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

Centre for Interdisciplinary Research
Department of Stem Cell & Regenerative Medicine and Medical Biotechnology.

Stem Cell & Regenerative Medicine

(*Choice based Credit System*)

BL-SC-01: Introduction

Department of Stem cell and Regenerative Medicine offer a specialized course on M. Sc. in Stem cell and Regenerative Medicine since 2011 for the aspiring candidates who are interested in the field of stem cell and regenerative medicine. The course covers basic and applied science covering various aspects of cell, molecular and developmental biology with special emphasis on stem cell biology from its origins to its current and potential application in pre-clinical and clinical fields related to various disorders.

BL-SC-02: Vision, Mission and Goal

Vision

To cultivate a broad range of interdisciplinary stem cell research (i.e., basic and translational stem cell biology research) To train future leaders for education, research and delivery of novel therapies using stem cells. To serve as a best teaching and educational centre for stem cell biology and regenerative medicine. Develop experimental models for use of stem cells to alter physiological and developmental characteristics of tissues and organ systems involved in disease processes. To seek a leadership role in basic and translational stem cell research through developing innovative, multidisciplinary collaborative approaches. Outcome Extensive theoretical and practical knowledge on Stem cells and Regenerative medicine in a short period of time Wide Job opportunities in industries, companies, Universities and other laboratories Increases the opportunities to pursue higher studies in foreign countries. The course prepares students for leadership in the critically important and dynamic industries of stem cells, biotechnology and pharmaceuticals.

Mission

The mission of the course is to impart in-depth knowledge on different types of stem cells and its in-vitro and in-vivo applications, scope and hope of stem cells and so on effectively. To advance the fundamental knowledge of stem cells and their differentiation pathways, understand how stem cells interact with tissues and organ systems of the body, and develop stem cell-based research and therapies to treat human diseases and injuries. To develop an Interdisciplinary course works with a strong base for success in life.

Goal

They can go as lecturers/Asst. professors in colleges of biotechnology, pharmacology, microbiology, and other biomedical sciences. They could get a vast idea about the research and development in this field, planning for their future research. They could get jobs in research centers and hospitals where stem cell clinical trials are on.

SEMESTER-I

Theory Papers	University Exam marks	Internal marks	Total marks	Credits
(Paper 1) SCRM.1.1.1 Biochemistry	80	20	100	4
(Paper 2) SCRM.1.1.2 Cell Biology and Developmental Biology	80	20	100	4
(Paper 3) SCRM.1.1.3 Genetics and Molecular Biology	80	20	100	4
(Paper 4) SCRM.1.1.4 Immunology and Virology	80	20	100	4
Practical				
(Practical 1) SCRM.P.1 Laboratory Course 1	200	-	200	8
Total	**520**	**80**	**600**	**24**

SEMESTER-II

Theory Papers	University Exam marks	Internal marks	Total marks	Credits
(Paper 5) SCRM.1.2.1 Metabolism and Clinical Biochemistry	80	20	100	4
(Paper 6) SCRM.1.2.2 Biostatistics and Bioinformatics	80	20	100	4
(Paper 7) SCRM.1.2.3 Biomedical Instrumentation and Nanobiotechnology	80	20	100	4
(Paper 8) SCRM.1.2.4 Stem Cell Biology	80	20	100	4
Practical				
(Practical 2) SCRM.P.2 Laboratory Course 2	200	-	200	8
Total	**520**	**80**	**600**	**24**

SEMESTER-III

Theory Papers	University Exam marks	Internal marks	Total marks	Credits

(Paper 9) SCRM 2.3.1 Regenerative Medicine and its Applications in Diseases	80	20	100	4
(Paper 10) SCRM 2.3.2 Biomaterials, Tissue Engineering and 3D BioPrinting	80	20	100	4
(Paper 11) SCRM 2.3.3 (A) Clinical research, Bioethics and Regulatory affairs **OR** (Paper 11) SCRM 2.3.3 (B) Nanobiotechnology	80	20	100	4
(Paper 12) SCRM 2.3.4 (A) Cell and Tissue banking and Cryopreservation **OR** (Paper 12) SCRM 2.3.4 (B) Environmental Impact and Risk Analysis	80	20	100	4
Practical				
(Practical 3) SCRM.P.3. Laboratory Course 3	200	-	200	8
Total	**520**	**80**	**600**	**24**

SEMESTER-IV

Theory Papers	University Exam marks	Internal marks	Total marks	Credits
(Paper 13) SCRM.2.4.1. (A) Research Methodology **OR** (Paper 13) SCRM.2.4.1. (B) Entrepreneurship and management	20	80	100	4
(Practical 4) SCRM.P.4. Research Project	300	100	400	16
(Practical 5) SCRM.P.5. Internship and Report	100	-	100	4
Total	**420**	**180**	**600**	**24**

Program Outcome 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. SCRM programme, the student will be able to:

PO1: Get knowledge and skill of Stem Cell and Regenerative Medicine in Industry, Medical or hospital related organizations, Regulatory Agencies and Academia.

PO2: Develop Planning and Problem-solving abilities in Stem cell handling and preservation, molecular biology, disease diagnosis, handling and maintenance biological instrumentation, analytical methods, interpretation of experimental data.

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

PO4: Do research in Stem cryopreservation, transplantation, diagnosis and drug development for carrier as well as placement.

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

PO6: Develop leadership skills, logical reasoning, time management and values required for self-directed, lifelong learning, soft skills for professional development and execute their professional roles in society as stem cell professionals, employers and employees in various industries, 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: Contribute in sustainable development to achieve the national sustainable development goal 3.

PO9: Become lifelong learner in Medical 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 immunotherapies.

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: Know about cause of metabolic diseases.

CO3: Learn biochemical methods for diagnosis of metabolic diseases.

CO4: Knowledge of metabolic disorders and organ system function test.

CO5: Get the knowledge metabolic disorders involved in metabolism.

CO6: 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: 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: Understand principle and Instrumentation involved in PCR and Flow cytometry techniques.

CO4: 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. Regenerative Medicine and its Applications in Diseases

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

CO1: Understand the concepts of regenerative medicine, stem cell therapy in degenerative neuronal disease and spinal cord regeneration.

CO2: Explain the role of stem cells in acute myocardial infarction and dilated cardiomyopathy.

CO3: Understand the role of stem cells in diabetes and muscular dystrophies.

CO4: Understand the role of stem cells in treatment of hereditary hemolytic anaemia.

CO5: Understand the CART cell therapy, NK & dendritic cell therapy for solid tumours.

