FACULTY OF SCIENCE

SYLLABI

FOR

M.Sc. STEM CELL & TISSUE ENGINEERING
(SEMESTER SYSTEM)

EXAMINATION 2013-2014

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### Semester – I

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SEMESTER-I

(STE-01) **Human Anatomy and Physiology**

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**Relevance**

For the basic understanding being a stem cell biologist and its potential in regenerative medicine it is paramount for the students to understand the anatomical and physiological concepts of the human body.

**Pattern of Question Paper**

In all, nine questions are to be set, two questions each from four sections and Q No 1 or 9 is compulsory covering the entire syllabus; out of which total five questions are to be attempted. All questions carry equal marks. Candidates will be required to attempt at least one question from each section.

**Unit-A**

1. Introduction to human body & tissues, structure and functions of skin (layers and accessory organs), Connective tissue & fascia (structure and function), Muscles (Classification, structure, differences and function)

**Unit-B**

2. Skeletal system (Bones: Classification, structure and function; Joints-Types) Cardiovascular (Blood vessels-Structure, Blood -Composition, structure of cells Haematopoiesis, function of various components, deficiency disorders) and immune system.

**Unit- C**

3. Digestive, excretory and respiratory System (components, structural & functional correlation with clinical implications), Nervous tissue (Classification, structure and function with applied aspect)

**Unit- D**

4. Reproductive system (Structure and function with Clinical correlation) & Endocrine System (General Disposition with special emphasis on the functional basis of metabolic and endocrinial disorders)

**Laboratory Exercise**

1. Representative mammalian tissue histology slides.
2. Total leukocyte count.
3. Differential leukocyte count.
4. Packed cell volume.

Books Recommended

(STE-02) Cell Culture & Cell Technologies

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Relevance

Cell culture and cell technologies forms the core subject in handling, maintaining and culturing any type of cells including stem cells under in vitro conditions and readily demands thorough understanding for setting up the establishment of stem cells and exploiting their usage in regenerative medicine.

Pattern of Question Paper

In all, nine questions are to be set, two questions each from four sections and Q No 1 or 9 is compulsory covering the entire syllabus; out of which total five questions are to be attempted. All questions carry equal marks. Candidates will be required to attempt at least one question from each section.

Unit-A

1. History and scope of animal cell culture.
2. Cell culture media and growth factors: metabolic requirements, equipments, aseptic technique, cryopreservation, cytotoxic assays, viability assays, physicochemical properties, balanced salt solution, complete media, serum, selection of medium & serum, condition media and other supplements, determination of cell growth and kinetics.

Unit-B

Unit-C

4. Primary cell cultures and established cell lines: types, isolation procedures, tissue disaggregation, establishment, characteristics, and enrichment of the primary cells, secondary cell culture, commonly used cell lines, cell fusion, production of monoclonal antibodies, scale up methods for propagation of anchorage dependent and suspension cultures.

Unit- D

5. Genetic modifications & applications in animal cells; in vitro & in vivo transformation along with their applications, in vitro fertilization and embryo transfer technology, introduction to stem cell biology,
6. Quality control of cell culture: transportation of cell line, quarantine and initial cell handling, microbial quality control, authentication, regulatory aspects.

Laboratory Exercise
1) Haemocytometer exercise, practice handling new equipment and supplies; inverted phase microscopes, trypan blue dye exclusion, incubators and ancillary equipment.
2) Aseptically prepare media in bio safety hood.
3) Cryopreservation of cells and retrieval of cells.
4) Cell passaging.
5) Handling of secondary animal cell culture.
6) Identification of contaminants in animal cell culture.
7) Sub culturing of continuous cell line growing in monolayer and suspension.
8) Construction and analysis of growth curve.
9) Isolation of primary cell culture.

BOOKS RECOMMENDED

(STE-03) Genomics & Proteomics-1

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Relevance

This subject emphasizes the importance of understanding the comparative analyses of the complete genomic sequences from different organisms and determination of global pattern of
gene expression and also enables the systematic study of modifications, interactions, localization and functions of proteins at the tissue, cellular and sub-cellular levels.

**Pattern of Question Paper**

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**Unit-A**


**Unit-B**

2. Clinical cytogenetics: Chromosomal abnormalities, autosomal and sex chromosomal abnormalities, chromosomal markers.

**Unit-C**

3. Inheritance of traits: Mendelian laws of Inheritance, allelic variance, cytoplasmic inheritance, autosomal recessive inheritance, autosomal dominant inheritance, X-linked dominant inheritance, X-linked recessive inheritance.

