

FACULTY OF LIFE SCIENCES

Syllabus

For

M. Sc. (HONS. SCHOOL) HUMAN GENETICS
(Under Credit Based Continuous Evaluation Grading System)

(SEMESTER: I to IV)

Examinations: 2014–15



Guru Nanak Dev University
Amritsar

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M.Sc. (Hons. School) Human Genetics (SEMESTER SYSTEM)
(Credit Based Continuous Evaluation Grading System)

Eligibility:- B.Sc. (HS) Human Genetics, GNDU with at least 5.62 CGPA or 50% Marks in aggregate.

SCHEME OF COURSES

Semester-I

Course No.	C/E/I	Course Title	L	T	P	Total Credits
Core Courses (22 Credits)						
HGL-406	C	DNA Technology	3	0	0	3
HGL-422	C	Medical Genetics	3	1	0	4
HGL-423	C	Methods of Research Design	3	1	0	4
HGL-424	C	Genetic Epidemiology	3	0	0	3
HGL-425	C	Perspectives of Human Genome	3	1	0	4
HGP-421	C	DNA Technology Practical	0	0	2	2
HGP-422	C	Medical Genetics Practical	0	0	2	2
Elective Course (3 Credits)						
HGP-431	E	Lab Rotations-I	0	0	3	3
Interdisciplinary/Optional Course (3 or 4 Credits)						
	I	To be taken from outside the department	3	0	0	3
Total Credits			18	3	7	28

1. The students are required to opt for one 'Elective' paper.
2. The students are also required to take one paper (Interdisciplinary/Optional) of 3 or 4 credits of their choice from any other department of Guru Nanak Dev University Campus, Amritsar.

M.Sc. (Hons. School) Human Genetics (SEMESTER SYSTEM)
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SCHEME OF COURSES

Semester-II

Course No.	C/E/I	Course Title	L	T	P	Total Credits
Core Courses (22 Credits)						
HGL-471	C	Human Molecular Genetics and Functional Genomics	3	1	0	4
HGL-472	C	Clinical Genetics and Genetic Counselling	3	1	0	4
HGL-473	C	Bioethics and Human Genetics	3	1	0	4
HGL-474	C	Recent Concepts in Human Genetics	3	1	0	4
HGS- 475	C	Seminar	1	0	0	1
HGP- 471	C	Human Molecular Genetics and Functional Genomics Practical	0	0	3	3
HGP-472	C	Clinical Genetics Practical	0	0	2	2
Elective Course (3 Credits)						
HGL-481	E	Genetics of Human Cancer	3	0	0	3
HGL-482	E	Tools and Techniques in Immunology	3	0	0	3
Interdisciplinary/Optional Course (3 or 4 Credits)						
	I	To be taken from outside the department	3	0	0	3
Total Credits			19	4	5	28

1. The students are required to opt for one 'Elective' paper.
2. The students are also required to take one paper (Interdisciplinary/Optional) of 3 or 4 credits of their choice from any other department of Guru Nanak Dev University Campus, Amritsar.

M.Sc. (Hons. School) Human Genetics (SEMESTER SYSTEM)
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SCHEME OF COURSES

Semester-III

Course No.	C/E/I	Course Title	L	T	P	Total Credits
Core Courses (25 Credits)						
HGL-505	C	Human Embryology and Developmental Genetics	3	0	0	3
HGL-521	C	Current Trends in Medical Genetics	3	1	0	4
HGL-522	C	Growth Disorders in Children	3	1	0	4
HGL-523	C	Genetics in Post-Genomic Era	3	1	0	4
HGL-524	C	Advanced Cytogenetics	3	1	0	4
HGP-521	C	Lab Rotations-II	0	0	6	6
Elective Course (3 Credits)						
HGL-531	E	Genetic Engineering-II	3	0	0	3
HGL-532	E	Human Genetics Research and Regulation	3	0	0	3
Interdisciplinary/Optional Course (3 or 4 Credits)						
–	I	To be taken from outside the department	3	0	0	3
Total Credits			21	4	6	31

1. The students are required to opt for one 'Elective' paper.
2. The students are also required to take one paper (Interdisciplinary/Optional) of 3 or 4 credits of their choice from any other department of Guru Nanak Dev University Campus, Amritsar.

M.Sc. (Hons. School) Human Genetics (SEMESTER SYSTEM)
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Semester-IV

Course No.	C/E/I	Course Title	L	T	P	Total Credits
Core Courses (12 Credits)						
HGL-552	C	Applied Human Molecular Genetics	3	0	0	3
HGL-554	C	Structural Biology and Pharmacogenomics	3	0	0	3
HGL-580	C	Birth Defects	3	0	0	3
HGP-581	C	Applied Human Molecular Genetics Practical	0	0	3	3
HGD-595	–	Dissertation* (To be graded as satisfactory/unsatisfactory)	0	0	0	0
Total Credits			9	0	3	12

*Topic of dissertation and name of supervisor to be finalized during Semester-II.

