

Central University of Punjab, Bathinda
Centre For Human Genetics and Molecular Medicine
M.Sc. Life Sciences Specialization in Molecular Medicine

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

Total Credit = 90 (Semester-I + Semester-II + Semester-III + Semester-IV = 24+22+24+20)

Course type	Required as per CBCS system, UGC	Percent and Actual Credit in M.Sc. Mol. Med
Foundation	10-15% i.e.7.2 to 10.8	12.2% (8 Cr)
Elective and IDs	25-35% i.e.18 to 25.2	33.3% (22 Cr)
Core	50-65% i.e. 36 to 46.7	54.5% (36 Cr)
Total credits (excluding dissertation)		100 % (66 Cr)

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Semester-I							
S. No	Course Code	Course Title	Course Type	L	T	P	Cr
1	LSL.501	Biostatistics and Research Methodology	F	2	1		3
2	LSL.503	Introduction to Cell and Molecular Biology	C	3	1	-	4
3	LSL.505	Basic and Clinical Biochemistry	C	3	1	-	4
4	LSL.507	Concepts of Genetics	C	3			3
5	LML.509	Trends in Molecular Medicine	E	4	-	-	4
6	*	Inter-Disciplinary Elective -1 (From Other Departments)	E	2	-	-	2
7	LSP.502	Introduction to Biostatistics & Research Methodology - Practical	F	-	-	2	1
8	LSP.504	Introduction to Cell and Molecular Biology	C	-	-	2	1
9	LSP.506	Basic and Clinical Biochemistry	C	-	-	2	1
10	LSP.508	Concepts of Genetics	C	-	-	2	1
11		Non credit seminar	F	-	-	-	-
		Total		17	3	8	24

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

S. No.	Course Code	Course title (offered by)	Credits
1	LML.511	Basics of Stem Cell Biology (Dr. Sandeep Singh)	2
2	LML.512	Introduction to Human Cancers (Dr. Harish Chander)	2

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LSL.501: Biostatistics and Research Methodology.

Credit Hours: 3.

Objective: 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. It will also ensure that the students of molecular medicine understand various aspects of research related methods, technical/scientific writings and literature search.

Unit 1

15 Lectures

Overview of Biostatistics: Difference between parametric and non-parametric statistics, Univariate and multivariate analysis, Frequency distribution, Measures of central tendency and variation.

Unit 2

12 Lectures

Experimental design and analysis: Sampling techniques, Sampling theory, Various steps in sampling, Sampling distribution. Graphical representation of data, Levels of significance, Hypothesis testing.

Unit 3

12 Lectures

Inferential Statistics: Chi-Square test, Student's t-test, One-way and two-way analysis of variance (ANOVA), Correlation and regression.

Unit 4

15 Lectures

Technical writing & Library: Scientific writing that includes the way of writing Synopsis, research paper, poster preparation and presentation, and dissertation. Classification systems, e-Library, web-based literature search engines.

Suggested Readings:

1. Norman, G. and Streiner, D. (2008). *Biostatistics: The Bare Essentials*. (with SPSS), 3rd Edition, Decker Inc. USA.
2. Sneath, P.H.A. and Sokal, R.R. (1973). *Numerical Taxonomy*. Freeman, San Francisco.
3. Sokal, R.R. and Rohlf, F.J. (1994). *Biometry: The Principles and Practices of Statistics in Biological Research*. W.H. Freeman publishers, USA.
4. Banerjee P.K (2014). *Introduction to Biostatistics*. S.Chand, India
5. Daniel WW (2010). *Biostatistics: A Foundation for Analysis in the Health Sciences*. John Wiley and Sons Inc.
6. Bailett NTJ. *Statistical Methods in Biology*. Cambridge Univ. Press.
7. Glaser AN. *High-Yield Biostatistics*. Lippincott Williams & Wilkins.

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LSL.503: Introduction to Cellular and Molecular Biology

Credit Hours: 4.

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.

Unit: 1

15 Lectures

Prokaryotic and eukaryotic cell.

Membrane Structure and Functions, 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.

Unit: 2

12 Lectures

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.

Unit: 3

15 Lectures

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

Gene and Genome organization: Split genes, Overlapping genes, Transposons & retro-transposons, Gene clusters, Mechanism of DNA replication, DNA damage and their repair.

Unit: 4

12 Lectures

Transcription: 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:

1. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J.D. (2010). *Molecular Biology of the cell*. Garland publishers, Oxford.
2. Celis, J.E. (2006). *Cell biology: A laboratory handbook*, Vol 1, 2, 3. Academic Press, UK.
3. Gupta, P.K. (2008). *Cytology, Genetics and Evolution*. Rastogi publications, Meerut, India
4. Karp, G. (2010). *Cell and Molecular Biology: Concepts and Experiments*. John Wiley & Sons. Inc. New Delhi, India.
5. Robertis, (2011). *Cell and Molecular Biology*. Lippincott Williams & Wilkins
6. Fasman, G.D. (1989). *Practical Handbook of Biochemistry and Molecular Biology*. CRC Press, Taylor and Francis Group, UK.
7. James, D.W., Baker, T.A., Bell, S.P., Gann, A. (2009). *Molecular Biology of the Gene*. Benjamin Cummings, USA.
8. Jocelyn, E.K., Elliott, S.G., Stephen, T.K. (2009). *Lewin's Genes X*. Jones & Bartlett Publishers, USA.
9. Johnson, A., Lewis, J., Raff, M. (2007). *Molecular Biology of the Cell*. Garland Science, USA.
10. Lodish, H., Berk, A., Chris, A.K. and Krieger, M. (2011). *Molecular Cell Biology*. W.H. Freeman, USA.
11. Sambrook, J., Fritish, E.F., Maniatis, T. (2012). *Molecular cloning: A laboratory manual*. Cold Spring Harbor Laboratory Press, New York.

