CENTRAL UNIVERSITY OF PUNJAB, BATHINDA

M.Sc. Life Sciences with Specialization in Molecular Medicine

Session - 2019-21

Department of Human Genetics and Molecular Medicine

SEMESTER-I

Sr. No.	Paper Code	Course Title	L	T	P	Total
Compulsory Foundation Courses						
1.	LHG.506	Biostatistics and Research Methodology	3	1	-	4
2.	LHG.507	Biostatistics & Research Methodology (Practical)	-	-	1	1
Core Courses						
3.	LMM.508	Cellular and Molecular Biology	4	-	-	4
4.	LMM.509	Cellular and Molecular Biology	-	-	1	1
5.	LHG.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
Interdisciplinary Elective Course – I						
10.	LMM.515	Introduction to Human Cancers	2	-	-	2
		Total Credit	**20**	**2**	**4**	**26**

SEMESTER-II

Sr. No.	Paper Code	Course Title	L	T	P	Total
Core Courses						
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
Discipline Elective – I (Choose any one)						
5.	LMM.525	Regenerative Medicine	4	-	-	4

6.	LHG.525	Human Embryology and Developmental Genetics	4	-	-	4
Discipline Elective – II (Choose any one)						
7.	LHG.526	Population Genetics and Genetic Epidemiology	4	-	-	4
8.	LMM.526	Molecular and Cellular Oncology	4	-	-	4
Interdisciplinary Elective Course – II						
9.	LMM.515	Introduction to Human Cancers	2	-	-	2
Skill Based Course						
10.	LMM.542	Seminar-I	1	-	-	1
		Total Credit	**22**	**1**	**1**	**24**

SEMESTER-III

Sr. No.	**Paper Code**	**Course Title**	**L**	**T**	**P**	**Total**
Compulsory Foundation						
1.		MOOC course (One course)	4	-	-	4
Core Courses						
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
Skill Based Course						
6.	LMM.599	Project-I	-	-	6	6
		Total Credit	**16**	**-**	**6**	**22**

SEMESTER-IV

Sr. no.	Paper Code	Course Title	L	T	P	Total
Core Courses						
1.	LMM.571	Genetic Engineering and Recombinant Therapeutics	4	-	-	4
2.	LMM.572	Advanced Practical Course in Molecular Medicine	-	-	3	3
Discipline Enrichment Course						
3.	LHG.573	Practice in Life Sciences-I	2	-	-	2
4.	LHG.574	Practice in Life Sciences-II	2	-	-	2
Skill Based Course						
5.	LMM.544	Credit Seminar-II (Presentation Skills)	1	-	-	1
6.	LMM.599	Research Project-II	-	-	6	6
Elective Foundation/Value based course						
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
	Total Credit		11	-	9	20

SEMESTER 1

Course Code: LHG.506
Course Title: Biostatistics and Research Methodology
Total Hours: 60

L	T	P	Cr
3	1	-	4

Learning Outcomes
On the completion of this course, the students will be able:

- To evaluate biological data using the principles of statistics.
- To analyze the experimental errors in the biological assays.
- To apply the knowledge of statistics in the field studies as well as population based studies.
- To analyze evaluate testing hypothesis, analyzing experimental data and interpreting the results of biological research.

Unit – I **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 – II **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 – III **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 – IV **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.

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

Suggested Readings:

1. Norman, G. and Streiner, D. (2008). *Biostatistics: The Bare Essentials.* (with SPSS), 3rd 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.

Course Code: LHG.507
Course Title: Introduction to Biostatistics & Research Methodology – Practical
Total Hours: 30

L	T	P	Cr
-	-	1	1

Learning Outcomes:
On the successful completion of this course the students will be able:
- To synthesize application of appropriate research methodology.
- Apply suitable statistical equations to analyze data

Experiments:
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. Regressions and Correlation.
8. Scientific writing skill development.

