

**Central University of Punjab, Bathinda**



**Course Scheme & Syllabus**

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

**Batch: 2018-20**

## SEMESTER-I

Sr. No.	Paper Code	Course Title	Lecture Credits	Tutorial Credits	Practical Credits	Total Credits
<b>Compulsory Foundation Courses</b>						
1.	LHG.506	Biostatistics and Research Methodology	3	1	-	4
2.	LHG.507	Biostatistics & Research Methodology (Practical)	-	-	1	1
<b>Core Courses</b>						
3.	LMM.508	Cellular and Molecular Biology	4	-	-	4
4.	LMM.509	Cellular and Molecular Biology	-	-	1	1
5.	LMM.510	Basic and Clinical Biochemistry	4	-	-	4
6.	LMM.511	Basic and Clinical Biochemistry	-	-	1	1
7.	LHG.512	Concepts of Genetics	4	-	-	4
8.	LHG.513	Concepts of Genetics	-	-	1	1
9.	LMM.514	Trends in Molecular Medicine	3	1	-	4
<b>Interdisciplinary Elective Course - I</b>						
10.	LMM.515	Introduction to Human Cancers	2	-	-	2
		<b>Total Credit</b>	<b>20</b>	<b>2</b>	<b>4</b>	<b>26</b>

**Transaction mode:** Lecture, Demonstration, lecture cum demonstration, group discussion, tutorial, problem solving, experimentation, SOLE (for selected few topics apart from syllabus), self-learning.

## SEMESTER-II

Sr. No.	Paper Code	Course Title	Lecture Credits	Tutorial Credits	Practical Credits	Total Credits
<b>Core Courses</b>						
1.	LHG.521	Human Physiology	4	-	-	4
2.	LMM.522	Human Physiology (Practical)	-	-	1	1
3.	LMM.523	Essentials of Immunology	4	-	-	4
4.	LMM.524	Techniques in Molecular Medicine	3	1	-	4
<b>Discipline Elective – I (Choose any one)</b>						
5.	LMM.525	Regenerative Medicine	4	-	-	4
6.	LHG.525	Human Embryology and Developmental Genetics	4	-	-	4
<b>Discipline Elective – II (Choose any one)</b>						
7.	LHG.526	Population Genetics and Genetic Epidemiology	4	-	-	4
8.	LMM.526	Molecular and Cellular Oncology	4	-	-	4
<b>Interdisciplinary Elective Course – II</b>						
9.	LMM.515	Introduction to Human Cancers	2	-	-	2
<b>Skill Based Course</b>						
10.	LMM.542	Seminar-I	1	-	-	1
		<b>Total Credit</b>	<b>22</b>	<b>1</b>	<b>1</b>	<b>24</b>

**Transaction mode:** Lecture, Demonstration, lecture cum demonstration, seminar, group discussion, tutorial, problem solving, experimentation, SOLE (for selected few topics apart from syllabus), self-learning.

### SEMESTER-III

Sr. No.	Paper Code	Course Title	Lecture Credits	Tutorial Credits	Practical Credits	Total Credits
<b>Compulsory Foundation</b>						
1.		MOOC course (One course)	4	-	-	4
<b>Core Courses</b>						
2.	LMM.551	Molecular Basis of Human Diseases	4	-	-	4
4.	LMM.552	Evolutionary and Developmental Biology	4	-	-	4
5.	LMM.553	Molecular Endocrinology and Signal Transduction	4	-	-	4
<b>Skill Based Course</b>						
6.	LMM.599	Research Project	-	-	6	6
		<b>Total Credit</b>	<b>16</b>	<b>-</b>	<b>6</b>	<b>22</b>

**Transaction mode:** Lecture, Demonstration, lecture cum demonstration, group discussion, tutorial, problem solving, experimentation, SOLE (for selected few topics apart from syllabus), project method, problem solving, case study, self-learning.