CO6: Explain Role of Hematopoietic stem cell transplantation for malignancies, lymphoma, leukaemia and myeloma.

	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	2	2	1	2
CO3	3	2	3	3	1	1	1	1	2
CO4	3	2	3	2	3	1	2	3	1
CO5	3	2	3	3	2	2	1	2	2
CO6	3	2	3	3	3	2	1	1	2

Paper 10. Biomaterials, Tissue engineering and 3D bioprinting.

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

CO1: Understand the Properties of Materials, Classes of materials used in Tissue engineering.

CO2: Concepts of biomaterials used in medicine and their reactions with biological systems.

CO3: Demonstrate the Tissue engineering of organs like bone, cartilage, liver, cornea.

CO4: Explain Tissue engineering of organs and their clinical application.

CO5: Understand the advances of 3D Printing Technology and its clinical applications.

CO6: Explain the concepts of Bio ink for 3D printing of Bone, cartilage, skin, arteries and heart.

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

Paper 11 (A) Clinical Research, Bioethics and Regulatory Affairs

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

CO1: Understand and Explain Clinical Research, Terminologies and definition in Clinical Research.

CO2: Know origin and History of Clinical Research, Difference between Clinical Research and Clinical Practice.

CO3: Understand and explain the Biosafety in laboratory institution: laboratory associated infection and other hazards, assessment of biological hazards and level of biosafety.

CO4: Understand and explain the rules and regulations involved in Clinical research.

CO5: Understand and explain concepts of Bioethics.

CO6: Understand and explain Intellectual property rights.

	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	2
CO5	3	2	3	3	2	3	1	2	3
CO6	3	2	3	3	3	2	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 strata's 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	3

Paper 12 (A) Cell and Tissue Banking and Cryopreservation

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

CO1: Understand the concepts of Cell and Tissue banking.

CO2: Know instrumentation for setting up of cell and organ tissue bank.

CO3: Understand the applications of cord blood banking.

CO4: Know advantages and disadvantages of transplantation.

CO5: Understand apply the knowledge of cryopreservation and cryoprotectants for cryopreservation.

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

Paper 12 (B) Environmental Impact and Risk Assessment

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

CO1: Understand the scope and methodologies of EIA

CO2: Acquire knowledge of Environmental Management Plan

CO3: Know the Strategy Environmental Assessment

CO4: Understand the Environmental appraisal, Environmental Management

CO5: Know the EIA regulations in India, Status of EIA in India, Current issue in India.

CO6: Understand the risk communication, environmental monitoring, community involvement, Legal and regulatory framework

	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	3

Paper 13 (A) Research Methodology

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

CO1: Understand basic concept of Research, Types of Research methodology.

CO2: Know about selection of research problem and Hypothesis.

CO3: Write research project and thesis

CO4: Use application of computer for research

CO5: Use Power point presentation, Excel, Word to compilation and analysis of data

CO6: Use of search engine for searching of literature.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	2	3	1	3	2	3	2	2
CO2	3	2	2	3	3	2	2	1	1
CO3	3	2	2	3	3	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 13 (B) Entrepreneurship and Management

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

CO1: Understand the nature of management, Roles of Management and Levels of Management

CO2: Understand the Nature and purpose of planning and Organization

CO3: Know the Nature and importance of staffing–Process of Recruitment and Selection

CO4: Understand the Meaning and nature of directing

CO5: Understand the Structure of a Biotechnology Company

CO6: Know the function of entrepreneur in successful, commercial application of innovations.

	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	3	3	3	2	3	1	2	2
CO6	2	2	3	3	3	2	1	1	1

Semester I

(Paper 1) SCRM 1.1.1 Biochemistry (60 h)

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

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)

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 (2015), Biochemistry, 8th edition, WH Freeman publications.
2. Voet, D., Voet, J. G., & Pratt, C. W. (2016). Fundamentals of biochemistry: life at the molecular level, 5th Edition, John Wiley & Sons.
3. David L. Nelson, Albert L. Lehninger, Michael M. Cox, (2008), Lehninger Principles of Biochemistry, 5th Edition), W. H. Freeman.
4. Jeremy M. Berg, Lubert Stryer, John L. Tymoczko, Gregory J. Gatto, Stryer, L. (2002). *Biochemistry*, 8th Edition, W. H. Freeman & Co Ltd.
5. S. P. Vyas, V. Dixit, (2018), Pharmaceutical Biotechnology, 1st Edition, CBS Publishers and distributors.

(Paper 2) SCRM.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). Molecular Biology of the Cell, 7th Edition, New York: Garland Science.
3. Gilbert SF., Barresi MJF. (2020) Developmental Biology; 12thEdition; Sinauer Associates Inc.
4. Wolper L., Tickle C; (2019); Principles of Development, 6thEdition, Oxford University Press, UK.

(Paper 3) SCRM 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 T_2 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, Duchene muscular dystrophy, Thalassemia, sickle cell anaemia, SCID, Downs syndrome.

Books for study and references:

1. Robert J Brooker, (2014), Genetics: Analysis and Principles, 5th Edition. Mc Graw Hill Publications
2. Jocelyn E. Krebs, Elliot S. Goldstein and Stephen T. Kilpatrick. Lewin S, (2014) Genes XI. Jones & Bartlett student edition.
3. Mark Walker, Ralph Rapley (2009), Route Maps in Gene Technology. Blackwell Science. Wiley.
4. Robert F. Weaver (2008) Molecular Biology, 5th edition, McGRAW Hill International Edition.
5. Brown TA, (2020), Gene Cloning and DNA Analysis , 8th Edition, Wiley.

(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, Cell mediated cytotoxic responses; ADCC, Regulation of immune responses; Immunological tolerance. T-cell immunodeficiencies.

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; viruses: MARS, SARS, Nipah, Dengue, Zika, 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., (1999), Immunobiology, 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. Murphy, F. A. (2009). The Foundations of Medical and Veterinary Virology: Discoverers and discoveries, inventors and inventions, developers and technologies. American Society for Microbiology, 208-08.
7. Mahy BWJ & Kangaro HO. (1996). Virology Methods Manual. Academic Press.

(Practical 1) SCRM.P.1. Laboratory Course 1 (60 h)

P.1.1. Biochemistry (Any 5)

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

P.1.2. Cell Biology & Developmental Biology (Any 5)

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.
6. Preparation of temporary slides of mitosis from onion root tips and study of mitotic index
7. Histotechnique for the preparation of paraffin spreaded slides of tissues
8. Staining of tissues of by hematoxylene- eosine (H&E) staining.

