Credit Structure of M.Sc. Life Sciences with specialization in Molecular Medicine

<table>
<thead>
<tr>
<th>Course type</th>
<th>Required as per CBCS system, UGC</th>
<th>Percent and Actual Credit in M.Sc. Mol. Med</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundation</td>
<td>10-15% i.e. 7.2 to 10.8</td>
<td>12% (8)</td>
</tr>
<tr>
<td>Elective and IDs</td>
<td>25-35% i.e. 18 to 25.2</td>
<td>32% (22)</td>
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<tr>
<td>Core</td>
<td>50-65% i.e. 36 to 46.7</td>
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<tr>
<td>Total credits (excluding dissertation)</td>
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<tr>
<td>S.No</td>
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<td>Course Title</td>
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</tr>
<tr>
<td>1</td>
<td>LSL_501</td>
<td>Research Methodology</td>
</tr>
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<td>2</td>
<td>LSL_502</td>
<td>Introduction to Biostatistics</td>
</tr>
<tr>
<td>3</td>
<td>LSL_504</td>
<td>Introduction to Cell and Molecular Biology</td>
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<tr>
<td>4</td>
<td>LSL_506</td>
<td>Basic and Clinical Biochemistry</td>
</tr>
<tr>
<td>5</td>
<td>LSL_508</td>
<td>Concepts of Genetics</td>
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<tr>
<td>6</td>
<td>LML_510</td>
<td>Concepts and Prospects in Molecular Medicine</td>
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<tr>
<td>7</td>
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<td>Inter-Disciplinary Elective -I (From Other Departments)</td>
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<td>8</td>
<td>LSP_503</td>
<td>Introduction to Biostatistics</td>
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<td>9</td>
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<td>Introduction to Cell and Molecular Biology</td>
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<td>LMS_599</td>
<td>Credit Seminar</td>
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L: Lecture  T: Tutorial  P: Practical  S: Seminar  Cr: Credit  F: Foundation Course, C: Core Course, E: Elective course, ID: Inter-disciplinary course

ID courses offered by Molecular Medicine faculty in Semester-I

<table>
<thead>
<tr>
<th>S.No</th>
<th>Course Code</th>
<th>Course title (offered by)</th>
<th>Credits</th>
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<tbody>
<tr>
<td>1</td>
<td>LML_511</td>
<td>Basics of Stem Cell Biology (Dr. Sandeep Singh)</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>LML_512</td>
<td>Introduction to Immune System (Dr. Monisha Dhiman)</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>LML_513</td>
<td>Introduction to Human Cancers (Dr. Harish Chander)</td>
<td>2</td>
</tr>
</tbody>
</table>
Central University of Punjab, Bathinda
Centre For Human Genetics and Molecular Medicine
M.Sc. Life Sciences Specialization in Molecular Medicine

**LSL 501: Research Methodology.**

**Credit Hours:** 2.

**Learning Objective:** To ensure that the students of molecular medicine understands various aspects of research related methods, technical/scientific writings and literature search.

**Unit:** 1

**5 Lectures**

**General principles of research:** Meaning and importance of research, critical thinking, formulating hypothesis and development of research plan, review of literature, interpretation of results and discussion, Plagiarism.

**Unit:** 2

**10 Lectures**

**Technical writing:** Scientific writing that includes the way of writing Synopsis, research paper, poster preparation and presentation, and dissertation.

**Unit:** 3

**5 Lectures**

**Library:** Classification systems, e-Library, web-based literature search engines

**Unit:** 4

**16 Lectures**

**Entrepreneurship and business development:** Importance of entrepreneurship and its relevance in career growth, characteristics of entrepreneurs, developing entrepreneurial competencies, types of enterprises and ownership (large, medium, SSI, tiny and cottage industries, limited, public limited, private limited, partnership, sole proprietorship) employment, self-employment and entrepreneurship, financial management-importance and techniques, financial statements-importance and its interpretation, and Intellectual Property Rights (IPRs).

**Suggested Reading:**

**LSL 502: Introduction to Biostatistics.**

**Credit Hours:** 2.

**Course Objectives:** This course will give a basic but significant exposure towards better understanding of biostatistics and application. Applications of biostatistical approaches are pivotal in testing hypothesis, designing experiments, analyzing experimental data and interpreting the results of biological research.

**Unit:** 1

**6 Lectures**
Overview of Biostatistics: Difference between parametric and non-parametric statistics, Univariate and multivariate analysis, Frequency distribution, Measures of central tendency and variation, Graphical representation of data, Levels of significance, Hypothesis testing.

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<thead>
<tr>
<th>Unit</th>
<th>Lectures</th>
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Descriptive Statistics: Probability and probability distributions (Binomial, Poisson and Normal), Kurtosis and skewness, Correlation and regression.

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<th>Unit</th>
<th>Lectures</th>
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</table>

Experimental Design and Analysis: Sampling techniques, Sampling theory, various steps in sampling, Sampling distribution.

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<th>Lectures</th>
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</table>

Inferential Statistics: Chi-Square test, Student’s t-test, F-Test, Z-Test, Mann-Whitney U-test, Wilcoxon signed-rank, One-way and two-way analysis of variance (ANOVA).

<table>
<thead>
<tr>
<th>Suggested Readings</th>
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</table>

LSL.504: Introduction to Cellular and Molecular Biology Credit Hours: 3.

Learning Objective: Students will understand the structures and purposes of basic components of membranes, and organelles and their related functions. Understanding the molecular processes of DNA replication, transcription, and translation, and how they are managed in cells. Understand the basic mechanisms of cellular signal transduction and regulation of gene expression.

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<th>Unit</th>
<th>Lectures</th>
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Introduction to the Cell: prokaryotic and eukaryotic cells, Single cell to multicellular organisms.

Membrane Structure and Function: Models of membrane structure, membranes of intracellular organelles, Membrane transport.

Protein Secretion and Sorting: Structure and functions of intracellular organelles, Intracellular traffic and secretory pathways, protein sorting, endocytosis and, exocytosis.

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<th>Unit</th>
<th>Lectures</th>
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The Cytoskeleton: cell cytoskeleton and its organization including extracellular matrix, adhesions and junctions.

Cell-cell communication and cell growth: Overview of cell signaling, cell surface receptors and second messengers, cell cycle and its regulation.