### SEMESTER-IV

Sr. no.	Paper Code	Course Title	Lecture Credits	Tutorial Credits	Practical Credits	Total Credits
<b>Core Courses</b>						
1.	LMM.571	Genetic Engineering and Recombinant Therapeutics	4	-	-	4
2.	LMM.572	Advanced Practical Course in Molecular Medicine	-	-	3	3
<b>Discipline Enrichment Course</b>						
3.	LHG.573	Practice in Life Sciences-I	2	-	-	2
4.	LHG.574	Practice in Life Sciences-II	2	-	-	2
<b>Skill Based Course</b>						
5.	LMM.544	Credit Seminar-II (Presentation Skills)	1	-	-	1
6.	LMM.599	Research Project	-	-	6	6
<b>Elective Foundation/Value based course</b>						
7.	Two courses of one credit each need to be chosen from the list of EF/VB courses given by the University		1+1 = 2	-		2
		<b>Total Credit</b>	<b>11</b>	-	<b>9</b>	<b>20</b>

## **LHG.506: Biostatistics and Research Methodology**

**Credit Hours: 4**

**Course Objectives:** This course will give a basic but significant exposure towards better understanding of implication of statistics in biology and applicability of appropriate research methodology. The course will help students in testing hypothesis, designing experiments, analyzing experimental data and interpreting the results of biological research.

### **Unit – 1**

**15 hours**

**Overview of Biostatistics:** Basic concepts of statistical data and different types of tables; graphical representation of experimental data for publication; frequency distribution; measurement of central tendency and variation; statistical errors.

### **Unit – 2**

**15 hours**

**Experimental design and analysis:** Basics of sampling in biological studies; different types of sampling techniques; various steps in sampling; concept of data distribution in sampling; graphical representation of data; level of significance; multiple corrections; hypothesis testing.

### **Unit – 3**

**15 hours**

**Inferential Statistics:** Chi-Square test: hypothesis testing, contingency, homogeneity; student's t-test: paired and unpaired, one tailed and two tailed; one-way and two-way analysis of variance (ANOVA); correlation and regression.

### **Unit – 4**

**15 hours**

**Study design & Technical writing:** Best practices in research and technicality of research design; interpretation and report writing; e-Library; web-based literature search engines; evaluation based development of scientific writing skill: synopsis, research paper, poster preparation and paper presentation and dissertation.

### **Suggested Readings**

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

**LHG.507: Introduction to Biostatistics & Research Methodology - Practical**  
**Credit Hours: 1**

1. Plotting different types of graphs using statistical data, using MS Excel.
2. Plotting normal distribution graph
3. Frequency distribution, SD, SE calculations
4. Chi-square tests
5. Student's t-test
6. ANOVA
7. Regression and Correlation.
8. Scientific writing skill development.

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

**LMM.508: Introduction to Cellular and Molecular Biology**

**Credit Hours: 4**

**Course Objective:** Students will understand the structures and functions of the basic components of membranes, and organelles and their related functions. The molecular processes of DNA replication, transcription, and translation, and how they are managed in cells will be understood. The course will give a thorough insight into basic mechanisms of cellular signal transduction and regulation of gene expression.

**Unit – 1**

**15 hours**

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, endocytosis and, exocytosis.

**Unit – 2**

**15 hours**

**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.

**Unit – 3**

**15 hours**

**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:** Eukaryotic gene organization, transposition, Mechanism of DNA replication, DNA damage and their repair.

**Unit – 4**

**15 hours**

**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 Readings**

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.

**LMM.509: 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. Sectioning of tissues.
5. Histochemical techniques (Fixing, Processing, Staining).
6. Epifluorescence and Confocal Microscopy.
7. Basics of bacterial/mammalian cell culture

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

## **LHG.510: Basic and Clinical Biochemistry**

**Credits Hours: 4**

**Course Objectives:** The course aims to provide an advanced understanding of the core principles and topics of Biochemistry and their experimental basis. This course integrates an introduction to the structure of macromolecules and a biochemical approach to cellular function.

### **Unit: 1**

**15 hours**

**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.

### **Unit: 2**

**15 hours**

**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**

**15 hours**

**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 hours**

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

### **Suggested Readings**

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.

### **LMM.511: 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

## **LHG.512: Concepts of Genetics**

**Credits Hours: 4**

**Course Objective:** The students will learn various basic concepts like chromosomes, genes, genetic inheritance and how genes govern life. Basic knowledge of genetics is also helpful in understanding applications of various inheritance predictions based models for human welfare.

### **Unit: 1**

**15 hours**

**Basics of Inheritance:** Mendel's laws of inheritance; concept of segregation; independent assortment and dominance; locus concept; alleles and multiple alleles; epistasis; crossing over and recombination; application of Mendel's laws to populations studies; Hardy-Weinberg principle.

