

**M.Sc. Programme in Life Sciences  
(Molecular Medicine)**

**Semester-1**

S.No	Paper Code	Course Title	L	T	P	Cr	% Weightage				
							A	B	C	D	E
1	LMM.501	Research Methodology	2			2	25	25	25	25	50
2	LMM.502	Biostatistics	2	-	-	2	25	25	25	25	50
3	LMM.504	Cell Biology	3	-	-	3	20	15	15	25	75
4	LMM.506	Biochemistry	3	-	-	3	20	15	15	25	75
5	LMM.508	Genetics	3			3	20	15	15	25	75
6	LMM.510	Concepts and Prospects in Molecular Medicine	4	-	-	4	25	25	25	25	100
7	*	Inter-Disciplinary Elective -1 (From Other Departments)	2	-	-	2	25	25	25	25	50
8	LMM.503	Biostatistics (P)	-	-	2	1	-	-	-	-	25
9	LMM.505	Cell Biology (P)	-	-	2	1	-	-	-	-	25
10	LMM.507	Biochemistry (P)	-	-	2	1	-	-	-	-	25
11	LMM.509	Genetics (P)	-	-	2	1					25
12	LMM.500	Credit Seminar			2	1					25
		<b>Total Sem-1</b>	19	0	10	24					600

A: Continuous Assessment: Based on Objective Type Tests

B: Pre-Scheduled Test-1: Based on Objective Type & Subjective Type Test (By Enlarged Subjective Type)

C: Pre-Scheduled Test-2: Based on Objective Type & Subjective Type Test (By Enlarged Subjective Type)

D: End-Term Exam (Final): Based on Objective Type Tests

E: Total Marks

**L: Lectures T: Tutorial P: Practical Cr: Credits**

**ID courses offered by GDMM faculty in semester-I**

S.No.	Code	Course title (offered by)	Credits
1		Biotechnology and Human Welfare (Prof. D. D. Singh)	2
2		Basics of Stem Cell Biology (Dr. Sandeep Singh)	2
3		Introduction to Immune system (Dr. Monisha Dhiman)	2
4		Introduction to Human Cancers (Dr. Harish Chander)	2

**LMM.501: Research Methodology.****Credit****Hours: 2.****Unit 1** **5 Lectures**

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

**Unit 2** **10 Lectures**

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

**Unit 3** **5 Lectures**

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

**Unit 4** **16 Lectures**

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

**Suggested Reading:**

1. Gupta, S. (2005). *Research methodology and statistical techniques*. Deep & Deep Publications (p) Ltd. New Delhi.
2. Kothari, C.R. (2008). *Research methodology (s)*. New Age International (p) Limited. New Delhi.
3. Standard /Reputed Journal authors' instructions.

**LMM.502: Biostatistics.****Credits Hours: 2.****Unit 1** **6 Lectures**

**Overview of Biostatistics:** Difference between parametric and non-parametric statistics, Univariate and multivariate analysis, Confidence interval, Errors, Levels of significance, Hypothesis testing.

**Unit 2** **8 Lectures**

**Descriptive statistics:** Measures of central tendency and dispersal, Histograms, Probability distributions (Binomial, Poisson and Normal), Sampling distribution, Kurtosis and Skewness.

**Unit 3** **8 Lectures**

**Experimental design and analysis:** Sampling techniques, Sampling theory, Various steps in sampling, collection of data-types and methods.

**Unit 4** **14 Lectures**

**Inferential Statistics:** Student's t-test, Paired t-test, Mann-Whitney U-test, Wilcoxon signed-rank, One-way and two-way analysis of variance (ANOVA), Critical difference (CD), Least

Significant Difference (LSD), Kruskal–Wallis one-way ANOVA by ranks, Friedman two-way ANOVA by ranks,  $\chi^2$  test. Standard errors of regression coefficients, Comparing two regression lines, Pearson Product-Moment Correlation Coefficient, Spearman Rank Correlation Coefficient, Power and sampling size in correlation and regression.

### Suggested Reading:

1. Gookin, D. (2007). *MS Word 2007 for Dummies*. Wiley, USA.
2. Harvey, G. (2007). *MS Excel 2007 for Dummies*. Wiley, USA.
3. Johnson, S. (2009). *Windows 7 on demand*. Perspiration Inc. USA.
4. Norman, G. and Streiner, D. (2008). *Biostatistics: The Bare Essentials*. 3/e (with SPSS). Decker Inc. USA.
5. Sokal, R.R. and Rohlf, F.J. (1994). *Biometry: The Principles and Practices of Statistics in Biological Research*. W.H. Freeman publishers, USA.
6. Thurrott, P. and Rivera, R. (2009). *Windows 7 Secrets*. Wiley, USA.

## LMM.504: Cell Biology.

Credit Hours: 3.

### Unit 1

15 Lectures

**Introduction to the cell:** Evolution of the cell, From molecules to first cell, From prokaryotes to eukaryotes, Prokaryotic and eukaryotic genomes, Single cell to multicellular organisms.

**Membrane structure and function:** Models of membrane structure, Membrane proteins, Membrane carbohydrates, Membrane transport of small molecules, Membrane transport of macromolecules and particles. Structural organization and function of intracellular organelles: The lysosomes, Ribosomes, The peroxisomes, The golgi apparatus, The endoplasmic reticulum, Mitochondria and chloroplast, Structure of mitochondria and chloroplast, Oxidation of glucose and fatty acids, Electron transport oxidative phosphorylation, Chloroplast and photosynthesis.

### Unit 2

12 Lectures

**Protein secretion and sorting:** Organelle biogenesis and protein secretion, synthesis and targeting, of mitochondria, chloroplast, peroxisomal proteins, translational modification in the ER. Intracellular traffic, vesicular traffic in the secretory pathway, protein sorting in the Golgi bodies, traffic in the endocytic pathway, exocytosis.

### Unit 3

15 Lectures

**The cytoskeleton:** The nature of cytoskeleton, Intermediate filaments, Microtubules, Actin filaments, Cilia and centrioles, Organization of the cytoskeleton. **Cell communication and cell signaling:** Cell adhesions, Cell junctions and the extra cellular matrix, Cell-cell adhesion and communication, Cell matrix adhesion, Collagen the fibrous protein of the matrix, Noncollagen component of the extra cellular matrix.