P.1.3. Genetics and Molecular Biology (Any 5)

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.

P.1.4. Immunology and Virology

1. Double Diffusion immunoprecipitation 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

P.1.5 Industry visit and report

Semester II

(Paper 5) SCRM.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, Hyper cholesterolemia. 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 Edition, Lippincott Williams and Wilkins.
2. Jeremy M. Berg, Lubert Stryer, John L. Tymoczko, Gregory J. Gatto, Stryer, L. (2002). *Biochemistry*, 8th Edition, W. H. Freeman & Co Ltd.
3. D.M. Vasudevan and Sreekumari, S, (2010). Textbook of Biochemistry for Medical Students, 6th Edition, Jaypee Brothers Medical Publishers, New Delhi.
4. Sucheta Dandekar (2010). Concise Medical Biochemistry, 3rd edition, Elsevier Health.
5. Satyanarayana and Chakrapani, (2013), Biochemistry, 4th Edition, Elsevier.

(Paper 6) SCRM.1.2.2. Biostatistics and Bioinformatics (60 h)

Unit I. Basics of Biostatistics (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 (15 h)

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 (15 h)

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. (2013), Cross- Biostatistics: A foundation for analysis in the health science, 10th edition, John Wiley & sons
2. Richard J. Sundar, P. S. Rao (2006), Introduction to Biostatistics and Research Methods, 4th edition, Prentice-Hall of India Pvt. Ltd. publication
3. Armitage P and Berry G, (2008), Statistical methods in medical Research, 4th edition Oxford Blackwell scientific publication

4. Lesk, A. M. (2014). *Introduction to Bioinformatics*. 4th Edition, Oxford: Oxford University Press.
5. Mount, D. W. (2004). Bioinformatics: Sequence and Genome Analysis. 2nd Edition, 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*. 2nd Edition, New York: Wiley-Interscience.
7. Pevsner, J. (2015). *Bioinformatics and Functional Genomics*, 3rd Edition, Wiley-Blackwell.
8. Bourne, P. E., & Gu, J. (2009). *Structural Bioinformatics*, 2nd Edition, Wiley-Liss.

(Paper 7) SCRM.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, phospholipidmembranes, viruses, Nucleic acids, Oligosaccharides, polysaccharides, biological polymers, Proteins. Biological nanomotors, protein assemblies: Kinesin and dynein, cilia. Bacterial flagella: structure andfunction; 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 bio barcode, Nanobiosensors. Therapeutics: Nanobiotechnology in imaging, Wound care 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. Tuszynski, J. A., & Kurzynski, M. (2003). Introduction to molecular biophysics. CRC press.
5. R.A. Day, A.L. (1999) Underwood, Quantitative Analysis, 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, (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.

(Paper 8) SCRM.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. Hematopoeitic 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. Haider, K. H., (2021). Stem Cells: Latest Advances. Springer Nature.

2. Al-Anazi, K. A., (2020). Update on mesenchymal and induced pluripotent stem cells. BoD–Books on Demand. Intech Open.
3. Jonathan M. W. Slack, (2017) The Science of Stem Cells, John Wiley & Sons, Inc.
4. Lanza, R., Verfaillie, C., Weissman, I., West, M. D., Blau, H., Gearhart, J., ... & Thomson, J. A. (Eds.). (2004). Handbook of stem cells, two-volume set: volume 1-Embryonic stem cells; volume 2-Adult & fetal stem cells, 3rd Edition, Elsevier, Academic Press.
5. Stewart Sell, (2013) Stem Cells Handbook, 2nd Edition, Humana Press.

(Practical 2) SCRM.P.2. Laboratory Course 2 (60 h)

P.2.1. Clinical Biochemistry and Disease Metabolism

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.

P.2.2. Biostatistics and Bioinformatics (Any 5)

1. Use of Statistical methods for data analysis.
2. PCR Primer designing by suing 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.

P.2.3. Biomedical instrumentation and Nanotechnology

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.

P.2.4. Stem Cell Biology (Any 5)

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.

P.2.5. Industry visit and report

Semester III

(Paper 9) SCRM.2.3.2 Regenerative Medicine and its applications in Diseases (60 h)

Unit I. Source of stem cells for neuronal repair (15 h)

Application of stem cell Therapy (SCT) for degenerative neuronal diseases (Parkinson disease, Motor neuron disease) and demyelinating diseases (Multiple sclerosis). Stem Cell Therapy in stroke, Stem Cell Therapy in spinal cord regeneration.

Unit II. Stem cell for Myocardial regeneration and Diabetes (15 h)

Pathology of acute myocardial infarction and chronic ischemic heart disease, Role of stem cells in acute myocardial infarction and dilated cardiomyopathy, Types of diabetes and stem cell applications.

Unit III. Stem cell in Genetic diseases and Immunological diseases (15 h)

Genetic basis of hereditary hemolytic anemias: Thalassemia, sickle cell anemia, and hereditary spherocytosis. Role of stem cells in treatment of hereditary hemolytic anemias. Severe combined immunodeficiency disease (SCID), Wiskott-Aldrich syndrome, Stem Cell Therapy for muscular dystrophies.

Unit IV. Stem cell and Tumors/Malignancy (15 h)

CART cell therapy, NK & dendritic cell therapy for solid tumors, Hematopoietic stem cell transplantation for malignancies, lymphoma, leukemia and myeloma

Applications of Artificial Intelligence (AI) in Regenerative Medicine: AI in stem cell therapy, stem cell transplantation, and treatments of diseases and diagnosis.

Books for study and references:

1. Deb, K., & Totey, S. (2009). Stem Cell: Basics and Applications. Tata McGraw-Hill Education.
2. Lanza, R., Verfaillie, C., Weissman, I., West, M. D., Blau, H., Gearhart, J., ... & Thomson, J. A. (Eds.). (2004). Handbook of stem cells, two-volume set: volume 1-Embryonic stem cells; volume 2-Adult & fetal stem cells, 3rd Edition, Elsevier, Academic Press
3. Stewart Sell, (2013) Stem Cells Handbook, 2nd Edition, Humana Press
4. Mao, J. J. (2007). Translational approaches in tissue engineering and regenerative medicine. Artech House.
5. Chiu, A. Y., & Rao, M. S. (2003). Human embryonic stem cells. Humana Press.
6. Somasundaram, I. (2014). Stem cell therapy for organ failure (No. 14756). Springer India.