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

Course Code: LMM.508:
Course Title: Cellular and Molecular Biology
Total Hours: 60

L	T	P	Cr
4	-	-	4

Learning Outcomes
On the successful completion this course, the students will be able:
- To evaluate the structures and functions of the basic components of membranes, and organelles and their related functions.
- To analyze the molecular processes of DNA replication, transcription, and translation.
- To apply the knowledge for thorough insight into basic mechanisms of cellular signal transduction and regulation of gene expression.
- To synthesize research questions in the filed of cell biology.

Unit – I **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 – II **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 – III **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 – IV **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.

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

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. (200*8). 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. James, D.W., Baker,T.A., Bell, S.P., Gann, A. (2009). *Molecular Biology of the Gene*. Benjamin Cummings, USA.
7. Jocelyn, E.K., Elliott, S.G., Stephen, T.K. (2009). *Lewin's Genes X*. Jones & Bartlett Publishers, USA.

8. Johnson, A., Lewis, J., Raff, M. (2007). *Molecular Biology of the Cell*. Garland Science, USA.
9. Lodish, H.,Berk, A., Chris, A.K. and Krieger, M. (2011). *Molecular Cell Biology*. W.H. Freeman, USA.
10. Sambrook, J., Fritish, E.F., Maniatis, T. (2012). *Molecular cloning: A laboratory manual*. Cold Spring Harbor Laboratory Press, New York.

Course Code: LMM.509
Course Title: Cellular and Molecular Biology – Practical
Total Hours: 30

L	T	P	Cr
-	-	1	1

Learning Outcomes
On the successful completion this course the students will be able:
- To evaluate the structures and functions of the basic components of membranes, and organelles and their related functions.
- To analyze the results of Immunofluorescence and IHC.
- To apply the knowledge for the research related to cell biology.

Experiments:
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. Epifluoresence and Confocal Microscopy.
8. Basics of bacterial/mammalian cell culture

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

Course Code: LHG.510:
Course Title: Basic and Clinical Biochemistry
Total Hours: 60

L	T	P	Cr
4	-	-	4

Learning Outcomes
On the successful completion of this course the students will be able:
- To evaluate the core principles and topics of Biochemistry and their experimental basis.
- To analyze the structure of macromolecules and a biochemical approach to cellular function.
- To Evaluate the basic structural features and functions of carbohydrates, lipids, nucleic acids, proteins and vitamins.
- To conceptualize the basic features of enzyme catalysis and regulation

Unit: I **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: II **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: III **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: IV **15 Hours**

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

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

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.

L	T	P	Cr
-	-	1	1

Course Code: LMM.511
Course Title: Basic and Clinical Biochemistry-Practical
Total Hours: 40

Learning Outcomes:
On successful completion of the course the student will be able to:

- To evaluate various biochemical tests of clinical samples.
- To apply the knowledge in the analysis of the clinical sample for determination of probable diseases state of the individual.
- Analyze various experiments like blood group typing, counting of RBCs and WBCs and identification of blood cells

Experiments:

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**

Course Code: LHG. 512
Course Title: Concepts of Genetics
Total Hours: 60

L	T	P	Cr
4	-	-	4

Learning Outcome:
On successful completion of the course the student will be able to:

- Evaluate the Mendelian and Non-Mendelian inheritance patterns
- Gather knowledge about gene expression regulation and sex determination
- Evaluate different chromosomal aberrations and ploidies
- Know the details of extra chromosomal inheritance patterns

Unit: I **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: II **15 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; andanalysis – Benzer's experiments, complementation and recombination.

Unit: III **15 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: IV **15 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.

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

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. Tamarin, R.H. (1996). *Principles of Genetics, International edtn.*McGrawhill, USA.