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LSL.505: Basic and Clinical Biochemistry.

Credits Hours: 4.

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

Unit: 1

15 Lectures

Essentials of Clinical Biochemistry: Molecular structure and physical properties of water, Ionization of water, weak acids and weak bases, pH and buffers. Interpretation of biochemical tests, Clinical hematology, chemical composition of blood, urine and cerebrospinal fluids, water and sodium balance, Acid-base balance disorders, Potassium, calcium, magnesium and phosphate metabolism and associated diseases. Vitamins and trace elements disorders and metal poisoning.

Unit: 2

14 Lectures

Biomolecules and Metabolic Disorders: Structure and functions of carbohydrates, lipids, amino acids, proteins, nucleic acids and vitamins. Bioenergetics and thermodynamics, Phosphoryl group transfer and ATP, Biological oxidation-reduction reactions, Glycolysis, citric acid cycle and oxidative phosphorylation. Liver function test, jaundice, diabetes mellitus, hypoglycemia, hypertension, hypo- and hyper-thyroidism.

Unit: 3

10 Lectures

Conformation of Biomolecules: Ramachandran plot, Secondary, Tertiary and Quaternary structure, Domains, Motif and Folds. Protein denaturation and folding, Oxygen binding proteins, Hill equation, Bohr Effect, Nucleic acids: A-, B-, Z-DNA forms, tRNA, micro-RNA, Stability of protein and Nucleic acid structures.

Unit: 4

15 Lectures

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

Suggested Reading:

1. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2010). *Biochemistry*. W.H. Freeman & Company. USA.
2. Brown, T.A. (2006). *Gene Cloning and DNA analysis: In Introduction*. Blackwell Publishing Professional. USA.
3. Haynie, D.T. (2007). *Biological thermodynamics*. Cambridge University. UK.
4. Mathews, C.K., Van Holde, K.E. and Ahern, K.G. (2000). *Biochemistry*. Oxford University Press Inc. New York.
5. Nelson, D. and Cox, M.M. (2008). *Lehninger Principles of Biochemistry*. BI publications Pvt. Ltd. Chennai, India.
6. Ochiai, E. (2008). *Bioinorganic Chemistry: A survey*. Academic Press. Elsevier, India.
7. Randall, D. J., Burggren, W. and French, K. (2001). *Eckert Animal Physiology*. W.H. Freeman & Company. USA.
8. Raven, P.H., Johnson, G.B. and Mason, K.A. (2007) *Biology*. Mcgraw-Hill. USA.
9. Shukla AN (2009). *Elements of Enzymology*. Discovery Publishing. New Delhi, India.
10. Voet, D. and Voet, J.G. (2008). *Principles of Biochemistry*. CBS Publishers & Distributors. New Delhi, India.
11. R Swaminathann. (2011). *Handbook of Clinical Biochemistry*. 2 edition, World Scientific Publishing Company, New Jersey, USA
12. Martin A Crook (2012). *Clinical Biochemistry and Metabolic Medicine*. CRC press, Taylor & Francis Group, USA

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LSL.507: Concepts of Genetics.

Credits Hours: 3.

Learning Objective: Students will learn the basic principles of inheritance at the molecular, cellular and organism levels. 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

10 Lectures

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.

Unit: 2

17 Lectures

Chromosomal Mutations and Gene Concept: Type of chromosomal aberrations: deletions, duplications, inversions, translocations, Change in chromosome number: trisomy and polyploidy. Evolutionary history of bread wheat, Aneuploids–nullisomics, monosomics, and trisomics, Somatic aneuploids, Changes in chromosome structure, Properties of chromosomes for detection of structural changes. Mutations: Spontaneous and induced mutations, Somatic vs germinal mutation. Gene concept: Fine structure of gene and gene concept, Fine structure analysis – Benzer’s experiments, Complementation analysis and fine structure of gene, Complementation and recombination.

Unit: 3

17 Lectures

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*.

Unit: 4

14 Lectures

Extra-Chromosomal Inheritance: Chloroplast and Mitochondrial inheritance, Yeast, *Chlamydomonas/Neurospora* and higher plants, Symbiosis.

Suggested Reading:

1. Anthony, J.F., Miller, J.A., Suzuki, D.T., Richard, R.C., Gilbert, W.M. (1998). *An Introduction to Genetic Analysis*. W.H. Freeman publication, USA.
2. Atherly, A.G., Girton, J.R., McDonald, J.F. (1999). *The science of Genetics*. Saunders College publication.
3. Snusted, D.P., Simmons, M. J. (2010). *Principles of Genetics*. John Wiley & Sons, New York.
4. Gupta, P.K. (2009). *Genetics*. Rastogi Publications, Meerut, India.
5. Gupta, P.K (2008). *Cytology, Genetics and Evolution*. Rastogi Publications, Meerut, India.
6. Jocelyn, E.K., Elliott, S.G., Stephen, T.K. (2009). *Lewin’s Genes X*. Jones and Bartlett Publishers, USA.
7. Schaum, W.D. (2000). *Theory & problems in Genetics* by Stansfield, outline series McGrawhill, USA.
8. Tamarin, R.H. (1996). *Principles of Genetics, International edn*. McGrawhill, USA.
9. Sambrook, J., Fritish, E. F., Maniatis, T. (2012). *Molecular cloning: A laboratory manual*. Cold Spring Harbor Laboratory Press, New York.
10. Korf, B.R. (2013) *Human Genetics and Genomics*. Wiley-Blackwell

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LML.509: Trends in 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 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, pharmacogenomics, Developing novel biomarkers and therapies using high throughput technologies.