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<th>Unit</th>
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<td>3</td>
<td>15</td>
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</table>

Chemical structure and functions of Nucleic acids: Chemical structure of DNA and RNA Watson-Crick model, different forms of DNA and RNA, Organelle DNA, Regulation of nucleosome assembly chromatin.

Gene and Genome organization: Split genes, Overlapping genes, Transposons & retrotransposons, Gene clusters, Mechanism of DNA replication, DNA damage and their repair.
Unit: 4

Transcription and mRNA Processing: transcription and transcription factors, Transcriptional and post-transcriptional gene silencing, mRNA processing: Capping, Polyadenylation, Splicing, editing, mRNA stability, Translation: Genetic code, the translation machinery, mechanisms of chain initiation, elongation and termination, regulation of translation, post-translational modifications of proteins.

Suggested Reading:

LSL 506: Basic and Clinical Biochemistry. Credits Hours: 3.

Course Objectives: The course aims to provide an advanced understanding of the core principles and topics of Biochemistry and their experimental basis.

Unit: 1


Unit: 2


Unit: 3


Unit: 4

Enzymology: Classification, Principles of catalysis, Mechanism of enzyme catalysis, Enzyme kinetics, Enzyme inhibition, Enzyme regulation, Isozymes and Clinical enzymology.
# Suggested Reading:


## LSL.508: Concepts of Genetics.

**Credits Hours:** 3

**Learning Objective:** Students will learn the basic principles of inheritance at the molecular, cellular and organism level. This course will make them understand the causal relationships between molecule/cell level phenomena (“modern” genetics) and organism-level patterns of heredity (“classical” genetics).

### Unit: 1  Basics of Inheritance: Mendel’s Laws of inheritance, Concept of segregation, independent assortment and dominance, Chromosome theory of inheritance, Alleles and multiple alleles, Locus concept, Epistasis, Crossing over and recombination, Pedigree analysis, Linkage analysis and gene mapping: Coupling and repulsion phase linkage, Application of Mendel’s laws to populations, Hardy-Weinberg principle, inheritance of quantitative traits.  
10 Lectures

17 Lectures

### Unit: 3  Sex Determination: Sex determination and Sex linked inheritance, Sex determination in humans, *Drosophila* and other animals, Sex determination in plants, Sex linked genes and dosage compensation in human, *Drosophila* and *C.elegans*.  
17 Lectures

### Unit: 4  Extra-Chromosomal Inheritance: Chloroplast and Mitochondrial inheritance, Yeast, *Chlamydomonas/Neurospora* and higher plants, Symbiosis.  
14 Lectures
Suggested Reading:

**LML.510: Concepts and Prospects of Molecular Medicine.**

**Credits Hours: 4.**

**Learning Objective:** The students will understand the background of molecular medicine i.e. molecular/cell biology relevant to medical applications. It will enhance their understanding how normal cellular processes change, fail or are destroyed by disease development, in particular for genetic diseases and role of modern therapeutics.

**Unit : 1**

**18 Lectures**

**Molecular Basis of Diseases:** Human genetics relevant to molecular medicine, single nucleotide polymorphisms, multiple gene polymorphisms, single and multi-gene diseases, gene-environment interactions in disease manifestation.

**Unit : 2**

**18 Lectures**

**Molecular Medicine Therapeutics:** Gene therapy and recombinant molecules in medicine and therapeutic development, Antiviral therapies, vehicles for gene therapies, pharmacogenomics, its application and role in developing novel therapies. RNAi and human diseases, alternate splicing and human disease.

**Unit : 3**

**18 Lectures**

**Signal Transduction and its Role in Human Diseases:** Cellular and tissue microenvironment in diseases, drug resistance with convention chemotherapies, construction of knock-out and transgenic animals, Protein as causes of human diseases.

**Unit : 4**

**18 Lectures**

Clinical trials, adjuvant therapies, monoclonal antibodies as drugs, nano-biotechnology and its applications in molecular medicine, next generation sequencing techniques.

**Suggested Reading:**
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
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<th>8.</th>
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<tbody>
<tr>
<td>LSP.503</td>
<td>Introduction to Biostatistics - Practical</td>
<td>1</td>
<td>Experimental design and analysis.</td>
<td>Training on basic usage of Microsoft Word, Microsoft Excel, Microsoft PowerPoint and Internet Explorer.</td>
<td>Optimizing web search: Google advanced search, Boolean operators, Literature search using Google Scholar, HighWire.</td>
<td>Bibliography management and research paper formatting using reference software EndNote.</td>
<td>Performing statistics analyses using MS Excel Analysis toolpack.</td>
<td>Creating a functional website using HTML.</td>
<td>Basic programming using DOS batch files and Auto Hot Key.</td>
<td>*Practical will be conducted depending upon the available facility/faculty</td>
</tr>
<tr>
<td>LSP.507</td>
<td>Basic and Clinical Biochemistry – Practical</td>
<td>1</td>
<td>Preparation of solutions, buffers, pH setting etc.</td>
<td>Amino acid and carbohydrate separations by paper &amp; thin layer chromatography.</td>
<td>Quantitative Estimation of Proteins, Sugars, total lipids and amino acids.</td>
<td>Assay and estimation of different enzymes e.g. invertase, amylases, acid and alkaline phosphatases in plant seeds.</td>
<td>Principle and application of electrophoresis, Native, SDS PAGE.</td>
<td>Estimation of total phenolic compounds.</td>
<td>Extraction and estimation of vitamins.</td>
<td>Basic clinical tests like Urea, lipid profiling, SGOT, SGPT etc.</td>
</tr>
<tr>
<td>LSP.509</td>
<td>Concepts of Genetics - Practical</td>
<td>1</td>
<td>Calculation of allele frequencies.</td>
<td>Calculating recessive gene frequency, Calculating frequency of sex-linked alleles.</td>
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</tbody>
</table>
4. Monohybrid and dihybrid ratios, Multiple alleles, Epistasis – Problems.
7. To test PTC tasting ability in a random sample and calculate gene frequencies for the taster and non-taster alleles.
8. Identification of inactivated X chromosome as Barr body and drumstick.
11. To study fingerprint and palmar dermatoglyphics and calculate indices.
12. To test for colour blindness using Ishihara charts.

