CENTRAL UNIVERSITY OF PUNJAB, BATHINDA

M.Sc. Human Genetics

Session - 2020-22

Department of Human Genetics and Molecular Medicine

Programme Outcome

M.Sc Human Genetics is a two years (4 semesters) post-graduation programme. This programme will provide students a very exciting avenue to nurture their scientific aptitude to achieve their academic goals. On successful completion of this programme the students will be able to:

- Integrate multidisciplinary approaches to analyze the role of genetic and molecular factors in health and disease
- Design and perform population genetics and epidemioloical studies for health reseach
- Compete at national and global level to pursue research and teaching in any field of life sciences
- Perform cytogenetic and molecular techniques for genetic diagnosis

Course Structure of the Programme

Semester-I

Course Code	Course Title	Course Type	Hours			Credit
			L	T	P	
LHG.506	Biostatistics and Research Methodology	Compulsory Foundation	4	0	0	4
LHG.507	Biostatistics and Research Methodology (Practical)	Skill based	0	0	2	1
LMM.508	Cellular and Molecular Biology	Core	4	0	0	4
LMM.509	Cellular and Molecular Biology (Practical)	Skill based	0	0	2	1
LHG.510	Basic and Clinical Biochemistry	Core	4	0	0	4
LHG.511	Basic and Clinical Biochemistry (Practical)	Skill based	0	0	2	1
LHG.512	Concepts of Genetics	Core	4	0	0	4
LHG.513	Concepts of Genetics (Practical)	Skill based	0	0	2	1
Inter-disciplinary Course-I (For other Departments)						
LHG.514	Basics of Human Genetics	IDC-I	2	0	0	2
LHG.515	Introduction to Intellectual Property Rights	IDC-II	2	0	0	2
Total			**18**	0	**8**	**22**

Semester-II

Course Code	Course Title	Course Type	Hours			Credit
			L	T	P	
LHG.526	Human Cytogenetics and Human Biochemical Genetics	Core	4	0	0	4
LMM.523	Essentials of Immunology	Core	4	0	0	4
LHG.524	Advanced Techniques in Human Genetics	Core	4	0	0	4
LHG.529	Human Anatomy and Physiology	Core	4	0	0	4
LHG.530	Human Anatomy and Physiology	Skill Based	0	0	2	1
Elective Course-I (Any one of the following)						
LHG.525	Human Embryology and Developmental Genetics	EC-I	4	0	0	4
LMM.525	Regenerative Medicine	EC-II	4	0	0	4
Inter-disciplinary Course-II (For other Departments)						
LHG.515	Introduction to Intellectual Property Rights	IDC-II	2	0	0	2
LHG.527	Prenatal Diagnosis and Genetic Counseling	IDC-III	2	0	0	2
LHG.528	Introduction to Population Genetics	IDC-IV	2	0	0	2
LHG.542	Seminar-I	Skill Based	0	0	0	1
Total			**22**	**0**	**2**	**24**

Semester-III

Course Code	Course Title	Course Type	Hours			Credit
			L	T	P	
LHG.551	Biosafety, Bioethics and Intellectual Property Rights	Core	4	0	0	4
LHG.552	Bioinformatics and Computational Biology	Core	4	0	0	4
LHG.553	Pharmacogenomics and Nutrigenomics	Core	4	0	0	4
Elective Course-II/MOOC (Any one of the following)						
LHG.554	Population Genetics and Genetic Epidemiology	EC-III	4	0	0	4
LMM.554	Molecular and Cellular Oncology	EC-IV	4	0	0	4
xxx.xxx	MOOC course (One course)	MOOC	4	0	0	4
LHG.503	Clinical Genetics (Practical)	Value added	0	0	2	1
LHG.599	Project –I	Skill Based	0	0	0	6
Total			**16**	0	**2**	**23**

Semester-IV

Course Code	Course Title	Course Type	Hours			Credit
			L	T	P	
LHG.571	Recombinant DNA Technology and Therapeutics	Core	4	0	0	4
LHG.572	Genetic Disease and Therapies	Core	4	0	0	4
LHG.573	Practice in Life Sciences-I	Discipline Enrichment	2	0	0	2
LHG.574	Practice in Life Sciences-II	Discipline Enrichment	2	0	0	2
LHG.504	Principles of Ecological Science	Elective Foundation/ Value Added	1	0	0	1
LHG.544	Seminar-II	Skill Based	0	0	0	2
LHG.599	Project -II	Skill Based	0	0	0	6
Total			**13**	**0**	**0**	**21**

Details of syllabus

Semester – I

Course Code: **LHG.506**

Course Title: **Biostatistics and Research Methodology**

L	T	P	Credits
4	0	0	4

Total Hours: **60**

UNIT I Hours: **15**

Learning Outcomes:

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

- Analyze and evaluate wide variety of statistical data
- Compose statistical data and summary statistics in graphical and tabular forms
- Apply suitable statistical tools to analyze data
- Write and communicate scientific reports, projects and publications

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 Hours: **15**

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 Hours: **15**

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 Hours: **15**

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 Modes: Lecture**;** Tutorial; Problem solving; Self-learning.

Suggested Readings:

1. Rao, S.P.S.S. Richard, J. (2016). *Introduction to biostatistics and research methods*. 5th Ed. Phi Learning Pvt. Ltd. New Delhi.
2. Hoffman, J. (2015). *Biostatistics for medical and biomedical practioners*. 1st Ed. Academic Press, London.
3. Banerjee P.K (2014). *Introduction to Biostatistics*. S.Chand, New Delhi.
4. Antonisamy, B. Christopher, S. Samuel, P.P. (2011). *Biostatistics: Principles and Practice*. Tata McGraw Hill. New Delhi.
5. Daniel W.W (2011). *Biostatistics*: *Basic Concepts and methodology for the health sciences*. 9th Ed. John Wiley and Sons Inc, New Delhi.
6. Norman, G. and Streiner, D. (2008). *Biostatistics: The Bare Essentials*. (with SPSS), 3rd Edition, Decker Inc. USA.
7. Sokal, R.R. and Rohlf, F.J. (1994). *Biometry: The Principles and Practices of Statistics in Biological Research*. W.H. Freeman publishers, USA.

Course Code: **LHG.507**

L	T	P	Credits
0	0	2	1

Course Title: **Biostatistics and Research Methodology (Practical)**

Total Hours: **30**

Learning Outcomes:

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

- Analyze variety of statistical data using appropriate tools
- Apply suitable statistical equations to analyze data
- Perform data stratification and representation
- Write and communicate scientific reports, projects and publications

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

Transactional Modes: Laboratory based practicals; Problem solving; Self-learning.

Evaluation criteria for practical courses:

- Continuous Assessment = **60 Marks**

Based on performance and good lab practices of the students and completion of the record book (60 divided by the number of practicals)

- Final Examination = **40 Marks**
  Subjective question = 10 Marks
  Performing experiment = 20 Marks
  Viva voce = 10 Marks

Course Code: **LMM.508**

L	T	P	Credits
4	0	0	4

Course Title: **Cellular and Molecular Biology**

Total Hours: **60**

Learning Outcomes:

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

- Evaluate the structures and functions of the basic components of membranes, and organelles and their related functions
- Conceptualize basic cellular and molecular mechanisms
- Analyze the molecular processes of DNA replication, transcription, and translation
- Apply the knowledge for through insight into basic mechanisms of cellular signal transduction and regulation of gene expression

UNIT I Hours: **15**

Membranes of intracellular organelles, Membrane transport, Structure and functions of intracellular organelles, Intracellular traffic and secretory pathways, endocytosis and exocytosis.