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.

Suggested Reading:

1. Littwack, G. (2008). *Human Biochemistry and Disease*. Academic Press.
2. Trent, R. J. (2012). *Molecular Medicine*, Fourth Edition: Genomics to Personalized Healthcare. Academic Press.
3. Trent, R. J. (2005). *Molecular Medicine: An Introductory Text*. Academic Press.
4. Elles, R., Mountfield, R. (2011). *Molecular Diagnosis of Genetic Diseases*. Springer Publication.
5. Liciniio, J., Wong, M. L. (2003). *Pharmacogenomics: The Search for Individualized Therapies*. Wiley.
6. Audet, J.,Stanford, W.and Stanford,W. L. (2009) *Stem cells in regenerative medicine*.New York, Humana press.

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LSP.502: Introduction to Biostatistics & Research Methodology - Practical.

Credit Hours: 1.

1. Experimental design and analysis.
2. Plotting different types of graphs using statistical data, using MS Excel
3. Plotting normal distribution graph
4. Frequency distribution, SD, SE calculations
5. Chi-square tests
6. Student's t-test
7. Regression and Correlation.
8. Writing scientific abstracts and papers.

*Practical will be conducted depending upon the faculty/facility.

LSP.504: Introduction to Cell and Molecular Biology – Practical.

Credit Hours: 1.

1. Preparation of mitotic & meiotic chromosomes.
2. Study of structure of cell organelles through electron micrographs.
3. Instrumental methods for cell biology-centrifugation, chromatography.
4. Immunofluorescence and fluorescent probes.
5. Sectioning of tissues.
6. Histochemical techniques (Fixing, Processing, Staining).
7. Epifluorescence and Confocal Microscopy.
8. Basics of bacterial/mammalian cell culture

*Practical will be conducted depending upon the available facility/faculty

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LSP.506: Basic and Clinical Biochemistry – Practical.

Credit Hours: 1.

1. Preparation of solutions, buffers, pH setting etc.
2. Amino acid and carbohydrate separations by paper & thin layer chromatography.
3. Quantitative Estimation of Proteins, Sugars, total lipids and amino acids.
4. Assay and estimation of different enzymes e.g. invertase, amylases, acid and alkaline phosphatases.
5. Principle and application of electrophoresis, Native, SDS PAGE.
6. Estimation of total phenolic compounds.
7. Extraction and estimation of vitamins.
8. Basic clinical tests like Urea, lipid profiling, SGOT, SGPT etc.

*Practical will be conducted depending upon the available facility/faculty

LSP.508: Concepts of Genetics - Practical.

Credit Hours: 1.

1. Calculation of allele frequencies.
2. Calculating recessive gene frequency, Calculating frequency of sex –linked alleles.
3. Karyotyping of normal & abnormal chromosome sets.
4. Monohybrid and dihybrid ratios, Multiple alleles, Epistasis – Problems.
5. Inheritance patterns in Man – Numericals on Pedigree analysis- Autosomal patterns, X–linked patterns, Y–linked patterns.
6. Mitochondrial inheritance patterns.
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.
9. Blood group typing using haemagglutination tests.
10. Studies of a Model organism: Identification of normal and mutant flies (*Drosophila melanogaster*) & Preparation of *Drosophila* polytene chromosomes.
11. To study fingerball and palmar dermatoglyphics and calculate indices.
12. To test for colour blindness using Ishihara charts.
13. Molecular Mapping of Genes.

*Practical will be conducted depending upon the available facility/faculty

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Interdisciplinary Courses for Semester-I

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.

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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 **18 Lectures**

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

Cellular Complexities: Evolution from single cell life to complex multicellular organisms, cell differentiation.

Unit: 2 **18 Lectures**

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

1. Alberts, B. Bray, D. Lewis, J., Raff, M., Roberts, K. and Watson, J.D. (2014). *Molecular Biology of the Cell*. Garland publishers, Oxford.
2. Celis, J.E. (2012). *Cell biology: A laboratory handbook*, Vol 1, 2, 3. Academic Press, UK.
3. Karp, G. (2010). *Cell and Molecular Biology: Concepts and Experiments*. John Wiley & Sons. Inc., New Delhi, India
4. Alimoghaddam, K. (2013). *Stem Cell Biology in Normal Life and Diseases*. INTECH publications.
5. Lanza R., Gearhart, J., Hogan, B., Melton, D., Pedersen, R., Thomas, E.D., Thomson, J., Wilmut, I. (2013). *Essentials of Stem Cell Biology* (Second Edition).

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LML. 512: 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

18 Lectures

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

18 Lectures

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:

1. Airley, R. (2010). *Cancer Chemotherapy: basics to clinic*. Willey-Blackwell publishing, New Jersey.
2. DeVita, V. T., Hellman, S., Rosenberg, S. A. (2011). *Cancer: principles and practice of oncology*. Lippincot Williams and Wilkins Publishers, Philadelphia.
3. Enders, G. H. (2010). *Cell cycle deregulation in cancer*. Humana Press, Springer science, New York.
4. Jocelyn, E. K., Elliot, S. G., Stephen, T. K. (2009). *Lewin's Gene X*. Jones & Barlett.
5. Wang, E. (2010). *Cancer Systems Biology*. CRC press, Taylor & Francis group, New York.
6. Weinberg, Robert A. (2007). *The Biology of Cancer*. New York: Garland Science

Related Web links:

<http://www.insidecancer.org/>
<http://www.cancer.gov/publications/patient-education>
<http://www.who.int/cancer/en/>
<http://www.cancer.gov/>
http://www.icmr.nic.in/ncrp/cancer_reg.htm

Non-Credit Seminar: The aim of the non-credit seminar is to help the students develop presentation skills.