* More practicals may be conducted depending on the available facilities / faculties.

LMS.599 Credit Seminar.  Credit Hours: 1.

Learning Objectives: To read the recent scientific articles and prepare presentation on some recent topic of ‘Molecular Medicine’ which will be helpful to overcome the presentation related fears and blunders.

Interdisciplinary Courses for Semester-1  Credit Hours: 2.

(To be offered by faculties from other centres)

Course Code: Code shall be brought from the department whose course is undertaken by the student.

Learning Objective: To ensure holistic development of student's knowledge and perspective, a course from other department must be undertaken by the student. This course shall carry 2 credits and will be evaluated out of 50 Marks.
Central University of Punjab, Bathinda  
Centre For Human Genetics and Molecular Medicine  
M.Sc. Life Sciences Specialization in Molecular Medicine

Interdisciplinary Courses offered by Faculty of Molecular Medicine  
Credit Hours: 2  
(To be offered in both the semesters throughout the year)

LML. 511: Basics of Stem Cell Biology  
Credits Hours: 2

Learning Objective: To instill awareness on very basics of cell biology and enable the student to understand the concept of stem cells and their importance for disease therapeutics.

Unit: 1  
9 Lectures

Basics of Cell Biology: Introduction to cell, different types of cells, prokaryotic, eukaryotic, plant, animal, microbial cells, somatic and germline cell types

Cellular Complexities: Evolution from single cell life to complex multicellular organisms, cell differentiation, cellular microenvironment, different types of human cells, cell signalling and its role in synchronized function of various tissues.

Unit: 3  
9 Lectures

Stem Cells: Types of stem cells, pluripotent, multipotent stem cells and precursor cells, adult, fetal, cord blood and embryonic stem cells.

Stem Cells and Therapeutics: Stem cells applications in treating various diseases like diabetes, RA, Parkinson’s, Alzheimer’s, Stroke and brain injury repair, Spinal cord injuries, anti-cancer, heart infarction, vision and hearing repair, teeth replacement, tissue replacements, skin grafting and wound healing.

Suggested Reading:

LML. 512: Introduction to Immune System  
Credits Hours: 2

Learning Objective: To instill awareness on very basics of immune system where student will learn the components of the human immune response that work together to protect the host.

Unit: 1  
9 Lectures

Elements of Immune System: Cells, Organs, and microenvironments of the immune system. Innate and adaptive immunity, cellular and humoral immunity, inflammatory and regulatory networks and small biochemical mediators (cytokines).

Functions of Immune System: Discriminate between self and non-self. A functional immune system confers a state of health through effective elimination of infectious agents (bacteria, viruses, fungi, and parasites) and through control of malignancies by protective immune surveillance.

Immunodeficiency and Dysfunction as the Basis of Disease: Immune Deficiency and dysfunction diseases. Because specific mechanism affects prognosis as well as therapeutic approaches, Gel and Coombs classified these dysfunctional immune responses into hypersensitivity diseases.
Unit: 4  

Immunological Processes and Therapeutics  

Suggested Reading:  

LML, 513: Introduction to Human Cancers  

Credits Hours: 2.  

Learning Objective: Introduction to human Cancers course is designed as an interdisciplinary course to acquaint the students of different streams of Life Sciences with a basic knowledge and understanding about various cancers.  

Unit: 1  

History, features of cancer including tumorigenesis and metastasis, Different types of cancers, symptoms of cancer, various methods for the detection of cancer, treatment of cancer, surgery and chemotherapy and targeted cancer therapy, institutes of national and international importance involved in cancer patient care and basic cancer research, application of new technologies in prevention, Tumor suppressors and oncogenes  

Unit: 2  

Role of hormones and growth receptors as carcinogens in tumorigenesis and metastasis, environmental mutagens, occupational cancers, role of modern industry in carcinogenesis, effect of environmental pollutants on tumor suppressor genes, effect of cancer on the functioning of cell machinery, lifestyle changes, stress and cancer, importance of molecular biology in basic cancer research, socioeconomic impact of cancer.  

Suggested Reading:  

Related Weblinks:  
http://www.insidecancer.org/  
http://www.who.int/cancer/en/  
http://www.cancer.gov/  
http://www.icmr.nic.in/ncrp/cancer_reg.htm
<table>
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<tr>
<th>S.No</th>
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<tr>
<td>1</td>
<td>LSL.521</td>
<td>Human Physiology</td>
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<td>2</td>
<td>LSL.523</td>
<td>Essentials of Immunology</td>
<td>C</td>
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<td>4</td>
<td>LML.524</td>
<td>Advanced Techniques in Human Genetics and Molecular Medicine</td>
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<td>Elective Course-I</td>
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<td>LSP.522</td>
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<td>LML.525</td>
<td>Regenerative Medicine and Stem Cell Therapies</td>
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<td>HGL.525</td>
<td>Human Embryology and Developmental Genetics</td>
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<td></td>
<td>LML.526</td>
<td>Molecular and Cellular Oncology</td>
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<td>LML.527</td>
<td>Molecular Endocrinology and Signal Transduction</td>
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<td>HGL.526</td>
<td>Population Genetics and Genetic Epidemiology</td>
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**LSL.521: Human Physiology.**

**Credit Hours: 3.**

**Learning Objective:** This course is designed to provide students with an understanding of the function and regulation of the human body and physiological integration of the organ systems to maintain homeostasis. Course content will include neural & hormonal homeostatic control mechanisms, as well as study of the musculoskeletal, circulatory, respiratory, digestive, urinary, immune, reproductive, and endocrine organ systems.

**Unit: 1**

**Muscle Physiology:** Types of muscles, Properties; Contractile force; Motor Unit. Skeletal, cardiac and smooth muscles.

**Cardiovascular System:** Myogenic heart, Cardiac cycle, Heart as a pump, blood pressure, neural and chemical regulation of all above, Blood cell synthesis and Bone marrow, Haemopoiesis and formed elements, Plasma function, Blood volume and its regulation, Blood groups, Haemoglobin, Haemostasis, blood associated diseases.

**Unit: 2**

**Digestive System:** Digestion, absorption, energy balance, BMR, Epithelial Barrier Function, Regulation of Swallowing and Gastric Emptying and small/ Large Bowel. Gastro-intestinal Secretions and accessory glands.