UNIT II Hours: **15**

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 Hours: **15**

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 Hours: **15**

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

Suggested Readings:

1. Sambrook, J., Fritsch, E. F., & Maniatis, T. (2015). Molecular cloning: a laboratory manual. Cold Spring Harbor Laboratory Pressn New York.
2. Lodish, H.,Berk, A. Chris, A.K. & Krieger, M. (2011). *Molecular Cell Biology*. W.H. Freeman, USA.
3. Robertis, (2011). *Cell and Molecular Biology*. Lippincott Williams & Wilkins.
4. Karp, G. (2010). *Cell and molecular biology: concepts and experiments*. John Wiley & Sons.
5. Krebs, J. E., Goldstein, E. S., & Kilpatrick, S. T. (2017). *Lewin's Genes XII*. Jones & Bartlett Learning.
6. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., & Levine, M. (2003). Molecular Biology of the Gene Benjamin Cummings.
7. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2007). Molecular biology of the cell. Garland Science. *New York*, *1392*.
8. Fasman, G.D. (1989). *Practical Handbook of Biochemistry and Molecular Biology*. CRC Press, Taylor and Francis Group, UK.

Course Code: **LMM.509**

L	T	P	Credits
0	0	2	1

Course Title: **Cellular and Molecular Biology (Practical)** Total Hours: **30**

Learning Outcomes:

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

- Evaluate the structures and functions of the basic components of membranes, and organelles and their related functions.
- Analyze the results of Immunofluroscence and IHC
- Apply the knowledge for the research related to cell biology.
- Perform cell or tissue culture

1 DNA isolation and Agarose gel electrophoresis
2. RNA isolation and denaturing gel electrophoresis
3. Instrumental methods for cell biology-centrifugation, chromatography.
4. Immunofluorescence and fluorescent probes.
5. Basics of mammalian cell culture
6. Histochemical techniques (Fixing, Processing, Staining).
7. Epifluoresence and Confocal Microscopy.

*Practical can be modified depending upon the available faculty/facility.

Transactional Modes: Hands-on practicals; Demonstration**;** Tutorial**;** Problem solving; Self-learning.

Evaluation criteria for practical courses:

- Continuous Assessment = **60 Marks**

Based on performance and good lab practices of the students and completion of the record book (60 divided by the number of practicals)

- Final Examination = **40 Marks**

  Subjective question = 10 Marks

  Performing experiment = 20 Marks

  Viva voce = 10 Marks

Course Code: **LHG.510**

L	T	P	Credits
4	0	0	4

Course Title: **Basic and Clinical Biochemistry**

Total Hours: **60**

Learning Outcomes:

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

- Understand the importance of maintenance of pH, role of vitamins and minerals in metabolic processes
- Compare the basic structural features of biomolecules namely carbohydrates, lipids, proteins and vitamins.
- Understand the structure of different forms of DNA and RNA
- Conceptualize the basic features of enzyme catalysis and regulation.

UNIT I Hours: **15**

Carbohydrates: Classification and functions, Epimers; Anomers; Mutarotation. Reactions of carbohydrates; General scheme of metabolism.
Clinical Biochemistry: Properties of water, Ionization of water, weak acids and weak bases, pH and buffers. Water and sodium balance, Interpretation of biochemical tests, Composition of blood, urine and cerebrospinal fluids, Vitamins and trace elements disorders. Liver and kidney function tests, Jaundice, diabetes mellitus, hypoglycemia, hypertension.

UNIT II Hours: **15**

Carbohydrate Metabolism: Basic concepts, Glycolysis, Krebs cycle, Pentose phosphate pathway, Gluconeogenesis, Regulation of carbohydrate metabolism. Inborn errors of carbohydrate metabolism
Lipids: Classification and functions, Beta oxidation - Pathway and regulation. Role of acyl carnitine in fatty acyl transport. Cholesterol synthesis. Ketone bodies- Formation and utilization. Clinical features and laboratory findings in disorders of triglyceride, lipoprotein and cholesterol metabolism.

UNIT III Hours: **15**

Proteins: Structure and function of proteins, Secondary, Tertiary and Quaternary structure, super secondary structures, Ramachandran plot. Oxygen binding proteins – Hemoglobin and myoglobin.
Nucleic Acids: Structure and functions, Nucleosides and nucleotides. Metabolism of purines and pyrimidines- Salvage and *de novo* pathways.

UNIT IV Hours: **15**

Enzymes: Definition, Classifications and nomenclature, prosthetic groups, cofactors, Mechanism of enzyme action and properties of enzymes; Enzyme activity, Factors affecting rate of enzyme catalyzed reactions: pH, temperature, etc. ES complex formation; Michaelis-Menten equation; Determination of Km and Vmax and its significance; Turnover number; Enzyme inhibition: reversible and irreversible inhibition. Isoenzymes, catalytic antibodies, multienzyme complexes and ribozymes.

Transactional Modes: Lecture**;** Demonstration**;** Tutorial**;** Lecture cum demonstration; Problem solving; Self-learning.

Suggested Readings:

1. Berg, J.M., Tymoczko, J.L., Gatto Jr, J.R., Stryer, L. (2015) Biochemistry Eighth Edition, 2015, W.H. Freeman & Company. USA.
2. Brown, T.A. (2016). Gene Cloning and DNA Analysis: An Introduction, 7th Edition January 2016, Blackwell Publishing Professional. USA.
3. Nelson, D.L., Cox, M.M. (2017). Lehninger Principles of Biochemistry. Seventh Edition| 2017
4. Donald Voet, Charlotte W. Pratt, Judith G. Voet (2012) Principles of Biochemistry, International Student Version. John Wiley & Sons, Publisher
5. Swaminathan, R. (2011). Handbook of clinical biochemistry. 2nd edition, World Scientific Publishing Company, New Jersey, USA
6. Palmer, T., Bonner, P.L. (2007) Enzymes: biochemistry, biotechnology and clinical chemistry. Woodhead Publishing Limited.
7. Price, N.C., Stevens, L. (2003) Fundamentals of enzymology: The cell and molecular biology of catalytic proteins. Oxford University Press, USA.
8. Swaminathan, R (2011) Handbook of Clinical Biochemistry, 2nd Edition, Publisher: World Scientific
9. Murphy M.J., Srivastava R., Deans, K. (2018) Clinical Biochemistry, 6th Edition. Elsevier's USA.
10. Devlin, T.M. (2010) Textbook of Biochemistry with clinical correlation. John Wiley and Sons Publishers.

Course Code: **LHG.511** Total Hours: **30**

L	T	P	Credits
0	0	2	1

Course Title: **Basic and Clinical Biochemistry (Practical)**

Learning Outcomes:

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

- Appreciate the importance of chemical safety and precautions in the biochemistry laboratory
- Prepare buffers and solutions with varied concentration.
- Quantitative estimation of biomolecules
- Qualitative estimation of biomolecules

1. Preparation of buffer solutions.
2. Estimation of proteins using Lowry's methods.
3. Quantitation estimation of lipids.
4. Quantitative estimation of carbohydrates.

5. Assay of enzyme activity.
6. Effect of temperature/pH on enzyme activity
7. Isolation of DNA from blood/saliva.
8. Liver function tests-SGOT and SGPT
9. Determination of urea

*Practical will be conducted depending upon the faculty/facility available.
Transactional Modes: Hands-on Practicals; Demonstration**;** Tutorial**;** Self-learning.

Suggested Readings:

1. Rajendiran, S., Dhiman, P. (2019) Biochemistry Practical Manual. Elsevier India.
2. Plummer, D. (2004) An Introduction to Practical Biochemistry. Tata McGraw Hill Publishers Co. Ltd., India
3. Gupta, P.P., Gupta, N. (2017) Essentials of Practical Biochemistry. Jaypee Brothers Medical Publishers Pvt. Ltd. India.
4. Hofmann, A., Clokie, S. (2018). Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology. Cambridge University Press, USA
5. Murphy M.J., Srivastava R., Deans, K. (2018) Clinical Biochemistry, 6th Edition. Elsevier's USA.
6. Swaminathan, R (2011) Handbook of Clinical Biochemistry, 2nd Edition, Publisher: World Scientific

Evaluation criteria for practical courses:

- Continuous Assessment = **60 Marks**

Based on performance and good lab practices of the students and completion of the record book (60 divided by the number of practicals)

- Final Examination = **40 Marks**

  Subjective question = 10 Marks

  Performing experiment = 20 Marks

  Viva voce = 10 Marks

Course Code: **LHG.512**

L	T	P	Credits
4	0	0	4

Course Title: **Concepts of Genetics**
Total Hours: **60**

Learning Outcomes:

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

- Evaluate the Mendelian and Non-Mendelian inheritance patterns
- Understand gene expression regulation and sex determination
- Evaluate different chromosomal aberrations and ploidies
- Describe extra chromosomal inheritance patterns

UNIT I

Hours: **15**

Transmission Genetics: Mendel's laws of inheritance and it's applications; concept of segregation, independent assortment and dominance; pedigree analysis; epistasis; crossing over and recombination; two and three point gene mapping.
Sex determination: Sex determination in Human and Drosophila; X-chromosome inactivation; dosage compensation.