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Semester-II							
S. No	Paper Code	Course Title	Course Type	L	T	P	Cr
1	LSL.521	Human Physiology	C	3	1	-	4
2	LSL.523	Essentials of Immunology	C	3	-	-	3
4	LML.524	Techniques in Molecular Medicine & Diagnostics	F	3			3
5		Elective Course-I	E	4			4
6		Elective Course-II	E	4			4
7		Interdisciplinary course-2	E	2			2
8	LSP.522	Human Physiology (P)	C	-	-	2	1
9	LMS.599	Credit Seminar	C			2	1
				19	1	2	22
Elective Course-I							
	LML.525	Regenerative Medicine	E	4	-	-	4
	HGL.525	Human Embryology and Developmental Genetics	E	4	-	-	4
Elective Course-II							
	LML.526	Molecular and Cellular Oncology	E	4	-	-	4
	HGL.526	Population Genetics and Genetic Epidemiology	E	4	-	-	4

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LSL.521: Human Physiology.

Credit Hours: 4.

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

14 Lectures

Cardiovascular System: Myogenic heart, Cardiac cycle, blood pressure, Hematopoiesis, Hemopoiesis and formed elements, Plasma function, Blood pressure and its neural and chemical regulation, Blood groups.

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

Unit: 2

12 Lectures

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

Respiratory System: Anatomical considerations, Transport of gases, Exchange of gases, Waste elimination, Neural and chemical regulation of respiration. Alveolar Ventilation, Diffusion across alveoli. Transport of respiratory. The Respiratory System under Stress: Altitude, Hypoxia

Unit: 3

14 Lectures

Nervous System: Neurons, action potential, Central and peripheral nervous system, Neural control of muscle tone and posture, Vision, hearing and tactile response.

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

Unit: 4

14 Lectures

Reproduction: Males and female reproductive system.

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

Suggested Reading:

1. Brody, T. (1998). *Nutritional biochemistry*. Academic Press, USA.
2. Devlin, T.M. (2005). *Textbook of Biochemistry with Clinical Correlations*. John Wiley & Sons Inc. USA.
3. Guyton. (2007). *Textbook of medical physiology*. 11th Edition. Elsevier India Pvt. Ltd. New Delhi.
4. Hill, R.W, Wyse, G. A. and Anderson, M. (2008). *Animal Physiology*. Sinauer Associates Inc. USA.
5. Khurana. (2006). *Textbook of Medical Physiology*. Elsevier India Pvt. Ltd.
6. Murray, R.K. (2009). *Harper's Illustrated Biochemistry*. Jaypee Publishers, New Delhi, India.
7. Tyagi, P. (2009). *A Textbook of Animal Physiology*. Dominant Publishers and distributors, New Delhi, India.
8. Silverthorn D, (2011) *Human Physiology*, Pearson; 6th edition.
9. Sherman V. (2013) *Vander's Human Physiology*. McGraw-Hill 13th edition.

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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

Immune System: The cells and organs of immune system. Recognition of self and nonself, Humoral immunity-immunoglobulin, basic structure, classes and subclasses, structural and functional relationships, nature of antigen, antigen-antibody reaction, estimation of affinity constants. Molecular mechanisms of antibody diversity and Cellular immunity: Organization of genes coding for constant and variable regions of heavy chains and light chains. Mechanisms of antibody diversity, class switching. Lymphocytes, cytokines, interferons, Interlukins, antigen recognition-membrane receptors for antigens.

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:

1. Kindt, T.J., Osborne, B.A. and Goldsby, R.A. (2007). *Kuby Immunology*. 7th Edition. W.H. Freeman, USA.
2. Abbas. (2008). *Cellular and Molecular Immunology*. CBS Publishers & Distributors, India.
3. Charles, A. and Janeway, J.R. (1994). *Immunobiology: The immune system in health and disease*. Blackwell Publishing, USA.
4. Delves, P.J., Roitt, I.M. and Seamus, J.M. (2006). *Roitt's Essential Immunology (Series–Essentials)*. Blackwell Publishers, USA.
5. Elgert, K.D. (2009). *Immunology: Understanding the immune system*. Wiley-Blackwell, USA.
6. Paul, W.E. (1993). *Fundamental immunology*. Raven Press, SD, USA.
7. Sawhney, S.K. and Randhir, S. (2005). *Introductory Practical Biochemistry*. Alpha Science International Ltd. New Delhi, India.
8. Tizard. (2008). *Immunology: An Introduction*. Cengage Learning, Thompson, USA.
9. Owen, Judith A; Punt, Jenni, Stranford, Sharon A. *Kuby's Immunology* (2013), W.H. Freeman and Company: New York, 2013

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LSL.524: Techniques in Molecular Medicine

Credit Hours: 3.

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

Unit 1

10 Lectures

Biochemical Techniques: Sterilization techniques, spectrophotometry, Centrifugation: Principle and applications, Chromatography: Principle, procedure and applications.

Unit:2

12 Lectures

Microscopy: Light microscopy, phase contrast microscopy, fluorescent microscopy, scanning electron microscopy (SEM/FESEM), transmission electron microscopy (TEM), micrometry and photomicrography, Histochemistry, Scanning-probe microscopy, Atomic force microscopy, CLSM.