Paper 10. SCRM.2.3.3. Biomaterials, Tissue engineering and 3 D bioprinting (60 h)

Unit I. Properties of Materials, Classes of materials used in medicine **(15 h)**

Metals, Polymers, Hydrogels, Bioresorbable and Biodegradable Materials, Ceramics, Natural materials, Composites, Thin films, grafts, Coatings, Medical fibers and Biological functional materials

Unit II. Host reactions to biomaterial and testing of biomaterials **(15 h)**

Inflammation, Wound healing and the Foreign bodyresponse. Systemic toxicity and Hypersensitivity, Blood coagulation and Blood-materials interactions,Tumorigenesis, Testing biomaterials: In Vitro and In Vivo assessment of tissue compatibility. Testing of blood-material interactions,

Unit III. Tissue Engineering And Its Clinical Application **(15 h)**

Reconstruction of the skeleton, bone, cartilage, teeth, Reconstruction of skeletal and cardiac muscle, urinary bladder, liver, cornea. Tissue engineering transplants: Trachea, Bladder, arteries.

Unit IV. 3D Printing technology **(15 h)**

3D printing design, its types and advantages, use of CT/MRI images for 3D printing, 3D printing and its clinical applications, Bio ink for 3D printing of Bone, cartilage, skin, arteries and heart

Books for study and references:

1. Ratner, B. D., Hoffman, A. S., Schoen, F. J., & Lemons, J. E. (2012). Biomaterials science: an introduction to materials in medicine. Elsevier. 3rd edition , Elsevier
2. Mao, J. J. (2007). Translational approaches in tissue engineering and regenerative medicine. Artech House.
3. Zhang, L. G., Leong, K., & Fisher, J. P. (2022). 3D bioprinting and nanotechnology in tissue engineering and regenerative medicine, academic press.
4. Chawla, K. (2018). Biomaterials for Tissue Engineering. Springer New York.
5. Larry H. Bernstein, Irina Robu, et al. (2017) Medical 3D BioPrinting – The Revolution in Medicine Technologies for Patient-centered Medicine: From R&D in Biologics to New Medical Devices (Series E: Patient-Centered Medicine Book 4) Leaders in Pharmaceutical Business Intelligence.

(Paper 11) SCRM .2.3.3 (A) Clinical Research, Bioethics and Regulatory affairs **(60 h)**

Unit I. Clinical Research **(15 h)**

Introduction to Clinical Research, Historical Perspectives: Nuremberg Code Study, The Belmont Report, Origin and Principles of International Conference on Harmonization, Types of Clinical Research, Good Clinical Practice (ICH-GCP) guidelines, Drug development process, Clinical drug development phases, Safety Monitoring in Clinical Trials, Analysis and reporting in clinical trials , Clinical Research regulations in India, Career in Clinical Research.

Unit II. Bioethics **(15 h)**

Introduction to bioethics, Social and ethical issues in biotechnology. Principles of bioethics. Ethical issues clinical research, Ethics committees, constitution and practices, Declaration of Helsinki and Informed consent process, Misconduct and Fraud in clinical research, Ethics and clinical trials in special population.

Unit III. Biosafety **(15 h)**

Biosafety: Definition of bio-safety, Biotechnology and bio-safety concerns at the level of individuals, institutions, society, region, country and world with special emphasis on Indian concerns. Bio safety regulation: handling of recombinant DNA products and processes in industry and in institutions (Indian context).

Unit IV. Intellectual Property Rights (IPR) **(15 h)**

Introduction to IPR, Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of New GMOs; International framework for the protection of IP. IPs of relevance to Biotechnology and few Case Studies; Introduction to History of GATT, WTO, WIPO and TRIPS.

Indian Patent Act 1970 and Recent Amendments.

Patent application- forms and guidelines, fee structure, time frames; Types of patent applications: provisional and complete specifications; PCT and convention patent applications.

Books for study and references:

1. Fleming, D.A., Hunt, D.L., (2000). Biotechnology and Safety Assessment, 3rd Edition Academic press.
2. Thomas, J. A., Fuch, R.L. (1999). Biotechnology and safety assessment, 3rd Edition, CRC press, Washington.
3. Recent Central Drugs Standard Control Organization. Good Clinical Practices-Guidelines for Clinical Trials on Pharmaceutical Products in India. New Delhi: Ministry of Health; 2013, 2017.
4. International Conference on Harmonization of Technical requirements for registration of Pharmaceuticals for human use. ICH Harmonized Tripartite Guideline. Guideline for Good Clinical Practice. E6; 1996.
5. Ethical Guidelines for Biomedical Research on Human Subjects 2000, 2014, 2017. Indian Council of Medical Research, New Delhi.
6. David Machin, Simon Day and Sylvan Green, (2005), Textbook of Clinical Trials, John Wiley and Sons.
7. Biotechnology - A comprehensive treatise (Vol. 12). Legal economic and ethical dimensions VCH, 2nd edition, ISBN-10 3527304320.
8. Encyclopedia of Bioethics 5 vol set, (2003) ISBN-10: 0028657748.
9. Thomas, J. A., Fuch, R. L. (2002). Biotechnology and safety Assessment, 3rd Edition, Academic press.
10. R K Rondels, S A Varley, C F Webbs (2000), Clinical Data Management, 2nd Edition, Wiley Publications.

11. Singh B. D. (2019), Biotechnology expanding horizons. Kalyani Publishers
12. Sibley (2007), Law and Strategy of biotechnological patents, Butterworth publication.
13. Intellectual property rights- Ganguli-Tat McGrawhill. (2001) ISBN-10: 0074638602,
14. Intellectual Property Right- Wattal- Oxford Publication House. (1997) ISBN:0195905024.
15. Kuhse, H. (2010). Bioethics: an Anthology. Malden, MA: Blackwell.

Paper 11 SCRM .2.3.3 (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 nanoparticle 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 Nanoparticles (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, (2012); *Multilayer Thin Films: Sequential Assembly of Nanocomposite Materials,* Wiley-VCH Verlag GmbH & Co. KGaA
2. David S. Goodsell, (2004); Bionanotechnology: Lessons from Nature, Wiley.
3. Neelina H. Malsch, (2005), Biomedical Nanotechnology, CRC Press
4. Greg T. Hermanson, (2013); *Bioconjugate Techniques*, 3rd Edition, Elsevier Science.

(Paper 12) SCRM.2.3.4 (A) Cell and Tissue Banking and Cryopreservation (60 h)

Unit I. Basics of tissue banking (15 h)

What is Cell and Tissue Banking? Definition. Scope and need of Cell and Tissue Banking and Cryopreservation, Processing of different organ tissues, Tissue preservation procedure, Validation and checking/quality control, Sterilization, disinfection and decontamination.