UNIT II Hours: **15**

Chromosomal Mutations: Chromosomal aberrations: structural and numerical; 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 and it's types; complementation and recombination;transposable elements in Pro- and Eukaryotes.
Genes and genome dynamics: Fine structure of gene; and analysis – Benzer's experiments,

UNIT III Hours: **15**

Microbial Genetics: Genetic systems of Viruses and Bacteria; genetic analysis and mapping in Bacteria and Bacteriophages – conjugation, transformation and transduction; recombination and gene mapping; evolution of microbial genome.

UNIT IV Hours: **15**

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

Suggested Readings:

1. Klug WS and Cummings MR. Concepts of Genetics. Prentice-Hall.2014
2. 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.
3. Pierce BA. Genetics: A Conceptual approach. Freeman Publishers.
4. Hartle DL and Jones EW. Genetics: Analysis of Genes and Genomes. Jones & Bartett.
5. Atherly, A.G., Girton, J.R., Mcdonald, J.F. (1999). *The science of Genetics*. Saundern College publication.
6. Snusted, D.P., Simmons, M. J. (2010). *Principles of Genetics*. John Wiley & Sons, New
7. Griffith AF et al. An Introduction to Genetic Analysis. John Wiley & Sons.

Course Code: **LHG.513**

L	T	P	Credits
0	0	2	1

Course Title: **Concepts of Genetics (Practical)**

Total Hours: **30**

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*.

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

*Practical list can be modify depending upon the available faculty /facility.

Transactional Modes: Hands-on practicals; Demonstration**;** Tutorial**;** Self-learning.

Evaluation criteria for practical courses:

- Continuous Assessment = **60 Marks**

Based on performance and good lab practices of the students and completion of the record book (60 divided by the number of practicals)

- Final Examination = **40 Marks**

Subjective question = **10 Marks**

Performing experiment = 20 Marks

Viva voce = 10 Marks

Course Code: **LHG.514**

L	T	P	Credits
2	0	0	2

Course Title: **Basics of Human Genetics**

Learning Outcomes:

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

- Know about cell division and genetic transmissions
- Know about patterns of inheritance
- Gather knowledge about different human genetic diseases
- Evaluate different chromosomal aberrations and ploidies

Total Hours: **30**

UNIT I Hours: **7**

Chromosomal analysis: Classification of human chromosomes; human chromosomes; the life cycle of a somatic cell: mitosis, meiosis gametogenesis.

UNIT II Hours: **8**

Genetic assessment: Medical applications of chromosomes; Symbols used in a pedigree drawing of a pedigree; terminology, consanguinity**,**

UNIT III Hours: **7**

Common chromosomal disorders: Aneuploidy, Down syndrome, Edwards syndrome, Patau's syndrome and other trisomies ; structural aberration

UNIT IV Hours: **8**

Patterns of inheritance: Autosomal and sex chromosomal inheritance patterns with examples; multiple, Uniparental disomy,, multifactorial disorders.

Transactional modes: Lecture**;** Demonstration**;** Tutorial**;** Lecture cum demonstration; Problem solving; Self-learning.

Suggested Readings:

1. Emery and Rimoin's, et aI., 2007. Principles and Practice of Medical Genetics. Fifth Edition.Volume - II, Churchill Livingstone Elsevier.
2. Emery and Rimoin's, Principles and Practice of Medical Genetics e-dition: 3-Volume.Set, Churchill Livingstone Elsevier

3. De Grouchy & Turleau.1984.Clinical atlas on Human Chromosomes.
4. Jankowski &Polak, 1996.*Clinical Gene Analysis and Manipulation*.
5. Robinson and Linden, Clinical Genetics Handbook. (latest edition)
6. F Vogel A.G. Motulusky. Human Genetics: Problems and Approaches. Second Completely Revised Edition, Springer-Verlag. (latest edition)
7. Golder N. Wilson, M.D., Ph.D.Clinical Genetics-A Short Course. A John Wiley and Sons. Inc., Publication. (latest edition)
8. William S Klug (Author), Michael R. Cummings, Charlotte A. Spencer , Michael A. Palladino, Darrell Killian, 2019, Concepts of Genetics Pearson Press, USA

Course Code: **LHG.515**

L	T	P	Credits
0	0	0	2

Course Title: **Introduction to Intellectual Property Rights**
Total Hours: **30**

Learning Outcomes:

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

- Gather knowledge about different forms of intellectual property rights
- Differentiate between patentable and nonpatentable invention/innovation
- Familiar with the various patent filing routes
- Be more aware about the protection of indigenous intellectual property

UNIT I Hours: **8**

Intellectual Property Rights (IPRs): Various forms of IP – patents, industrial designs, trade secrets, geographical indications and plant breeder's right; copyright.

UNIT II Hours: **8**

Patent system in India: Patent filing in India and abroad: determination of patentability of inventions; filing a patent application in India: timeline, procedure involved in the granting of a patent; gene patent; patenting of living organisms.

UNIT III Hours: **7**

Various routes of filing international patent application: Different phased of Patent co-operation treaty (PCT) application

UNIT IV Hours: **7**

Protection of indigenous intellectual property: Traditional Knowledge Digital Library (TKDL).

Transactional Modes: Lecture**;** Demonstration**;** Tutorial**;** Lecture cum demonstration; Problem solving; Self-learning.

Suggested Readings:

1. Dutfield G. (2003*). Intellectual Property Rights and the Life Science Industries: A Twentieth Century History* (Globalization and Law).Routledge.
2. Mahop, M.T. (2010). *Intellectual Property, Community Rights and Human Rights: The Biological and Genetic Resources of Developing Countries.*Routledge.
3. Martin Khor (2002). Intellectual Property, Biodiversity and Sustainable Development: Resolving the Difficult Issues. Zed Books limited.

Details of syllabus

Semester – II

Course Code: **LHG.526**

L	T	P	Credits
4	0	0	4

Course Title: **Human Cytogenetics and Human Biochemical Genetics**
Total Hours: **60**

Learning Outcomes:

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

- Apply cytogenetic techniques for the identification of individual chromosomes
- Apply classical cytogenetic and molecular cytogenetic techniques for the identification of chromosomal disorders
- Describe biochemistry and genetics of various blood group types Distinguish different disorders caused due to abnormal variants of hemoglobin, lysosomal enzymes, lipids and DNA nitrogenous bases

UNIT I Hours: **15**

General features of Human Chromosome and Chromosome staining: Chromatin structure; nucleosome model; constitutive and facultative heterochromatin; centromeres, Telomere and its maintenance; nuclear organization region (NOR); chromosome nomenclature; sister chromatid exchanges (SCE); mosaicism; structure of human X and Y chromosome; ring chromosomes; human artificial chromosome.

UNIT II Hours: **15**

Cytogenetic and Molecular Cytogenetic Techniques: Methods of Chromosome preparation; chromosome banding techniques: G banding, Q banding, R banding and C banding; fluorescent in situ hybridization (FISH); different types of FISH probes: centromeric probes, chromosome specific probes and telomeric probes; reverse painting; flow cytometry; comparative genomic hybridization (CGH) mapping technique, whole chromosome painting; spectral karyotyping (SKY).