Unit:3

16 Lectures

Proteins and mass spec, 2d, high throughput techniques

Nucleic Acids: Isolation, purification and analysis of nucleic acids. Electrophoresis: Principle of gel electrophoresis, polyacrylamide gel electrophoresis (PAGE and SDS-PAGE), agarose gel electrophoresis, pulse field gel electrophoresis (PFGE) and Two-Dimensional gel electrophoresis. Polymerase chain reaction (PCR): Principle, types and applications, PCR based markers: RAPDs, SSRs, SNPs, ISSRs, and SCARs etc. Blotting techniques: Southern, Northern, Western, Dot blotting and hybridization, DNA fingerprinting.

Unit:4

16 Lectures

Cell culture and Related Techniques: Sterile culture practices, Cell sorting, Hybridoma technology/Production of antibodies, Flow cytometry, Histochemical and Immunotechniques, Immunochemical Techniques, Developing Monoclonal and Polyclonal antibodies, Immunocytochemistry, Radioimmunoassay (RIA), Enzyme Linked Immunosorbent Assay (ELISA).

Suggested Reading:

1. Brown, T.A. (2010). *Gene cloning and DNA analysis: An Introduction*. 6th Edition, Wiley-Blackwell Publisher, New York.
2. Goldsby, R.A., Kindt, T.J. and Osborne, B.A. (2008). *Kuby Immunology*. 6th Edition, W. H. Freeman & Company, San Francisco.
3. Gupta, P.K. (2005). *Elements of biotechnology*. Rastogi Publications, Meerut.
4. Gupta, S. (2005). *Research methodology and statistical techniques*, Deep & Deep Publications (P) Ltd. New Delhi.
5. Lewin, B. (2010). *Genes X*, CBS Publishers & Distributors. New Delhi.
6. Nelson, D. and Cox, M.M. (2009). *Lehninger Principles of Biochemistry*. W.H. Freeman and Company, New York.
7. Primrose. S.B. and Twyman, R. (2006). *Principles of Gene Manipulation and Genomics*. Blackwell Publishing Professional, U.K.
8. Sambrook, J. (2006). *The Condensed Protocols from Molecular Cloning: A Laboratory Manual*. Cshl Press. New York.
9. Sambrook, J., Fritish, E.F., Maniatis, T. (2012). *Molecular cloning: A laboratory manual*. Cold Spring Harbor Laboratory Press, New York.
10. Sawhney, S.K. and Singh, R. (2005). *Introductory Practical Biochemistry*. Narosa Publishing House, New Delhi .

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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.
 9. Estimation of glucose by different methods.
- *More practicals may be conducted depending on available faculties/facilities.

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Elective Course-I

Credit Hours: 4.

Students has to choose 1 out of 2 elective course

LML.525: Regenerative Medicine

Credit Hours: 4.

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

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 teratogens, teratomas. Stem cell culture, organ culture, artificial blood, Somatic cell fusion and somatic cell genetics.

Unit: 2

16 Lectures

Stem Cells: Stem cells and their properties, classification of stem cells, *in-vitro* culture techniques, isolation, identification and characterization of stem cells, stem cells in various organs and in disease conditions.

Unit: 3

20 Lectures

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: 4

20 Lectures

Regenerative Medicine: Modes of tissue and organ delivery, tissue Engineering and transplantation techniques, immunoisolation techniques, regeneration of bone and cartilage, Islet cell transplantation and bio-artificial pancreas, lung regeneration

Suggested Reading:

1. Lanza, R., Gearhart, J. (2009). *Essential of Stem Cell Biology*. Elsevier Academic Press.
2. Lanza, R., Klimanskaya, I. (2009). *Essential Stem Cells Methods*. Academic Press.
3. Mao, J. J., Vunjak-Novakovic (2008). *Translational Approaches in Tissue Engineering & Regenerative Medicine*. Artech House INC Publications.
4. Lanza, R. (2007). *Principles of Tissue Engineering, 3rd Edition*. Academic Press.
5. Stein. (2011). *Human Stem Cell Technology and Biology: A Research Guide and Laboratory Manual*. Wiley-Blackwell.
6. Lanza, R. (2004). *Handbook of Stem Cells, Two-Volume Set: Volume 1-Embryonic Stem Cells; Volume 2-Adult and Fetal Stem Cells*. Academic Press.

Related Weblinks:

1. www.stemcells.wisc.edu
2. <http://stemcells.nih.gov/info/scireport/Pages/2006report.aspx>
3. stemcells.nih.gov/
4. <http://instem.res.in/>

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HGL.525: Human Embryology and Developmental Genetics

Credit Hours: 4.

Unit: 1

18 Lectures

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

18 Lectures

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

18 Lectures

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

18 Lectures

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:

1. Green, D. R. & Reed J. C. (2010). *Apoptosis: Physiology and Pathology*. Cambridge press, UK.
2. Milunsky, J. & Milunsky, A. (2010). *Genetic Disorders and the Fetus: Diagnosis, Prevention & Treatment*. Willey Blackwell India, New Delhi.
3. Nussbaun, R., Roderick, R. M. and Huntington, F.W.(2007). *Genetics in Medicine*. Saunders Elsevier Philadelphia.
4. Prakash, G. (2007). *Reproductive Biology*. Narosa Publication House Pvt. Ltd., New Delhi.
5. Sadler, T.W., Tosney, K., Chescheir, N.,C., Imseis, H., Leland, J. and Sadler-Redmond, S.,L. (2011). *Langman's Medical Embryology (Longmans Medical Embryolgy)*. Lippincott Williams and Wilkins.
6. Schaefer, B.D. (2013). *Medical Genetics: An integrated Approach*. McGraw Hill Education, New Delhi.
7. Tyagi R. (2011). *Understanding Evolutionary Biology*. Discovery Publication House Pvt. Ltd., New Delhi.