Course Code: LMM.513
Course Title: Concepts of Genetics-Practical
Total Hours: 40

L	T	P	Cr
-	-	1	1

Learning Outcomes:
On successful completion of the course the student will be able to:

- Analyze genetic linkage and epistasis
- Evaluate different mutants of *Drosophila*
- Demonstrate X inactivation in females

Experiments:

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**

Course Code: LMM. 514
Course Title: Trends in Molecular Medicine
Total Hours: 60

L	T	P	Cr
3	1	-	4

Learning Outcomes:
On the successful completion of this course, the students will be able:

- To evaluate the relationship between the molecular/cell biology and translational research.

- To analyze how normal cellular processes change, fail or are destroyed by disease development and how research contributes to development of better therapeutics.
- To ask questions in molecular mechanisms in development of disease.
- To apply the knowledge to characterize the cellular processes.

Unit: I **15 Hours**

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

Unit: II **15 Hours**

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

Unit: III **15 Hours**

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

Unit: IV **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.

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

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. Audet, J.,Stanford, W.and Stanford,W. L. (2009) *Stem cells in regenerative medicine.*New York, Humana press.

Course Code: LMM. 515
Course Title: Introduction to Human Cancers
Total Hours: 30

L	T	P	Cr
2	-	-	2

Learning Outcomes:
On the successful completion of this course the students will be able to:

- To evaluate and apply the knowledge in basic concepts of cancer biology
- To apply the knowledge in awareness about various cancers.
- To synthesize ideas about awareness programmes in cancers
- To know the research programmes in cancer at various institutes in the country

Unit: I **7 Hours**
Cancer Hallmarks, classifications of human cancers, common symptoms and cancer diagnostics.

Unit: II **7 Hours**
Tumor suppressor and oncogenes, metastasis, angiogenesis, apoptosis in cancer

Unit: III **8 Hours**
Standard cancer therapies: Chemo and radiotherapies, surgery, importance of molecular biology in basic cancer research.

Unit: IV **8 Hours**
Institutes of national and international importance involved in cancer patient care and basic research, lifestyle changes, stress and cancer

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

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

SEMESTER II

Course Code: LMM. 521
Course Title: Human Physiology
Total Hours: 60

L	T	P	Cr
4	-	-	4

Learning Outcomes:
On the successful completion of this course the students will be able to:

- To apply the knowledge in the function and regulation of the human body and physiological integration of the organ systems to maintain homeostasis content includes neural & hormonal homeostatic control mechanisms
- To evaluate the analysis of various physiological parameters.
- To synthesize ideas and research questions in human physiology
- To identify various human diseases.

Unit: I **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: II **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: III **15 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: IV **15 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.

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

Suggested Readings:

1. Sherman V. (2013)*Vander's Human Physiology*. McGraw-Hill 13th edition.
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. 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; 6th edition.

Course Code: 522
Course Title: Human Physiology- Practical
Total Hours: 30

L	T	P	Cr
-	-	1	1

Learning Outcomes:
On successful completion of the course the student will be able to:

- To evaluate various physiological parameters.
- To apply the knowledge in the analysis of the sample for determination of physiological state of the individual.
- Demonstrate several biophysical techniques regularly used in health sciences

Experiments:

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.**

Course Code: LMM. 523
Course Title: Essentials of Immunology
Total Hours: 60

L	T	P	Cr
4	-	-	4

Learning Outcomes:
At the completion of this course, the students will learn:

- To evaluate basic concepts of immune system.

- To appraise the concept of immune-based diseases as either a deficiency of components or excess activity as hypersensitivity.
- To apply the knowledge how immune system is involved in diseases caused by internal or external factors.
- To synthesize the hypothesis for research about immunological processes at a molecular level.

Unit: I **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: II **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: III **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: IV **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.

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

Suggested Readings:

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. Delves, P.J., Roitt, I.M. and Seamus, J.M. (2006). *Roitt's Essential Immunology (Series–Essentials).*Blackwell Publishers, USA.
4. Elgert, K.D. (2009). *Immunology: Understanding the immune system*. Wiley-Blackwell, USA.
7. Paul, W.E. (1993). *Fundamental immunology.* Raven Press, SD, USA.
8. Sawhney, S.K. and Randhir, S. (2005). *Introductory Practical Biochemistry*. Alpha Science International Ltd. New Delhi, India.