UNIT III Hours: **15**

The concept of Biochemical Polymorphism: Concept of enzyme and protein polymorphism; molecular structure; biosynthesis and genetics of the ABH antigens; Rh antigens and MN antigens; quantitative and qualitative variation of enzymes; haemoglobin variants; effects of single amino acid substitutions (Sickle cell disease).

UNIT IV Hours: **15**

Disorders due to abnormal variants of lysosomal enzymes, lipids and DNA nitrogenous bases: Disorders due to abnormal lysosomal enzymes: Tay-sachs disease and Mucopolysaccharidoses; disorders of lipoprotein and lipid metabolism: hyper lipoproteinemia; disorders of purine metabolism: Lesch Nyhan syndrome; disorders of pyrmidine metabolism: Orotic Aciduria.

Transactional modes: Lecture**;** Demonstration**;** Tutorial**;** Lecture cum demonstration; Problem solving; Self-learning.

Suggested Readings:

1. Gillham, N. (2011). *Genes, Chromosomes and Disease*. Pearson
2. Griffiths, A.J.F., Wessler, S.R. and Carroll, S.B. (2012). *An Introduction to Genetic Analysis*. W.H. Freeman Publication, USA.
3. Hein, S. and Mitelman, F. (2009). *Cancer Cytogenetics*. Wiley-Blackwell.
4. William S Klug (Author), Michael R. Cummings, Charlotte A. Spencer , Michael A. Palladino, Darrell Killian, 2019, Concepts of Genetics
5. Korf, B.R and Irons, M.B. (2013). *Human Genetics and Genomics*. Wiley-Blackwell.
6. Kumar, A. and Srivastava, M. (2012) A textbook of Molecular Cytogentics, Narendra Publishing House, India
7. Purandare, H. and Chakravarty, A. (2000) *Human Cytogenetic Techniques and Clinical Applications.*Bhalani Publishing House, Mumbai, India.
8. Ram, M. (2010). *Fundamental of Cytogenetics and Genetics*. PHI Learning Pvt. Ltd.
9. Roy, D. (2009). *Cytogenetics.*Narosa Publishing House. New Delhi, India.
10. Tom, S and Read, A (2010). *Human Molecular Genetics.* Garland Science.
11. Shukla, A.N. (2009). *Elements of enzymology.* Discovery Publishing. New Delhi, India.
12. Voet, D. and Voet, J.G. (2008). *Principles of Biochemistry*. CBS Publishers & Distributors, New Delhi.

Course Code: **LMM.523**

L	T	P	Credits
4	0	0	4

Course Title: **Essentials of Immunology**
Total Hours: **60**

Learning Outcomes:

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

- Evaluate basic concepts of immune system and to understand the concept of immune-based diseases as either a deficiency of components or excess activity as hypersensitivity.
- Apply the knowledge how immune system is involved in diseases caused by internal or external factors.

UNIT I Hours: **15**

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 Hours: **15**

Immune Effectors: Complement system, their structure, functions and mechanisms of activation by classical, alternative and lectin pathway. Th1 and Th2 response, various effector cells of immune system: DC, NK, Monocytes etc.

UNIT III Hours: **15**

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 Hours: **15**

Immune System in Health and Diseases: Inflammation, hypersensitivity and autoimmunity, AIDS and immunodeficiencies, vaccine development.

Transactional Modes: Lecture**;** Demonstration**;** Tutorial**;** Lecture cum demonstration; Problem solving; Self-learning.

Suggested Readings:

1. Kindt, T.J., Osborne, B.A. and Goldsby, R.A. (2018). *Kuby Immunology*. W.H. Freeman, USA.

2. Abbas. (2018). *Cellular and Molecular Immunology*.CBS Publishers & Distributors, India.
3. Charles, A. and Janeway, J.R. (2001). *Immunobiology: The immune system in health and disease.* Blackwell Publishing, USA.
4. Delves, P.J., Roitt, I.M. and Seamus, J.M. (2016). *Roitt's Essential Immunology (Series–Essentials).*Blackwell Publishers, USA.
5. Elgert, K.D. (2015). *Immunology: Understanding the immune system*. Wiley-Blackwell, USA.
6. Tizard. (2018). *Immunology: An Introduction*. Cengage Learning, Thompson, USA.
7. Owen, Judith A; Punt, Jenni, Stranford, Sharon A. *Kuby's Immunology* (2013), W.H. Freeman and Company: New York, 2013

Course Code: **LHG.524**

L	T	P	Credits
4	0	0	4

Course Title: **Advanced Techniques in Human Genetics** Total Hours: **60**

Learning Outcomes:

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

- Analyze various cellular processes technically.
- Apply the knowledge to decipher the mechanisms of molecular and cell biology.
- Know specific technical aspects for variety of techniques used in biological experiments
- Conceptualize principles of different techniques used in life sciences

UNIT I Hours: **15**

Biochemical Techniques: Sterilization techniques; spectrometry; colorimetry;Mass, UV, IR, NMR and atomic absorption spectrophotometery; 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, dHPLC and FPLC.

UNIT II Hours: **15**

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 III Hours: **15**

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, SNPs; blotting techniques: southern, northern, western, dot blotting and hybridization; DNA fingerprinting.

UNIT IV Hours: **15**

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.

Transactional Modes: Lecture**;** Demonstration**;** Tutorial**;** Lecture cum demonstration; Problem solving; 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, 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). 3rd 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*. 6th Edition, Cambridge University Press India Pvt. Ltd., New Delhi.
15. Sue Carson Heather Miller Melissa Srougi D. Scott Witherow (2019)Molecular Biology Techniques. Academic Press, USA

Course Code: **LHG.529**

L	T	P	Credits
4	0	0	4

Course Title: **Human Anatomy and Physiology**
Total Hours: **60**

Learning Outcomes:

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

- Understand anatomical structures of
- Understand the physiological functions of body systems.
- Evaluate the interrelationships between physiological systems of the human body.
- Recognize the principle of homeostasis and control mechanisms of physiological systems in the human body.
- Make a connection between knowledge of anatomy and physiology and real-world situations, including healthy lifestyle decisions

UNIT I Hours: **15**

Muscular System: Structure and organization of muscles: skeletal, cardiac and smooth muscles; Skeletal muscle contraction

Cardiovascular System: Anatomy of Heart; cardiac cycle; blood constituents; haematopoiesis; blood pressure and its neural and chemical regulation.

UNIT II Hours: **15**

Digestive System: Overview of parts of digestive system, Digestion; absorption; epithelial barrier function; regulation of swallowing and gastric emptying and small/large bowel; gastro-intestinal secretions and accessory glands; energy balance; BMR.

Urinary System: Kidney; urine formation; regulation of water balance; electrolyte and acid-base balance.

UNIT III Hours: **15**

Nervous System: Central and peripheral nervous system, Neuron, generation of action potential; vision; hearing and tactile response.

Thermoregulation and stress adaptation: Comfort zone; body temperature – physical, chemical and neural regulation; acclimatization.

UNIT IV Hours: **15**

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 Modes: Lecture**;** Seminar**;** Tutorial**;** Problem solving; Self-learning; group discussion.

Suggested Readings:

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.
4. Guyton. (2007). *Textbook of medical physiology*. 11th Edition. Elsevier India Pvt. Ltd. New Delhi.
5. Hill, R.W, Wyse, G. A. and Anderson, M. (2008). *Animal physiology*. Sinauer Associates Inc. USA.
6. Khurana. (2006). *Textbook of medical physiology*. Elsevier India Pvt. Ltd.
7. Murray, R.K. (2009). *Harper's illustrated biochemistry*.Jaypee Publishers, New Delhi, India.
8. Tyagi, P. (2009). *A textbook of Animal Physiology*.Dominant Publishers and distributors, New Delhi, India.

9. Silverthorn D, (2011) *Human Physiology*, Pearson; 6th edition.
10. Sherman V. (2013) *Vander's Human Physiology*. McGraw-Hill 13th edition.