**Unit-D**

4. Molecular defects affecting metabolic pathways: Overview of structure, function, metabolism and related diseases of amino acids, carbohydrates, fats and lipids, nucleic acids with special emphasis on inborn errors of metabolism & degenerative diseases.

**Laboratory Exercise**

1) Preparation of metaphase chromosome.
2) Karyotyping.
3) Banding Pattern (G-banding).
4) Quantization of cellular macromolecules (DNA, RNA and Protein)
5) Preparation of blood smears for study of sex chromatin.
6) Study of human sex chromatin.

**BOOKS RECOMMENDED**

1 B. S. Gardener and D. P. Smaustad, Principles of Genetics., 5th edition, 2009 John Wiley & Sons Ltd.
Relevance

Cell and molecular biology is a rich integrative science that brings together the fundamentals of biochemistry, biophysics, genetics and allied fields to enable students for better understanding the functioning of a cell and its associated molecules.

Pattern of Question Paper

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Unit-A

1. Cell Biology: prokaryotic cell, eukaryotic cell and their organelles, cytoskeleton and cell motility, cell interactions; extracellular matrix, adhesive proteins, cell-cell, cell matrix interactions, and transport across membranes.

Unit-B

2. Eukaryotic cell cycle & check points, cell growth regulation & cell cycle progression, programmed cell death.

Unit-C


Unit-D


Laboratory Exercise

1. To perform cell fractionation using rodent tissue.
2. Protein determination.
4. Isolation of plasmid.
5. Isolation of genomic DNA.
6. Determination of $T_m$ of DNA.
7. To perform DNA fragmentation test for apoptosis.

**BOOKS RECOMMENDED**
2) B. Lewine, Genes IX, 2010 Jones and Bartlett Publishers.

**(STE-05) Cell and Molecular Techniques**

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**Relevance**

This subject enables students to perform the most complex experiments in the field by simplest measures following understanding the principles and functioning of various cell and molecular techniques.

**Pattern of Question Paper**

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**Unit-A**

1. **Analytical techniques**: Spectrophotometry, spectrofluorometry, chemiluminescence, chromatography and electrophoresis techniques, radio-isotopic techniques, cell fractionation methods and centrifugation, density gradient centrifugation, ultracentrifugation.

**Unit-B**

2. **Techniques in cell biology**: Microscopy: principle and applications of light phase contrast, fluorescence, confocal, electron microscopy and atomic force microscopy.

**Unit-C**

3. **Techniques in molecular biology**: DNA amplification- PCR, real time PCR, qPCR, RT-PCR, restriction digestion, cloning, DNA sequencing, Northern, Southern & Western
blotting, dot blot, autoradiography, genomic and cDNA library construction, RFLP, RAPD, AFLP, mutagenesis, whole genome sequencing.

Unit-D

4. Electrophoretic mobility shift assay, CHIP assay, RNAi technique, phage display, flow-cytometry, immunohistochemistry and immunocytometry.

Laboratory Exercise
1. To perform the absorption spectra.
2. To study living matter under phase contrast microscope.
3. To study the parts of compound microscope and phase contrast microscope and its maintenance.
4. Chromatographic techniques.
5. Radio isotopic counting techniques
7. To perform native PAGE for proteins.
8. To perform SDS-PAGE for separation of protein.
9. DNA electrophoresis
10. Restriction digestion
11. PCR analysis.
12. Gene cloning & sub-cloning

BOOKS RECOMMENDED
SEMESTER-II

(STE-6) Histology

Time allotted 3 hrs
Total Marks 125
Annual Theory 80
Internal Assessment 20
Total Theory 100
Practical 25
Theory 4 hrs per week
Practical 3 hrs per week

Relevance

Studying the histological concepts would help students getting familiar with various topics and techniques for better understanding of the microscopic structure of different types of tissues.

Pattern of Question Paper

In all, nine questions are to be set, two questions each from four sections and Q No 1 or 9 is compulsory covering the entire syllabus; out of which total five questions are to be attempted. All questions carry equal marks. Candidates will be required to attempt at least one question from each section.