HGL-406: DNA TECHNOLOGY

Credits: 3-0-0

Unit-I

Nucleic acids probes, Methods of labelling probes, Polymerase chain reaction (PCR) and applications, Principles and applications of Southern blotting, Northern blotting, Western blotting, Dot blotting, DNA Foot printing, Two-dimensional gel electrophoresis (2DE) and Pulse-field gel electrophoresis.

Unit-II

An overview of recombinant DNA (rDNA) technology, Cloning vectors; Plasmids, Cosmids, Phagemids, Enzymes used in DNA technology — Restriction endonucleases, Ligases, Kinases and phosphatases, Linkers and adaptors, Construction of cDNA and genomic DNA libraries, Identification of specific cloned sequences, Applications of recombinant DNA technology, Safety issue in rDNA experiments.

Unit-III

Principles and Applications of Amplification Refractory Mutation System (ARMS), Single-Strand Conformational Polymorphism (SSCP), Simple Sequence Length Polymorphism (SSLP), Restriction Fragment Length Polymorphism (RFLP), Denaturing High-Pressure Liquid Chromatography (dHPLC), Denaturing Gradient Gel Electrophoresis (DGGE), DNA Sequencing, High Throughput Sequencing Techniques, Serial Analysis of Gene Expression (SAGE).

Books Recommended:

1. Brown, T.A. (2010). Gene Cloning and DNA Analysis: An Introduction. Blackwell Publishing Co., Oxford, 6th ed.
2. Dieffenbach, C.W. and Dveksler, G.S. (2003). PCR Primer: A Laboratory Manual, Cold Spring Harbor Press, 2nd ed.
3. Freifelder, D.C. (2008). Molecular Biology. Narosa Publishing House, New Delhi, 2nd ed.
4. Hartl, D.L. and Jones, E.W. (2011). Genetics: Analysis of Genes and Genomes. Jones and Barlett Publishers, USA, 7th ed.
5. Lewin, B. (2011). Genes-X. Jones and Barlett Publishers, Inc., USA.
6. Pierce, B.A. (2012) Genetics: A Conceptual Approach. W.H. Freeman and Company, New York, 4th ed.

HGL-422: MEDICAL GENETICS

Credits 3-1-0

Unit-I

Growth and development of medical genetics (1956-to-present), Role of genetics in medicine, Types of genetic disorders – single gene, chromosomal, multifactorial. Genetic disorders with classical Mendelian inheritance with examples, Medical relevance of meiosis and mitosis, Dominance and recessiveness, Mechanism of dominance, Concept of phenotype and relationship between genotype and phenotype in genetic disease, Clinical consequences of mutation, General concepts on enzyme deficiencies and diseases.

Unit-II

Concept of genetic heterogeneity, Reduced penetrance, Variable expressivity, Pseudoautosomal inheritance, Pleiotropy with suitable examples, Consequences of consanguineous marriages, Genomic imprinting, Mosaicism, Uniparental disomy, Mitochondrial inheritance, Retinoblastoma, Retinitis pigmentosa, Diabetes, Neural tube defects.

Unit-III

Pharmacogenetic diseases (Hereditary disorders with altered drug response, Malignant hyperthermia, G-6-PD deficiency), Chromosomal instability syndromes, Sex chromosomal and differentiation anomalies, Chromosomal microdeletion syndromes, Prion diseases, Gene mapping in DMD, CF HD.

Recommended Books:

1. Jorde, L. B., Carey, J.C. and Bamshad, M. J. (2010). Medical Genetics, 4th Edition. Mosby
2. Nussbaum, R. L., McInnes, R.R. and Willard, H.F.(2007). Thompson & Thompson Genetics in Medicine, 7th Edition. Saunders.
3. Tobias, E. S., Connor, M. and Ferguson Smith,M. (2011). Essential Medical Genetics, Wiley-Blackwell.
4. Turnpenny, P.D. (2012). Emery's Elements of Medical Genetics, 14th Edition, Churchill Livingstone.
5. Speicher, M., Antonarakis, S.E. and Motulsky, A.G. (Eds.) (2010). Vogel and Motulsky's Human Genetics: Problems and Approaches 4th edition, Springer Verlag.

HGL-423: METHODS OF RESEARCH DESIGN

Credits: 3-1-0

Unit-I

Common methods of Sampling: simple random, stratified, multistage, cluster and systematic random sampling. Probability proportional to size sampling. Non-random methods of sampling: convenience sample, snowball sampling. Questionnaire, Schedule, Advantage, Limitations and precautions of sampling, Prognostic and concomitant variables, Cohort and longitudinal study, Case-control and nested case-control design, Cross-sectional studies with merits and demerits, Sample size determination, general consideration and power analysis.