Course Code: **LHG.530**

L	T	P	Credits
0	0	2	1

Course Title: **Human Anatomy and Physiology (Practical)** Total Hours: **30**

Learning Outcomes:

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

- Perform key hands-on experiments on human physiology
- Demonstrate several biophysical techniques regularly used in health sciences
- Get familiar with the basic principles of physiological experiments

1. Equipment in the laboratory - maintenance and use.
2. **Hematology:** Blood group typing, Observation of types of blood cells, Counting of WBCs and RBCs, Determination of hemoglobin
3. **Cardiovascular system**: Studying characteristics of ECG, Measurement of blood pressure and pulse rate, Study the effect of exercise on blood pressure and pulse rate
4. **Respiratory function:** Estimation of Breathing rate and Breath holding capacity.
5. **Muscle Physiology**: Distinguish different types of muscles and Observation of types of muscular contraction.
6. **Urinalysis:** Detection of glucose and protein in Urine
7. **Digestive system:** Study the role of digestive enzymes

* Practical list can be modify depending upon the available faculty /facility.

Transactional Modes: Hands-on practicals; Demonstration**;** Tutorial**;** Self-learning.

Evaluation criteria for practical courses:

- Continuous Assessment = **60 Marks**

Based on performance and good lab practices of the students and completion of the record book (60 divided by the number of practicals)

- Final Examination = **40 Marks**

  Subjective question = 10 Marks

  Performing experiment = 20 Marks

Viva voce = 10 Marks

L	T	P	Credits
4	0	0	4

Course Code: **LHG.525**

Course Title: **Human Embryology and Developmental Genetics**
Total Hours: **60**

Learning Outcomes:

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

- Conceptualize basics of reproductive physiology
- Correlate genetic regulation in different embryonic developmental stages
- Evaluate the role of biomolecules in embryonic development
- Know different genetic and environmental triggers for post-natal development, ageing and senescence

UNIT I Hours: **15**

Basic concepts of development: Gametogenesis; fertilization; embryogenesis: gastrulation and implantation of embryo; fetal membrane and placenta; different stages of development: morula, blastula and gastrula; potency, commitment, specification, induction, competence, determination and differentiation;

UNIT II Hours: **15**

Gene expression regulation in development: Basics of gene expression regulation during early embryogenesis; homeotic genes,; P granules, role of key developmental genes: polycomb gene, *SOX*, *HOX*.

UNIT III Hours: **15**

Stem Cell and Organogenesis: Stem cell: embryonic and adult; cell-cell communication; neural crest cells and axonal specificity; vertebrate eye and central nervous system development; hematopoiesis.

UNIT IV Hours: **15**

Post-natal Development, Aging and senescence: Environmental and genetic factors during maturations, Sex linked changes, Deciduous and primary teeth, ,Clinical death.

Teratology: Teratogens, introduction to toxicogenomis.

Transactional Modes: Lecture**;** Demonstration**;** Tutorial**;** Lecture cum demonstration; Problem solving; Self-learning.

Suggested Readings:

1. Gilbert, S.F. (2013). Developmental Biology. Tenth Edition.
2. Slack, J.M.W. (2012). Essentiel Developmental Biology. Third Edition.
3. Moody, A.A. (2014). Principles of Developmental Genetics. Second Edition.
4. Slack, J.M.W. (2018). The Science of Stem Cells. First Edition.
5. Milunsky, J. & Milunsky, A. (2010). *Genetic Disorders and the Fetus: Diagnosis, Prevention & Treatment.* Willey Blackwell India, New Delhi.
6. Prakash, G. (2007). *Reproductive Biology*. Narosa Publication House Pvt. Ltd., New Delhi.
7. 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.
8. Keith L. Moore BA ., T. V. N. Persaud MD.,Mark G. Torchia (2019) The Developing Human Clinically Oriented Embryology, Elsevier, Netherlands

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Course Code: **LMM.525**

L	T	P	Credits
4	0	0	4

Learning Outcomes:

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

- Synthesize the ideas for research in stem cell biology
- Apply the knowledge for translational research as well as industrial aspects of the tissue engineering and regenerative medicine
- Get in depth knowledge about tissue engineering
- Conceptualize regenerative medicine

Course Title: **Regenerative Medicine** Total Hours: **60**

UNIT I Hours: **15**

Basics of cell culture and media, Culturing primary cells and cell lines, suspension and adherent cultures, cell growth, growth inhibition and apoptotic studies, Embryo culture, transplantation and teratogens, teratomas, stem cell culture, organ culture.

UNIT II Hours: **15**

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

UNIT III Hours: **15**

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 IV Hours: **15**

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

Transactional Modes: Lecture**;** Demonstration**;** Tutorial**;** Lecture cum demonstration; Problem solving; Self-learning.

Suggested Readings:

1. Lanza, R., Gearhart,J. (2016). *Essential of Stem Cell Biology*. Elsevier Academic Press.
2. Lanza, R., Klimanskaya, I. (2018). *Essential Stem Cells Methods*. Academic Press.
3. Mao, J. J. & (2017). *Translational approaches in tissue engineering and regenerative medicine*. Artech House.
4. Lanza, R. (2017). *Principles of Tissue Engineering, 3rd Edition*. Academic Press.
5. Stein, G. S., Borowski, M., Luong, M. X., Shi, M. J., Smith, K. P., & Vazquez, P. (Eds.). (2011). *Human stem cell technology and biology: A research guide and laboratory manual*. John Wiley & Sons.
6. Lanza, R., Blau, H., Gearhart, J., Hogan, B., Melton, D., Moore, M., ... & Weissman, I. (Eds.). (2014). *Handbook of Stem Cells, Two-Volume Set: Volume 1-Embryonic Stem Cells; Volume 2-Adult & Fetal Stem Cells*. Elsevier.

Course Code: **LHG.527**

L	T	P	Credits
2	0	0	2

Course Title: **Prenatal Diagnosis and Genetic Counseling**

Total Hours: **30**

Learning Outcomes:

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

- Integrate knowledge of physiological aspects of conditions with a genetic component to promote client well-being.
- Construct relevant, targeted and comprehensive personal and family histories and pedigrees.
- Investigate the availability, the analutic validity, clinical validity, and clinical utility of screening, diagnostics and predictive genetic/genomic tests.
- Assess probability of conditions with genetic component or career status using relevant knowledge and data based on pedigree analysis, inheritance patterns, genetic epidemiology, quantitative genetics principles, and mathematical calculations.

UNIT I Hours: **8**

Prenatal screening & diagnosis: Indications for prenatal diagnosis; preliminaries to prenatal diagnosis; procedures for obtaining fetal tissue; ultrasonography; laboratory studies; psychosocial issues.

UNIT II Hours: **7**

Techniques used in prenatal diagnosis: Amniocentesis, Chorionic villus sampling, fetoscopy, cordocentesis, maternal serum screening.

UNIT III Hours: **8**

Genetic Counseling: History taking; examination; genetic counseling in clinical genetics; determining recurrence risks; population screening for genetic diseases; reproductive decision making.

UNIT IV Hours: **7**

Indications for prenatal diagnosis: Advanced maternal age, previous child with a chromosome abnormality, family history of a chromosomal abnormality, family history of a single gene disorder, family history of neural tube defect

Transactional Modes: Lecture; Case study, Demonstration**;** Tutorial**;** Lecture cum demonstration; Problem solving; Self-learning.

Suggested Readings:

1. Peter Snustad and Michael J Simmons(2009). Principles of Human Genetics. Fifth Edition. John Wiley & Sons, Inc.
2. Strachan T and Read A 2010 Human Molecular Genetics, Fourth Edition. Taylor and Francis

3. Ricki Lewis (2009) Human Genetics-Concepts and Application. Ninth Edition. McGraw-Hill College Publishers

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Course Code: **LHG.528**

L	T	P	Credits
2	0	0	2

Course Title: **Introduction to Population Genetics** Total Hours: **30**

Learning Outcomes:

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

- Know about attributes of a population and it's dynamics
- Explore different causes for population diversity and heterogeneity
- Examine and analyze causes of population diversity

UNIT I Hours: **8**

Hardy-Weinberg Equilibrium: Historical emergence; subdivisions of human population; dynamics and conditions of the Hardy-Weinberg law and its application for autosomal locus with two alleles and multiple alleles; testing of Hardy-Weinberg proportion.