### Unit 4

12 Lectures

**Cell growth and division:** Overview of the cell cycle and its control, The molecular mechanisms for regulating mitotic and meiotic events, Amitosis, Cell cycle control, Checkpoints in cell cycle regulation. Cell to cell signaling, Overview of the extra cellular signaling,

Identification of cell surface receptors, G-protein coupled receptors and their effectors, Second messengers, Enzyme-linked cell surface receptors, Interaction and regulation of signaling pathways.

**Suggested reading:**

1. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J.D. (2010). *Molecular Biology of the cell*. Garland publishers, Oxford.
2. Celis, J.E. (2006). *Cell biology: A laboratory handbook*, Vol 1, 2, 3. Academic Press, UK.
3. Gupta, P.K. (2008). *Cytology, Genetics and Evolution*. Rastogi publications, Meerut, India.
4. Karp, G. (2010). *Cell and Molecular Biology: Concepts and Experiments*. John Wiley & Sons. Inc. New Delhi, India.

**LMM.506: Biochemistry.**

**Credits Hours: 3.**

**Unit 1** **12 Lectures**

Principles of biophysical chemistry pH, Buffer, Reaction kinetics, Thermodynamics, Colligative properties, Structure of atoms, Molecules and chemical bonds. Stabilizing interactions: Van der Waals, Electrostatic, Hydrogen bonding, Hydrophobic interaction, etc.

**Unit 2** **15 Lectures**

**Composition, structure and function of Biomolecules:** Carbohydrates, Lipids, Proteins, Nucleic acids and Vitamins. Bioenergetics and metabolism of Carbohydrates, Lipids, Amino Acids and Nucleotides.

**Unit 3** **15 Lectures**

**Enzymology:** Classification, Principles of catalysis, Mechanism of enzyme catalysis, Enzyme kinetics, Enzyme regulation, Isozymes Clinically important enzymes.

**Unit 4** **12 Lectures**

**Protein Chemistry:** Ramachandran plot, Secondary, Tertiary and Quaternary structure, Domains, Motif and Folds. Nucleic acids: A-, B-, Z-DNA, tRNA, micro-RNA, Stability of protein and Nucleic acid structures.

**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.

### LMM.508: Genetics.

**Credits**

**Hours: 3.**

#### Unit 1

**14 Lectures**

**Introduction and scope of genetics, DNA as genetic material:** The vehicles of inheritance, Chemical structure and base composition of nucleic acids, Double helical structure, Structure of DNA and RNA, Different types of DNA molecules, forces stabilizing nucleic acid structure, super coiled DNA, properties of DNA, denaturation and renaturation of DNA and Cot curves. **DNA replication:** Messelson and Stahl Experiment, Carins Experiment, Okazaki Experiment, Basic mechanism of DNA replication.

#### Unit 2

**12 Lectures**

**Cell division and Cell cycle:** Mitosis, Meiosis, Chromosomal basis of inheritance. Basic principles of Mendelian inheritance: Segregation and independent assortment, Alleles and multiple alleles, Human pedigrees and inheritance. Linkage analysis and gene mapping: Coupling and repulsion phase linkage, Crossing over and recombination. Population genetics: Application of Mendel's laws to populations, Hardy-Weinberg principle, inbreeding depression and heterosis, inheritance of quantitative traits.

#### Unit 3

**14 Lectures**

**Gene Interaction:** Sex determination and Sex linked inheritance, Sex determination in humans, *Drosophila* and other animals, Sex determination in plants, Sex linked genes and dosage compensation. Human genetics: pedigree analysis. Gene concept: Fine structure of gene and gene concept, Fine structure analysis – Benzer's experiments, Complementation analysis and fine structure of gene, Complementation and recombination, Concept of gene.

#### Unit 4

**14 Lectures**

**Extra-chromosomal inheritance:** Chloroplast and Mitochondrial inheritance, Yeast, *Chlamydomonas/Neurospora* and higher plants Chromosomal aberrations: Types of changes—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.

**Suggested Reading:**

1. Anthony, J.F., Miller, J.A., Suzuki, D.T., Richard, R.C., Gilbert, W.M. (1998). *An introduction to Genetic Analysis*. W.H. Freeman publication, USA.
2. Atherly, A.G., Girton, J.R., McDonald, J.F. (1999). *The science of Genetics*. 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*. Rastogi publications, Meerut, India.
5. Gupta, P.K (2008). *Cytology, Genetics and Evolution*. Rastogi publications, Meerut, India.
6. Jocelyn, E.K., Elliott, S.G., Stephen, T.K. (2009). *Lewin's Genes X*. Jones & Bartlett Publishers, USA.
7. Schaum, W.D. (2000). *Theory & problems in Genetics by Stansfield, out line series* McGrahill, USA.
8. Tamarin, R.H. (1996). *Principles of Genetics, International edtn*. McGrawhill, USA.

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

**Credits Hours: 4.**

**Unit 1**

**14 Lectures**

**Molecular basis of diseases:** Human genetics relevant to molecular medicine, single nucleotide polymorphisms, multiple gene polymorphisms, single and multi-gene diseases, gene-environment interactions in disease manifestation, genetic and physical mapping of human genome and identification of diseases gene.

**Unit 2**

**14 Lectures**

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

**Unit 3**

**14 Lectures**

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

**Unit 4**

**12 Lectures**

Clinical trials, adjuvant therapies, monoclonal antibodies as drugs, nanobiotechnology and its applications in molecular medicine, next generation sequencing techniques. Stem cell research and its application in human health

**Suggested Reading:**

1. Littwack, G. (2008). *Human Biochemistry and Disease*. Academic Press.

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

### **LMM.503: Biostatistics - practical. Credit Hours: 1. Semester I.**

1. Experimental design and analysis.
  2. Training on basic usage of Microsoft Word, Microsoft Excel, Microsoft PowerPoint and Internet Explorer.
  3. Optimizing web search: Google advanced search, Boolean operators, Literature search using Google Scholar, HighWire.
  4. Bibliography management and research paper formatting using reference software EndNote.
  5. Performing statistics analyses using MS Excel Analysis toolpack.
  6. Creating a functional website using HTML.
  7. Basic programming using DOS batch files and Auto Hot Key.
- \*More practicals may be added/modified from time to time depending on available faculties/facilities.