Unit-II

Magic threshold of $p=0.05$, Statistical significance and 'P'-values, Dramatic P-values. Correlation versus cause- effect relationship and criteria for cause and effect. Null and alternative hypothesis, Type-I and Type-II errors, General procedure to obtain 'P'-value, Test of methods through sensitivity, specificity and likelihood ratio, Positive and negative predictivity, Odds ratio for independent and matched samples.

Unit-III

Research problem, Objectives and hypothesis, Uses of sources of information such as journals, books, Index Medicus, Excerpta Medica, Biological Abstract, Science Citation Index, Preparing a manuscript for publication, Editing and galley proof correction of manuscript, Protocol content for research project, Scientific presentation. Punctuation and abbreviations in foot notes, precaution for writing research report, outlines of technical and popular report.

Books Recommended

1. Dear, P.H. (Ed.) (1997). Genome Mapping. IRL Press, OUP, UK.
2. Ford, E.D. (2000). Scientific Methods in Ecological Research. Cambridge University Press, UK.
3. Gurumani, N. (2007). Research Methodology for Biological Sciences. M.J.P. Publishers, India.
4. Hawkins, C. and Sorigi, M. (1985). Research – How to Plan, Speak and Write about it. Springer-Verlag, Berlin.
5. Indrayan, A. (2008). Medical Biostatistics. Chapman and Hall, New York.
6. Kothari, C.R. (2009). Research Methodology: Methods and Techniques. New Age International Publication, New Delhi.

HGL-424: GENETIC EPIDEMIOLOGY**Credits 3-0-0****Unit-I**

The basic principles and measures of epidemiology. Kinship and Genetic Sharing. Fisher Model for a Single Locus, Additive genetic effects and dominance deviations. Statistical tests of Hardy-Weinberg Equilibrium (HWE) like Goodness-of-fit test, Likelihood-ratio test, Monte Carlo approximation. Relevance of tests of HWE to gene mapping. Some commonly used indices such as BMI, Bispectral index, Glycemic index, Craniofacial index and Occupation stress index. Scoring system for diagnosis. Ponderal index for neonates. Apgar score. Z-score and percent of median. Standardized death rate and ratio for abortion, still birth, peri-natal and neo-natal mortality. Gender Empowerment.

Unit-II

Foundation of Genetic Epidemiology. Introduction and concept of Genome-Wide Association Study (GWAS). Study design for GWAS like sampling, Controls, Family-based and Multistage design and Experimental bias. Epidemiological study design for cross-sectional, case control and cohort. Gaussian and other distributions, assessing Gaussian pattern for small n and Statistical threshold. Reference or Normal values and its implications. The Concept of Person-Time. Capture-Recapture Methodology. Epidemiologically consistent estimates. Impact of gender on research study design, sampling approaches, recruitment of retention of study subjects. Indicators, choice of indicators, merits and demerits of indicators.

Unit-III

Phenotype aggregation within families. Linkage Disequilibrium (LD). Measures and Calculation of LD. Dynamics of LD like effects of mutation, admixture, genetic drift, inbreeding, founder effects and selection. Relevance of LD to gene mapping studies. Population stratification and basic principles of admixture mapping.

Books Recommended:

1. Balding, D.J., Bishop, M. and Cannings, C.C. (Eds.) (2007). Handbook of Statistical Genetics. John Wiley and Sons, England, Vol. 1 & 2, 3rd ed.
2. Falconer, D.D. (1989). Introduction to Quantitative Genetics. ELBS/Longman, England.
3. Friis, R.H and Sellers, T.A (2009). Epidemiology for Public Health (4th Edition). Jones and Bartlett Publication, Sudbury, MA.
4. Hartl, D.L. and Clark, A.G. (1997). Principles of Population Genetics. Sinaur Associates, Inc., Massachusetts.
5. Hedrick, P.W. (2005). Genetics of Population. Jones and Barlett Publishers, Massachusetts.
6. Indrayan, I. (2008). Medical Biostatistics. Chapman and Hall/CRC, USA.
7. Kothari, C.R. (2009). Research Methodology: Methods and Techniques (Revised Edition). New Age International Publication, New Delhi.
8. Neale, B., Ferriera, M.A.R., Medland, S.E. and Posthuma, D. (Eds.) (2008). Statistical Genetics. Gene Mapping through Linkage and Association. Taylor and Francis Group, USA.
9. Merrill R.M (2010). Introduction to Epidemiology (5th edition). Jones and Bartlett Publication, Sudbury, MA.

HGL-425: PERSPECTIVES OF HUMAN GENOME

Credits 3-1-0

Unit-I

The Human Genome Project (HGP) – historical perspective, goals and controversies, Human Genome Project organization, Overview of mapping strategies used in Human Genome Project, Draft and complete sequence of the human genome.