Unit-A

1. Introduction to histology, the cell, cell organelles, nucleus, cell division.
2. Fixation of tissue, processing of tissue, dehydration, impregnation in the wax, manual and automatic tissue processor, section cutting- microtome, instrument, principle, use in section cutting, parts and working of commonly used microtome.

Unit- B

3. Different kinds of microtome-rotary, base sledge, sliding, low temperature microtome, cryostat, microtome knives, homing and stropping knives, section cutting of paraffin blocks, section preparation from frozen tissues, fixing of tissue to slide.

Unit- C

4. Staining techniques: natural dyes, synthetic dyes, basic and acidic dyes, haematoxylin-eosin staining, Pap, methanamine silver nitrate, Ziehl-Neelsen’s stain, propylene glycol, sudan technique, papanicolaou, haematoxylin, acridine orange technique.
Unit-D

5. Histology basics-epithelium, connective tissue, cartilage, blood, muscle, nervous, cardiovascular, lymphatic, respiratory tract, endocrine gland, digestive tract, urinary tract, reproductive tract, special senses.

Laboratory Exercise
1) Tissue processing
2) Fixation
3) Paraffin Embedding
4) Section cutting
5) Mounting techniques
6) Staining of tissue sections
7) Microscopic examination

BOOKS RECOMMENDED

(STE-7) Immunology & Immunogenetics

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Relevance

Immunology and immunogenetics forms an another core subject for the comprehensive knowledge of the body’s defence mechanisms and its reactions towards exposure to various foreign antigens i.e. bacterial, viral etc. and warrants complete information regarding the subject.

Pattern of Question Paper

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Unit-A
1. Overview and generation of immune responses: history, innate and adaptive immunity, Antigens: Immunogens, epitopes, haptens, adjuvants, antibodies: basic and fine structure, antibody classes, their diversity and effector functions, antigen antibody interactions, major histocompatibility complex: MHC molecules and genes, cellular distribution, genetic organization and inheritance, MHC and disease susceptibility.

Unit-B
2. Cells and organs of immune system: haematopoiesis, haematopoietic stem cells, lymphoid cells: B and T cells, NK cells, mononuclear phagocytes, granulocytic cells, dendritic cells, primary lymphoid organs: thymus, bone marrow, lymphatic system and secondary lymphoid organs: lymph nodes, spleen, MALT, CALT.

Unit-C

Unit-D
4. Immune response in health and disease: tolerance, autoimmune diseases: organ specific and systemic, animal models, transplantation, graft rejection, immune-suppressive therapy, Cancer, tumor antigens, cancer immunotherapy, Engineering T cells against HIV and cancer, Transgenic mice, humanised monoclonal antibodies, vaccines

Laboratory Exercise
1. Histology of lymphoid organs.
2. Blood film preparation and identification of WBC from normal and infected animals.
4. Demonstration of antigen-antibody interaction by oucerylony method.
5. Separation of WBC from blood by Density gradient centrifugation.
7. To perform indirect fluorescent antibody test.

BOOKS RECOMMENDED
3) A.K. Abbas, A. Lichtman, and J. S. Pober, Cellular and Molecular Immunology, 2000, W.B. Saunders Company.
Relevance

Stem cell biology would provide students towards building the basic knowledge of what are stem cells, their types, respective functions, regulation and their role in revolutionizing the concept of modern regenerative medicine.

Pattern of Question Paper

In all, nine questions are to be set, two questions each from four sections and Q No 1 or 9 is compulsory covering the entire syllabus; out of which total five questions are to be attempted. All questions carry equal marks. Candidates will be required to attempt at least one question from each section.

Unit-A

1. Basic biology of stem cells; Types & sources of stem cell with characteristics: embryonic, adult, haematopoietic, fetal, cord blood, placenta, bone marrow, primordial germ cells, cancer stem cells, induced pleuripotent stem cells.

Unit-B

2. Stem cell characterizations: isolation & characterizations, markers & their identification, growth factor requirements and their maintenance in culture. Feeder and feeder free cultures.
3. Cell cycle regulators in stem cells.

Unit-C

4. Molecular basis of stem cell renewal and differentiation, Metaplasia and trans-differentiation.
5. Molecular basis of pleuripotency and stem cell niche.