### **Unit: 2**

**16 hours**

**Chromosomal mutations and gene concept:** 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; pedigree analysis. **Gene concept:** Fine structure of gene; and analysis – Benzer's experiments, complementation and recombination.

### **Unit: 3**

**16 hours**

**Sex determination:** Sex determination and sex linked inheritance; sex determination in *Caenorhabditis elegans*, humans, *Drosophila* and other animals; sex determination in plants; sexlinked genes and dosage compensation in human, *Drosophila* and *C.elegans*. **Linkage analysis and gene mapping:** Monohybrid and dihybrid cross.

### **Unit: 4**

**13 hours**

**Extra-chromosomal inheritance:** Chloroplast: variegation in Four O'Clock plants; mutations in *Chlamydomonas*; mitochondrial inheritance: poky in neurspora, petites in yeast; molecular organization and gene products of chloroplast and mitochondrial DNA; infectious heredity: Kappa in *Paramecium*: Infective particles in *Drosophila*; endosymbiont theory.

### **Suggested Reading**

1. Korf, B.R.(2013) *Human Genetics and Genomics*. Wiley-Blackwell
2. Atherly, A.G., Girton, J.R., Mcdonald, J.F. (1999). *The science of Genetics*.Saundern College publication

3. Snusted, D.P., Simmons, M. J. (2010). *Principles of Genetics*. John Wiley & Sons, New York.
4. Gupta, P.K. (2009). *Genetics*. RastogiPublications, Meerut, India.
5. Gupta, P.K (2008). *Cytology, Genetics and Evolution*.RastogiPublications, 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 seriesMcGrahill, USA.
8. Tamarin, R.H. (1996). *Principles of Genetics, International edtn*.McGrawhill, USA.

### **LHG.513: Concepts of Genetics - Practical**

#### **Credit Hours: 1**

1. Monohybrid and dihybrid ratios, Multiple alleles, Epistasis – Problems.
2. Inheritance patterns in Human– Numericals on Pedigree analysis- Autosomal patterns, X-linked patterns, Y-linked patterns.
3. Segregation analysis in *Drosophila* (Monohybrid, Dihybrid)
4. Analysis on Linkage
5. Identification of inactivated X chromosome as Barr body and drumstick
6. Studies of a Model organism: *E.coli*, *C.elegans*, *D.melanogaster* and *D. rerio*.

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

### **LMM.514: Trends in Molecular Medicine**

#### **Credits Hours: 4**

**Course Objective:** The students will understand the background of molecular medicine i.e. molecular/cell biology relevant to translational research. It will enhance their understanding how normal cellular processes change, fail or are destroyed by disease development and how research contributes to development of better therapeutics.

#### **Unit: 1**

**15 hours**

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

**Unit: 2****15 hours**

**Molecular Medicine Therapeutics:** Gene therapy and recombinant molecules in medicine and therapeutic development, pharmacogenomics.

**Unit: 3****15 hours**

**Signal Transduction and its Role in Human Diseases:** Cellular and tissue microenvironment in diseases, drug resistance with convention chemotherapies.

**Unit: 4****15 hours**

**Advances in translational research:** Clinical trials, nano-biotechnology and its applications in molecular medicine, Developing novel biomarkers and therapies using high throughput technologies.

**Suggested Readings**

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.

**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.

**Interdisciplinary Courses offered by Faculty of Molecular Medicine****LMM. 515: Introduction to Human Cancers****Credits Hours: 2**

**Course Objective:** The course is designed as an interdisciplinary course to acquaint the students of different streams with basic concepts of cancer biology and understanding about various cancers.

**Unit: 1****8 hours**

Cancer Hallmarks, classifications of human cancers, common symptoms and cancer diagnostics.

**Unit: 2****7 hours**

Tumor suppressor and oncogenes, metastasis, angiogenesis, apoptosis in cancer

**Unit: 3****8 hours**

Standard cancer therapies: Chemo and radiotherapies, surgery, importance of molecular biology in basic cancer research.

**Unit: 4****7 hours**

Institutes of national and international importance involved in cancer patient care and basic research, lifestyle changes, stress and cancer

**Suggested Readings**

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

**LHG.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 includes neural & hormonal homeostatic control mechanisms, as well as the study of the musculoskeletal, circulatory, respiratory, digestive, urinary, immune and reproductive organ systems.