Unit-II

Genetic databases, Human Genome ownership and patenting, Applications of Human Genome Project and ELSI. Basic concepts and goals of The Human Genome Diversity Project, The Environmental Human Genome Project, The Cancer Genome Anatomy Project, The SNP Project, Stem cell forum,

Unit-III

Overviews of the phenome project, toxicogenomics, transcriptomics, metabolomics/metabonomics. The Human connection and model organisms in genome projects: *Escherichia coli*, *Saccharomyces cerevisiae*, *Caenorhabditis elegans*, *Drosophila melanogaster*, Mouse, Rat, Pufferfish, Zebrafish, Monkey, Chimpanzee.

WEBSITES AND ELECTRONIC REFERENCES

<http://www.nhgri.nih.gov/>

<http://www.ncbi.nlm.nih.gov/>

<http://www.hgmp.mrc.ac.uk./GenomeWeb/>

<http://www.ncbi.nlm.nih.gov/genemap99/>

<http://www.ncbi.nlm.nih.gov/CGAP>

<http://www.ncbi.nlm.nih.gov/HUGO>

<http://www.ebi.ac.uk/~sterk/genome-MOT/>

<http://www-fp.mcs.anl.gov/~gaasterland/genomes.html>

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

<http://www.biol.tsukuba.ac.jp/>

<http://www.nuffieldbioethics.org>

HGP-421: DNA TECHNOLOGY (PRACTICAL)

Credits: 0-0-2

Sterilization of glassware and plasticware, Preparation of stock solutions, Preparation of working solutions from stock solutions, Extraction of DNA by organic method, Quality checking of DNA by agarose gel electrophoresis, Quantification of DNA, Amplification of genomic DNA by PCR.

HGP-422: MEDICAL GENETICS (PRACTICAL)

Credits 0-0-2

Analysis of different modes of inheritance, Numericals on medical genetics, Disease survey (Field work), Karyotyping from abnormal chromosomal preparations, Genetic databases – OMIM, London dysmorphology database, Possum, Repertox, Human cytogenetics database, Online medical genetics resources – OMIM, Gene clinics, Gene tests, ESRG; Sites for patients – Genetic alliance, Family village.

HGP-431: LAB ROTATIONS-I

Credits 0-0-3

The students will **visit** various research labs in the department for varying time span and will be examined for different practical techniques that they have learnt during the semester.

M.Sc. (Hons. School) Human Genetics (Semester – II)
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HGL-471: HUMAN MOLECULAR GENETICS AND FUNCTIONAL GENOMICS

Credits 3-1-0

Unit I

Gene structure, Role of promoters, enhancers and silencers, Promoter characterization: reporter gene assay, EMSA, DNA Foot printing, Split genes, Alternative splicing, Role of alternative splicing, Alternative splicing in human diseases and therapy, Overlapping genes and their significance, Non-coding genes, Mechanisms of gene silencing.

Unit II

Human transposons, DNA hybridization/denaturation and its significance, DNA Cot curves, Unique DNA and multigene families in humans, Repetitive DNA, Genetic mechanisms underlying pathogenic sequence exchanges in unique and repetitive DNA, Evolution of human mitochondrial genome, nuclear genome, sex chromosomes and DNA sequence families.

Unit III

Principles and applications of Real-Time PCR, Microarray and its applications, cDNA array, SNP array, oligonucleotide array, GWAS, Traditional DNA sequencing and next generation sequencing techniques, disease gene identification by exome sequencing, Clinical applications of exome sequencing.

Recommended Books:

1. Strachan, T. and Read, A. (2010). Human Molecular Genetics. Garland Publishers, London, 4th Ed.
2. Brown, T. A. (2005). Genetics: A Molecular Approach. Bio Scientific Publishers Ltd., Oxford, 3rd Ed.
3. Sudbery, P. and Sudbery, I. (2009). Human Molecular Genetics. Pearson Education, UK. 3rd Ed.
4. Wang, J., Tan, A C., Tian, T. (Eds.) (2012). Next Generation Microarray Bioinformatics: Methods and Protocols. Humana Press, Totowa. www.ebook3000.com
5. Kaufmann, M., and Klinger, C. (Eds.). (2012). Functional Genomics: Methods and Protocols. Humana Press, Totowa, 2nd Ed. www.ebook3000.com

M.Sc. (Hons. School) Human Genetics (Semester – II)
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HGL-472: CLINICAL GENETICS AND GENETIC COUNSELLING

Credits 3-1-0

Unit-I

Clinical Applications of Medical Genetics – Prenatal diagnosis: purpose, indications and techniques – invasive and non-invasive, Amniocentesis, Chorionic villus sampling, Ultrasound, Fetoscopy, Maternal serum screening, Fetal cells in maternal blood, Preimplantation diagnosis, Effect of mutagenic and teratogenic exposure in early pregnancy.

Unit-II

Carrier screening – criteria for heterozygous screening programmes, Carrier testing for autosomal recessive and X-linked disorders, Risk calculations, Population screening for genetic disease – adult, newborn, Clinical utilization of presymptomatic and predispositional testing, Presymptomatic testing for genetic diseases and malignancy.