UNIT II Hours: **8**

Heterozygosity: heterozygous advantages, inbreeding and its consequences, Selection co-efficient and fitness, heterozygous advantages.

UNIT III Hours: **7**

Kinetics of changes of gene frequencies: dynamics of migration and genetic drifts; equilibrium between mutation and selection.

UNIT IV Hours: **7**

Genetic load: Non-recurrent and recurrent mutation, mutation pressure and estimation of rate of mutation.

Transactional Modes: Lecture**;** Demonstration**;** Tutorial**;** Lecture cum demonstration; Problem solving; 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 Populations.* Dover Publications.
3. Hamilton M.B. (2009). *Population Genetics*. Wiley-Blackwell, UK.
4. Hedrick P.W.(2011). *Genetics of Populations*. Jones and Bartlett Publishers, Massachusetts.
5. Jobling, M., Hollox, E., Hurles, M., Kivisild, T. and Tyler-Smith, C. (2013). *Human Evolutionary Genetics*. Garland Science.
6. Knight, J.C. (2009). *Human Genetic Diversity –Functional consequences for Health and Disease*. Oxford University Press, USA.
7. Krebs, J.E, Goldstein, E.S. and Kilpatrick, S.T. (2013) *Lewin's Essential Genes*. Jones and Bartlett learning, USA.
8. Nielsen, R. and Slatkin, M. (2013). An Introduction to Population Genetics: Theory and Applications. Sinauer Associates, Inc.
9. Relethford, J.H. (2012). *Human Population Genetics.* John Wiley & Sons.
10. Snusted, D.P., Simmons, M. J. (2010). *Principles of Genetics*. John Wiley & Sons, New York.

Course Code: **LHG.542**

L	T	P	Credits
0	0	0	1

Course Title: **Seminar-I**

Total Hours: **15**

Learning Outcomes:

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

- Improve communication aptitude
- Learn presenting paper or data in scientific forum

Evaluation criteria for Seminar:

- 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.
- The performance of the students will be continuously evaluated based on the choice of the topic, preparation of the topic, referring new research in the area and also discussing the future perspective = **50 marks**
- Final presentation and report writing = **50 marks**

Details of syllabus

Semester – III

Course Code: **LHG.551**

Course Title: **Biosafety, Bioethics and Intellectual Property Rights**

L	T	P	Credits
4	0	0	4

Total Hours: **60**

Learning Outcomes:

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

- Interpret the bioethical issues concerning biotechnological advancements like recombinant DNA technology, cloning, gene manipulation.
- Implement biosafety while carrying out research.
- Distinguish different types of Intellectual Property Rights.
- Describe the ways of protecting traditional knowledge from Biopiracy.

UNIT I Hours: **15**

Biosafety: Good laboratory practices; gene pollution; biological invasion; risk and safety assessment from genetically engineered organisms; special procedures for r-DNA based products; biological containment (BC) and physical containment (PC); CDC biosafety levels; biohazard management.

UNIT II Hours: **15**

Bioethics: Ethical considerations during research; Animal testing; xenotransplantation; embryonic and adult stem cell research; assisted reproductive technologies; cloning; ethical issues of the human genome project; the element of informed consent; ethical issues in MTP and euthanasia.

UNIT III Hours: **15**

Intellectual Property Rights (IPRs): Various forms of IP – patents, industrial designs, trade secrets, geographical indications and plant breeder's right; copyright: fair use, plagiarism and open access publishing; criticism of intellectual property; protection of indigenous intellectual property.

UNIT IV Hours: **15**

Patent system in India: Patent filing in India and abroad: Determination of patentability of inventions, filing a patent application in India: timeline, procedure involved in the granting of a patent, various routes of filing patent application abroad, patent co-operation Treaty (PCT);Gene patent, Patenting of Living Organisms.

Transactional Modes: Lecture**;** Demonstration**;** Tutorial**;** Lecture cum demonstration; Problem solving; Case study; Self-learning.

Suggested Readings:

1. Clarke, A (2012). *Genetic Counseling: Practice and Principles*. Taylor & Francis
2. Fleming, D.O. and Hunt, D.L. (2006). *Biological Safety: Principles and Practices*. American Society for Microbiology, USA.
4. Mahop, M.T. (2010). *Intellectual Property, Community Rights and Human Rights: The*

Biological and Genetic Resources of Developing Countries.Routledge.
5. Shannon, T.A. (2009). *An Introduction to Bioethics*. Paulist Press, USA.
6. Thompson J and Schaefer, B.*D (2013).Medical Genetics: An Integrated Approach*. McGraw Hill.
9. Vaughn, L. (2009). *Bioethics: Principles, Issues, and Cases*. Oxford University Press, UK.
8. WHO. (2005). *Laboratory BiosafetyManual*. World Health Organization.

Course Code: **LHG.552**

L	T	P	Credits
4	0	0	4

Course Title: **Bioinformatics and Computational Biology**
Total Hours: **60**

Learning Outcomes:

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

- Analyze publicly available and experimental genomics data
- Perform *in-silico* prediction of protein structures and protein-protein interaction
- Perform in silico functional annotation of genetic findings
- Demosntrate physical property of biomolecules in silico

UNIT I Hours: **15**

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.

UNIT II Hours: **15**

Sequence analysis: Gene Prediction methods and programs, Promoter analysis, RNA secondary structure thermodynamics, Refining multiple sequence alignment based on RNA secondary structure predictions, 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.

UNIT III Hours: **15**

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.

UNIT IV Hours: **15**

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.

Transactional Modes: Lecture**;** Demonstration**;** Tutorial**;** Lecture cum demonstration; Problem solving; Case study; Self-learning.

Suggested Readings:

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.

Course Code: **LHG.553**

L	T	P	Credits
4	0	0	4

Course Title: **Pharmacogenomics and Nutrigenomics** Total Hours: **60**

UNIT I Hours: **15**

Learning Outcomes:

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

- Define pharmacogenomics and will understand its application in clinical setting. The students will be aware about the challenges in the field on account of different ethnic background.
- Have an understanding about the nutritional requirements and the role of gut microbiota in human nutrition.
- Be aware of the effect of genetic polymorphisms in variable response to micronutrients and will understand the regulation of transcription factors by the nutrients.
- Get aware of the genetic markers involved in the regulation of metablomics and the role of these markers in health and disease.

Pharmacogenomics: Pharmacokinetics and pharmacodynamics; drug-metabolizing enzymes: cytochrome P450s, VKORC1 and TPMT; personalized treatment: example of warfarin, anti-epileptic and anti-cancer drugs like methotrexate and tamoxifen, trastuzumap; heredity disorders with altered drug response: porphrriavariegata, hemoglobinopathies, grigler-najjar syndrome; concept of pharmacogenomics; progress in understanding the genomic basis for adverse drug reactions; ethnic diversity in pharmacogenomics studies and challenges posed by ethnicity.

UNIT II Hours: **15**

Nutritional Biochemistry: Essential and non-essential nutrients; micro and macro nutrients; measurement of calorie values of foods; recommended dietary allowances; basal metabolic rate (BMR); malnutrition; malabsorption and interventional strategies. Concept of gut microbiota in human nutrition.

UNIT III Hours: **15**

Nutrigenomics in determining health: Diet and gene expression; nutritionalstatusin early life and metabolic programming; nutrients as regulators of activity and transcription factors; modulating the risk of celiac disease; obesity and vitamin D deficiency through nutrigenomics

UNIT IV Hours: **15**

Biomarkers and recent advances in Nutrigenomics: Genetic and nutritional control of lipid metabolism, metabolomics; effect of diet on epigenetic processes, concept of oral and gut microbiome and its implications in health and disease; therapeutic approaches through microbiota transplantation.

Transactional Modes: Lecture**;** Demonstration**;** Tutorial**;** Lecture cum demonstration; Problem solving; Self-learning.