**Unit: 1****15 hours**

**Cardiovascular System:** Heart, Cardiac cycle, blood constituents, groups and hematopoiesis, blood pressure, Blood pressure and its neural and chemical regulation. **Excretory System:** Kidney, Urine formation, Urine concentration,

Waste elimination, Micturition, Regulation of water balance, Electrolyte and acid-base balance.

**Unit: 2**

**15 hours**

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

**Unit: 3**

**17 hours**

**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**

**13 hours**

**Respiratory System:** Anatomical considerations, Transport of gases, Exchange of gases, Waste elimination, Neural and chemical regulation of respiration. Alveolar Ventilation, Diffusion across alveoli, and respiration under Stress: Altitude, Hypoxia. **Reproduction:** Males and female reproductive system.

**Suggested Readings**

1. Sherman V. (2013) *Vander's Human Physiology*. McGraw-Hill 13<sup>th</sup> edition.
2. Devlin, T.M. (2005). *Textbook of Biochemistry with Clinical Correlations*. John Wiley & Sons Inc. USA.
3. Guyton. (2007). *Textbook of medical physiology*. 11<sup>th</sup> Edition. Elsevier India Pvt. Ltd. NewDelhi.
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. Silverthorn D, (2011) *Human Physiology*, Pearson; 6<sup>th</sup> edition.

**LMM.522: Human Physiology – Practical**

**Credit Hours: 1**

1. Sensory physiology practical
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 practical may be conducted depending on available faculties/facilities.

### **LMM.523: Essentials of Immunology**

**Credit Hours: 4**

**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. The student will be able to understand how immune system is involved in diseases caused by internal or external factors.

#### **Unit: 1**

**15 hours**

**Immune System:** The cells and organs of immune system. cells of immune system, Humoral immunity-immunoglobulin, basic structure, classes and subclasses, structural and functional relationships, nature of antigen, antigen-antibody reaction, antibody diversity, class switching. B and T cell development.

#### **Unit: 2**

**15 hours**

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

#### **Unit: 3**

**15 hours**

**Mechanisms of Immune System Diversity:** Structure and functions of Major Histocompatibility Complex (MHC) and Human Leukocyte Antigen (HLA) system, polymorphism, distribution, variation and their functions.

#### **Unit: 4**

**15 hours**

**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, immunotoxins.

#### **Suggested Readings**

1. Kindt, T.J., Osborne, B.A. and Goldsby, R.A. (2007). *Kuby Immunology*. 7<sup>th</sup> 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

### **LMM.524: Techniques in Molecular Medicine**

#### **Credit Hours: 4**

**Learning Objective:** This course will help the students to understand basic as well as specialized molecular and cell biology techniques. These methods help the students to explore cells, their characteristics, parts, and chemical processes, to learn how molecules control a cell's activities and growth.

#### **Unit 1**

**14 hours**

**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: 2**

**18 hours**

**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: 3**

**14 hours**

**Proteins: western blotting,** mass spec, Enzyme Linked Immunosorbent Assay (ELISA), 2D gel electrophoresis, high throughput techniques.

**Unit: 4****14 hours**

**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),

**Suggested Readings**

1. Brown, T.A. (2010). *Gene cloning and DNA analysis: An Introduction*. 6<sup>th</sup> Edition, Wiley-Blackwell Publisher, New York.
2. Goldsby, R.A., Kindt, T.J. and Osborne, B.A. (2008). *Kuby Immunology*. 6<sup>th</sup> 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.

**Elective Course-I****Credit Hours: 4****Students has to choose 1 out of 2 elective course****LMM.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 requirements for tissue engineering and regenerative medicine.

**Unit: 1****15 hours**

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.

**Unit: 2**

**15 hours**

**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**

**15 hours**

**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**

**15 hours**

**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 Readings**

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.

**LHG.525: Human Embryology and Developmental Genetics**

**Credit Hours: 4**

**Course Objectives:** The course aims to make students familiar with the fundamental concepts in developmental genetics and embryology. It will provide a broad and multifaceted training in modern biology, ranging from traditional morphology and experimental embryology to the latest molecular approaches in genetics, cell biology, stem cell biology and biotechnology.