Unit-D

6. Applications of stem cells: neurodegenerative diseases, spinal cord injury, heart disease, diabetes, burns and skin ulcers, muscular dystrophy, orthopaedic applications, eye diseases, stem cells and gene therapy.
**Laboratory Exercise**
1. Preparation of feeder cell culture.
2. Culturing of stem cell line.
3. Isolation of cells from blastocyst.
4. Isolation of placenta.
5. Isolation of cells from placenta.
6. Growing mesenchymal stem cell.
7. Differentiation of mesenchymal stem cells.

**Books Recommended**

(STE–09) **Genomics & Proteomics-II**
- Time allotted: 3 hrs
- Total Marks: 125
- Annual Theory: 80
- Internal Assessment: 20
- Total Theory: 100
- Practical: 25
- Theory: 4 hrs per week
- Practical: 3 hrs per week

**Relevance**
This subject is an extension from the previous semester with advancement of newer concepts and apprises the students with the advent of newer techniques in this field.

**Pattern of Question Paper**
In all, nine questions are to be set, two questions each from four sections and Q No 1 or 9 is compulsory covering the entire syllabus; out of which total five questions are to be attempted. All questions carry equal marks. Candidates will be required to attempt at least one question from each section.

**Unit-A**
1) Essentials of genome analysis: nuclear architecture, eukaryotic genome domains, genome expression analysis, repair and analysis of transcriptome.
2) Genomics and beyond: Introduction to structural, functional, comparative and quantitative genetics, population and evolutionary genetics; genetic variations, Hardy-Weinberg law, non-random mating, changes in allelic frequencies, molecular evolutions, genomic reprogramming, applications of genomics.

**Unit-B**

3) Advanced techniques in genome studies: PFGE, CHEF, microarray analysis, yeast two hybrid assays, FISH, FRET and BRET assays, FACS analysis.

**Unit-C**

4) Introduction to stem cell bioinformatics & proteome analysis; introduction, structural and functional proteomics (structural hierarchy, protein folding, protein functions & regulation of protein function).

**Unit-D**

5) Tools in proteomic analysis: fusion proteins, GST pull down assays, basic proteomic analysis: two-dimensional PAGE, isoelectric focusing, mass spectrophotometry, peptide finger printing, peptide sequencing, circular dichroism and stop flow.
6) Metabolomics and biochemical network analysis.

**Laboratory exercise**

1) Western blotting.
2) GST Pull down assays.
3) Mass spectroscopic data analysis.
4) FACS Analysis.

**Books Recommended**


**(STE-10) Tissue Engineering-1: Biomaterials/Biopolymers**

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**Relevance**

This paper would help students to know the applications and usage of stem cells in various therapies and also would impart information regarding the development of various scaffolds and concepts of tissue engineering for various stem cell based therapies.

**Pattern of Question Paper**

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**Unit-A**

1. Introduction to biomaterials, characterization of materials; mechanical properties; thermal properties, surface properties and adhesion, biological tolerance.

**Unit-B**

2. Metals, ceramics and polymers, properties and uses.

**Unit-C**

3. Biologically active scaffold based on tissue engineering, polysaccharide scaffold in tissue engineering, materials, modification and properties of scaffolds, tissue engineering applications.

**Unit-D**

4. Applications of nanotechnology in tissue engineering, tissue engineering approaches to stem cell-based therapies.

**Laboratory Exercise**

1) Isolation of collagen.
2) Use of collagen scaffold for stem cell growth.
3) Preparation of mixed scaffolds.
4) SEM of scaffold.

**Books Recommended**

Relevance

The developmental biology is a core subject for the students of Stem Cell biology. It deals with various aspects of development in different model organisms to provide an insight into the human development programs.

Pattern of Question Paper

In all, nine questions are to be set, two questions each from four sections and Q No 1 or 9 is compulsory covering the entire syllabus; out of which total five questions are to be attempted. All questions carry equal marks. Candidates will be required to attempt at least one question from each section.

Unit-A

1. Introduction to Development, an overview (*Drosophila melanogaster*, and *Caenorhabditis elegans*).

2. Development in *Drosophila melanogaster*: Control of body segments, role of maternal genes in early embryogenesis, role of specific morphogenetic gradients, genes and signal transducers for anterior and posterior asymmetry, determining the cell fate, role of zygotic genes, role of homeotic genes.