Excretory System: Comparative physiology of excretion, Kidney, Urine formation, Urineconcentration, Waste elimination, Micturition, Regulation of water balance, Electrolyte and acid-base balance. Renal Function and Hemodynamics

Unit: 3 14 Lectures

Nervous System: Neurons, action potential, Gross neuroanatomy of the brain and spinal cord, Central and peripheral nervous system, Neural control of muscle tone and posture. Sense organs: Vision, hearing and tactile response.

Thermoregulation and Stress Adaptation: Comfort zone, Body temperature – physical, chemical, Neural regulation, Acclimatization.

Unit: 4 14 Lectures

Endocrinology: Endocrine glands, Hormone Structure and Function, Basic mechanism of hormone action, Hormones and diseases, Reproductive processes, Neuroendocrine regulation.

Reproduction: Males and female reproductive system. Gametogenesis, fertilization and early development.

Suggested Reading:

**LSL.523: Essentials of Immunology. Credit Hours:3.**

Learning Objective: The objective of this course is to cover basic concepts of immune system and to understand the concept of immune-based diseases as either a deficiency of components or excess activity as hypersensitivity.

Unit: 1 12 Lectures


Unit: 2 10 Lectures

Immune Effectors: Complement system, their structure, functions and mechanisms of activation by classical, alternative and lectin pathway. Th1 and Th2 response, cytokines, Chemokines.Antigen and antibody interactions

Unit: 3 10 Lectures

Mechanisms of Immune System Diversity: Organization and expression of immunoglobulin genes, Mechanisms of antibody diversity, class switching. Structure and functions of Major Histocompatibility Complex (MHC) and Human Leukocyte Antigen (HLA) system, polymorphism, distribution, variation and their functions.Organization and rearrangement of T-cell receptor genes (TCR).
Unit: 4

12 Lectures

**Immune System in Health and Diseases:** Inflammation, hypersensitivity and autoimmunity, Immunity to microbes, immunity to tumors, AIDS and immunodeficiencies, hybridoma technology and vaccine development associated challenges for chronic and infectious diseases. Production, characterization and applications of monoclonal antibodies in diagnosis, therapy and basic research, concept of making immunotoxins.

**Suggested Reading:**


**Learning Objective:** This course will help the students to understand safe laboratory practices and basic molecular biology techniques of specialized molecular and cell biology techniques.
Suggested Reading:

**LSP.522: Human Physiology – Practical.** Credit Hours: 1.

1. Sensory physiology practicals
2. Equipment in the laboratory - maintenance and use.
3. Determination of hemoglobin in the blood by various methods.
4. Isolation and estimation of DNA and RNA.
5. Extraction and estimation of acid phosphatases from serum.
6. Enzyme-linked Immunosorbent assay (ELISA).
7. Electrophoresis of egg proteins.
8. Determination of urea and uric acid in the urine.
   *More practicals may be conducted depending on available faculties/facilities.*

**Elective Course-1** Credit Hours: 3.

Students has to choose 1 out of 2 elective course

**LML.525: Regenerative Medicine and Stem Cell Therapies.** Credit Hours: 3.

Learning Objective: To teach students the advanced techniques in medicine in gene and molecular therapeutics. The students will understand basic stem cell biology and corresponding requirement for tissue engineering.

**Unit: 1** 16 Lectures

**Stem Cells:** Stem cells and their properties, classification of stem cells: Hematopoietic Stem Cells, mesenchymal Stem Cells, Embryonic Stem Cells, Fetal Stem Cells, adult stem cells, cancer stem cells, in-vitro culture techniques, isolation, identification and characterization of stem cells, stem cells in gastrointestinal, liver, pancreas, kidney, heart, spinal cord, eye diseases and cancer.

**Unit: 2** 16 Lectures
**Central University of Punjab, Bathinda**

**Centre For Human Genetics and Molecular Medicine**

**M.Sc. Life Sciences Specialization in Molecular Medicine**

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**Tissue Engineering:** Principles of tissue culture, tissue and organ culture, extracellular matrices, bioreactors, ethical issues related to stem cell therapies, stem cell banks, bone marrow transplantation.

**Unit: 3**

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<th>Lectures</th>
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**Regenerative Medicine:** Modes of tissue and organ delivery, tissue Engineering and transplantation techniques, immunosolation techniques, regeneration of bone and cartilage, Islet cell transplantation and bio-artificial pancreas, lung regeneration

**Unit: 4**

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<th>Lectures</th>
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**Somatic and Germine Engineering:** Basics of cell culture and media, Culturing primary cells and cell lines, suspension and adherent cultures, cell growth, growth inhibition and apoptotic studies, Embryo culture, transplantation and teratogenesis, teratomas. Stem cell culture, organ culture, artificial blood, Somatic cell fusion and somatic cell genetics, radiation hybrids.

**Suggested Reading:**


**Related Weblinks:**

1. www.stemcells.wisc.edu
3. stemcells.nih.gov/

---

**HGL.525: Human Embryology and Developmental Genetics Credit Hours: 4.**

**Unit: 1**

<table>
<thead>
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<th>Lectures</th>
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</table>

**Reproductive Physiology:** Structure and Functions of Adult Human Reproductive organs, Reproductive Endocrinology, Gametogenesis, Formation of male and female gametes, Embryogenesis: Fertilization, Gastrulation and Implantation of Embryo, Lactation.

**Unit: 2**

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**Basic Concepts of Development:** 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: 3**

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<th>Lectures</th>
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</table>

**Regulation of Organ Development:** Genetic and molecular control of development of limbs, Gastrointestinal system and cardiovascular system; Genetics of sex determination in humans and development of urogenital system; Programmed cell death and role of cell death in formation of digits and joints, Genetic and molecular control of development of head and neck region, Formation of nervous system.

**Unit: 4**

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</table>
Central University of Punjab, Bathinda
Centre For Human Genetics and Molecular Medicine
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Post-natal Development, Aging and Senescence: Environmental and genetic factors during maturations, Sex linked changes, Deciduous and primary teeth, Cognitive development ageing: its causes and regulation; Clinical death.