Unit-III

Genetic Counseling – Process, Role of genetic Counsellors, Diagnostic problems in genetic counseling, Psychosocial aspects of genetic Counseling, Genetic care pathway and preventive management guidelines. Role of social workers, nutritional, occupational, physical, speech therapist, psychologists and school professionals in genetics, Gene therapy and stem cell research.

Recommended Books:

1. Gunder, L.M. and Sudbury, S.A.M. (2011). Essentials of Medical Genetics for Health Professionals. Jones and Bartlett Learning.
2. Jorde, L. B., Carey, J.C. and Bamshad, M. J. (2010). Medical Genetics, 4th Edition. Mosby.
3. Nussbaum, R. L., McInnes, R.R. and Willard, H.F. (2007). Thompson & Thompson Genetics in Medicine, 7th Edition, Saunders.
4. Mummery, C., Wilut, I., Van de Stolpe, A. and Roelen, B.A.J. (Eds). (2011). Stem Cells: Scientific Facts and Fiction, Academic Press, London.
5. Panno, J. (2010). Stem Cell Research-Medical Applications and Ethical Controversies. Viva Books, New Delhi.
6. Read, A. and Donnai, D. (2010). New Clinical Genetics, 2nd Ed., Scion, U.K.
7. Stein, G.S., Borowski, M., Luong, M.X., Shi, M-J., Smith, K. P. and Vazquez, P. (Eds.) (2011). Human Stem Cell Technology and Biology. John Wiley, Hoboken.
8. Strachan, T. and Read, A. (2011). Human Molecular Genetics. 4th ed., Garland Publishers, New York.

M.Sc. (Hons. School) Human Genetics (Semester – II)
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HGL-473: BIOETHICS AND HUMAN GENETICS

Credits 3-1-0

Unit-I

History, scope and development of bioethics, Prescriptive and descriptive bioethics, Basic aspects of rights'-based ethical theory, duty-based ethical theory, utilitarian ethics.

Unit-II

Basics of Principles of Bioethics (autonomy, non-maleficence, beneficence, justice, dignity, etc.), Informed consent and confidentiality, Bioethical maturity, Universality of bioethics.

Unit-III

Cross-cultural bioethics, Environmental ethics. Vignettes on ethical dilemmas in medical genetic advances: Genethics, Genetic selection, Germline gene therapy, Genetic screening, Genetic determinism, Genome ownership, Genetic discrimination, Genetic insurance, Genetic privacy, ART, Modern eugenics, Euthanasia, Pre-conceptual and pre-symptomatic screening.

Recommended Books:

1. Beauchamp T.L. and Childress, J.F. (1994). Principles of Biomedical Ethics. Oxford Univ. Press, New York.
2. Brown, S.M., Hay, H.G. and Ostrer, H. (2009). Essentials of Medical Genomics, Second Edition. Wiley-Blackwell, Hoboken.
3. Ignacimuthu, S. (2009). Bioethics. Narosa, New Delhi.
4. Jecker, N.S., Jonsen A.R. and Pearlman, R.A. (2010). Bioethics: An Introduction to History, Methods and Practice. 2nd Ed., Jones and Bartlett, New Delhi.
5. Mummery, C., Wilut, I., Van de Stolpe, A. and Roelen, B.A.J. (Eds). (2011). Stem Cells: Scientific Facts and Fiction, Academic Press, London.
6. Panno, J. (2010). Stem Cell Research-Medical Applications and Ethical Controversies. Viva Books, New Delhi.
7. Stein, G.S., Borowski, M., Luong, M.X., Shi, M-J., Smith, K. P. and Vazquez, P. (Eds.) (2011). Human Stem Cell Technology and Biology. John Wiley, Hoboken.
8. Yashon, R.K. and Cummings, M.R. (2012). Human Genetics and Society, Oxford University Press.

M.Sc. (Hons. School) Human Genetics (Semester – II)
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HGL-474 RECENT CONCEPTS IN HUMAN GENETICS

Credits 3-1-0

Unit I

microRNA and other non-coding RNA, microRNA and epigenetic regulatory mechanisms, Role of microRNA and noncoding RNAs in normal development, Role of microRNA in diseases: lymphocytic leukemia, prostate cancer, colitis associated cancer, microRNA as regulators of key oncogenes and tumor suppressor genes, Mitochondrial view of microRNA, RNAi, Segmental deletions, duplications, CNVs and their role in human diseases.

Unit II

Epigenetic mechanisms, Histones and DNA modifications, Methods of analysis of DNA methylation, Methods of studying histone modifications, Inter-individual variations in DNA methylation, MHC complex and epigenetic mechanisms in gene regulation, Role of epigenetic mechanisms in human diseases; cancer, birth defects, epileptic disorders

Unit III

Gene transfer techniques, New approaches to gene therapy for genetic disease: Spliceosome-Mediated RNA Trans-splicing (SMaRT), Triple-helix-forming oligonucleotides, Antisense gene therapy, Ribozymes, DNA drugs and vaccines, Studying human gene function through animal models.