Unit II. Cord blood banking (15 h)

Advantage and disadvantages of cord blood banking, Regulation of cord blood banks, Donor Recruitment, Cord blood collection, processing and testing, Registration of cord blood units, Search, issue and release for transplantation, HLA typing and other related issues.

Unit III. Tissue banking (15 h)

Tissue banking of Skin, musculo-skeletal, Ocular, Cardiovascular tissue and sperm Structure of skin, Wound healing, Use of allograft, Long bone formation, growth and endochondral ossification, Bone characteristics and functions, Bone and tendons, processing storage and issue, Bone remodeling, Structure and function of the cornea, Ocular tissue transplantation, Corneal storage, processing and tissue, Eye banking, tissue processing, storage and issue of heart valves, Pericardium, Blood vessels and tissue transplantation, sperm banking indications, Culture Media, Protocols, Instrumentation, Applications.

Unit IV. Cryopreservation (15 h)

Introduction and Historical Background of Cryopreservation, Review of Basic, Thermodynamics, Properties of Cryogenic fluids, first and Second Law, approaches to the study of thermodynamic cycles, Isothermal, Adiabatic and Isenthalpic processes. Production of Low Temperatures: Liquefaction systems, ideal, Cascade, Linde Hampson and Claude cycles and their derivatives; Refrigerators: Stirling, Gifford-McMahon cycles and their derivatives. Cryogenic Insulations: Foam, Fibre, powder and Multilayer. Principles of Cryopreservation, Effects of Freezing on Cells, Thawing & amp; Post Thaw Handling, Cryoprotectants.

Books for study and references:

1. Andrew Gordon Hadley, Helen Gillan, (2007), An Introduction to cell and Tissue Transplantation Science, published by British Blood Tranfusion Society, Manchester.
2. Rober Lanza, (2013), Hand book of Stem Cells, 2nd Edition, Academic Press.
3. Stewart Sell, (2013), Stem Cells Handbook, 2nd Edition, Humana Press.
4. Arlene Y. Chiu, Mahendra Rao, (2011), Human embryonic stem cells, 1st Edition, Humana Press.
5. Jeremy J. Mao, (2008), Translational Approaches In Tissue Engineering & Regenerative Medicine, Artech House.
6. Nagy A Habib, Natasa Levicar, Myrtle Y Gordon, Jiao Long, Nichoas M Fisk (2008), Stem Cell Repair And Regeneration – Volume 2, World Scientific Publishing Company.

Paper 12 SCRM .2.3.4 (B) Environmental Impact and Risk Assessment (60 h)

Unit 1. Environmental impact assessment (15 h)

EIA Definitions, introduction and concepts; Rational and historical development of EIA; Scope and methodologies of EIA; role of project proponents, project developers and consultants; Terms of reference; impact identification and prediction; baseline data collection. Environmental impact statement (EIS), Environmental Management Plan (EMP).

Unit 2. Rapid EIA (15 h)

Strategic Environmental Assessment; Social impact assessment; Cost benefit analysis; Life cycle assessment; Environmental appraisal; Environmental Management.- Principles, Problems and strategies. Environmental Planning; Environmental Audit; Introduction to ISO and ISO 14000. Sustainable development.

Unit 3. EIA regulations (15 h)

EIA regulations in India, Status of EIA in India, Current issue in India; EIA case study of hydropower projects/ Thermal Projects.

Unit 4. Risk assessment (15 h)

Introduction and scope, project planning, exposure assessment, toxicity assessment, hazard identification and assessment, risk characterization, risk communication, environmental monitoring, community involvement, Legal and regulatory framework, human and ecological risk assessment.

References

1. Environmental Impact Assessment Training Manual, (2016), International Institute for Sustainable Development, IISD.org.
2. Glasson, J. and Therivel, R. (2013). Introduction to Environmental Impact Assessment, 3rd Edition, Routledge.
3. Morris. P. and Therivel. R. (2001). Methods of environmental impact assessment, 2nd Edition. Spon Press, New York, With a chapter on GIS and EIA by A.R. Bachiller and G. Wood, p. 381-401.
4. Grumbine, R. E. and Pandit, M. K. (2013). Threats from India's Himalaya dams. Science. 339:36-37.
5. Petts, J. (1999). Handbook of Environmental Impact Assessment. Vol. 1, Blackwell Science.

(Practical 3) SCRM.P.3. Laboratory Course 3 (60 h)

P.3.1. Regenerative Medicine and its applications in Diseases (Any 5)

1. Isolation of $CD34^+$/ $EPCAM^+$cells from cord blood using magnetic cell sorting.
2. Isolation of MSCs from Placenta using magnetic cell sorting.
3. Potency Analysis of Hematopoietic Stem Cells Obtained from Umbilical Cord Blood using Colony Forming Units (CFU) Assay.

4. Potency Analysis of Hematopoietic Stem Cells Obtained from Umbilical Cord Blood using Aldehyde Dehydrogenase Enzyme Histochemistry.
5. Differentiation of Stem Cells in to various lineages.
6. Isolation of Cancer stem cells using magnetic cell sorting.
7. Case studies of stem cell therapy for various diseases.

P.3.2. Biomaterials and Tissue engineering and 3D Printing (Any 5)

1. Preparation of tissue engineered Alginate Capsules.
2. Tissue engineered composites Hydrogel.
3. Preparation and decellularization of porcine/ bovine tracheal scaffold.
4. Preparation of thin films by dip coating method.
5. CAM assay for biocompatibility of scaffolds.
6. 3D Printing of Scaffolds.

P.3.3. (A) Clinical research, bioethics and regulatory affairs (Any 5)

1. Preparation of Informed Consent Process (ICF) for the following population.
    - Geriatric Patients
    - Pediatric patients
    - Psychiatric patients
    - Unconscious patients
2. Preparation of the standard operating procedures (SOP) for procurement and storage filing of Investigational product (IP).
3. Preparation of e-CRF(Electronic Case Report Form) for dummy clinical data.
4. Preparation of protocols for handling and disposal of laboratory Biohazard material and waste.
5. Preparation of Patent application Draft.
6. Preparation of case study report of Karyotype and Pedigree analysis.

OR

P.3.3. (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. FTIR spectroscopy analysis of given nanomaterial.

P.3.4. (A) Cryopreservation and tissue banking (Any 5)

1. Introduction of different Cryopreservation Solutions and Formulation.
2. Protocol for Pre-freeze Processing and Post-freeze Processing of whole Blood Lymphocytes.