**Suggested Reading:**

**Elective Course-II**

**Credit Hours: 3.**

**Students has to choose 1 out of 3 elective course**

**LML 526: Molecular and Cellular Oncology**

**Credit Hours: 3.**

**Learning Objective:** Cancer Biology course is designed as an elective course to equip the students of different streams of Life Sciences with a conceptual understanding and advanced comprehension to cope up with the ever-expanding role of molecular biology in basic cancer research as well as clinical oncology.

**Unit: 1**
**18 Lectures**

**Fundamentals and Genetics of Cancer:** History, hallmarks of cancer research, cancer classification, Mutagens, carcinogens and gene mutations and genetic arrangements in progenitor cells. Chromosomal aberrations, tumor viruses and discovery of oncogenes, Mechanism of activation of oncogenes. Transcription factors as tumor suppressors and oncogenes, Familial cancer syndromes, telomere regulation in cancer, micro RNA profiling in cancer, cancer stem cells.

**Unit: 2**
**18 Lectures**


**Unit: 3**
**18 Lectures**

**Cancer Detection:** General and organ specific symptoms associated with cancer, techniques for cancer detection, biomarkers for cancer detection of various stages of cancer, population genetics based screening methods, *In-vitro* assays to detect angiogenesis, metastasis, cell proliferation, mice models to study cancer (transgenic, knock-out, knock-in, xenografts and patient derived xenografts), genomic and proteomic approaches to develop better cancer markers.

**Unit: 4**
**18 Lectures**

**Cancer Therapies and Recent Advances in Cancer Research:** Traditional Chemotherapies, radiotherapy, Onco-surgery, Bone marrow transplantation, stem cell therapies, Immunotherapy, combinational therapies, natural products as therapeutics, cancer vaccines, gene therapies and delivery vehicles, targeted anticancer therapies,

Suggested Reading:

Related Weblinks
http://www.insidecancer.org/
http://www.who.int/cancer/en/
http://www.cancer.gov/
http://www.icmr.nic.in/ncrp/cancer_reg.htm

**LML_527: Molecular Endocrinology and Signal Transduction**

**Credit Hours: 3.**

**Learning Objective:** The course is designed for the students of life sciences who are interested to learn the basics of signal transduction and its role in various cellular processes. Various pathways deregulated during disease manifestation will also be discussed in detail.

**Unit: 1**

**15 Lectures**

History, endocrine glands, and hormones as chemical messengers, stimulus for hormone release: change in homeostasis, sensory stimulus and others.

**Cell Signaling and Mechanism of Hormone Action:** Receptor study, Binding affinity, specificity, Scatchard plot and purification. G protein linked receptor family; Signal transduction pathways involving G-proteins, Adenylcyclases, Ca$^{2+}$,Phosphoinositides, PI-3 Kinase, DAG, cAMP, cGMP, NO, Protein kinases (A,B,C,G), Phosphoprotein phosphatases &Phosphodiesterases. Receptor tyrosine kinase family- EGFrceptor family, Insulin receptor family, & Cytokine/erythropoietin receptor family associated with non-receptor Tyrosine kinase (Signal transduction pathways involving: SH2 proteins, Ras, IRS-1, Raf, MEK, MAP kinase, JAK-STAT pathway).

**Unit: 2**

**15 Lectures**

**Hormones:** Structures, Receptor type, Regulation of biosynthesis and release (including feedback mechanism). Physiological and Biochemical actions, & Pathophysiology (hyper & hypo secretion). Hypothalamic Hormones: CRH, TRH, GnRH, PRL/PRH, GHRIH/GHRIH, Pituitary Hormones - Anterior Pituitary hormones- Growth hormone, Prolactin, POMC peptide family, LH, FSH, TSH; Posterior Pituitary: Vasopressin, Oxytocin.
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Suggested Reading:

HGL. 526: Population Genetics and Genetic Epidemiology

Course Objectives: Study of population genetics is necessary to understand the evolution. This course will be helpful to the students to conceptualize the existence of genetic variation and speciation. Further, this course will give students exposure towards understanding population health and disease susceptibility.

Unit 1 18 Lectures
Population dynamics and Fundamental of Epidemiology: Dynamics and conditions of the Hardy-Weinberg law; Selection coefficient and fitness; Heterozygous advantages, Inbreeding and its consequences; Mutation pressure and estimation of rates, Genetic load, Selection coefficient and Fitness, Dynamics of migration and genetic drifts.

Unit 2 12 Lectures
Introduction of different types of epidemiological studies: Experimental and observational; Cohort studies; Association studies, genome-wide association studies (GWAS), general approaches to access the genetic basis of disease; heritability; basic parameters of epidemiology: frequency, occurrence, prevalence, Incidence; Association; variation;

Unit 3 12 Lectures
Population and Speciation: Adaptive radiation; Isolating mechanisms; Speciation; Allopatricity and Sympatricity; convergent evolution; sexual selection; co-evolution.

Unit 4 12 Lectures
Genetic Variation and Inheritance of Complex Traits: Basics of genetic variation, Genetic markers – SNP, CNV, Indels, VNTR, STR, Microsatellite. Tag markers and Haplotypes, Linkage disequilibrium, Fixation index; Quantitative Genetic analysis; Broad-Sense Heritability and Narrow-Sense Heritability.

Suggested Reading:
<table>
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<td>Medical Microbiology</td>
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<td>2</td>
<td>LML.602</td>
<td>Molecular Basis of Human Diseases</td>
<td>C</td>
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**Elective Course-III**

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<td>LML.604</td>
<td>Evolutionary and Developmental Biology</td>
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<td>HGL.604</td>
<td>Genetic Diseases and Therapies</td>
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**Elective Course-IV**

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<tr>
<td>HGL.605</td>
<td>Aging, Longevity and Health</td>
<td>4</td>
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</tbody>
</table>

**LSL.601: Medical Microbiology.**

**Credit Hours: 2.**

**Learning Objective:** The student will learn the mechanism of infectious diseases their causes, detection, molecular diagnosis and possible therapeutics.

**Unit: 1**

**Prokaryotic, Eukaryotic structure and function:** Cell structure and function, Classifications. Bacteria, Fungi, Protozoa, Algae, and viruses. Structure of major viruses, and Viral replication.