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Elective Course-II

Credit Hours: 4.

Students has to choose 1 out of 2 elective course

LML. 526: Molecular and Cellular Oncology

Credit Hours: 4.

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, Chromosomal aberrations, tumor viruses and discovery of oncogenes, Mechanism of activation of oncogenes. tumor suppressors and oncogenes, familial cancer syndromes, telomere regulation in cancer.

Unit: 2 **18 Lectures**

Signal Transduction in Cancer Progression: Deregulation of Cell cycle in cancer. Cell signaling in cancer; cancer metabolism; hypoxia and metastasis, angiogenesis, tumor microenvironment. DNA damage and repair mechanisms, DNA repair defects and their relation to cancer, cancer stem cells.

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, Application of new technologies in prevention, assessing risk, diagnostics and treatment.

Suggested Reading:

1. Airley, R. (2010). *Cancer Chemotherapy: basics to clinic*. Willey-Blackwell publishing, New Jersey.
2. DeVita, V. T., Hellman, S., Rosenberg, S. A. (2011). *Cancer: Principles and Practice of Oncology*. Lippincot Williams and Wilkins publishers, Philadelphia.
3. Enders, G. H. (2010). *Cell cycle deregulation in cancer*. Humana Press, Springer science, New York.
4. Grutzmann, R., Pilarsky, C. (2010). *Cancer Gene Profiling: Methods and Protocols*. Humana Press, Springer science, New York.
5. Gusev, Y. (2010). *Micro RNA Profiling in Cancer*. Pan Stanford publishing pvt.Ltd., Singapore.
6. Hiem, S., Mitelman, F. (2009). *Cancer Cytogenetics*. IIIrd edition. Willey-Blackwell publishing, New Jersey.
7. Jocelyn, E. K., Elliot, S. G., Stephen, T. K. (2009). *Lewin's Gene X*. Jones & Barlett.
8. Wang, E. (2010). *Cancer systems biology*. CRC press, Taylor & Francis group, New York.
9. Weinberg, Robert A. (2007). *The Biology of Cancer*. New York: Garland Science

Related Weblink

<http://www.insidecancer.org/>

<http://www.who.int/cancer/en/>

<http://www.cancer.gov/>

http://www.icmr.nic.in/ncrp/cancer_reg.htm

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HGL. 526: Population Genetics and Genetic Epidemiology

Credit Hours: 4.

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:

1. Bhasker, H.V. and Kumar S (2008). *Genetics*. Campus Books International, New Delhi, India.
2. Cavalli-Sforza, L.L. and Bodmer, W.F. (2013). *The Genetics of Human Populations*. Dover Publications.
3. Hamilton M.B. (2009). *Population Genetics*. Wiley-Blackwell, UK.
4. Hedrick P.W.(2011). *Genetics of Populations*. Jones and Bartlett Publishers, Massachusetts.
5. Jobling, M., Hollox, E., Hurles, M., Kivisild, T. and Tyler-Smith, C. (2013). *Human Evolutionary Genetics*. Garland Science.
6. Knight, J.C. (2009). *Human Genetic Diversity –Functional consequences for Health and Disease*. Oxford University Press, USA.
7. Krebs, J.E, Goldstein, E.S. and Kilpatrick, S.T. (2013) *Lewin's Essential Genes*. Jones and Bartlett learning, USA.
8. Nielsen, R. and Slatkin, M. (2013). *An Introduction to Population Genetics: Theory and Applications*. Sinauer Associates, Inc.
9. Relethford, J.H. (2012). *Human Population Genetics*. John Wiley & Sons.
10. Snusted, D.P., Simmons, M. J. (2010). *Principles of Genetics*. John Wiley & Sons, New York.
11. Palmer LJ, Burton PR and Smith GD (2011): *An introduction to genetic epidemiology* (Policy Press, University of Bristol)
12. Dawn TM (2011): *Genetic Epidemiology* (Springer)
13. Austin M (2013): *Genetic Epidemiology: Methods and Applications*, 1st Edition (CABI Publishing)

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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' that will be helpful to overcome the presentation related fears and blunders.

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Semester-III								
S. No	Course Code	Course Title	Course Type		L	T	P	Cr
1	LSL.601	Molecular Basis of Human Diseases	C		4	-	-	4
2	LML.602	Bioinformatics and Computational Biology	C		4	-	-	4
3		Elective Course-III	E		4			4
4		Elective Course-IV	E		4	-	-	4
5	LMD.600	Research Project					16	8
					16	0	8	24
Elective Course-III								
	LML.604	Evolutionary and Developmental Biology	E		3	-	-	3
	HGL.604	Genetic Diseases and Therapies	E		3	-	-	3
Elective Course-IV								
	LML.605	Molecular Endocrinology and Signal Transduction	E		4	-	-	4
	LML.606	Diseases of National Importance	E		4	-	-	4

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LSL.601: 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 life style, diet and heredity in the human diseases.

Unit: 2

18 Lectures

Genetic disorders: various classifications of genetic disorders, Intersex Disorders: Male Pseudo-hermaphrodite (MPH), Female Pseudo-hermaphrodite (FPH), True Hermaphrodites (TH), Mixed gonadal dysgenesis (MGD) & Dysgenetic male pseudohermaphrodite (DMP) and Persistent Mullerian duct syndrome (PMDS), 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: 3

18 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.