3. Liquid Nitrogen Safety and Quality Control Protocols.
4. Preparation of Umbilical Cord Blood Mono Nuclear Cells (UCMNCs) for cryopreservation.
5. Preparation of Umbilical Cord derived Mesenchymal Stem Cells (UCMSCs) for cryopreservation.
6. Chemically Defined and Xeno-Free Cryopreservation of Cord Blood Mono Nuclear Cells (UCMNCs).
7. Storage and Shipping of Frozen Cells in different Liquid Nitrogen (LN_2) Phases.
8. Thawing and Post-Thaw Processing using Trypan Blue Exclusion method.

OR

(B) Environmental Impact and Risk assessment (Any 5)

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.

P.3.5. Research Project Synopsis preparation and submission

Guidelines for synopsis preparation and submission:

1. The allocation of students to guides for Research project must be done in semester II according to their area of interest.
2. The Research project synopsis must be submitted as per given format below individually by the student to HOD forwarded through guide in semester III.
    1. Title Page
    2. Certificated from Guide and HOD
    3. Introduction
    4. Aim, Objective, and hypothesis
    5. Review f of literature
    6. Materials and Methods
    7. Expected outcome
    8. References
3. The approval of IRC must be taken for Research project work.
4. The IEC, IAEC approval need to be taken for animal experiments.
5. The synopsis presentation evaluated by external examiner in semester III exam.

SEMESTER-IV

	University Exam marks	Internal marks	Total marks	Credits	Hours
(Paper 13) SCRM.2.4.1. (A) Research Methodology **OR** (Paper 13) SCRM.2.4.1. (B) Entrepreneurship and management	20	80	100	4	60
Practical					
(Practical 4) SCRM.P.4. Research Project					
(A) Oral / Poster Presentation in conference/ workshop/ any other relevant activity	-	100	100	4	24
(B) Dissertation	200	-	200	8	
(A) Viva	100	-	100	8	
(Practical 5) SCRM.P.5. Internship and Report	100		100	4	60
Total	**420**	**180**	**600**	**24**	

(Paper 13) SCRM.2.4.1. (A) Research Methodology (60 h)

Unit-I Research Problem Design (15 h)

Meaning and objective of research, motivation in research, types of research, significance of research, importance and criteria of good research.

Research Process and Planning for Research, Formulation of Research Problem, sources of research problem.

Research Designs – Features of good research design, important concepts of relating research design, different basic research designs: Exploratory, Descriptive and Experimental Research Designs, Sampling Design.

Unit-II Scientific Writing (15 h)

Literature Searching: On-line literature searching tools, Different databases (Science direct, PubMed, Scopus, Web of Science, Google scholar), Searching strategy for research articles.

Writing scientific publication: Structure and components of research paper, Paper writing for International Journals, paper submission procedure.

Conference presentation: oral and poster presentation, preparation of slides, pictures, graphs and citation styles.

Unit III: Ethics in Medical Research (15 h)

General principles on ethical considerations involving human subjects, Institutional ethics committee, its organization and functions, general ethical issues.

Specific principles in stem cell therapy, specific principles in human genetic research, specific principles for research in transplantation including fetal tissue implantation.
Ethical guidelines for experimental animals for specific research, CPCSEA guidelines, In–vitro system to replace animals, legal provisions to experimentation of animals.

Unit IV: Measures of Research Excellence and Plagiarism (15 h)

Research indices: Basic of research indices, merits and demerits of research indices, Citation Index, Impact Factor, H-index, i-10.
Plagiarism: definitions and types of Plagiarism, causes of Plagiarism, importance of Plagiarism, ways to avoid Plagiarism, paraphrasing and citations and references, consequences of Plagiarism, Role of educator, Plagiarism checker software, cases of Plagiarism.

Suggested reading:

1. C. R. Kothari, (1985) Research Methodology Methods and Techniques, Wiley Easter Ltd, New Delhi.
2. Robert A. Day and Barbara Gastel, (2012), How to write and Publish a Scientific Paper, 7th Edition, Cambridge University Press.
3. Federico Rosei and Tudor Johnson (2006), Survival skills for Scientists by, Imperial College Press.
4. Loraine Blaxter, Christina Hughes and Malcum Tight, (2001) How to Research, 4th Edition, Viva Books.
5. Ethical Guidelines for Biomedical research on human subjects, ICMR, New Delhi 2006.
7. Clapper Nikki, (2013), Learning about Plagiarism, Capstone press.
8. Michael Donnelly et al, (2012) Critical conversation about Plagiarism, Parler press.

(Paper 13) SCRM.2.4.1. (B) Entrepreneurship and management (60 h)

Unit I. Introduction (15 h)

Meaning – nature and characteristics of Management, Scope and Functional areas of management. Management V/s Administration – Roles of Management, Levels of Management. Evolution of management thought: early, contemporary and modern.

Unit II. Nature and purpose of planning and Organization (15 h)

Types of plans. Decision making. Importance of planning – steps in planning & planning premises. Hierarchy of plans. Components of planning. Principles of organization, Types of organization. Departmental Committees. Centralization Vs Decentralization of authority and responsibility. Nature and importance of staffing–Process of Recruitment and Selection.

Unit III. Meaning and nature of directing (15 h)

Understanding, Supervision, motivation and leadership. Leadership styles, Motivation Theories (Abraham Maslo, Herzberg and Victor Hvrom's). Communication – Meaning and importance. Meaning and steps in controlling –Essentials of a sound control system –Methods of establishing control (in brief).

Unit IV. Structure of a Biotechnology Company **(15 h)**

Start-up of Biotechnology Company, New Product Development. Market Research. Sales &Marketing Principles. Intellectual Property Principles in Biotechnology. Health Care Overview and Role of Government in Biotechnology. Ethical and Other Legal Issues in Biotechnology

Suggested Reading

1. P.C.Tripathi, P. N. Reddy (2012), Principles of Management, 5th edition Tata McGraw Hill,
2. Vasant Desai (2001), Dynamics of Entrepreneurial Development & Management, 4th edition, Himalaya Publishing House.
3. Poornima M. Charantimath (2006), Entrepreneurship Development Small Business Enterprises, 2nd edition, Pearson Education.
4. Stephen Robbins (2003), Management, 17th Edition, Pearson Education.