**Unit: 1****15 hours**

**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****15 hours**

**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****15 hours**

**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****15 hours**

**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 Readings**

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 Embryology)*. 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.

### **Elective Course-II**

**Credit Hours: 4**

**Students has to choose 1 out of 2 elective course**

#### **LMM. 526: Molecular and Cellular Oncology**

**Credit Hours: 4**

**Learning Objective:** This course is designed to equip the students 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. The students will learn basics of cancer disease, cell biology of the disease and how modern diagnostic and therapeutics approaches function at molecular level.

#### **Unit: 1**

**13 hours**

**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**

**16 hours**

**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 defects and their relation to cancer, cancer stem cells.

#### **Unit: 3**

**16 hours**

**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**

**15 hours**

**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 Readings**

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 Web link**

1. <http://www.insidecancer.org/>
2. <http://www.who.int/cancer/en/>
3. <http://www.cancer.gov/>
4. [http://www.icmr.nic.in/ncrp/cancer\\_reg.htm](http://www.icmr.nic.in/ncrp/cancer_reg.htm)

## **LHG. 526: Population Genetics and Genetic Epidemiology**

### **Credit Hours: 4**

**Course Objectives:** 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**

**15 hours**

**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**

**15 hours**

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**

**15 hours**

**Population and Speciation:** Adaptive radiation; Isolating mechanisms; Speciation; Allopatricity and Sympatricity; convergent evolution; sexual selection; co-evolution.

**Unit: 4**

**15 hours**

**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 Readings**

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. Dawn TM (2011): *Genetic Epidemiology* (Springer)
12. Austin M (2013): *Genetic Epidemiology: Methods and Applications*, 1<sup>st</sup> Edition (CABI Publishing)

## **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.

### **Interdisciplinary Courses offered by Faculty of Molecular Medicine**

#### **LMM. 515: Introduction to Human Cancers**

**Credits Hours: 2**

**Course Objective:** The course is designed as an interdisciplinary course to acquaint the students of different streams with basic concepts of cancer biology and understanding about various cancers.

#### **Unit: 1**

**8 hours**

Cancer Hallmarks, classifications of human cancers, common symptoms and cancer diagnostics.

#### **Unit: 2**

**7 hours**

Tumor suppressor and oncogenes, metastasis, angiogenesis, apoptosis in cancer

#### **Unit: 3**

**8 hours**

Standard cancer therapies: Chemo and radiotherapies, surgery, importance of molecular biology in basic cancer research.

#### **Unit: 4**

**7 hours**

Institutes of national and international importance involved in cancer patient care and basic research, lifestyle changes, stress and cancer

### **Suggested Readings**

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

**LMM.542: Seminar-I**

**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.

**MOOC course**

**Credit Hours: 4**

MOOC course of 4 credits may be chosen by student from the list provided by swayam to the Head of the concerned Department. The student is required to submit the pass certificate of MOOC course before the declaration of result. The link for selection of MOOC course is:

<http://ugcmoocs.inflibnet.ac.in/course.php>

**LMM.551: 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 diabetes, obesity, metabolic syndromes 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**

**15 hours**

Molecular basis of the diseases, cardiomyopathies, cancers, chronic inflammatory disorders, including inflammatory bowel disease and rheumatoid, 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: 2**

**14 hours**

**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.

**Unit: 3****17 hours**

**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****14 hours**

**Novel therapies for diseases:** Tyrosine kinase inhibitor, Monoclonal antibody, Chemo & Radio, Gene Therapies, problems in gene therapy, ethical and biosafety issues in gene therapies.

**Suggested Readings**

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). *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.

**LMM.552: Evolutionary and Developmental Biology****Credit Hours: 4**

**Learning Objective:** This course will 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 to understand organogenesis and histogenesis, as well as pathology related to mechanisms of development and differentiation.

**Unit: 1****16 hours**

**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 hours**

**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****16 hours**

**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****14 hours**

**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 Readings**

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 Hallgrímsson, 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.

### **LMM.553: Molecular Endocrinology and Signal Transduction**

#### **Credit Hours: 4**

**Learning Objective:** The course is designed to teach the basics of endocrine system and signal transduction at physiological levels and their role in various cellular processes. Various pathways deregulated during disease manifestation will also be discussed in detail.