### **LMM.505: Cell Biology – Practical. Credit Hours: 1. Semester I.**

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. Bacterial staining and identification.
  5. Sectioning of tissues (Plant and animal).
  6. Histochemical techniques (Fixing, Processing, Staining).
- \*More practicals may be added/modified from time to time depending on available faculties/facilities.

### **LMM.507: Biochemistry – Practical. Credit Hours: 1. Semester I.**

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 in plant seeds.
  5. Principle and application of electrophoresis, Native, SDS PAGE.
  6. Estimation of total phenolic compounds.
  7. Extraction and estimation of vitamins.
- \*More practicals may be added/modified from time to time depending on available faculties/facilities.

#### **LMM.509: Genetics - Practical. Credit Hours: 1. Semester I.**

1. Calculation of allele frequencies.
  2. Calculating recessive gene frequency, Calculating frequency of sex –linked alleles.
  3. Karyotyping of normal & abnormal chromosome sets.
  4. Monohybrid and dihybrid ratios, Multiple alleles, Epistasis – Problems.
  5. Inheritance patterns in Man – Numericals on Pedigree analysis- Autosomal patterns, X–linked patterns, Y–linked patterns.
  6. Mitochondrial inheritance patterns.
  7. To test PTC tasting ability in a random sample and calculate gene frequencies for the taster and non–taster alleles.
  8. Identification of inactivated X chromosome as Barr body and drumstick.
  9. Blood group typing using haemagglutination tests.
  10. Studies of a Model organism: Identification of normal and mutant flies (*Drosophila melanogaster*) & Preparation of *Drosophila* polytene chromosomes.
  11. To study fingerball and palmar dermatoglyphics and calculate indices.
  12. To test for colour blindness using Ishihara charts.
  13. Molecular Mapping of Genes.
- \*More practicals may be added/modified from time to time depending on available faculties/facilities.



## Interdisciplinary Courses for Semester-I

(To be offered by faculties from other centres)

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

L	T	P	Credits	Marks
2	0	0	2	50

**Course Objectives:** To ensure holistic development of student's knowledge and perspective, a course from other department must be undertaken by the student. This course shall carry 2 credits and will be evaluated out of 50 Marks.

### Interdisciplinary Courses offered by Faculty of Genetic Diseases and Molecular Medicine

**Course Title: Biotechnology & Human Welfare**

**Course Code:**

L	T	P	Credits	Marks
2	0	0	2	50

**Course Objective:** The course is designed as an inter-disciplinary course to be offered to candidates from centres other than CGDMM to make them appreciate the strengths and concerns of biotechnological interventions in human welfare. It is expected the student will be knowledgeable about the current trends in the area and how these are beneficial to humans.

#### **PART-A**

**5hours**

**Introduction:** Historical development, basic concepts in biotechnology. Recombination, gene cloning, transgenics,

#### **PART-B**

**10hours**

**Therapeutic biologicals:** The development of important therapeutic products like streptokinase, erythropoietin, insulin, etc. Therapeutic products under development

#### **PART-C**

**8hours**

**Transgenics:** The different transgenic products available like Bt cotton, soya. Products under development and future potential.

#### **PART-D**

**5hours**

**Biotechnological product concerns:** Environmental concerns about BT products and the technological limitations. A survey of approval of biotechnological products in different parts of the world. Regulatory bodies in India

**Suggested Reading:**

1. Pharmaceutical Biotechnology **Crommelin**, Daan J. A., **Sindelar**, Robert D., **Meibohm**, Bernd (Eds.) Springer 4<sup>th</sup> Ed. 2013
2. Biotechnology Prospects and Applications, **Salar**, R.K., **Gahlawat**, S.K., **Siwach**, P., **Duhan** (Eds.) 2014 Springer
3. Molecular Biotechnology, by [Bernard J. Glick](#) (Author), [Jack J. Pasternak](#) (Author), [Cheryl L. Patten](#) (Author), ASM press

**Course Title: Basics of Stem Cell Biology**

**Course Code:**

<b>L</b>	<b>T</b>	<b>P</b>	<b>Credits</b>	<b>Marks</b>
<b>2</b>	<b>0</b>	<b>0</b>	<b>2</b>	<b>50</b>

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

**PART-A**

**7 Hours**

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

**PART-B**

**7 Hours**

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

**PART-C**

**7 Hours**

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

**PART-D**

**7 Hours**

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

**Suggested Reading:**

1. Alberts, B. Bray, D. Lewis, J., Raff, M., Roberts, K. and Watson, J.D. (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. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. John Wiley & Sons. Inc., New Delhi, India
4. Alimoghaddam, K. (2013). Stem Cell Biology in Normal Life and Diseases. INTECH publications.
5. *Lanza R., Gearhart, J., Hogan, B., Melton, D., Pedersen, R., Thomas, E.D., Thomson, J., Wilmut, I. (2013). Essentials of Stem Cell Biology (Second Edition).*

**Course Title: Introduction to Immune system**

**Course Code:**

<b>L</b>	<b>T</b>	<b>P</b>	<b>Credits</b>	<b>Marks</b>
<b>2</b>	<b>0</b>	<b>0</b>	<b>2</b>	<b>50</b>

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

**PART-A**

**7 Hours**

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

**PART-B**

**7 Hours**

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

**PART-C**

**7 Hours**

**Immunodeficiency and dysfunction as the basis of disease:** Immune Deficiency and dysfunction diseases. Because specific mechanism affects prognosis as well as therapeutic approaches, Gel and Coombs classified these dysfunctional immune responses into hypersensitivity diseases.