(Practical 7) SCRM.2.4.P.7 Research Project

Guidelines

1. The Research project work can be started in semester III and need to be completed before one month of semester IV exams under the guidance of faculty.
2. The project work must be presented in the form of poster or oral National/International conference, workshop, college level poster/ oral presentation competition or any other relevant activity. This will be evaluated internal examiner.
3. The Research project progress meetings will be held twice in semester IV.
4. The Research project progress presentation must be given by the student in before IRC member and departmental expert committee.
5. The project can be done in M.Sc./research laboratory within University or outside the University.
6. The research project report shall be written with following specifications:
   For research project report writing 'Time New Roman' font shall be used. Size of the paper shall be A4 size. A margin 3. 5 cm can be maintained with a line spacing of 1.5 A. Project report
7. The final research project report/ dissertation must be submitted in format as per following format.

Content
Title Page Certificate by Supervisor, Forwarded through HOD Declaration by Student

Dedication
Acknowledgement
Table of Content
List if Table
List of Figures
Abbreviations
Abstract
Introduction
Review f of literature
Materials and Methods
Results
Discussion
Summary
Concussion
References
List of Conferences/ Workshop/ seminars attended
Certificates

8. Three copies of final dissertation must be prepared and two copies of must be submitted to University and one must be keep with them.
9. The dissertation evaluated by external examiner during final semester exam.

(Practical 5) SCRM.P.5. Internship and Report

Objectives:

- To develop communication, interpersonal, and other critical thinking skills for future jobs.
- To acquire additional skills required for the world of work.
- To acquire employment contacts leading directly to a full-time job after post-graduation.
- To provide workplace skills

Learning outcomes:

- After the Internship, the students will integrate theory and practice.
- Develop work habits and attitudes necessary for job success

- Build a record of work experience.
- Acquire additional skills required for the world of work.

Internship Type:

- Short-Term Internship: Minimum of three weeks or 15 working days

Schedule:

- Internship must be scheduled in between 2nd semester final examinations and one month before 4th semester final examinations with prior permission.

Type of Institute: Biotechnology Industry/ Pharmaceutical industry/ Stem Cell industry/ Cord blood bank/ Food, soil, water testing Laboratory/ Hospital/ Clinical Research organizations/ Diagnostic Laboratory/ any other Research institute.

Guidelines for Internship and Report:

1) The duration of Internship must be minimum of three weeks or 15 working days.

2) The internship training and report must be done individually.

3) Students must identify an institute for Internship in consultation with and approval of their faculty guide and head of the Department. Simultaneously, students should also have identified a guide within the company (industry guide) under whose supervision and guidance they would carry out their Industry Internship.

4) During their stay with the company, students are required to gain and understand the company's history, details of its founders or shareholders, the nature of the business, type of products, organizational structure, reporting relationships, working of the different management functions (such as finance, HR, production, R & D, quality control, marketing, sales and operations), key issues and concerns, and nature and types of customers through observation, discussion, and interaction with the company personnel. This list is only indicative and not exhaustive. Students should collect and gather as much as possible of written materials, published data, and related matters.

5) Obtain an Internship Report completion certificate on company letterhead before leaving the organization.

6) Maintain an Industry Internship diary with details on activities and personal learning during the project period.

7) A committee, the Head of the department, and other members of the faculty is formed for the compliance of the internship.

8) At the end of the Internship, the student shall prepare three copies of the report: one for submission to the college and one for the student. More copies may be prepared If the organization or the guide or both ask for one copy each. The report should indicate the sources from which information was obtained. All pages should be numbered, and numbers should be placed at the center of the bottom of the page. All tables, figures, and appendices should be consecutively numbered or lettered and suitably labelled. The report shall be printed (preferably spiral bound) with not less than 30 A4 size pages.

9) The internship report (Anexures I to X) should be submitted to the department a month before the fourth semester End Examination.

Evaluation of the Internship:

- Total Marks: 100
- Evaluation will be based on three factors:

  i. Assessment and feedback from the industry guide

  ii. Assessment by the faculty guide

  iii. Quality of report (to be evaluated by the external examiner)

College Guide Manual –Internship

1. The guide should give proper procedures to the intern before and after the Internship.
2. The guide should interact with the company at least once before completing the internship.
3. The weekly report submitted by the student should be reviewed and reported to the Guide.
4. The final report should be perfectly vetted and authenticated by the guide and submitted for the viva voce.

Annexure-I

THE CONTENTS OF INDUSTRIAL INTERNSHIP REPORT

■ Title Page (Annexure II)
■ Official Certification (Annexure III)
■ Certificate from Intern Organization (Annexure IV)
■ Student's Declaration (Annexure V)
■ Acknowledgements

➢ **Contents**

Chapter 1: Executive Summary

The internship report shall have only a one-page executive summary. It shall include five or more Learning Objectives and Outcomes achieved, a brief description of the business sector and intern organization, and a summary of all the activities done by the intern during the period.

Chapter 2: Overview of the Organization

Suggestive contents:

A. Introduction of the Organization
B. Vision, Mission, and Values of the Organization
C. Policy of the Organization, in relation to the intern role
D. Organizational Structure
E. Types of Products
F. Roles and responsibilities of the employees in which the intern is placed.
G. Performance of the Organization regarding turnover, profits, market reach, and market value.
H. Future Plans of the Organization.

Chapter3: Internship Part

Description of the Activities/Responsibilities in the Intern Organization during the Internship, which shall include - details of working conditions, weekly work schedule, and equipment used, and tasks performed. This part could end by reflecting on what kind of skills the intern acquired.

- Joining Report (Annexure VI)
- Activity Log for the Week (For Every Week) (Annexure VII)
- Final Report (Annexure VIII)

Chapter 4: Outcomes Description

- Description of the work environment the student has experienced (in terms of people interactions, facilities available and maintenance, clarity of job roles, protocols, procedures, processes, discipline, time management, harmonious relationships, socialization, mutual support, and teamwork, motivation, space, and ventilation, etc.)
- Description of the real-time technical skills the student has acquired (in terms of the job-related skills and hands-on experience)
- Description of the managerial skills the student has acquired (in terms of planning, leadership, teamwork, behavior, workmanship, productive use of time, weekly improvement in competencies, goal setting, decision making, performance analysis, etc.
- Description of how the student could improve the student communication skills (in terms of improvement in oral communication, written communication, conversational abilities, confidence levels while communicating, anxiety management, understanding others, getting understood by others, extempore speech, ability to articulate the key points, closing the

conversation, maintaining niceties and protocols, greeting, thanking and appreciating others, etc.,)

- Description of how the student could enhance the student's abilities in group discussions, team participation, contribution as a team member, and leading a team/activity.
- Description of the technological developments the student has observed relevant to the subject area of training (focus on digital technologies relevant to your job role)

➢ Photos & Video Links
➢ Student self-evaluation (Annexure IX)
➢ Evaluation by the supervisor of the intern organization (Annexure X)