Recommended Books:

1. Darnell, J. (2011). RNA: Life's Indispensable Molecules. Cold Spring Harbor Laboratory Press, New York.
2. Mallick, B. and Ghosh, Z. (Eds). (2012). Regulatory RNAs Basics, Methods and Applications. Springer-Verlag, Heidelberg, Germany.
3. Mráz, M. (2007). Web book: Biological Role of microRNAs in Animal Cells, Development and Cancer. <http://www.microrna.ic.cz/>
4. Deng, HW. and Shen, H. (eds.). (2007). Current Topics in Human Genetics: Studies in Complex Diseases. World Scientific Publishing Co. Pte. Ltd.
5. Strachan, T. and Read, A. (2010). Human Molecular Genetics. Garland Publishers, London, 4th ed.
6. Richard, C. F. (2011) Epigenetics : The Ultimate Mystery of Inheritance. W.W. Norton & Company, Inc. New York, 1st ed.

M.Sc. (Hons. School) Human Genetics (Semester – II)
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**HGP-471: HUMAN MOLECULAR GENETICS AND FUNCTIONAL GENOMICS
(PRACTICAL)**

Credits 0-0-3

DNA/RNA/Proteins quantification spectrophotometrically, Polymerase chain reaction (PCR), Analysis of PCR products by agarose gel electrophoresis, PCR-RFLP analysis, PCR-SSCP analysis, Demonstration of Real-Time PCR, Biological databases searches.

M.Sc. (Hons. School) Human Genetics (Semester – II)
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HGP-472: CLINICAL GENETICS (PRACTICAL)

Credits 0-0-2

Case studies, Designing proformae (Thalassemia, Primary ammenorhea, Mental retardation, Recurrent abortions, Prenatal screening questionnaires, Taking history, Preconceptional screening and Counseling, Case management of selected genetic diseases (congenital anomalies , Down syndrome, Achondroplasia, Marfan syndrome, Dysmorphology and Clinical teratology) Genetic Registers, importance and maintenance.

M.Sc. (Hons. School) Human Genetics (Semester – II)
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HGL-481: GENETICS OF HUMAN CANCER

Credits: 3-0-0

Unit-I

Types of cancer, Origin and classification of cancer, Genetic basis of cancer, Role of tumor-suppressors and oncogenes in cancer, Gene-environment interactions, Cancer syndromes.

Unit-II

Cytogenetics in myeloid leukaemia, acute myeloid leukaemia, Myelodysplastic syndromes and myeloproliferative disorders, Acute lymphoblastic leukaemia, Cytogenetics of haematological neoplasm, Lymphomas and chronic lymphoproliferative disorders.

Unit-III

Genetic basis of solid tumors, Colorectal, breast and ovarian cancer, Uterine cancer, Solid tumor cytogenetics, Neoplasia associated genomic arrangements, Cancer risk assessment.

Books Recommended:

1. Gersen, S.L. and Keagle, M.B. (2005). The Principles of Clinical Cytogenetics. Humana Press, 2nd Ed.
2. Kakunaga, T., Sugimura, T., Tomatis, L. and Yamasaki, H. (1988). Cell Differentiation Genes and Cancer. IAPC Scientific Publications.
3. Lodish, H., Berk, A., Kaiser, A.C., Krieger, M., Scott, M.P., Bretscher, A., Ploegh, H. and Matsudaira, P. (2008). Molecular Cell Biology. W.H. Freeman and Co., New York, 6th Ed.
4. Nussbaum, R.L., McInnes, R.R. and Willard, H.F. (2004). Thompson and Thompson Genetics in Medicines. W.B. Saunders and Co., New York, 6th Ed.
5. Rooney, D.E. and Czepulkowski, B.H. (1992). Human Cytogenetics: A Practical Approach. IRL Press, Vol. 1&2, 2nd ed.
6. Strachan, T. and Read, A. (2011). Human Molecular Genetics. Garland Publishers, London, 4th Ed.

M.Sc. (Hons. School) Human Genetics (Semester – II)
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HGL-482: TOOLS AND TECHNIQUES IN IMMUNOLOGY

Credits: 3-0-0

Unit I

Evaluation of antigen-antibody interaction by Immunoelectron microscopy, microarray analysis, flow cytometry, Immunoelectrophoresis, Immunoprecipitation, agglutination assays, western blotting etc.; Immunolocalization of antigens

Unit II

Experimental systems in immunology including cell lines, knock out mice, knock in mice, SCID mice, SCID Human mice, Inbred strains, nude mice; Vaccines to prevent infectious diseases

Unit III

Cancer immunotherapy; Transplantation Immunology; HLA typing; Prolongation of allograft survival; Maternal–fetal incompatibility; Circumvention of autoimmune diseases

Books Recommended:

1. Abbas, A.K., Lichtman, A.H. and Pillai, S. (2010). Cellular and Molecular Immunology. WB Saunders Co., USA
2. Benjamini, E., Coico, R. and Sunshine, G. (2009). Immunology: A Short Course. John Wiley and Sons, Inc., New York.
3. Delves, P.J., Martin, S.J., Burton, D.R. and Roit, I.M. (2006). Essential Immunology. Blackwell Scientific Publications, *Oxford*.
4. Kindt, T.J., Goldsby, R.A. and Osborne, B.A. (2007). Kuby Immunology .W.H. Freeman and Co., New York.
5. Parham, P. (2009). The Immune System. Taylor and Francis Group, New York.