Suggested Readings:

1. Altman RB, Flockhart D and Goldstein DB (2012). Principles of Pharmacogenetics and Pharmacogenomics.Cambridge University Press.
2. Ferguson, L,R.(2013) *Nutrigenomics and Nutrigenetics in Functional Foods and Personalized Nutrition*. CRC Press.
3. Tollefsbol T (2011). *The New Molecular and Medical Genetics*. Elsevier Inc
4. Simopoulos A.P. and Ordovas J.M. (2004). Nutrigenetics and Nutrigenomics Karger Publishers
5. Rimbach, G and Fuchs, J (2005) *Nutrigenomics (Oxidative Stress and Disease*). CRC press
6. Yui-Wing Francis Lam Stuart Scott (2018) Pharmacogenomics :Challenges and Opportunities in Therapeutic Implementation, Elsevier, Netherlands

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Course Code: **LHG.554**

L	T	P	Credits
4	0	0	4

Course Title: **Population Genetics and Genetic Epidemiology**

Total Hours: **60**

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 Hours: **15**

Population dynamics and basics of epidemiology: Dynamics and conditions of the Hardy-Weinberg law; selection co-efficient and fitness; heterozygous advantages; inbreeding and its consequences; mutation pressure and estimation of rates; genetic

load; selection co-efficient and fitness; dynamics of migration and genetic drifts; construction of pedigree and pedigree analysis.

UNIT II Hours: **15**

Evolution and Speciation: Emergence of evolutionary thoughts Lamarck; Darwinism – concepts of variation, adaptation, struggle, fitness and natural selection; Mendelism; spontaneity of mutations; the evolutionary synthesis.

Mechanism of evolution: Adaptive radiation; isolating mechanisms; speciation; allopatricity and sympatricity; convergent evolution; sexual selection; co-evolution.

UNIT III Hours: **15**

Fundamentals of epidemiological studies: Experimental and observational studies; basic parameters of epidemiology: frequency, occurrence, prevalence, incidence; association; causation, variation; Cohort studies: cross sectional and longitudinal; Association studies: candidate gene association and genome-wide association studies (GWAS);concept of heritability; systematic review and meta-analysis.

UNIT IV Hours: **15**

Genetic variation and complex trait inheritance: Basics of genetic variations; genetic markers – SNP, CNV, Ins/dels, VNTR, STR, microsatellite; concepts of tag markers and haplotypes, linkage disequilibrium; quantitative genetic analysis; QTL and eQTL.

Genetic variation and complex trait inheritance: Next-generation sequencing; DNA micro -array.

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

10. Snusted, D.P., Simmons, M. J. (2010). *Principles of Genetics*. John Wiley & Sons, New York.
11. Palmer LJ, Burton PR & Smith GD (2011). *An introduction to genetic epidemiology* (Policy Press, University of Bristol)
12. Dawn TM (2011). *Genetic Epidemiology* (Springer)
13. Austin M (2013). *Genetic Epidemiology: Methods and Applications*, 1st Edition (CABI Publishing).

Course Code: **LMM.554**

L	T	P	Credits
4	0	0	4

Course Title: **Molecular and Cellular Oncology**
Total Hours: **60**

Learning Outcomes:

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

- Conceptualize basic aspects of oncobiology
- Evaluate comprehensive analysis to cope up with the ever-expanding role of molecular biology in basic cancer research as well as clinical oncology
- Apply the knowledge to modern diagnostic and therapeutics approaches function at molecular level
- Synthesize the ideas about novel cancer therapeutic approaches

UNIT I Hours: **15**

Fundamentals and Genetics of Cancer: Hallmarks of cancer, cancer classification, Mutagens, carcinogens and gene mutations, Chromosomal aberrations, tumor viruses and discovery of oncogenes, tumor suppressors and oncogenes, familial cancer syndromes, telomere regulation in cancer.

UNIT II Hours: **15**

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 Hours: **15**

Cancer Detection: General and organ specific symptoms associated with cancer, techniques for cancer detection, biomarkers for cancer detection of various stages of cancer, *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 Hours: **15**

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, targeted anticancer therapies, CAR T and other new anticancer therapies.

Transactional Modes: Lecture**;** Demonstration; Tutorial; Seminar presentation; Lecture cum demonstration; Problem solving; Self-learning.

Suggested Readings:

1. DeVita, V. T., Rosenberg, S. A., & Lawrence, T. S. (2018). *DeVita, Hellman, and Rosenberg's cancer*. Lippincott Williams & Wilkins.
2. Enders, G. H. (2010). Cell *cycle deregulation in cancer.* Humana Press, Springer science, New York.
3. Gusev, Y. (2019). *Micro RNA Profiling in Cancer.* Pan Standford publishing pvt.Ltd., Singapore.
4. Hiem, S., & Mitelman, F. (2019). *Cancer Cytogenetics*. IIIrd edition. Willey-Blackwell publishing, New Jersey.
5. Jocelyn, E. K., Elliot, S. G., Stephen, T. K. (2018). *Lewin's Gene X*. Jones &Barlett.
6. Wang, E. (2018). *Cancer systems biology*. CRC press, Taylor & Francis group, New York.
7. Weinberg, Robert A. (2015). *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: xxx.xxx

L	T	P	Credits
4	0	0	4

Course Title: **MOOC course** Total Hours: **60**

Learning Outcomes:

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

Acquire knowledge on specific topics and will be able to apply it to real data or experiments.

MOOC course of 4 credits may be chosen by a 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: **LHG.503**

L	T	P	Credits
0	0	2	1

Course Title: **Clinical Genetics**

Total Hours: **15**

Learning Outcomes:

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

- Take a family history and construct and interpret a pedigree Have an understanding about the nutritional requirements and the role of gut microbiota in human nutrition.
- Communicate the concept risk in a manner that can be understood by the patients Get aware of the genetic markers involved in the regulation of metablomics and the role of these markers in health and disease.
- aware of the type of clinical features suggesting common chromosomal disorders and role of teratogens in human congenital disorders.

UNIT I Hours: **3**

Genetic assessment and drawing pedigree

UNIT II Hours: **4**

Genetic counseling

UNIT III Hours: **4**

Common chromosomal disorders-case studies

UNIT IV Hours: **4**

Teratogens and dysmorphology

Transactional Modes: Lecture**;** Demonstration**;** Demonstration; Problem solving; Self-learning, Pedigree drawing.

Suggested Readings:

1. Brooker, R.J (2017). Genetics: analysis and principles. 6th Ed. New York, NY: McGraw-Hill Education.
2. Hartwell, L. et al (2017). Genetics: from genes to genomes. 6th Ed. New Your, NY: McGraw-Hill Education.
3. Helen, M.K. 2002. ABC of clinical Genetics. 3rd Ed. BMJ Publishing Group. London.

Course Code: **LHG.599**

L	T	P	Credits
0	0	0	6

Course Title: **Project-I**

Total Hours: **180**

Learning Outcomes:

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

- Apply genetic and genomics technique for research
- Construct study design
- Interpret result of a genetic experiment
- Present oral and written scientific communication skills

The objective of this course would be to ensure that the student learns the nuances of the scientific aptitude, presentation and writing. Herein the student shall have to write his/her synopsis including an extensive review of literature with simultaneous identification of scientifically sound (and achievable) objectives backed by a comprehensive and detailed methodology.

Synopsis will be evaluated as per the University policy.

Evaluation criteria for Project:

The 2-point assessment is **satisfactory** or **not satisfactory** based on the following parameters:

- Daily assessment by the mentor based on the performance of the student = **50 marks**
- Final presentation with written report = **50 marks**

Details of syllabus

Semester – IV

Course Code: **LHG.571**

L	T	P	Credits
4	0	0	4

Course Title: **Recombinant DNA Technology and Therapeutics**

Total Hours: **60**

Learning Outcomes:

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

- Demonstrate cloning and expression vectors in E.Coli in recombinant DNA techniques
- Get familiar with vectors for Eukaryotes
- Learnconventional methods used in recombinant DNA technology
- Learn therapeutics aspect of recombinant DNA technologies

UNIT I Hours: **15**

Basics of Genetic Engineering: Isolation and purification of nucleic acids; restriction and DNA modifying enzymes; restriction modification systems; cloning vectors: plasmids, phages, lambda vectors, cosmids, PAC, BAC, YAC; selection and screening of clones.