**Unit: 2**

**Growth, Nutrition and Control:** Phases in bacterial growth, Growth Curve, Calculation of G-time, Physical and environmental requirements of growth, Microbial nutritional requirements, Types of culture media. Physical and Chemical methods, Antimicrobial drugs, Antibiotic assays, Drug resistance in bacteria.

**Unit: 3**

**Microbial Genetics:** DNA replication, Transcription and translation, Operon, Horizontal Gene Transfer.

**Host-pathogen Interactions:** Infectious diseases, host-pathogen interactions, genetic susceptibility to infection. Entry of pathogens into the host; colonization and factors predisposing to infections; types of toxins and their structure; Mode of actions, host signalling in response to infections, bacterial two component signaling systems, bacterial adhesins, virulence factors, bacterial biofilms and applications

**Unit: 4**

**Applied Microbiology:** Environmental microbiology, Microbial ecology, Aquatic Microbiology, Food, Dairy and Agricultural Microbiology, Industrial Microbiology. Major bacterial diseases of animals and plants, Airborne, Foodborne, Soil-borne, Nosocomial and Sexually Transmitted/Contagious Diseases, Principles of disease and epidemiology, Host-Microbe relationship, Viral pathogenesis, Major viral diseases of plants and animals. Avian Influenza A/H5N1, A/H1N1 Swine Influenza, SARS, AIDS, Japanese encephalitis, Malaria and Tuberculosis, West Nile, Mechanisms of emergence and reemergence.
Suggested Reading:

**LM1602: Molecular Basis of Human Diseases. Credit Hours: 4.**

**Learning Objective:** This course aims to provide students with in-depth knowledge of the basic mechanisms of common human diseases, such as cancer, diabetes, obesity, metabolic syndrome and muscle wasting conditions and to prepare them for future translational research. This course focuses on the current molecular mechanisms underlying the pathogenesis of each disease.

**Unit 1:** 16 Lectures
Molecular basis of the diseases, their susceptibility, progression and prognosis with a focus on developing better diagnostics and new therapeutics for human genetic disorders, cardiomyopathies, cancers, chronic inflammatory disorders, including inflammatory bowel disease and rheumatoid arthritis and infectious diseases. Role of factors such as lifestyle, diet and heredity in the human diseases.

**Unit 2:** 18 Lectures
**Genetic disorders:** Common genetic disorders due to altered chromosome numbers, aberrations; Diabetes as a genetic disease, recessive genetic disorders, Intersex Disorders: Male Pseudo-hermaphrodite (MPH) including testicular feminization syndrome, Female Pseudo-hermaphrodite (FPH) including congenital adrenal hyperplasia, True Hermaphrodites (TH), Mixed gonadal dysgenesis (MGD) & Dysgenetic male pseudohermaphrodite (DMP) and Persistent Mullerian duct syndrome (PMDS), diabetes and other complex human diseases.

**Unit 3:** 18 Lectures
**Disorders of Haematopoietic and Muscular System and Multifactorial diseases:** Haematopoietic systems - Sickle cell anemia, Thalassemias and Haemophilias and Haematopoietic Malignancies. Muscular Dystrophy. Molecular and genetic basis of Diabetes, Dementia, Schizophrenia, Cancer, Coronary Artery diseases, Hypertension and neuronal disorders such as Autism, Alzheimer’s and Parkinson. Mental Retardation.

**Unit 4:** 20 Lectures
**Mechanisms of Infection and Therapeutic Interventions:** Protein and DNA secreting systems and pathogenicity island. Molecular basis of antimicrobial resistance and its detection. Molecular approaches in clinical microbiology, antimicrobial agents; Sulfa drugs; Antibiotics: Penicillins and Cephalosporins; Broad-spectrum antibiotics; Antibiotics from prokaryotes; Antifungal antibiotics; Mode of action; Resistance to antibiotics.

**Novel therapies for diseases:** Tyrosine kinase inhibitor, Monoclonal antibody, Chemo, Radio, Gene and Stem Cell Therapies, Anticancer drugs targeting genomic DNA, radiations to kill abnormal cells, gene therapies in various diseases, problems in gene therapy, ethical and biosafety issues in gene therapies, current stem cell therapies, stem cells in heart, brain and spinal cord regeneration.

**Suggested Reading:**
LML 603: Bioinformatics and Computational Biology  Credit Hours: 4.

Learning Objective: Bioinformatics course is being offered to the students as fundamental course to brush up the basics of the students in this important emerging area. Students will be composed to the concepts of data mining, computational and algorithmic tools for biological data analysis and are expected to get a good idea on using computational resources to understand and resolve biological problems.

Unit: 1  18 Lectures
Biological data: Types of biological data (various omics)  Biological Databases  Nucleic acid and protein sequence and protein structure databases  Overview of available Bioinformatics resources on the web

Unit: 2  18 Lectures
DNA Sequence Analysis: Sequence annotation and sequence analysis - Phylogeny of gene (blast, fasta, HMMer) and residue conservation. Primer design and Tm Calculation, DNA Restriction pattern analysis. Condon bias and its effect on the protein expression with reference to various expression system.

Unit: 3  18 Lectures
Bioinformatic Tools: Protein sequence and structure insights (PSSI)  X-ray, NMR, Comparative modeling, ab initio, threading methods. Structure refining techniques Energy minimization approaches (Steepest descent, Conjugate gradient etc.), Basis of Molecular dynamics simulations and its application.

Unit: 4  18 Lectures

Suggested Reading:
LMD.600: Dissertation. Credit Hours: 8

Learning Objective: The objective of dissertation part I would be to ensure that the student learns the nuances of the scientific writing. Herein the student shall have to write his synopsis including an extensive review of literature with simultaneous identification of scientifically sound (and achievable) objectives backed by a comprehensive and detailed methodology.

The Evaluation criteria shall be multifaceted as detailed below: Total marks 200

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<th>S.No.</th>
<th>Criteria</th>
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<tbody>
<tr>
<td>1.</td>
<td>Review of literature:</td>
<td>50</td>
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<td>2.</td>
<td>Identification of gaps in knowledge:</td>
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<td>3.</td>
<td>Objective formulation:</td>
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<td>4.</td>
<td>Methodology</td>
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<td>5.</td>
<td>References</td>
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The synopsis shall be evaluated by a three membered committee consisting of
- a. COC of the department
- b. Supervisor or Co-supervisor
- c. One faculty of allied department

Elective Course-III Credit Hours: 3.