Unit: 4

20 Lectures

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:

1. Patch, H. S. C. (2009). *Genetics for the Health Sciences*. Scion Publishing Ltd., UK.
2. Brown, S. M., (2009). *Essentials of Medical Genomics*. Wiley-Blackwell.
3. Jocelyn, E. K., Elliot, S. G., Stephen, T. K. (2009), *Lewin's Gene X*. Jones & Barlett.
4. Milunsky, A., Milunsky, J. (2009). *Genetic Disorders and the Fetus: Diagnosis, Prevention and Treatment, 6th Edition*. Wiley-Blackwell publishers.
5. Trent, R. J. (2010). *Molecular Medicine, Fourth Edition: Genomics to Personalized Healthcare*. Academic Press.
6. Trent, R. J. (2005). *Molecular Medicine: An Introductory Text*. Academic Press.
7. Elles, R. and Mountford, R. (2012). *Molecular Diagnosis of Genetic Diseases Series: Methods in Molecular Medicine*.
8. Coleman, W. B. and Tsongalis, G. J. (2009). *Molecular Pathology: The Molecular Basis of Human Disease*. Academic Press.
9. Nussbaum, R.L., McInnes, R. Mc., Willard, H.F. (2009). *Genetics in Medicine*. Elsevier Inc., Philadelphia.
10. Read A and Donnai D (2007). *New clinical Genetics*. Scion Publishing Lmt., Oxfordshire, UK.

Related Weblinks

<http://www.journals.elsevier.com/bba-molecular-basis-of-disease/>
<http://biology.gsu.edu/mbd/>

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LML.602: 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 T_m 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**

Simulation Methods: algorithm for time dependence; leapfrog algorithm, Verlet algorithm, Boltzmann velocity, time steps, duration of the MD run, Starting structure, analysis of MD job, uses in drug designing, ligand protein interactions. Various methods of MD, Monte Carlo, systematic and random search methods. Differences between MD and MC, Energy, Pressure, Temperature, Temperature dynamics, simulation softwares. Various methods of MD, Monte Carlo, systematic and random search methods.

Suggested Reading:

1. Andrew R. Leach *Molecular Modelling Principles and applications* . (2001) II ed . Prentice Hall.
2. A.D. Baxevaniset. al., *Current Protocols in Bioinformatics*, (2005) Wiley Publishers
3. David W. Mount *Bioinformatics* (2001) Cold Spring Harbor Laboratory Press, ISBN 0-87969-608-7
4. *Computational Molecular Biology* by P. A. Pevzner, Prentice Hall of India Ltd, (2004) ISBN 81-203-2550-8
5. D.E. Krane and M.L. Raymer *Fundamental concepts of Bioinformatics* (2003) Pearson Education ISBN 81-297-0044-1
6. N. Gautham *Bioinformatics* Narosa publications. (2006) ISBN-13: 9781842653005
7. Fenniri, H. “*Combinatorial Chemistry – A practical approach*”, (2000) Oxford University Press, UK.
8. Lednicer, D. “*Strategies for Organic Drug Discovery Synthesis and Design*”; (1998) Wiley International Publishers.
9. Gordon, E.M. and Kerwin, J.F “*Combinatorial chemistry and molecular diversity in drug discovery*” (1998) Wiley-Liss Publishers.

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LMD.600: Research Project

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 multifacted as detailed below: **Total marks 200**

S.No.	Criteria	Marks allotted
1.	Review of literature:	50
2.	Identification of gaps in knowledge:	20
3.	Objective formulation:	50
4.	Methodology	50
5.	References	30

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

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Elective Course-III

Credit Hours: 4.

Students has to choose 1 out of 2 elective course

LML.604: Evolutionary and Developmental Biology.

Credit Hours: 4.

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, 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

14 Lectures

Paleontology 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

14 Lectures

Basic Concepts of Development: Totipotency, 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: 4

10 Lectures

Gametogenesis, Fertilization and Cell death: 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. Hypersensitive response, functions, relevance with diseases, apoptosis..

Suggested Reading:

1. Darwin, C.R. (1911). *On the origin of species by means of natural Selection, or preservation of favoured races in the struggle for life.*Hurst Publishers, UK.
2. Dawkins, R. (1996). *The Blind Watchmaker*, W.W. Norton & Company Jones and Bartlett Publishers.
3. Futuyma, D.J. (2009). *Evolution*. Sinauer Associates Inc. USA.
4. Hake, S. and Wilt, F. (2003). *Principles of Developmental Biology*.W.W. Norton & Company, New York, USA.
5. Hall, B.K. and Hallgrimsson, B. (2007). *Strickberger's Evolution*.Jones and Bartlett Publishers, India.
6. Lewin, R. (2004). *Human Evolution - An Illustrated Introduction*.Wiley-Blackwell, USA.
7. Scott, F. and Gilbert, S.F. (2010). *Developmental Biology*. Sinauer Associates, Inc. USA.
8. Slack, J.M.W. (2005). *Essential Developmental Biology*, Wiley-Blackwell, USA.

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HGL.604: Genetic Diseases and Therapies

Credit Hours: 3.

Learning Objective: 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

Genomic Imprinting and Human Diseases: Uniparental Disomy & Genomic Imprinting Prader-Willi & Angelman syndromes, Beckwith-Wiedeman syndrome & Silver Russell Syndrome; Imprinting and brain and behaviour; Imprinting and Cancer.