**PART-D**

**7 Hours**

Immunological Processes and Therapeutics

**Suggested Reading:**

1. Abbas. (2010). *Cellular and Molecular Immunology*. CBS Publishers & Distributors, India.
2. Charles, A. and Janeway, J. R. (1994). *Immunobiology: The Immune system in health and disease*. Blackwell Publishing, USA.
3. Delves, P. J., Roitt, I. M. and Seamus, J. M. (2011). *Roitt's essential immunology (Series–Essentials)*. Blackwell Publishers, USA.
4. Elgert, K. D. (2009). *Immunology: Understanding the immune system*. Wiley-Blackwell, USA.
5. Kindt, T. J., Osborne, B. A. and Goldsby, R. A. (2007). *Kuby Immunology* 7th Edition. W. H. Freeman, USA.
6. Sawhney, S. K. and Randhir, S. (2005). *Introductory practical biochemistry*. Alpha Science International Ltd. New Delhi, India.
7. Tizard. (2009). *Immunology: An Introduction*. Cengage Learning, Thompson, USA

**Course Title: Introduction to Human Cancers**

**Course Code:**

L	T	P	Credits	Marks
2	0	0	2	50

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

**PART-A**

**14hours**

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

**PART-B**

**14hours**

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

**Suggested Reading:**

1. Airley, R. (2010). *Cancer Chemotherapy: basics to clinic*. Willey-Blackwell publishing, New Jersey.
2. DeVita, V. T., Hellman, S., Rosenberg, S. A. (2011). *Cancer: principles and practice of oncology*. Lippincot Williams and Wilkins publishers, Philadelphia.

3. Enders, G. H. (2010). *Cell cycle deregulation in cancer*. Humana Press, Springer science, New York.
4. Jocelyn, E. K., Elliot, S. G., Stephen, T. K. (2009). *Lewin's Gene X*. Jones & Barlett.
5. Wang, E. (2010). *Cancer systems biology*. CRC press, Taylor & Francis group, New York.
6. Weinberg, Robert A. (2007). *The Biology of Cancer*. New York: Garland Science

#### WEBLINKS

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

<http://www.cancer.gov/publications/patient-education>

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

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

[http://www.icmr.nic.in/ncrp/cancer\\_reg.htm](http://www.icmr.nic.in/ncrp/cancer_reg.htm)

Semester 2												
S.No	Paper Code	Course Title	L	T	P	Cr	% Weightage					
							A	B	C	D	E	
1	LMM.511	Human Physiology	3	-	-	3	20	15	15	25	75	
2	LMM.513	Immunology	2	-	-	2	15	10	10	15	50	
3	LMM.514	Regenerative medicine and Stem Cell Therapies	4			4	25	25	25	25	100	
4	LMM.515	Molecular Biology	3			3	20	15	15	25	75	
5	LMM.517	Techniques in Life Sciences	3			3	20	15	15	25	75	
6	LMM.XXX	Elective Course-1	4			4	25	25	25	25	100	
7		Interdisciplinary course-2	2			2	15	10	10	15	50	
8	LMM.512	Human Physiology (P)	-	-	2	1	-	-	-	-	25	
9	LMM.516	Molecular Biology (P)			2	1					25	
10	LMM.599	Seminar			2	1					25	
			19	0	6	24					600	
Opt any one course from the following Elective courses												
13	LMM.551	Structural Biology	4			4	25	25	25	25	100	
14	LMM.552	Cancer Biology	4			4	25	25	25	25	100	
15	LMM.553	Radiation Biology	4			4	25	25	25	25	100	
16	LMM.554	Signal Transduction	4			4	25	25	25	25	100	

A: Continuous Assessment: Based on Objective Type Tests

B: Pre-Scheduled Test-1: Based on Objective Type & Subjective Type Test (By Enlarged Subjective Type)

C: Pre-Scheduled Test-2: Based on Objective Type & Subjective Type Test (By Enlarged Subjective Type)

D: End-Term Exam (Final): Based on Objective Type Tests

E: Total Marks

**L: Lectures T: Tutorial P: Practical Cr: Credits**

**LMM.511: Human Physiology.****Credit Hours: 3.****Unit: 1****14 Lectures**

**Muscle Physiology:** Types of muscles, Properties; Contractile force; Motor Unit. Skeletal, cardiac and smooth Muscle Mechanics & Metabolism. Control of Body Movement.

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

**Unit: 2****12 Lectures**

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

**Respiratory system:** Anatomical considerations, Transport of gases, Exchange of gases, Waste elimination, Neural and chemical regulation of respiration. Alveolar Ventilation, Diffusion Across Alveoli. Transport of Respiratory Gases in Blood. The Respiratory System Under Stress: Altitude, Hypoxia

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

**Unit: 3****14 Lectures**

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

**Thermoregulation and stress adaptation:** Comfort zone, Body temperature – physical, chemical, Neural regulation, Acclimatization.

**Unit: 4****14 Lectures**

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

**Reproduction Growth and Ageing:** Males and female reproductive system. Gametogenesis, fertilization and early development: Production of gametes, cell surface molecules in sperm-egg recognition in animals. Growth rates in boys and girls, mental growth and factors influencing growth- genetic, nutritional and hormonal. Disorders of normal growth, Abnormalities of fetal and postnatal growth, Hereditary short stature. Physiology of ageing: Changes in various systems and mechanisms involved, factors affecting ageing. Apoptosis.

**Suggested Reading:**

1. Brody, T. (1998). *Nutritional biochemistry*. Academic Press, USA.
2. Devlin, T.M. (2005). *Textbook of Biochemistry with clinical correlations*. John Wiley & Sons Inc. USA.
3. Guyton. (2007). *Textbook of medical physiology*. 11th Edition. Elsevier India Pvt. Ltd. New Delhi.
4. Hill, R.W, Wyse, G. A. and Anderson, M. (2008). *Animal physiology*. Sinauer Associates Inc. USA.
5. Khurana. (2006). *Textbook of medical physiology*. Elsevier India Pvt. Ltd.
6. Murray, R.K. (2009). *Harper's illustrated biochemistry*. Jaypee Publishers, New Delhi, India.

7. Tyagi, P. (2009). *A textbook of Animal Physiology*. Dominant Publishers and distributors, New Delhi, India.
8. Silverthorn D, (2011) *Human Physiology*, Pearson; 6<sup>th</sup> edition.
9. Sherman V. (2013) *Vander's Human Physiology*. McGraw-Hill 13<sup>th</sup> edition.

