
| | c. | d. |
| 4. | a. | b. |
| | c. | d. |
| 5. | a. | b. |
| | c. | d. |
| 8. | a. | b. |
| | c. | d. |

9.
a. b.
c. d.
10.
a. b.
c. d.
11.
a. b.
c. d.
12.
a. b.
c. d.
13.
a. b.
c. d.
14.
a. b.
c. d.
15.
a. b.
c. d.
16.
a. b.
c. d.

SET-____

M. Sc. Sem..... - Examination, 202 _
(Stem Cells & Regenerative Medicine)

Paper No-_____ Paper Name:_____

Total Duration: Section A+B = 3 Hours

SECTION – B

Time: - 2 ½ hours

Date:-

Total Marks: 64

Instructions:

1. Q. No. 2 is compulsory.
2. Attempt any three Questions from Q3 to Q7
3. The number to the right indicates full marks.
4. Draw diagrams wherever necessary.
5. Do not write anything on the **blank portion of question paper**. If written anything, such type of act will be considered as an attempt to resort to unfair means.

Q 2	Write a short note on (any 4)	16
	a)	(4x4)
	b)	
	c)	
	d)	
	e)	
Q 3	a) Long	12
	Short	04
Q 4	a) Long	12
	b) Short	04
Q 5	a) Long	12
	b) Short	04
Q 6	a) Long	12
	b) Short	04
Q 7	a) Long	12
	b) Short	04

M. Sc. Sem.-..... - Examination, 2022
(Stem Cells & Regenerative Medicine / Medical Biotechnology)

Paper No-_____ Paper Name: Biostatistics and Bioinformatics

Total Duration: Section A+B = 3 Hours

Total Marks (A+B): 80

Time: - 30 Minutes

Date:-

SECTION – A
(MCQ)

Instructions:

1. *Darken the appropriate circle against the question number once only.*
2. *Use Blue/Black ball point pen only.*
3. *Each questions carries one mark.*
4. *A student will not be allotted any marks if he/she overwrites, strikes out or*
5. *puts white ink on the circle once marked.*
6. *Do not write anything on the **blank portion of question paper.** If written anything, such type of act will be considered as an attempt to resort to unfair means.*

Q.1) Multiple Choice Questions

16x1=16

Biostatistics

- | | | |
|----|----|----|
| 1. | a. | b. |
| | c. | d. |
| 2. | a. | b. |
| | c. | d. |
| 3. | a. | b. |
| | c. | d. |
| 4. | a. | b. |
| | c. | d. |
| 5. | a. | b. |
| | c. | d. |
| 8. | a. | b. |
| | c. | d. |

Bioinformatics

- | | | |
|-----|----|----|
| 9. | a. | b. |
| | c. | d. |
| 10. | a. | b. |
| | c. | d. |
| 11. | a. | b. |
| | c. | d. |
| 12. | a. | b. |
| | c. | d. |
| 13. | a. | b. |
| | c. | d. |
| 14. | a. | b. |
| | c. | d. |
| 15. | a. | b. |
| | c. | d. |
| 16. | a. | b. |
| | c. | d. |

M. Sc. Sem..... - Examination, 202 _
(Stem Cells & Regenerative Medicine/ Medical Biotechnology)

Paper No-_____ Paper Name: Biostatistics and Bioinformatics
Total Duration: Section A+B = 3 Hours

SECTION – B

Time: - 2 ½ hours Date:-

Total Marks: 64

Instructions:

- 1. Q. No. 2 is compulsory.**
2. Attempt any three Questions from Q3 to Q7
3. The number to the right indicates full marks.
4. Draw diagrams wherever necessary.
5. Do not write anything on the **blank portion of question paper**. If written anything, such type of act will be considered as an attempt to resort to unfair means.

Q 2	2.1 Write a short note on (From Bioinformatics) (Any 2)	16
	a)	(4x4)
	b)	
	c)	
	2.2 Write a short note on (From Biostatistics) (Any 2)	
	a)	
	b)	
	c)	
Q 3	b) Long answer question from bioinformatics	08
	c) Long answer question from Biostatistics	08
Q 4	d) Long answer question from bioinformatics	08
	c) Long answer question from Biostatistics	08
Q 5	e) Long answer question from bioinformatics	08
	c) Long answer question from Biostatistics	08
Q 6	f) Long answer question from bioinformatics	08
	c) Long answer question from Biostatistics	08
Q 7	g) Long answer question from bioinformatics	08
	c) Long answer question from Biostatistics	08



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