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:

1. Brown, S.M., (2009). *Essentials of Medical Genomics*. Wiley-Blackwell.
2. Jocelyn, E. K., Elliot, S. G., Stephen, T. K. (2009), *Lewin's Gene X*. Jones & Barlett.
3. Krebs, J.E., Goldstein, E.S. and Kilpatrick, S.T. (2014). *Lewin's Genes XI*. Jones and Bartlett India Pvt. Ltd.

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Elective Course-IV

Credit Hours: 4.

Students has to choose 1 out of 2 elective course

LML.605: Molecular Endocrinology and Signal Transduction

Credit Hours: 4.

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.

Unit: 2 **15 Lectures**

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- EGF receptor 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: 3 **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/PRIH, GHRH/GHRIH. Pituitary Hormones - Anterior Pituitary hormones- Growth hormone, Prolactin, POMC peptide family, LH, FSH, TSH; Posterior Pituitary: Vasopressin, Oxytocin, reproductive hormones, Other organs with endocrine function: Heart (ANP), Kidney (erythropoietin), Liver (Angiotensinogen, IGF-1), Adipose tissue (Leptin, adiponectin).

Unit: 4 **15 Lectures**

Endocrine disorders: Gigantism, Acromegaly, dwarfs, pigmies; Pathophysiology: Diabetes insipidus. Thyroid Hormone (include biosynthesis) Goiter, Graves disease, Cretinism, Myxedema, Hashimoto's disease. Pancreatic Hormones: Insulin, Glucagon, Diabetes type I & II. Hormones associated with obesity: Ghrelin, Leptin.

Suggested Reading:

1. Norris, D.O., and Carr, J.A. *Vertebrate Endocrinology*, 5th Edition. Academic Press, 2012.
2. Nelson, David L., and Cox, Michael M., *Lehninger Principles of Biochemistry*, 5th Edition. WH Freeman & Company, New York, 2008.
3. Widmaier, E.P., Raff, H., and Strang, K.T. *Vander's Human Physiology*, 13th Edition. McGraw-Hill Higher Education, 2013.
4. Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A., and Scott, M.P. *Molecular Cell Biology*, 7th Edition. W.H. Freeman, 2012

Central University of Punjab, Bathinda
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LML.605: Diseases of National Importance

Credit Hours: 4.

Learning Objective: The course is designed for the students of life sciences who are interested to in understanding the prevalent diseases in India. The course will include epidemiological data, potential known disease mechanisms and mechanisms of disease manifestation will also be discussed in detail.

Unit: 1 **15 Lectures**

National health policy and health economics. Socio-economic impact of various diseases. Epidemiology of the diseases prevalent in India. Role of nutrition in the prevention of diseases

Unit: 2 **16 Lectures**

Epidemiology and mechanisms of disease manifestation for disease common in India e.g. Diabetes, Cardio-vascular disorders, Endocrine disorders, Allergic disorders, Neurological disorders.

Unit: 3 **16 Lectures**

Epidemiology and mechanisms of disease manifestation for common cancers in India e.g. Childhood Cancers, Prostrate, cervical, breast and ovarian cancer, lung cancer, Leukemia and lymphoma

Unit: 4 **15 Lectures**

Emerging infections in modern India. Drug resistant infections caused by viruses and other microbes, Indian system of Medicine

Suggested Readings:

Related Weblinks

<http://www.cdc.gov/globalhealth/countries/india/default.htm>

<http://www.ncdc.gov.in/>

<http://www.icmr.nic.in/>

<http://www.dhr.gov.in/>

<http://www.mohfw.nic.in/>

<http://mdws.gov.in/>

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Semester IV							
S.No	Paper Code	Course Title	Course Type	L	T	P	Cr
1	LML.621	Genetic Engineering and Recombinant Therapeutics	C	4	-	-	4
2	LMD.600	Research Project				32	16
				6	0	32	20

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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

16 Lectures

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

16 Lectures

Gene Cloning Vectors: Plasmids, bacteriophages, cloning in M13 mp Vectors, phagemids, Lamda vectors; insertion and replacement vectors, EMBL, λ DASH, λ gt10/11, λ ZAP etc. Cosmid vectors.

Unit: 3

20 Lectures

Expression Vectors: Artificial chromosome vectors (YACs, BACs), Animal virus derived vectors-Sv-40, vaccinal/baculo& 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

20 Lectures

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:

1. R.W. Old & S.B. Primrose (2007) *Principles of Gene Manipulation* 7th Edition Blackwell science.
2. Bernard R. Glick & Jack J. Pasternak. (2010) *Molecular Biotechnology* 4th Edition ASM Press Washington.
3. James, Watson Micheal Gilman Jan Witkowsk (2007) *Recombinant DNA* 3rd edition, CSHL, New York.
4. Cokin Rateldge and Bjorn Christiansen, (2006) *Basic Biotechnology* 3rd edition Cambridge University press.
5. John E. Smith. (2009) *Biotechnology* 5th Edition by Cambridge University press.
6. *Molecular Biology of Gene* 6th Edition by Watson CSHL Press New York.
7. Sambrook& Russell *Molecular cloning* , CSHL Press, New York.
8. David & Freifelder John & Barlett (2008) *Molecular biology* 2nd Edition , Narosa publishing , New Delhi.

Related Weblinks:

1. <http://www.genengnews.com/ontheweb.asp>
2. <http://www.ige-india.com/>
3. <http://www.icgeb.org/~bsafesrv/>
4. <http://www.livescience.com/32648-whats-genetic-engineering.html>

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LMD.600: Research Project

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 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)