**LMM.513: Immunology.**

**Credit Hours: 2.**

**Unit: 1**

**10 Lectures**

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

**Unit: 2**

**8 Lectures**

**Complement system and major histocompatibility system:** Complement components, their structure and functions and mechanisms of complement activation by classical, alternative and lectin pathway. Structure and functions of Major Histocompatibility Complex (MHC) and Human Leukocyte Antigen (HLA) system, polymorphism, distribution variation and function. Association of MHC with disease and superantigen, recognition of antigens by T and B-cells, antigen processing, role of MHC molecules in antigen presentation and co stimulatory signals, tumor immunology

**Unit: 3**

**8 Lectures**

**Hypersensitivity:** Types, features and mechanisms of immediate and delayed hypersensitivity reactions, immunity to microbes, immunity to tumors, AIDS and immunodeficiencies, hybridoma technology and vaccine, natural, synthetic and genetic, development of vaccine for diseases like AIDS, cancer and malaria.

**Unit: 4**

**10 Lectures**

**Monoclonal antibodies and Diagnostic immunology:** Production, characterization and applications in diagnosis, therapy and basic research, immunotoxins, concept of making immunotoxins. Methods for immunoglobulin determination-quantitative and qualitative antigen and antibody reactions, agglutination-precipitation, immunofluorescence, immunoblotting and assessment of human allergic diseases.

**Suggested Reading:**

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.

#### **LMM.514: Regenerative Medicine and Stem Cell Therapies.**

**Credit Hours: 4.**

##### **Unit 1**

**16 Lectures**

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

##### **Unit: 2**

**16 Lectures**

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

##### **Unit: 3**

**20 Lectures**

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

##### **Unit: 4**

**20 Lectures**

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

#### **Suggested Reading:**

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 & Fetal Stem Cells*. Academic Press.

Related Weblinks:

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

**LMM.515: Molecular Biology.**

**Credit Hours: 3.**

**Unit: 1**

**14 Lectures**

**Structure, Conformation, Denaturation, Renaturation of Nucleic acids:** Carrier of genetic information, Chemical structure of DNA and base composition, Watson-Crick model, Supercoiled DNA, Different forms of RNA: mRNA, tRNA, rRNA and other Types of RNA. Organelle DNA: mitochondria and chloroplast DNA. Chromosome Structure, Chromatin and the Nucleosome: Genome Sequence and Chromosome Diversity, Chromosome Duplication and segregation, The nucleosome, Chromatin structure: euchromatin, heterochromatin, Constitutive and facultative heterochromatin, Regulation of chromatin structure and nucleosome assembly, Nucleolus.

**Unit: 2**

**14 Lectures**

**Gene & Genome organization:** Split genes, Overlapping genes, Transposons & retrotransposons, Gene clusters, Histones, Non-histones, Nucleosome, Chromatin, Chromosome structure in prokaryotes & eukaryotes. Basic Processes, Replication of DNA: Prokaryotic and eukaryotic DNA replication, Mechanism of DNA replication, Enzymes and accessory proteins involved in DNA replication, Replication errors, DNA damage and their repair.

**Unit: 3**

**14 Lectures**

**Transcription and mRNA processing:** Prokaryotic & eukaryotic transcription, general and specific transcription factors, Regulatory elements and mechanisms of transcription regulation, Transcriptional and posttranscriptional gene silencing: Initiation, Elongation & Termination of transcription, Capping, Polyadenylation, Splicing, editing, mRNA stability, RNA interference, Microarray.

**Unit: 4**

**12 Lectures**

**Translation:** Genetic code, Prokaryotic & eukaryotic translation, the translation machinery, mechanisms of chain initiation, elongation and termination, regulation of translation, co- and post-translational modifications of proteins, Epigenetics.

**Suggested Reading:**

1. Fasman, G.D. (1989). *Practical Handbook of Biochemistry and Molecular Biology*. CRC Press, Taylor and Francis Group, UK.
2. Gupta, P.K. (2005). *Cell and Molecular Biology*. Rastogi publications, Meerut, India.
3. James, D.W., Baker, T.A., Bell, S.P., Gann, A. (2009). *Molecular Biology of the Gene*. Benjamin Cummings, USA.

4. Jocelyn, E.K., Elliott, S.G., Stephen, T.K. (2009). *Lewin's Genes X*. Jones & Bartlett Publishers, USA.
5. Johnson, A., Lewis, J., Raff, M. (2007). *Molecular Biology of the Cell*. Garland Science, USA.
6. Lodish, H., Berk, A., Chris, A.K. and Krieger, M. (2008). *Molecular Cell Biology*. W.H. Freeman, USA.
7. Sambrook, J., Fritish, E.F., Maniatis, T. (2000). *Molecular cloning: A laboratory manual*. Cold Spring Harbor Laboratory Press, New York.

### **LMM.517: Techniques on Life Sciences.**

**Credit Hours: 3.**

#### **Unit 1**

**10 Lectures**

**Good laboratory practices:** Sterilization techniques, Spectrometry: Colorimetry, mass, UV, IR, NMR and atomic absorption spectrophotometry, Centrifugation: Principle and applications, Ultracentrifugation. Chromatography: Principle, procedure and applications of thin layer chromatography (TLC), gel filtration and ion exchange, affinity chromatography, GC, GLC, HPLC and FPLC.

#### **Unit: 2**

**12 Lectures**

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

#### **Unit: 3**

**16 Lectures**

**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 2-Dimensional gel electrophoresis. Polymerase chain reaction (PCR): Principle, types and applications, PCR based markers: RAPDs, SSRs, SNPs, ISSRs, and SCARs etc. Blotting techniques: Southern, Northern, Western, Dot blotting and hybridization, DNA fingerprinting.

#### **Unit: 4**

**16 Lectures**

**Flow cytometry:** Cell sorting, Hybridoma technology/Production of antibodies, Histochemical and Immunotechniques, Immunochemical Techniques, Developing Monoclonal and Polyclonal antibodies, Immunocytochemistry, Radioimmunoassay (RIA), Enzyme Linked Immunosorbent Assay (ELISA) and Autoradiography. **Mutation Analyses Techniques:** Restriction mapping, SSCP analyses, DNA sequencing-manual and automated methods. **Cell and tissue culture techniques:** Plants and animals.