9. Tizard. (2008). *Immunology: An Introduction*. Cengage Learning, Thompson, USA.
10. Owen, Judith A; Punt, Jenni, Stranford, Sharon A. Kuby's Immunology (2013), W.H. Freeman and Company: New York, 2013

Course Code: LMM. 524
Course Title: Techniques in Molecular Medicine
Total Hours: 60

L	T	P	Cr
4	-	-	4

Learning Outcomes:
On the successfulend of this course, the students will be able:

- To analyze various cellular processes technically.
- To apply the knowledge to decipher the mechanisms of molecular and cell biology.
- To evaluate the experimental results on the basis of multiple techniques.
- To synthesize the ideas for the improvement in the current technology.

Unit: I **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: II **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: III **14 Hours**

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

Unit: IV **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)

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

Suggested Readings:

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, S. (2005). *Research methodology and statistical techniques*, Deep & Deep Publications (P) Ltd.New Delhi.
4. Lewin, B. (2010). *Genes X*, CBS Publishers & Distributors. New Delhi.
5. Nelson, D. and Cox, M.M. (2009). *Lehninger Principles of Biochemistry*. W.H. Freeman and Company, New York.
6. Primrose. S.B. and Twyman, R. (2006). *Principles of Gene Manipulation and Genomics*.Blackwell Publishing Professional, U.K.
7. Sambrook, J. (2006). *The Condensed Protocols from Molecular Cloning: A Laboratory Manual*.Cshl Press. New York.
8. Sambrook, J., Fritish, E.F., Maniatis, T. (2012). *Molecular cloning: A laboratory manual*. Cold Spring Harbor Laboratory Press, New York.
9. Sawhney, S.K. and Singh, R. (2005). *Introductory Practical Biochemistry*.Narosa Publishing House, New Delhi.

Course Code: LMM. 551
Course Title: Regenerative Medicine
Total Hours: 60

L	T	P	Cr
4	-	-	4

Learning Outcomes:

At the completion of this course, the students will learn:

- To synthesize the ideas for research in stem cell biology.
- To apply the knowledge for translational research as well as industrial aspects of the tissue engineering and regenerative medicine.
- To evaluate the different kinds of bioreactors for tissue engineering.
- To synthesize the newer ideas and work in collaboration with clinicians regarding therapeutics.

Unit: I **15 Hours**

Stem Cells: Stem cells, their properties and classification, adult stem cells, iPSCs, methods of isolation, identification and characterization of stem cells, special features of stem cell culture.

Unit: II **15 Hours**

Stem cells of various organs specially; Hematopoietic, mesenchymal and neural stem cells: their signaling and applications, cancer stem cells.

Unit: III **15 Hours**

Tissue Engineering: Principles of tissue culture, tissue and organ culture, extracellular matrices, bioreactors.

Unit: IV **15 Hours**

Regenerative Medicine: Regeneration of bone and cartilage, lung, liver, spinal cord and heart, Islet transplantation and bio-artificial pancreas.

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

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.

Course Code: LHG. 551
Course Title: Human Embryology and Developmental Genetics
Total Hours: 60

L	T	P	Cr
4	-	-	4

Learning Outcomes:

On successful completion of the course the student will be able:

- To correlate genetic regulation in different embryonic developmental stages
- To evaluate different genetic and environmental triggers for post-natal development, ageing and senescence
- To analyze the fundamental concepts in developmental genetics and embryology.
- To apply the knowledge to 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: I **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: II **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 cytoplamic determinants; imprinting; mutants and transgenics in analysis of development.

Unit: III **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: IV **15 Hours**

Post-natal Development, Aging and Senescence: Environmental and genetic factors during maturations, Sex linked changes, Deciduous *and p*rimary teeth, Cognitive development ageing: its causes and regulation; Clinical death.

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

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 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.