Unit-B


Unit-C


Unit-D

5. Development of vertebrates: gametogenesis, fertilization, blastocyst formation, implantation, gastrulation, organogenesis in vertebrates, differentiation of muscle, Neural tube development.
**Laboratory exercise**
1) Determining the reproductive phases in mouse.
2) Carrying out timed pregnancies in mouse.
3) Isolating the embryos at specific days of embryonic development.
4) Preparation of embryonic growth medium.
5) Culturing of whole embryos.
6) Histology slides of embryogenesis.

**Books Recommended**

(STE –12)  **Stem Cell Signal Transduction and Epigenetic Mechanisms**

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**Relevance**

Signal transduction process is important to various biological phenomena and would help in understanding the conversion of an extracellular signal to an intracellular mechanism for a specific cellular response. There are unique signalling mechanisms for stem cells which maintain their pool as well as in their differentiation proliferation process. How these signals are orchestrated are dealt here in this subject.

**Pattern of Question Paper**

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**Unit-A**

1. Introduction to cell signalling: Crosstalk of extracellular signal to the physiological response, cell surface receptors, conserved components of signalling.

**Unit-B**

2. G-Protein signalling: Heterotrimeric and monomeric G-proteins, their types and G-protein coupled receptors (GPCR) regulating activities of adenylate cyclase, phosphodiesterase, ion channels, phospholipase and calcium homeostasis, receptor switching.

**Unit-C**

3. Genomic response through Signalling: GPCR, TGFβ, Cytokine signalling, Receptor tyrosine kinase, RAS/RAF and MAP kinase pathway, Wnt signalling classical and non-classical, phosphoinositide signalling.

4. Signalling based on protein cleavage pathways (Hedge hog, Notch signalling).

5. Role of signal transduction pathways in stem cell renewal and differentiation.

**Unit-D**

6. Epigenetic mechanisms: Role in development and cell remembrance, histone modifications, acetylation, methylation etc., factors affecting these modifications, reprogramming, cellular response, DNA methylation and development, functional role of epigenetic in development.

**Laboratory Exercise**

1. Demonstration of calcium mediated signalling.
2. Signal mediated activation of transcription factors.
3. Demonstration of Wnt canonical pathway.
4. GSK-3-beta kinase pathway and stem cell differentiation.

**Books Recommended**

Relevance
This is an advanced course on stem cells that would help students to comprehend state of art technologies used in understanding various applications of stem cells both for the basic as well as translational studies.

Pattern of Question Paper
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Unit-A
1. Regulatory mechanisms in stem cell: Transgene expression and RNA interference in Embryonic stem cells, lentiviral vector mediated gene delivery in human embryonic stem cells.

Unit-B
2. Organ Derived Stem cells: Heart, Lung, Kidney, liver, adipose tissue, dental pulp, neural, mammary cell, skeletal muscle, spermatogonial cells etc.
3. Induced Stem cells mechanism and applications.

Unit-C
4. Industrial approach to stem cell & tissue engineering: Introduction, Stem cells and Tissue engineered products, bioreactors in stem cells and tissue engineering, cell delivery and recirculation, delivery of molecular agents in tissue engineering, stem cells in toxicology studies and as drug vehicles, case studies in tissue engineering.

Unit-D
5. Setting up stem cell culture and tissue engineering laboratory, hazards in stem cell storage & transplantation.

Laboratory Exercise
1) Coat cover slips with fibronectin.
2) Actin stained with rhodamine phalloidin.
3) Stain differentiated adipocytes with Oil Red O.
4) Transfection in stem cells experiments.
5) In vivo experiments using stem cells in rodent model of diabetes.
Books Recommended

(STE-14) Tissue Engineering-II: Translational & Ethics

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Relevance

Various topics discussed under this subject would allow the students to understand various methodologies for generating different tissue engineered products and also enable to familiarizes the students about various translational and ethical issues associated with engineered scaffold, biopolymers and or tissue.

Pattern of Question Paper

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Unit-A

1. Tissue engineering using embryonic, mesenchymal and adult stem cells, soft tissue grafts, orthopaedic tissue engineering engineered skin, skeletal tissue, neuronal tissue, intestine engineering etc.

Unit-B

2. Engineering embryonic stem cells with recombinase system, engineered tissues & regenerative medicine, Functional tissue engineering, Monitoring of engineered tissues.