#### **Unit: 1**

**15 hours**

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

#### **Unit: 2**

**15 hours**

**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 hours**

**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 hours**

**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 Readings**

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

### **LMM.599: Research Project**

**Credit Hours: 4.**

**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.

**Evaluation criteria:** Thesis will be evaluated as per the University policy. The final result of the project will be on five-point scale and evaluated as **excellent, very good, good, average and unsatisfactory.**

**Transaction mode:** Lecture, Demonstration, lecture cum demonstration, group discussion, tutorial, problem solving, experimentation, SOLE (for selected few topics apart from syllabus), project method, problem solving, case study, self-learning, MCQ solving.

### **LMM.571: Genetic Engineering and Recombinant Therapeutics**

**Credit Hours: 4**

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

**Unit: 1**

**15 hours**

**Basics of Genetic Engineering:** Gene manipulation tools for molecular cloning, restriction enzymes their types, 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**

**13 hours**

**Gene Cloning Vectors:** Plasmids, bacteriophages, cloning in M13 mp Vectors, phagemids, Lamda vectors; insertion and replacement vectors, EMBL,  $\lambda$  DASH,  $\lambda$  gt10/11,  $\lambda$ ZAP etc. Cosmid vectors, Site directed mutagenesis.

**Unit: 3**

**17 hours**

**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**

**15 hours**

**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, Yeast two hybrid system, phage display, characterization of expressed proteins through various biophysical, biochemical methods, applications rDNA in diagnosis of pathogens and abnormal genes, transgenic animals for production of proteins and pharmaceuticals, Biosafety and Ethical considerations in genetic engineering.

**Suggested Readings**

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* 4<sup>th</sup> Edition ASM Press Washington.
3. James, Watson Micheal Gilman Jan Witkowsk (2007) *Recombinant DNA* 3<sup>rd</sup> edition, CSHL, New York.
4. Cokin Rateldge and Bjorn Christiansen, (2006) *Basic Biotechnology* 3<sup>rd</sup> edition Cambridge University press.
5. John E. Smith. (2009) *Biotechnology* 5<sup>th</sup> Edition by Cambridge University press.
6. *Molecular Biology of Gene* 6<sup>th</sup> Edition by Watson CSHL Press New York.
7. Sambrook& Russell *Molecular cloning* , CSHL Press, New York.
8. David &Freifelder John &Barlett (2008) *Molecular biology* 2<sup>nd</sup>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>

### **LMM.572: Advanced Practical Course in Molecular Medicine**

**Credit Hours: 3**

**Learning Objectives:** The aim of this course is to train students in techniques specific and relevant to Molecular Medicine.

1. **Molecular Medicine:** Introduction to advanced instrumentation like confocal microscope, flow cytometer, real time PCR etc., Cell culture techniques, MTT based cytotoxicity assay, Measurement of cellular ROS, Western Immunoblotting, Real Time PCR and data analysis, Flow cytometer based cell analysis
2. **Bioinformatics:** PCR and RT-PCR primer designing; global and local sequence alignment, Sanger sequencing data analysis; data mining, comparative modeling; docking; protein-ligand; structure-based drug design; virtual screening, molecular phylogenetics.

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

### **LHG.573. Practice in Life Sciences-I**

**Credit Hours: 2**

**Learning Objectives:** Preparatory classes will be taken to improve skills for reasoning bases MCQ for examinations such as UGC CSIR-NET, GATE, ICMR and DBT-JRF examinations. Series of scheduled MCQ based test paper solving and test serious will be conducted.

**Unit: 1**

**Credit Hours: 7**

**Molecules and their interaction relavent to biology:** Structure of atoms, molecules and chemical bonds, composition, structure and function of biomolecules, stablizing interactions, principles of biophysical chemistry, bioenergetics, glycolysis, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers, principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isozymes, conformation of proteins (ramachandran plot, secondary structure, domains, motif and folds), conformation of nucleic acids stability of proteins and nucleic acids, metabolism of carbohydrates, lipids, amino acids nucleotides and vitamins.

**Unit: 2****Credit Hours: 10**

**Cellular organization:** Membrane structure and function, structural organization and function of intracellular organelles, organization of genes and chromosomes, cell division and cell cycle, dna replication, repair and recombination, rna synthesis and processing, protein synthesis and processing, control of gene expression at transcription and translation level, cell communication and cell signaling.