L	T	P	Cr
4	-	-	4

Course Code: LMM. 552
Course Title: Molecular and Cellular Oncology
Total Hours: 60

Learning Outcomes:
On the successful completion of this course the students will be able:

- To evaluate comprehensive analysis to cope up with the ever-expanding role of molecular biology in basic cancer research as well as clinical oncology.
- To apply the knowledge to modern diagnostic and therapeutics approaches function at molecular level.
- To evaluate the different models for cancer research and application of suitable one.
- To synthesize the research questions and their exploration on the basis of central principles of molecular oncology.

Unit: I **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: II **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: III **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: IV **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.

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

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 Standford 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

Course Code: LHG. 552
Course Title: Population Genetics and Genetic Epidemiology
Total Hours: 60

L	T	P	Cr
4	-	-	4

Learning Outcomes:

On successful completion of the course the student will be able to:

- Conceptualize the basic concepts in population genetics and apply statistics relevant to the study of genomic diversity
- Examine the major genetic and ecological processes underlying evolution and explain the process driving speciation
- Perform different epidemiological studies to identify the cause-effect relationship in variety of human traits/diseases
- Design genetic studies and perform association and linkage analysis on any relevant data.

Unit: I **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: II **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: III **15 Hours**

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

Unit: IV **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.

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

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*
3. *Populations.* Dover Publications.
4. Hamilton M.B. (2009). *Population Genetics*. Wiley-Blackwell, UK.
5. Hedrick P.W.(2011). *Genetics of Populations*. Jones and Bartlett Publishers, Massachusetts.
6. Jobling, M., Hollox, E., Hurles, M., Kivisild, T. and Tyler-Smith, C. (2013). *Human Evolutionary Genetics*. Garland Science.
7. Knight, J.C. (2009). *Human Genetic Diversity –Functional consequences for Health and Disease*. Oxford University Press, USA.
8. Krebs, J.E, Goldstein, E.S. and Kilpatrick, S.T. (2013) *Lewin's Essential Genes*. Jones and Bartlett learning, USA.
9. Nielsen, R. and Slatkin, M. (2013). An Introduction to Population Genetics: Theory and Applications. Sinauer Associates, Inc.
10. Relethford, J.H. (2012). *Human Population Genetics.* John Wiley & Sons.

11. Snusted, D.P., Simmons, M. J. (2010). *Principles of Genetics*. John Wiley & Sons, New York.
12. Dawn TM (2011): Genetic Epidemiology (Springer)
13. Austin M (2013): Genetic Epidemiology: Methods and Applications, 1st Edition (CABI Publishing)

Course Code: LMM. 515
Course Title: Introduction to Human Cancers
Total Hours: 30

L	T	P	Cr
2	-	-	2

Learning Outcomes:
On the successful completion of this course the students will be able to:

- To evaluate and apply the knowledge in basic concepts of cancer biology
- To apply the knowledge in awareness about various cancers.
- To synthesize ideas about awareness programmes in cancers
- To know the research programmes in cancer at various institutes in the country

Unit: I **7 Hours**
Cancer Hallmarks, classifications of human cancers, common symptoms and cancer diagnostics.

Unit: II **7 Hours**
Tumor suppressor and oncogenes, metastasis, angiogenesis, apoptosis in cancer

Unit: III **8 Hours**
Standard cancer therapies: Chemo and radiotherapies, surgery, importance of molecular biology in basic cancer research.

Unit: IV **8 Hours**
Institutes of national and international importance involved in cancer patient care and basic research, lifestyle changes, stress and cancer

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

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 ScienceCourse Code: LMM. 542

Course Code: LMM.542
Course Title: Seminar-I
Total 15 Hours

L	T	P	Cr
-	1	-	1

Learning Outcomes:
On the successful completion of this course, the students will be able to:

- To comprehensive literature survey in molecular medicine.
- To apply the knowledge to the preparation of scientific presentations.