### **Suggested Reading:**

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. Kothari, C.R. (2008.) *Research methodology(s)*. New Age International (P) Ltd., New Delhi
6. Lewin, B. (2010). *Genes X*, CBS Publishers & Distributors. New Delhi.
7. Mangal, S.K. (2007). *DNA Markers In Plant Improvement*. Daya Publishing House, New Delhi.
8. Nelson, D. and Cox, M.M. (2009). *Lehninger Principles of Biochemistry*. W.H. Freeman and Company, New York.
9. Primrose. S.B. and Twyman, R. (2006). *Principles of Gene Manipulation and Genomics*. Blackwell Publishing Professional, U.K.
10. Sambrook, J. (2006). *The Condensed Protocols from Molecular Cloning: A Laboratory Manual*. Cshl Press. New York.
11. Sambrook, J. and Russell, D.W. (2000). *Molecular Cloning: A Laboratory Manual* (3 Vol-set). 3<sup>rd</sup> Edition, CSHL Press, New York.
12. Sawhney, S.K. and Singh, R. (2005). *Introductory Practical Biochemistry*. Narosa Publishing House, New Delhi .
13. Slater, A., Scott, N.W. and Fowler, M.R. (2008). *Plant Biotechnology: The Genetic Manipulation of Plants*. Oxford University Press, USA.
14. Wilson, K. and Walker, J. (2006). *Principles and Techniques of Biochemistry and Molecular biology*. 6<sup>th</sup> Edition, Cambridge University Press India Pvt. Ltd., New Delhi.

**LMM.512: Human Physiology – Practical.**

**Credit Hours: 1.**

1. Sensory physiology practicals
2. Equipment in the laboratory - maintenance and use.
3. Determination of hemoglobin in the blood by various methods.
4. Isolation and estimation of DNA and RNA.
5. Extraction and estimation of acid phosphatases from serum.
6. Enzyme-linked Immunosorbent assay (ELISA).
7. Electrophoresis of egg proteins.
8. Determination of urea and uric acid in the urine.
9. Estimation of glucose by different methods.

\*More practicals may be added/modified from time to time depending on available faculties/facilities.

**LMM.516: Molecular Biology Practical**

**Credit Hours: 1.**

1. Isolation of genomic DNA from bacteria (E.coli) and human blood, Quantification of DNA using spectrophotometric method.
2. RNA isolation.

3. cDNA synthesis.
4. RT-PCR.
5. Isolation of plasmid DNA from bacteria.
6. Transformation of bacteria using CaCl<sub>2</sub> heat shock method-Competent cell preparation.
7. Digestion of DNA using restriction endonucleases, Resolution and molecular weight estimation of fragmented DNA using agarose gel electrophoresis.
8. Construction of restriction map by single and double digestion, Designing DNA probe, Southern blot hybridization (demonstration only).
9. 1 Amplification of known DNA sequences by Polymerase Chain Reaction.  
\*More practicals may be added/modified from time to time depending on available faculties/facilities.

**LMM.599: Seminar on Molecular Medicine**

**Credit Hours: 1.**

Semester-3											
S.No	Paper Code	Course Title	L	T	P	Cr	% Weightage				
							A	B	C	D	E
1	LMM.601	Ecology and Environment	3	-	-	3	20	15	15	25	75
2	LMM.602	Evolutionary and Developmental Biology	3	-	-	3	20	15	15	25	75
3	LMM.603	Microbiology	2	-	-	2	15	10	10	15	50
4	LMM.604	Molecular Basis of Human Diseases	4	-	-	4	25	25	25	25	100
5	LMM.605	Bioinformatics	4	-	-	4	25	25	25	25	100
6	LMM.698	Dissertation past-I			16	8					200
			<b>16</b>	<b>0</b>	<b>8</b>	<b>24</b>					<b>600</b>

A: Continuous Assessment: Based on Objective Type Tests

B: Pre-Scheduled Test-1: Based on Objective Type & Subjective Type Test (By Enlarged Subjective Type)

C: Pre-Scheduled Test-2: Based on Objective Type & Subjective Type Test (By Enlarged Subjective Type)

D: End-Term Exam (Final): Based on Objective Type Tests

E: Total Marks

**L: Lectures T: Tutorial P: Practical Cr: Credits**

**LMM.601: Ecology and Environment.****Credit Hours: 3.****Unit: 1****14 Lectures**

**The Environment:** Physical environment, biotic environment, biotic and abiotic interactions. Concept of habitat and niche, niche width and overlap, fundamental and realized niche, resource partitioning and character displacement.

**Unit: 2****14 Lectures**

**Ecosystem:** Structure and function, energy flow and mineral cycling (CNP), primary production and decomposition, structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, eustarine). Types, mechanisms, changes involved in succession, concept of climax. Nature of communities, community structure and attributes, levels of species diversity and its measurement, edges and ecotones.

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

**Population ecology:** Characteristics of a population, population growth curves, population regulation, life history strategies (*r* and *K* selection), concept of metapopulation – demes and dispersal, interdemec extinctions, age structured populations. Types of interactions, interspecific competition, herbivory, carnivory, pollination and symbiosis.

**Unit: 4****8 Lectures**

**Environmental pollution:** Global environmental change, ozone depletion, biodiversity-status, monitoring and documentation, major drivers of biodiversity change, biodiversity management approaches, Carbon credit.

**Suggested Reading:**

1. Odum, E. and Barrett, G.W. (2005). *Fundamentals of Ecology*. Brooks Cole, USA.
2. Prasanthrajan, M and Mahendran, P.P. (2008). *A Text Book on Ecology and Environmental Science*. Agrotech, India.
3. Sharma, P.D. (2005). *Ecology and Environment*. Rastogi Publications, Meerut, India.
4. Verma, P.S. Agarwal, V. K. (2000). *Environmental Biology: Principles of Ecology*. S. Chand, New Delhi, India.

**LMM.602: Evolutionary and Developmental Biology.****Credit Hours: 3.****Unit: 1****16 Lectures**

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

**Unit: 2****14 Lectures**

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

**Unit: 3**

**14 Lectures**

**Basic concepts of development:** Totipotency, Commitment, Specification, Induction, Competence, Determination and Differentiation, Morphogenetic gradients, Cell fate and cell lineages, Stem cells, Genomic equivalence and the cytoplasmic determinants, Imprinting, Mutants and transgenics in analysis of development.

**Unit: 4**

**10 Lectures**

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

**Suggested Reading:**

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.