Students has to choose 1 out of 2 elective course

LML.604: Evolutionary and Developmental Biology. Credit Hours: 3.

Learning Objective: This course is an introduction to animal evolution and development. The principal objective is to introduce students to the origin of life and developmental processes that lead to the establishment of the body plan of vertebrates and the corresponding cellular and genetic mechanisms. This will allow students, at a later stage, to understand organogenesis and histogenesis, as well as pathology related to mechanisms of development and differentiation.

Unit: 1 16 Lectures

Origin of Life: Lamarckism, Darwinism, Concepts of variation, adaptation, struggle, Mendelism, Spontaneity of mutations, Theories of phyletic gradualism vs. punctuated equilibria, Modern evolutionary synthesis. Origin of basic biological molecules, Abiotic synthesis of organic monomers and polymers, Concept of Oparin and Haldane,
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Experiment of Miller (1953), The first cell, Evolution of prokaryotes, Origin of eukaryotic cells, Evolution of unicellular eukaryotes, Anaerobic metabolism, Photosynthesis and aerobic metabolism.

Unit: 2

Paleontontology and Molecular Evolution: The evolutionary time scale, Eras, periods and epoch, Major events in the evolutionary time scale, Origins of unicellular and multicellular organisms, Stages in primate evolution including Homo sapiens. Concepts of neutral evolution, Molecular divergence and molecular clocks, Molecular tools in phylogeny, Classification and identification; Origin of new genes and proteins; Gene duplication and divergence.

Unit: 3


Unit: 4

Gametogenesis, Fertilization and Cell death: Production of gametes, Cell surface molecules in sperm-egg recognition in animals; Embryo-sac development and double fertilization in plants, Zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals, Embryogenesis and establishment of symmetry in plants, Seed formation. Hypersensitive response, functions, relevance with diseases, apoptosis, Caspases, Importance of PCD in plant development, role of PCD, model of PCD.

Suggested Reading:

HGL.604: Genetic Diseases and Therapies
Credit Hours: 3

Learning Objective: Course Objectives: The students will become familiar with the various types of genetic disorders and the therapies which although are in the research stage but may emerge as a future treatment method.

Unit 1

9 Lectures
Monogenic Disorders: Albinism, Cystic fibrosis, Achondroplasia, Huntington disease, Muscular dystrophy, X-linked rickets
Multifactorial Diseases in man: Diabetes, Celiac disease, Liver cirrhosis, Obesity, Hypertension, Cancer as genetic disease, Cancer-prone syndromes.

Unit 2

18 Lectures
Neurofibromatosis I; X/Y linked Human Syndromes due to Numerical Chromosomal Anomalies

Unit 3

18 Lectures
Genetic Screening: Risk calculations, Population screening for genetic disease-adult, Clinical utilization of presymptomatic and predispositional testing, Presymptomatic testing for genetic diseases and malignancy, carrier detection; prenatal and postnatal screening; Assisted reproductive techniques and Pre-implantation diagnosis and Genetic Counseling

Unit: 4  |  9 Lectures
Therapies for genetic disorders and Multifactorial diseases: Stem Cell Therapies: Stem cell types, cord blood cells, bone marrow transplantation, current stem cell therapies, Gene Therapies, Problems in gene therapy, Chemo and Radio therapies; Techniques in tissue engineering: tissue grafting, synthetic blood, skin grafts and metallic implants.

Suggested Reading:

Elective Course-IV

Credit Hours: 4.

Students has to choose 1 out of 2 elective course

LML.605: Radiation Biology

Learning Objective: From this course the students would have fair knowledge of basic concepts of radiation biology such as radiation physics, radiation biology and radiological protection. the students will also learn the applications of raditions and radio diagnosis/therapeutics.

Unit: 1  |  20 Lectures

Radiation Safety and Regulation: Storage and handling of radioactive sources, safe work practice and decontamination. Radiation protection measures in industrial establishment, radioisotope labs, diagnostic/therapeutic installation and during transportation of radioactive substances, disposal of radioactive waste, administrative & legislative aspect of radiation protection.

Unit: 2  |  18 Lectures
The oxygen Effect: Chemistry and biology of reactive oxygen species (ROS), oxidative stress and free radicals their role in cell metabolism, effects on macro/micromolecules (proteins, lipids and DNA) and diseases (diabetes, neurodegenerative diseases, inflammation and cardiovascular disorders). Antioxidant defence system.

Radiation and Cell Signalling: Extracellular mediators and enzymes involved in radiation-induced bystander effects (RIBE) and their role in signalling, intracellular pathways and apoptotic and cell cycle regulatory factors (p53, p21, p34, and MDM2). Correlation between membrane integrated channels and mitochondrial functions with radiation-induced bystander effects. Radiation immunology: immunity response, radiation as immunosuppressive agent.

Unit: 3  |  18 Lectures
Acute Radiation Effects: Concept of LD50, central nervous system syndrome, gastro-intestinal syndrome, bone marrow syndrome and skin reactions. Chronic effects of radiations: Early and delayed effects of radiation

**Unit: 4**


**Suggested Reading:**

**Related Weblinks:**
http://informahealthcare.com/loi/rab
http://www.rob.ox.ac.uk/

**HGL.607: Aging, Longevity and Health**

**Credit Hours: 4.**

**Learning Objective:** From the course students should be able to understand the known mechanisms behind process of ageing and how diet, genetics and environmental factors affect the process of ageing.

**Unit: 1**

**Basic Concept & Theories of Aging:** Overview and symptoms of aging, model organisms, Theories of aging—Genetic (Genetic control, Hayflick limit, DNA damage, error and repair, accumulated mutation, gene mutation, telomerase, antagonistic pleiotropy and redundant DNA theories), Non-genetic (Wear and tear, waste accumulation, cross-linkage, free-radical, order to disorder and disposable soma) and Physiological theories (Immunological, neuroendocrine, death hormone (DECO), thymic-stimulating, rate of living and calorie restriction theories).

**Unit: 2**

**Factors influencing Aging:** DNA damage and repair, cellular senescence and apoptosis, sirtuins and deacetylases, hormones, glycation, protein damage, attenuated immunity, inflammation, accumulation of toxins and garbage in aging.