**Unit: 3****Credit Hours: 8**

**Innate and adaptive immune system:** cells and molecules involved in innate and adaptive immunity, antigens, antigenicity and immunogenicity. B and t cell epitopes, structure and function of antibody molecules, MHC molecules, antigen processing and presentation, activation and differentiation of B and T cellshumoral and cell - mediated immune responses, primary and secondary immune modulation, the complement system, toll - like receptors, cell - mediated effector functions, inflammation, hypersensitivity and autoimmunity, immune response during bacterial (tuberculosis), parasitic (malaria) and viral (HIV) infections, congenital and acquired immunodeficiencies, vaccines.

**Unit: 4****Credit Hours: 5**

**Developmental biology:** Basic concepts of development, gametogenesis, fertilization and early development, programmed cell death, aging and senescence

**LHG.574. Practice in Life Sciences-II****Credit Hours: 2**

**Learning Objectives:** Preparatory classes will be taken to improve skills for reasoning bases MCQ for examinations such as UGC CSIR-NET, GATE, ICMR and DBT-JRF examinations. Series of scheduled MCQ based test paper solving and test serious will be conducted.

**Unit: 1****Credit Hours: 8**

**System physiology – animal:** Blood and circulation, cardiovascular system, respiratory system, nervous system, sense organs, excretory system, thermoregulation, stress and adaptation, digestive system, endocrinology and reproduction

**Unit: 2****Credit Hours: 5**



**Inheritance biology:** Mendelian genetics, concept of gene, extensions of mendelian principles, gene mapping methods, extra chromosomal inheritance, microbial genetics, human genetics, quantitative genetics, mutation, structural and numerical alterations of chromosomes, recombination.

**Unit: 3**

**Credit Hours: 8**

**Evolution and behaviour:** Emergence of evolutionary thoughts- lamarck; darwin, origin of cells and unicellular evolution, 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, paleontology and evolutionary history, molecular evolution, mechanisms of evolution, population genetics, brain, behavior and evolution.

**Unit: 4**

**Credit Hours: 9**

**Applied biology:** Application of immunological principles, vaccines, diagnostics. Tissue and cell culture methods for plants and animals, transgenic animals, molecular approaches to diagnosis, genomics and its application to health, molecular biology and recombinant dna methods, histochemical and immunotechniques, biophysical method, statistical methods, radiolabeling techniques, microscopic techniques, electrophysiological methods, methods in field biology.

**LMM.544: Seminar-II**

**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. The preferable topics may be related to the Research project of the student.

**Evaluation criteria:** the detailed assessment criteria are as per university policy. The students will be assessed based on presentation and report submitted on the topics assigned by seminar coordinator.

**LMM.599: Research Project**

**Credit Hours: 6.**

**Learning Objective:** The objective of Project in SEM-IV would be to ensure that the student learns the nuances of the scientific research and/or literature review. Herein the student shall have to carry out experiments to achieve the objectives as mentioned in the synopsis. The data collected as a result of the experiments must

be meticulously analyzed in light of established scientific knowledge to arrive at cogent conclusions.

**Evaluation criteria:** Thesis will be evaluated as per the University policy. The final result of the project will be on five-point scale and evaluated as **excellent, very good, good, average and unsatisfactory**.

**Value based Elective Foundation: course I and course II**

**Credit Hours: 1 + 1 = 2**

Two courses of 1 credit each may be chosen from a pool of courses designed to provide value-based and/or skill-based knowledge and should contain both theory and lab/hands-on/training/field work. The list of Value added courses is given below:

(i) Ethics for Science	(ii) Professional Ethics
(iii) Academic Writing	(iv) Value Education
(v) Stress Management	(vi) Personality Development through Life Skills
(vii) Physical & Mental Well Being	(viii) Pedagogical Studies
(ix) Data Analysis using spread sheet	(x) Soft Skill Training
(xi) Leadership	(xii) Personal Management
(xiii) Wealth Management	(xiv) Reasoning Ability
(xv) MS office Specialist	(xvi) Practical Taxation
(xvii) Ethical Issues & Legal Awareness	(xviii) Disaster Management
(xix) Nutrition and Specialty Foods	(xx) Shorthand & Typing
(xxi) SPSS	

\* The list is subject to addition/deletion/modifications at University level.