SEMESTER III

MOOC course
Total Hours: 60
MOOC course of 4 credit hours 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

Course Code: LMM. 551
Course Title: Molecular Basis of Human Diseases
Total Hours: 60

L	T	P	Cr
4	-	-	4

Learning Outcomes:
On the successful completion of this course the students will be able:

- To evaluate the in-depth knowledge of the basic mechanisms of common human diseases, such as diabetes, obesity, metabolic syndromes.
- To synthesize hypothesis for research based molecular mechanism of human diseases.
- To evaluate the central principles of multifactorial disorders.
- To apply the knowledge for future translational research.

Unit: I **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: II **15 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: III **15 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: IV **15 Hours**

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

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

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). 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.

Course Code: LMM. 552
Course Title: Evolutionary and Developmental Biology
Total Hours: 60

L	T	P	Cr
4	-	-	4

Learning Outcomes:
On the successful completion of this course the students will be able:

- To analyze the various theories of 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.
- To apply the knowledge gained to the mechanisms of organogenesis and histogenesis, as well as pathology related to mechanisms of development and differentiation.
- To synthesize ideas based on cellular evolution and developmental biology.
- To have knowledge about molecular evolutionary processes, knowledge and skills in phylogenetic analysis and how this can be used to study (molecular) evolution.

Unit: I **15 Hours**

Origin of Life: Lamarckism, Darwinism, Concepts of variation, adaptation, struggle, Mendelism, Spontaneity of mutations, and 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: II **15 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: III **15 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: IV **15 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.

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

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 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.

L	T	P	Cr
4	-	-	4

Course Code: LMM. 553
Course Title: Molecular Endocrinology and Signal Transduction
Total Hours: 60

Learning Outcomes:

On the successful completion of this course the students will be able:

- To evaluate endocrine system and signal transduction at physiological levels and their role in various cellular processes.
- To analyze the various pathways that are deregulated during disease manifestation.
- To apply the knowledge in diagnosis and therapeutics of endocrine disorders
- To synthesize research ideas to explore the connection between endocrine system and physiology.

Unit: I **15 Hours**

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

Unit: II **15 Hours**

Cell Signaling and Mechanism of Hormone Action: Receptor study, Binding affinity, specificity, Scatchard plot and purification. G protein linkedreceptor 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- EGFreceptor 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: III **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: IV **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.

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

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

Course Code: LMM. 599
Course Title: Project-I
Total Hours: 60

L	T	P	Cr
4	-	-	4

Learning Outcomes:
On successful completion of the course the student will be able:

- To get hands-on training on several genetic and genomics techniques
- To learn study designing and report writing
- To apply the knowledge in interpretation of results and discussion
- To improve communication skills

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

SEMESTER IV

Course Code: LMM. 571
Course Title: Genetic Engineering and Recombinant Therapeutics
Total Hours: 60

L	T	P	Cr
4	-	-	4

Learning Outcomes:
On the successful completion of this course the students will be able:

- To analyze and evaluate the modern tools for genetic engineering and cutting edge molecular engineering.
- To apply the knowledge for the solving the problems in diagnosis and therapeutics.
- To understyand application of genetic engineering techniques in basic and applied experimental biology.
- To make themselves proficient in designing and conducting experiments involving genetic manipulation.

Unit: I **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 opimization, *in-silico* methods of design.

Unit: II **13 Hours**
Gene Cloning Vectors: Plasmids, bacteriophages, cloning in M13 mp Vectors, phagemids, Lamda vectors; insertion and replacement vectors, EMBL, λ DASH, λ gt10/11, λZAP etc. Cosmid vectors, Site directed mutagenesis.

Unit: III **16 Hours**

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

Unit: IV **16 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.