M.Sc. (Hons. School) Human Genetics (Semester-III)
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HGL-505 HUMAN EMBRYOLOGY AND DEVELOPMENTAL GENETICS

Credits: 3-0-0

Unit-I

Fertilization and molecular events during fertilization, and prenatal development of human embryo up to three germinal layers. differential gene activity and cell differentiation, Gastrulation, cleavage patterns, fate map during gastrulation, Notochord formation, Neurulation, Formation of somites, Structure of somites, Formation of blood vessels.

Unit-II

Implantation, Formation and types of placenta, Genetic and molecular control of development of head and neck region, development of nervous system.

Unit-III

Genetic and molecular control of development of limbs, gastrointestinal system and cardiovascular system, Genetics of sex determination in humans and development of urogenital system.

Books Recommended

1. Gilbert, S.F. (2011). Developmental Biology. Sinauer Association, Inc., Sunderland, MA.
 2. Mueller, R.F. and Young, I.D. (2010). Emery's Elements of Medical Genetics. Churchill Livingstone, New York, 11th ed.
 3. Nussbaum, R.L., McInnes, R.R. and Willard, H.F. (2001). Thompson and Thompson Genetics in Medicines. W.B. Saunders and Co., New York, 6th ed.
 4. Sadler, T.W. (2010). Langman's Medical Embryology. Williams and Wilkins, Philadelphia, USA, 11th ed.
 5. Snustad, P. and Simmons, M.J. (2010) Principle of Genetics. John Wiley and Sons, Inc., N.J., USA.
 6. Singh, I. and Paul, G.P. (2009). Human Embryology. McMillan Co., New Delhi.
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M.Sc. (Hons. School) Human Genetics (Semester-III)
(Credit Based Continuous Evaluation Grading System)

HGL-521 CURRENT TRENDS IN MEDICAL GENETICS

Credits: 3-1-0

Unit-I

General concepts of disease and homeostasis, Principles of disease diagnosis, Epigenetics and human diseases, Personalized Medicine: race and genetics, The Human Microbiome, Ageing and its implications for medical research.

Unit-II

Personal genomics, Cell-based therapies, Nuclear reprogramming, Nuclear transplantation and its medical implications, Overview of Systems biology and Systems medicine.

Unit-III

Cell-free fetal nucleic acids, Preconceptional and preimplantation genetic diagnoses. Case studies – genomics and patents; Overview of ecogenetics and genetic weapons, Synthetic biology and its applications.

Books Recommended:

1. Allis, C.D., Jenuwein, T and Reinberg, D. (Eds.) (2013). Epigenetics, (2013). Cold Spring Harbor, N.Y.; Cold Spring Harbor Laboratory Press.
2. Brown, S.M., Hay, H.G. and Ostrer, H. (2009). Essentials of Medical Genomics. Blackwell Scientific Publication, USA, 2nd ed.
3. Crowley, L.V. (2011). Essentials of Human Disease. Jones and Bartlett Publishers, USA.
4. Ginsburg, G.S. and Willard, H.F. (2013). Genomic and Personalized Medicine, Vol. 1, Academic Press, London, 2nd ed.
5. Gunder, L.M. and Sudbury, S.A.M. (2011). Essentials of Medical Genetics for Health Professionals. Jones and Bartlett Learning.
6. Jorde, L.B., Carey, J.C. and Bamshad, M.J. (2010). Medical Genetics. Elsevier, Mosby, 4th ed.
7. Mummery, C., Wilut, I., Van de Stolpe, A. and Roelen, B.A.J. (Eds.) (2011). Stem Cells: Scientific Facts and Fiction. Academic Press, London.
8. Read, A. and Donnai, D. (2010). New Clinical Genetics. Scion, U.K., 2nd ed.
9. Speicher, M., Antonarakis, S.E. and Motulsky, A.G. (Eds.) (2010). Vogel and Motulsky's Human Genetics: Problems and Approaches. Springer Verlag, 4th ed.
10. Stein, G.S., Borowski, M., Luong, M.X., Shi, M-J., Smith, K. P. and Vazquez, P. (Eds.) (2011). Human Stem Cell Technology and Biology. John Wiley, Hoboken.
11. Strachan, T. and Read, A. (2011). Human Molecular Genetics. Garland Publishers, New York, 4th ed.
12. Tobias, E.S., Connor, M. and Smith, M.F. (2011). Essential Medical Genetics. Blackwell Scientific Publication, USA.
13. Turnpenny, P.D. (2012). Emery's Elements of Medical Genetics. Churchill Livingstone, New York, 14th ed.