Unit-C

3. Regulations & Ethics: Ethics in use of stem cell, regulatory bodies for use of material for human need, commercial developments and stem cell based products, bio-vigilance.
Unit-D

4. Patents and Law: Introduction to the basic principles of the law of patents origin and function of the patent system, the nature of patents as property and legal instruments, comparisons with other forms of intellectual property, subject matter eligible for patenting, conditions for patent-ability of an invention and the disclosure requirements for a patent application, regulatory challenges in engineered tissue and regenerative medicine.

Laboratory exercise
1. Preparation of synthetic scaffolds.
2. Use of scaffolds for stem cell differentiation.
3. Scaffolds for bone.
4. Tissue engineering using commercially available stem cell lines.

Books Recommended

(STE-15) Xenoantigens and Stem Cells

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Relevance

The behaviour and the development of stem cells is greatly influenced by the presence of innocuous agents (xenoantigens) which might include the components of the various culture systems including the presence of microbes their secreted peptides and other biomolecules important in tissue growth and development. Thus it becomes important to study the stem cell behaviour in relation to the various xenoantigens.

Pattern of Question Paper

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Unit-A

1. Xenoantigens and stem cell contaminations; Introduction, types and mechanisms, cross contaminations.
Unit-B

2. Microbial taxonomy and nomenclature, microbial cell structure and function, quality control procedures in stem cells, Environmental contaminants and other pathogenic organisms and their role in contamination during Stem cell culturing.

Unit-C

3. Normal flora of human body and its role in cell differentiation and development in buccal cavity, skin, intestines, liver, lungs, and kidney.

Unit-D

4. Role of GLP and GMP facility in stem cell laboratory and stem cell banks, storage and transportation of stem cells, preventing contamination.

Laboratory exercise
1. Identification of mycoplasma.
2. PCR analysis for different xenoantigens to animal cells in culture.
3. Identification of different microbes.

Books Recommended
SEMMESTER –IV

(STE-16) Stem Cell Research Methodology

Time allotted 3 hrs
Total Marks 125
Annual Theory 80
Internal Assessment 20
Total Theory 100
Practical 25
Theory 4 hrs per week
Practical 3 hrs per week

Relevance
This subject will introduce the students to the various aspects in lab management, designing new experiments, model systems, experimental strategies and data interpretation in order to achieve relevant findings and also help students to venture out into their respective research activities in future. Since the student would be pursuing their research projects, hence emphasis would be given to the quality designing of the research problem etc.

Pattern of Question Paper
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Unit-A
1. Introduction to research methodology, types of research, key steps in research, tools of research.
2. Introduction to literature collection, its importance and sources, preparing a research report, types of research reports, and their components.

Unit-B
3. Research designs and hypothesis, basic principles of research designs, laboratory safety, animal handling.

Unit-C
4. Introduction to computer fundamentals in research, hardware, software.
5. Working with MS-DOS, LAN (Novell Netware) environment, windows operating system, MS-Office: MS Word, Excel, power point and spreadsheet.

Unit-D
6. Introduction to spread sheet applications, data entries, statistical and logical, graphical applications and data analysis.
Books Recommended

(STE-17) Biostatistics and Computational Approach

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Relevance
Various Biostatistical/Computational tools discussed herein would help the students to plan their research in studying comparative functional genomics together with comprehensively analysing the data acquired from different experiments.

Pattern of Question Paper

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Unit-A

1. Biostatistics: its meaning and objectives, measurement scales, Population and Samples. Frequency tables and their graphs, Measures of location, variability (box and whisker plot), Skewness and Kurtosis, (Use of SPSS package).
2. Intuitive concept of probability, conditional probability (Bayes’ theorem), Specificity, Sensitivity and ROC Curve.

Unit-B

3. Random variables, probability mass function, probability density function, distribution function, expectation and variance, Bernoulli’s trials, Binomial, Poisson and normal distributions. Scatter diagram, correlation and Spearman’s rank Correlation Coefficient, Regression and multiple regressions (using SPSS only).

Unit-C

4. Sampling, distributions of sample mean, difference of means, sample proportion and difference of proportions, the basic idea of significance tests, tests of hypothesis for the parameters of a normal distribution (two sample problems also) including testing for population proportions, paired ‘t’-test, chi-square tests for association, Yates’ correction.
Unit-D


Books Recommended

(STE -18) One Journal Club 25 Marks
One Seminar 50 Marks

(STE-19) Thesis/Project reports 225 Marks
Viva voce Examination 75 Marks