**Unit: 3**

**Molecular Mechanism of Aging:** Mechanisms affecting aging due to calorie restriction, insulin signalling, mitochondria and telomerase. Longevity genes and biomarkers of aging. Cancer and aging.

**Unit: 4**

**Age associated diseases and Healthy Aging:** Atherosclerosis and cardiovascular disease, cancer, arthritis, cataracts, osteoporosis, type 2 diabetes, hypertension and Alzheimer's disease. Concept of healthy aging.

**Suggested Readings:**

**Semester IV**

<table>
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<th>S.No</th>
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<td>LML.622</td>
<td>Clinical and Medical Diagnostics</td>
<td>C</td>
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**LML.621: Genetic Engineering and Recombinant Therapeutics. Credit Hours: 4.**

**Learning Objective:** This course will introduce modern techniques for genetic engineering and students will learn cutting edge molecular engineering. Course will start with the basics of genetic engineering, the methodology of gene manipulation, and the implications of genetic engineering.

**Unit: 1**

**Basics of Genetic Engineering:** Gene Manipulation, Tools for molecular cloning. Restriction enzymes their types, Type I, II and III, restriction modification systems, Cohesive and blunt and ligation, linkers, adaptors, homopolymeric tailing, transformation, transfection: chemical and physical methods, sequencing and clone confirmation, expression optimization, *in-silico* methods of design.

**Unit: 2**

**Gene Cloning Vectors:** Plasmids, bacteriophages, cloning in M13 mp Vectors, phagenids, Lambda vectors; insertion and replacement vectors, EMBL, lambda DASH, lambda gt10/11, lambda ZAP etc. Cosmid vectors.

**Unit: 3**

**Expression Vectors:** Artificial chromosome vectors (YACs, BACs), Animal virus derived vectors-Sv-40, caccinial/bacculo& retroviral vectors. Expression vectors; pMal, GST, PET – based vectors. Protein purification; His-tag, GST-tag, MBP-tag. Restriction proteases, intein-based vectors. Inclusion bodies methodologies to reduce formation of inclusion bodies, *baculovirus* and *pichia* vectors system. Site Directed Mutagenesis.

**Unit: 4**

**Techniques and Applications of recombinant DNA technology:** Isolation and Detection of DNA, RNA and proteins by Southern blotting, Northern blotting, Western blotting and *in situ* hybridization techniques. Sites specific mutagenesis: Yeast two hybrid system, phage display, characterization of expressed proteins through various biophysical, biochemical methods. Gene mapping and Microarrays. Genetically modified microbes (Recombinant
bacteria) for the production of commercial scale production of proteins and pharmaceuticals, antibiotics, enzymes, insulin, growth hormones, monoclonal antibodies. Applications rDNA in diagnosis of pathogens and abnormal genes. Transgenic animals. Transgenic animals for production of proteins and pharmaceuticals. Genetically modified insect cells for the production of commercially important bioproducts. Biosafety and Ethical considerations in rDNA and genetic engineering.

Suggested Reading:

Related Weblinks:

LML..622: Clinical and Medical Diagnostics Credit Hours: 4.

Learning Objective: This course will help the student to understand the mechanisms of the origin and development of disease and its manifestations in the form of molecular, chemical, physiological and morphological changes. Student will able to integrate the clinical information with the underlying pathophysiology and will be able to correlate the disease symptoms and associated laboratory diagnosis.

Unit: 1 18 Lectures
Bioethics and Biosafety in Research, Clinical studies and Medicine: Good laboratory practices, Biological Containment (BC) and Physical Containment (PC), CDC Biosafety levels, Biosafety in Clinical Laboratories and Biohazard Management. Biosafety for human Health, Biosafety issues for using cloned genes, Genetically Engineered Organisms and r-DNA based products. Bioethics in Research, Animal Testing. Animal Rights, Perspectives and Methodology. Ethical Issues of the Human Genome Project, Code of Ethics in Medical/clinical laboratories. Healthcare rationing, Ethical Issues of Xenotransplantation, Ethics involved in Embryonic and Adult Stem Cell Research, Ethics in Assisted Reproductive Technologies: animal and human cloning and In-vitro fertilization, the element of Informed Consent, Ethical issues in MTP and Euthanasia

Unit: 2 18 Lectures
Clinical Pathology and Medical Diagnostics: Analyses of body fluids and tissues and from various disciplines of microbiology, serology, clinical chemistry, hematology, transfusion medicine, cytogenetics. Importance of diagnostic tools, Instruments used in medical diagnostics, imaging techniques.

Unit: 3 18 Lectures
Clinical Laboratory Sciences: Urine analysis to measure general health, collection methods, physical Examination of Urine, chemical Examination of Urine, microscopic Examination of Urine, blood, glucose or protein detection in
urine, disease association. Blood group and Rh factor, Clinical correlation of RBC and WBC counts, Platelets and Blood clotting disorders, Blood cancers. Histopathology: Grossing of tissue, tissue processing, fixation of tissue, section cutting, staining techniques, Hematoxylin and Eosin and Special Stains, Immunohistochemistry and immunofluorescence techniques.

Unit: 4 18 Lectures


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**Related Weblinks:**
2. http://www.hopkinsmedicine.org/healthlibrary/conditions/pathology/clinical_pathology_overview_85,P00955

**LMD.600: Dissertation**

**Credit Hours: 16.**

**Learning Objective:** The objective of dissertation part II would be to ensure that the student learns the nuances of the scientific research. Herein the student shall have to carry out the experiments to achieve the objectives as mentioned in the synopsis. The data collected as a result of experiments must be meticulously analysed in light of established scientific knowledge to arrive at cogent conclusions.

The Evaluation criteria shall be multifactored as detailed below:

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<th>S.No.</th>
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<td>2.</td>
<td>Presentation and open defence of research work</td>
<td>125</td>
</tr>
<tr>
<td>3.</td>
<td>Continuous evaluation of student by Guide</td>
<td>150</td>
</tr>
</tbody>
</table>

The synopsis shall be evaluated by a three membered committee consisting of

a. COC of the department
b. External Expert
c. Supervisor (and Co-supervisor if applicable)