**LMM.603: Microbiology.**

**Credit Hours: 2.**

**Unit: 1**

**10 Lectures**

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

**Unit: 2**

**8 Lectures**

**Growth, nutrition & control:** Phases in bacterial growth, Growth Curve, Calculation of G-time, Physical and environmental requirements of growth, Microbial nutritional requirements, Types



of culture media. Physical and Chemical methods, Antimicrobial drugs, Antibiotic assays, Drug resistance in bacteria.

**Unit: 3** **6 Lectures**

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

**Unit: 4** **12 Lectures**

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

**Suggested Reading:**

1. Bauman, R.W. (2011). *Microbiology with Diseases by Body System*. Benjamin Cummings, USA.
2. Capuccino, J.G. and Sherman, N. (2004). *Microbiology-A Laboratory Manual*. Benjamin Cummings, USA.
3. Pelczar, M. J., Chan, E.C.S. and Krieg, N.R. (1993). *Microbiology: Concepts and Applications*. McGraw-Hill Inc. USA.
4. Pommerville, J.C. (2010). *Alcarno's Fundamentals of Microbiology*. Jones & Bartlett Publishers, USA.
5. Prescott, L.M., Harley, J.P. and Klein, D.A. (2004). *Microbiology*. McGraw-Hill Science, USA.
6. Strelkauskas, A., Strelkauskas, J. and Moszyk-Strelkauskas, D. (2009). *Microbiology: A Clinical Approach*. Garland Science, New York, USA.
7. Tortora, G.J., Funke, B.R. and Case, C.L. (2009). *Microbiology: An Introduction*. Benjamin Cummings, USA.

**LMM.604: Molecular Basis of Human Diseases.**

**Credit Hours: 4.**

**Unit: 1** **16 Lectures**

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

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

**Genetic disorders:** Common genetic disorders due to altered chromosome numbers, aberrations; Diabetes as a genetic disease, recessive genetic disorders, Intersex Disorders: Male Pseudo-hermaphrodite (MPH) including testicular feminization syndrome, Female Pseudo-hermaphrodite (FPH) including congenital adrenal hyperplasia, True Hermaphrodites (TH),

Mixed gonadal dysgenesis (MGD) & Dysgenetic male pseudohermaphrodite (DMP) and Persistent Mullerian duct syndrome (PMDS), diabetes and other complex human diseases.

**Unit: 3**

**18 Lectures**

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

**Unit: 4**

**20 Lectures**

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

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

**Suggested reading:**

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

**Related Weblinks**

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

**Unit: 1****20 Lectures**

**Biological databases:** Nucleotide Sequence Databases, GenBank, DDBJ, EMBL, Sequence Flatfile and submission process, Protein sequence databases, UniProt in detail, Mapping databases, Genomic databases, Data mining.

**Sequence analysis:** Gene Prediction methods and programs, Markov and Hidden Markov models in gene prediction, Promoter analysis, RNA secondary structure thermodynamics, Dynamic programming and genetic algorithms for secondary structure prediction, refining multiple sequence alignment based on RNA secondary structure predictions, Vienna RNAfold, Evolution and origins of sequence polymorphisms, SNP discovery methods and databases, Genotyping, International haplotype map project, 1000 genomes project.

**Analysis for protein sequences:** Predicting features of individual residues, Predicting function, Neural networks, Protein structure prediction, Protein structure databases, PDB in detail, 3D visualization softwares, Pathway and molecular interaction databases, Prediction algorithms for pathways and Molecular Interactions, Integrating gene expression data with pathway information.

**Unit: 2****14 Lectures**

**Inferring relationships:** Global Vs. local sequence alignments, Dotplots, Scoring matrices, Pairwise sequence alignment, BLAST, Position-Specific scoring and PSI-BLAST, MegaBLAST, BL2SEQ, BLAT, FASTA Vs BLAST, Protein multiple sequence alignments, Multiple structural alignments, Shotgun sequencing, Sequence assembly and finishing.

**Phylogenetic analysis:** Basics of phylogenetics, Nucleotide substitution models and selection, Distance-matrix-based methods, Neighbor-Joining, Fitch-Margoliash, Outgroups, UPGMA, Minimum evolution, Maximum parsimony, Maximum likelihood, Bayesian inference, Searching for trees, Rooting trees, Bootstrapping, Likelihood ratio tests.

**Unit: 3****12 Lectures**

**Genomics:** Comparative genomics, Genomic alignments, Gene predictions in genomic alignments, Genome-wide association study, Phylogenetic footprinting, Gene annotation, Gene expression analysis using DNA Microarray, Annotation of array probes, Image processing, Normalizing expression measurements.

**Proteomics:** Major proteomic approaches, Protein analysis by MALDI and SELDI methods, Time of Flight MS in protein analysis, Protein Identification by Mascot, Peptide Mass fingerprinting, Comparative proteomics, protein docking site, potential interactome prediction, prediction of chemical nature of protein, UniProt, Expassy. Two-Dimensional polyacrylamide gel electrophoresis.

**Unit: 4****16 Lectures**

**Modelling and structure:** From protein sequence to structure, theoretical and practical aspects of protein sequence alignments, secondary, tertiary structure prediction, comparative modeling, Docking, protein-protein and protein-ligand docking. Techniques for 3-D structure determination like X-ray, NMR, MS/MS analysis.

**Computational drug designing:** Structure-based drug design, virtual screening, quantitative structure activity relations, Cheminformatics and pharmacophore mapping in therapeutic development.