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

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* 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* 2ndEdition ,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

Course Code: LMM. 572
Course Title: Advanced practical course in Molecular Medicine
Total Hours: 45

L	T	P	Cr
-	-	3	3

Learning Outcomes:
At the completion of this course, the students will learn:

- To evaluate biological experiments using the principles of molecular biology and its applied aspect.
- To analyze the experimental results based on variety of techniques to prove biological hypothesis.
- To apply the gained knowledge in diagnosis and therapeutics practically.
- To evaluate the differences between the basic and advanced aspect of the subject.

Course Code: LMM. 573
Course Title: Practice in Life Sciences-I
Total Hours: 30

L	T	P	Cr
2	-	-	2

Learning Outcomes:
On the successful completion of this course, the students will be able:

- To apply the knowledge gained to the preparation and qualification of national level UGC CSIR-NET, GATE, ICMR and DBT-JRF examinations
- To evaluate the improvement in knowledgebase required for competitive examinations
- To synthesize the aptitude for research and development
- To revise several key topics of life sciences

Unit: I **7 Hours**

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: II **10 Hours**

Cellular organization: Membrane structure and function, structural organization and fu nction 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: III **8 Hours**

Innate and ada ptive 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: IV **5 Hours**

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

Transactionalal Modes: Lecture**;** Demonstration**;** Tutorial**;** Lecture cum demonstration; Problem solving; Self-learning; MCQ practice.

Course Code: LMM. 574
Course Title: Practice in Life Sciences-II
Total Hours: 30

L	T	P	Cr
2	-	-	2

Learning Outcomes:

On successful completion of the course the student will be able:

- To apply the knowledge in the improvement of skills required for competitive examinations
- To analyze the aptitude for research and development
- To apply the knowledge gained to the preparation and qualification of national level UGC CSIR-NET, GATE, ICMR and DBT-JRF examinations
- Revise several key topics of life sciences

Unit: I **8 Hours**

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

Unit: II **5 Hours**

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: III **8 Hours**

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; experiement of miller (1953); the first cell; evol ution of prokaryotes; origin of eukaryotic cells; evolution of unicellular eukaryotes; anaerobic metaboli sm, photosynthesis and aerobic metabolism, paleontology and evolutionary history, molecular evolution, mechanisms of evolution, population genetics, brain, behavior and evolution.

Unit: IV **9 Hours**

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, statisitcal methods, radiolabeling techniques, microscopic techniques, electrophysiological methods, methods in field biology.

Course Code: LMM. 544
Course Title: Credit Seminar-II
Total 15 Hours

L	T	P	Cr
-	1	-	1

Learning Outcomes:

At the completion of this course, the students will learn:

- To comprehensive literature survey in molecular medicine.
- To apply the knowledge to the preparation of scientific presentations
- To improve communication aptitude
- To synthesize the ideas for scientific presentations.

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.

Course Code: LMM. 599
Course Title: Project-II
Total Hours: 60

L	T	P	Cr
-	-	-	6

Learning Outcomes:

At the end of this course, the students will learn:

- To write thesis including an extensive review of literature with simultaneous identification of scientifically sound (and achievable) objectives backed by a comprehensive and detailed methodology.
- To apply the knowledge gained in designing and executing scientific experiments.

- To independently participate in, and take responsibility for, a scientific investigation in Molecular Medicine and will be able to report on the result and its relevance both in writing and orally.

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 Total 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.

Programme Outcome:
Successful students will be expected to, using their knowledge of the scientific literature in the field, to generate a research question and to propose an experimental plan to test hypothesis in Molecular Medicine. Successful students shall be able to present themselves for employment in variety of scientific job market. Students shall be able to demonstrate their talent and intellect in this field.

Evaluation Criteria for Theory Courses

A. Continuous Assessment: [25 Marks]
i. Surprise Test (minimum three) - Based on Objective Type Tests (10 Marks)
ii. Term paper (10 Marks)
iii. Assignment(s) (5 Marks)
B. Mid Semester Test-1: Based on Subjective Type Test [25 Marks]
C. Mid Semester Test-2: Based on Subjective Type Test [25Marks]
D. End-Term Exam: Based on Objective Type Tests [25 Marks]