Annexure II

AN INDUSTRIAL INTERNSHIP REPORT SUBMITTED TO

D.Y. PATIL EDUCATION SOCIETY

(DEEMED TO BE UNIVERSITY) KOLHAPUR

FOR THE DEGREE OF

MASTER OF SCIENCE

Stem Cell and Regenerative Medicine/ Medical Biotechnology

BY

MR/Miss. ----------

Under the guidance of

Dr. ----------

Department of Stem Cell and Regenerative Medicine and Medical Biotechnology

D.Y. Patil Education Society (Deemed to Be University) Kolhapur

(Academic year)

Annexure III

CERTIFICATE

This is to certify that _____ (Name of the student) Reg. No. _____ has completed his/her Internship in _____ (Name of the Intern Organization/Industry) on _____ (Title of the Internship) under my supervision as a part of partial fulfillment of the requirement for the Degree of M.Sc. in Stem Cell and Regenerative Medicine/Medical Biotechnology, D. Y. Patil Education Society, (Deemed to be University), Kolhapur.

Signature of the Guide

Signature of the HOD

Annexure IV

INDUSTRIAL INTERNSHIP COMPLETION CERTIFICATE

(on Company Official Letter Head)

This is to certify that Mr/Ms ……. Roll no……. a student of the Department of Stem Cell and Regenerative Medicine and Medical Biotechnology, D. Y. Patil Education Society, (Deemed to be University), Kolhapur had undergone an Industrial Internship during the period ……to ……..

During the tenure, his/her performance was very good/good/average/poor.

Industrial Guide
Name and Designation:
Postal Address:
Mobile No:
Phone No:
Fax:
E-mail id:

Signature of the
Industrial Guide
(Company Seal)

Annexure V

STUDENT'S DECLARATION

I,_____ a student of M.Sc. in Stem Cell and Regenerative Medicine/Medical Biotechnology Program, Reg. No. _____ of the Department of Stem Cell and Regenerative Medicine and Medical Biotechnology, D. Y. Patil Education Society (Deemed to be University), Kolhapur, do hereby declare that I have completed the mandatory internship from _____to _____ in _____ (Name of the intern organization) under the Faculty Guideship of _____ (Name of the Faculty Guide)

Name and sign of student

Date-

Place-

Annexure VI

JOINING OR ACCEPTANCE LETTER (on Company Official Letter Head)

Date:

To

The Head of the Department,

Department of Stem Cell and Regenerative Medicine and

Medical Biotechnology, Centre for Interdisciplinary Research,

D. Y. Patil Education Society (Deemed to be University), Kolhapur

416006, Maharashtra, INDIA

This is to inform that Mr/Ms. ……,Roll number …….., a student of the Department of Stem Cell and Regenerative Medicine and Medical Biotechnology, D. Y. Patil Education Society (Deemed to be University), Kolhapur has reported to Mr/Ms …….. on ……. to undergo an Internship in partial fulfilment of his/her MSc. program.

Industry Guide's
Name and Designation:
Postal Address:
Mobile No:
Phone No:
Fax:
E-mail id:

Signature of the
Industry Guide
(Company Seal)

Annexure VII

WEEKLY ACTIVITY LOG

Day & Date	Brief Description of The Daily Activity	Learning Outcome	Person In-Charge Signature

Name and Signature of the Student

Industry Guide's
Name and Designation:

Signature of the
Industry Guide
(Company Seal)

Annexure VIII

FINAL REPORT

(From Dt…….. to Dt….....)

1. Introduction of company

2. Information of facility
3. Detailes of work done
4. Techniques learned
5. Photographs

Name and Signature of the Student

Industrial Guide's
Name and Designation:
Postal Address:

Signature of the
Industrial Guide
(Company Seal)

Annexure IX

STUDENT SELF-EVALUATION

Student Self-Evaluation of the Short-term / Semester Internship

Student Name:

Registration Number:

Term of Internship: From: To:

Date of Evaluation:

Organization Name & Address:

Rating Scale: 1 is lowest and 5 is highest rank

1.	Oral communication	1	2	3	4	5
2.	Written communication	1	2	3	4	5
3.	Proactiveness	1	2	3	4	5
4.	Interaction ability with community	1	2	3	4	5
5.	Positive Attitude	1	2	3	4	5
6.	Self-confidence	1	2	3	4	5
7.	Ability to learn	1	2	3	4	5
8.	Work Plan and organization	1	2	3	4	5
9.	Professionalism	1	2	3	4	5
10.	Creativity	1	2	3	4	5
11.	Quality of work done	1	2	3	4	5
12.	Time Management	1	2	3	4	5
13.	Understanding the Community	1	2	3	4	5
14.	Achievement of Desired Outcomes	1	2	3	4	5
15.	**OVERALL PERFORMANCE**	**1**	**2**	**3**	**4**	**5**

Date: Signature of the Student

Annexure X

EVALUATION BY THE INDUSTRY GUIDE

Student Name:

Registration Number:

Term of Internship: From: To:

Date of Evaluation:

Organization Name & Address:

Name & Address of the Industry Guide with Mobile Number:

Note: Your evaluation shall be done independent of the Student's self-evaluation.

Rating Scale: 1 is lowest and 5 is highest rank

1.	Oral communication	1	2	3	4	5
2.	Written communication	1	2	3	4	5
3.	Proactiveness	1	2	3	4	5
4.	Interaction ability with community	1	2	3	4	5
5.	Positive Attitude	1	2	3	4	5
6.	Self-confidence	1	2	3	4	5
7.	Ability to learn	1	2	3	4	5
8.	Work Plan and organization	1	2	3	4	5
9.	Professionalism	1	2	3	4	5
10.	Creativity	1	2	3	4	5
11.	Quality of work done	1	2	3	4	5
12.	Time Management	1	2	3	4	5
13.	Understanding the Community	1	2	3	4	5
14.	Achievement of Desired Outcomes	1	2	3	4	5
15.	**OVERALL PERFORMANCE**	**1**	**2**	**3**	**4**	**5**

Date: Signature of the industry guide

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

Paper No-_____ Paper Name:_____

Total Duration: Section A+B = 3 Hours
Time: - 30 Minutes

Total Marks (A+B): 80
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 white ink on the circle once marked.*
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.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**) a) b) c) d) e)	**16** (4x4)
Q 3	a) Long b) Short	**12** **04**
Q 4	a) Long b) Short	**12** **04**
Q 5	a) Long b) Short	**12** **04**
Q 6	a) Long b) Short	**12** **04**
Q 7	a) Long b) Short	**12** **04**