### **Suggested reading**

1. Baxevanis, A.D. and Ouellette, B.F.F. (2005). *Bioinformatics: A Practical guide to the Analysis of Genes and Proteins*. Wiley-Interscience, USA.
2. Hall, B.G. (2011). *Phylogenetic Trees Made Easy: A How-To Manual*. Sinauer Associates, Inc. USA.
3. Lesk, A.M. (2008). *Introduction to Bioinformatics*. Oxford University Press, UK.
4. Zvelebil, M. and Baum, J. (2007). *Understanding Bioinformatics*, Garland Science, New York, USA.
5. Ramsden, J. (2010). *Bioinformatics: An Introduction (Computational Biology)*. Springer, India.
6. Ye, S.Q. (2008). *Bioinformatics: A Practical approach*. Chapman & Hall/CRC, UK.
7. Mount, D. (2012). *Bioinformatics: Sequence and Genome Analysis*. Cold Spring Harbor Laboratory Press.
8. Graur, D., Li, W. H. (2000). *Fundamentals of Molecular Evolution*. Sinauer Associates.
9. Tisdall, J. (2001). *Beginning Perl for Bioinformatics*. O'Really Publishers.
10. **Orengo, C., Jones, D., Thornton, J. (2005). *Bioinformatics: Genes, Proteins and Computers (Advanced Texts)*. Taylor and Francis Publishers.**

### **LMM.698: Dissertation Part – I**

#### **Course Code:**

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

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

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

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

- a. COC of the department
- b. Supervisor or Co-supervisor
- c. One faculty of allied department

Semester-4											
S.No	Paper Code	Course Title	L	T	P	Cr	% Weightage				
							A	B	C	D	E
1	LMM.606	Genetic Engineering and Recombinant Therapeutics	4	-	-	4	25	25	25	25	100
2	LMM.607	Clinical Biotechnology	4	-	-	4	25	25	25	25	100
3	LMM.699	Dissertation Part-II			32	16					400
			6	0	32	24					600

A: Continuous Assessment: Based on Objective Type Tests

B: Pre-Scheduled Test-1: Based on Objective Type & Subjective Type Test (By Enlarged Subjective Type)

C: Pre-Scheduled Test-2: Based on Objective Type & Subjective Type Test (By Enlarged Subjective Type)

D: End-Term Exam (Final): Based on Objective Type Tests

E: Total Marks

**L: Lectures T: Tutorial P: Practical Cr: Credits**

**LMM.606: Genetic Engineering and Recombinant Therapeutics. Credit Hours: 4.**

**Unit: 1 16 Lectures**

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

**Unit: 2 16 Lectures**

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

**Unit: 3 20 Lectures**

**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: 4 20 Lectures**

**Techniques and Applications of recombinant DNA technology:** Isolation and Detection of DNA, RNA and proteins by Southern blotting, Northern blotting, western blotting and *in situ* hybridization techniques. Sites specific mutagenesis: Yeast two hybrid system, phage display, characterization of expressed proteins through various biophysical, biochemical methods. Gene mapping and Microarrays. Genetically modified microbes (Recombinant bacteria) for the production of commercial scale production of proteins and pharmaceuticals, antibiotics,

enzymes, insulin, growth hormones, monoclonal antibodies. Applications rDNA in diagnosis of pathogens and abnormal genes. Transgenic animals. Transgenic animals for production of proteins and pharmaceuticals. Genetically modified insect cells for the production of commercially important bioproducts.

**Suggested Reading:**

1. R.W. Old & S.B. Primrose (2007) *Principles of gene manipulation* 7th Edition Blackwell science.
2. Bernard R. Glick & Jack J. Pasternak. (2010) *Molecular Biotechnology* 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/>

<http://www.livescience.com/32648-whats-genetic-engineering.html>

**LMM.607: Clinical Biotechnology**

**Credit Hours: 4.**

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

**Medical diagnostics:** Importance of diagnostic tools, Instruments used in medical diagnostics, imaging techniques, bioethics, biosafety and IPR issues.

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

**Clinical Pathology:** Analyses of body fluids and tissues and from various disciplines of microbiology, serology, clinical chemistry, hematology, transfusion medicine, cytogenetics.

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

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

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

Gene therapy in various diseases. Vectors used in gene therapy Biological vectors – retrovirus, adenoviruses, Herpes Synthetic vectors– liposomes, receptor mediated gene transfer. Gene therapy trials – Familial Hypercholesterolemia, Cystic Fibrosis, Solid tumors. Cell and tissue engineering: Stem cell Potential use of stem cells – Cell based therapies, Nanomedicine. **Chromosomal disorders:** autosomal; sex chromosomal; karyotype analysis, G-banding, in situ hybridization (FISH and on-FISH), and comparative genomic, hybridization (CGH).Cancer cytogenetics: spectral karyotyping, DNA diagnostics: PCR based diagnostics; ligation chain reaction, southern blot, diagnostics, array-based diagnostics, DNA sequencing, genetic profiling, single nucleotide polymorphism.

### **Suggested reading:**

1. Jocelyn, E. K., Elliot, S. G., Stephen, T. K. (2009), *Lewin's Gene X*. Jones & Barlett.
2. Milunsky, A., Milunsky, J. (2009). *Genetic Disorders and the Fetus: Diagnosis, Prevention and Treatment, 6th Edition*. Wiley-Blackwell publishers.
3. Patch, H. S. C. (2009). *Genetics for the Health Sciences*. Scion Publishing Ltd., UK.
4. Brown, S. M., (2009). *Essentials of Medical Genomics*. Wiley-Blackwell.
5. Lodish, H., Berk, A., Chris, A. K., Krieger, M. (2008), *Molecular Cell Biology*. W.H. Freeman, USA.
6. Kingston H (2002) *ABC of Clinical Genetics*. Blackwell BMJ books, 3rd edition.
7. McPherson and Pincus. *Henry's Clinical Diagnosis and Management by Laboratory Methods*. 22nd edition, Saunders Publishing Company

### Related Weblinks:

1. <http://csu-cvmb.colostate.edu/vth/diagnostic-and-support/clinical-pathology/Pages/default.aspx>
2. [http://www.hopkinsmedicine.org/healthlibrary/conditions/pathology/clinical\\_pathology\\_overview\\_85,P00955/](http://www.hopkinsmedicine.org/healthlibrary/conditions/pathology/clinical_pathology_overview_85,P00955/)
3. <http://www.biomedcentral.com/bmclinpathol>
4. <http://www.genome.gov/11508982>

## LMM.699: Dissertation Part – II

<b>L</b>	<b>T</b>	<b>P</b>	<b>Credits</b>	<b>Marks</b>
<b>0</b>	<b>0</b>	<b>16</b>	<b>16</b>	<b>400</b>

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

The Evaluation criteria shall be multifaceted as detailed below:

**Total marks 300**

<b>S.No.</b>	<b>Criteria</b>	<b>Marks allotted</b>
1.	Report Writing	125
2.	Presentation and defence of research work	125
3.	Continuous evaluation of student by Guide	150

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

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