UNIT II Hours: **15**

Construction of DNA libraries: Genomic and cDNA libraries; screening of genomic and expression libraries.

Analysis of gene expression: Northern blotting; RT-PCR; digital PCR; EST analysis; promoter analysis; TSS mapping; cDNA and oligos array; serial analysis of gene expression (SAGE).

UNIT III Hours: **15**

Expression Vectors: 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; intein-based vectors. Inclusion bodies methodologies to reduce formation of inclusion bodies, *baculovirus* and pichia vectors system.

UNIT IV Hours: **15**

Techniques and Applications of recombinant DNA technology: Sites specific mutagenesis; Gene Editing through; CRISPR/CAS system, Genetically modified microbes (Recombinant bacteria) for the production of commercial scale production of proteins, pharmaceuticals; transgenic animals; RNA based therapeutics.

Transactional Modes: Lecture**;** Demonstration**;** Tutorial**;** Lecture cum demonstration; Problem solving; 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* 3rdedition . CSHL, New York.
4. CokinRateldge and Bjorn Christiansen, (2006) *Basic Biotechnology* 3rdEdition 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

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Course Code: **LHG.552**

L	T	P	Credits
4	0	0	4

Course Title: **Genetic Diseases and Therapies**

Total Hours: **60**

Learning Outcomes:

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

- Understand the genetic causes of monogenic disorders
- Understand the genetic basis of common multifactorial diseases.
- Analyze the consequences of altered epigenetic processes in causing genetic disorders.
- Apply the principal of genetics and biostatistics for genetic disorders risk assessment

UNIT I Hours: **15**

Monogenic Disorders: Cystic fibrosis**;** Huntington's disease; Duchenne Muscular dystrophy; X-linked rickets.

Multifactorial Diseases: Diabetes type 2; Cancers; Hypertension; Obesity; Neurodegenerative diseases.

UNIT II Hours: **15**

Genomic Imprinting and Human Diseases: Uniparental disomy & genomic imprinting: Prader-Willi & Angelman syndrome; Beckwith-Wiedeman syndrome & Silver Russell Syndrome; Imprinting and brain and behaviour; imprinting and Cancer.

Neurofibromatosis I; X/Y linked human syndromes due to numerical chromosomal anomalies.

UNIT III Hours: **15**

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

UNIT IV Hours: **15**

Therapies for genetic disorders and multifactorial diseases: Stem cell therapies**:** stem cell types, cord blood cells, bone marrow transplantation; current stem cell therapies; gene therapies: methods; diseases suitable for gene therapies: hemoglobinopathies, cystic fibrosis, muscular dystrophies, cancer; challenges in gene therapy; regulatory requirements.

Transactional Modes: Lecture**;** Demonstration**;** Tutorial**;** Lecture cum demonstration; Problem solving; Self-learning.

Suggested Readings:

1. Brown, S.M., (2009). *Essentials of Medical Genomics*. Wiley-Blackwell.
2. Jocelyn, E. K., Elliot, S. G., Stephen, T. K. (2009), *Lewin's Gene X*. Jones &Barlett.
3. Krebs, J.E., Goldstein, E.S. and Kilpatrick, S.T. (2014). *Lewin's Genes XI*. Jones and Bartlet India Pvt. Ltd.
4. Lodish, H., Berk, A., Chris, A. K., Krieger, M. (2008), *Molecular Cell Biology*. W.H. Freeman, USA.
5. MilunskyA,Milunsky J (2009). *Genetic Disorders and the Fetus: Diagnosis, Prevention and Treatment*, 6th Edition. Wiley-Blackwell publishers.

Course Code: **LHG.573**

L	T	P	Credits
2	0	0	2

Course Title: **Practice in Life Sciences-I** Total Hours: **30**

Learning Outcomes:

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

- Understand basic and applied topics relevant to competitive exams. Present aptitude for research and development

UNIT I Hours: **8**

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 Hours: **7**

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 Hours: **8**

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 Hours: **7**

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

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

Course Code: **LHG.574**

L	T	P	Credits
2	0	0	12

Course Title: **Practice in Life Sciences-II** Total Hours: **30**

Learning Outcomes:

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

- Understand basic and applied topics relevant to competitive exams

  Present aptitude for research and development

UNIT I Hours: **7**

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 Hours: **7**

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 Hours: **8**

Evolution and behaviour: Emergence of evolutionary thoughts- lamarck; darwin, origin of cells and unicellular evolution, origin of basic biological molecules; abiotic synthesis of organic monomers and polymers; concept of oparin and haldane; 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 Hours: **8**

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.

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

Course Code: **LHG.505**

L	T	P	Credits
1	0	0	1

Course Title: **Principles of Ecological Sciences**

Total Hours: **15**

Learning Outcomes:

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

- Improve their knowledgebase about basics of ecological science
- Improve student's aptitude for research and development on ecological succession and dynamics
- Contribute in conservation science

UNIT I Hours: **3**

Environmental components: Physical environment; biotic environment; biotic and abiotic interactions. Concept of habitat and niche; resource partitioning; character displacement. Major terrestrial biomes; theory of island biogeography; biogeographical zones of India.

UNIT II Hours: **4**

Biological components of environment: Characteristics of a population; life history strategies (r and K selection); concept of metapopulation – demes and dispersal, interdemic extinctions, age structured populations; Species Interactions: Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis; Community Ecology: Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones.

UNIT III Hours: **4**

Ecosystem and Ecological Succession: Ecosystem: structure and function; energy flow and mineral cycling (C,N,P); primary production and decomposition; structure and function of some Indian ecosystems: terrestrial and aquatic. Ecological Successions: Types; mechanisms; changes involved in succession; concept of climax.

UNIT IV Hours: **4**

Applied Ecology and Conservation Biology: Environmental pollution; biodiversity: status, monitoring and documentation; biodiversity management approaches; Principles of conservation and it's management; Indian case studies on conservation/management strategy: Project Tiger, Biosphere reserves.

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

Suggested Readings:

4. JS Singh, SP Singh, SR Gupta. 2006. Ecology, Environment and Resource conservation. Anamaya Publications, New Delhi, 688pp.
5. RC Das and BK Behera. 2008. Environmental Science Principle and Practice. Prentice Hall of India Pvt. Ltd, Delhi.
6. Andrew S. Pullin. Conservation Biology. 2002. Cambridge University Press, UK.
7. RT Wright. 2005. Environmental Science. 9th Ed. Pearson Education Inc.
8. ML Hunter Jr, JP Gibbs. 2006. Fundamentals of Conservation Biology. 3rd Ed. Wiley-Blackwell. 516pp.

Course Code: **LHG.544**

L	T	P	Credits
0	0	0	2

Course Title: **Seminar-II**

Total Hours: **30**

Learning Outcomes:

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

- Present scientific findings orally
- Illustrate scientific communication in written form
- Analyze scientific literature

Evaluation criteria for Seminar:

- The performance of the students will be continuously evaluated based on the choice of the topic, preparation of the topic, referring new research in the area and also discussing the future perspective = **50 marks**
- Final presentation and report writing = **50 marks**

Course Code: **LHG.599**

L	T	P	Credits
0	0	0	6

Course Title: **Project-II**

Total Hours: **180**

Learning Outcomes:

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

- Apply genetic and genomics technique for research
- Construct study design
- Interpret result of a genetic experiment
- Present oral and written scientific communication skills

Project work will be evaluated by the Departemtn, as per the University policy.

Evaluation criteria for Project:

The 2-point assessment is **satisfactory** or **not satisfactory** based on the following parameters:

- Daily assessment by the mentor based on the performance of the student = **50 marks**
- Final presentation with written report = **50 marks**

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: Based on Subjective Type Test [25 Marks]
C. End-Term Exam: Based on Subjective Type Test [25Marks]
   Based on Objective Type Tests [25 Marks]