M.Sc. (Hons. School) Human Genetics (Semester-III)
(Credit Based Continuous Evaluation Grading System)

HGL-522 GROWTH DISORDERS IN CHILDREN

Credits: 3-1-0

Unit-I

Identification of abnormal growth and growth failure, Growth references, Growth standards, Growth charts, Velocity of growth, Uses of anthropometry for differential diagnosis of growth.

Unit-II

Undernutrition, Underweight, Stunting, Wasting, Protein energy malnutrition (PEM), Marasmus, Kwashiorkor, Failure to thrive, Nutritional anaemia, Overnutrition, General obesity and Central/Abdominal obesity, Health consequences of obesity, Factors influencing the development of undernutrition, overweight and obesity.

Unit-III

Regional growth disorders, Short and tall stature, Delayed puberty, Precocious puberty, Chromosomal aberrations and growth, Developmental disabilities.

Books Recommended:

1. Ghai, O.P., Paul, V.K. and Bagga, A. (2010). Essential Pediatrics. CBS Publishers and Distributors, New Delhi.
2. Gibney, M.J., Margetts, J.M., Kearney, J.M. and Arab, L. (2004}. Public Health Nutrition. Blackwell Publishing Co., Oxford.
3. Hermanussen, M. (2013). Auxology: Studying Human Growth and Development. Schweizerbart Science Publishers, Stuttgart, Germany.
4. Parthasarthy, Nair, M.K.C. and Menon, F.S.N. (2006). Textbook of Pediatrics. Jaypee Brothers Medical publishers (P) Ltd., New Delhi.
5. Ulijaszek, S.J., Johnston, F.E. and Preece, M.A. (1998). The Cambridge Encyclopedia of Human Growth and Development. Cambridge University Press, U.K.

M.Sc. (Hons. School) Human Genetics (Semester-III)
(Credit Based Continuous Evaluation Grading System)

HGL-523 GENETICS IN POST-GENOMIC ERA

Credits: 3-1-0

Unit-I

Introduction to post-genomic era, Scope, Tools and Challenges in post-genomic era, High throughput methods; Next Generation and Third generation sequencing technologies.

Unit-II

Role of bioinformatics in post-genomic era, Data mining and management tools, Information retrieval from biological databases, Sequence annotation, Computational methods in comparative genomics, Proteomics in post-genomics era; Protein sequence databases, Protein structure prediction analysis.

Unit-III

Translational genomics, Genomic medicine; 1000 Genome project, Concept of personalised medicine, Introduction to pathway analysis, Basic concepts of node, pathway and networks, Tools for pathway analysis, Types; Knowledge driven and data driven.

Books Recommended:

1. Andreas, D., Baxevanis, B.F. and Francis, O. (2005). Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. Wiley publishing Co., 3rd ed.
2. Augen, J. (2004). Bioinformatics in the Post-Genomic Era: Genome, Transcriptome, Proteome, and Information-Based Medicine. Addison-Wesley publishers., 1st ed.
3. Dassanayake, Y.I.N. and Gunawardene, S. (2011). Genomic and Proteomic Techniques: In Post Genomics Era. Narosa Publishing House, 1st ed.
4. Kwon, Y.M. and Ricke, S.C. (2011). High-Throughput Next Generation Sequencing: Methods and Applications. Humana Press, 1st ed.

M.Sc. (Hons. School) Human Genetics (Semester-III)
(Credit Based Continuous Evaluation Grading System)

5. Najarian, K. (2009). Systems Biology and Bioinformatics: A Computational Approach. CRC Press, 1st ed.
6. Nikolsky, Y. and Bryant, J. (2009). Protein Networks and Pathway Analysis (Methods in Molecular Biology). Humana Press, 1st ed.
7. Pevsner, J. (2009). (2009). Bioinformatics and Functional Genomics. Wiley Blackwell Publishing Co., 2nd ed.

M.Sc. (Hons. School) Human Genetics (Semester-III)
(Credit Based Continuous Evaluation Grading System)

HGL-524 ADVANCED CYTOGENETICS

Credits: 3-0-0

Unit-I

Process of cell culture, culture environment and media, Methods of culture, Types of cell culture systems, Maintenance and storage of culture, Cell-line banking, Scaling-up of cultures for tissue engineering and commercial culture, Stem cells, Cell quantitation methods and cytotoxicity assays.

Unit-II

Methods of cell imaging, Quantification of images, Transmitted light imaging, Principle and applications of fluorescent microscope, Confocal microscope, Scanning electron microscope, Flow cytometer, Fluorescent *in situ* hybridization technique and its applications: CGH, M-FISH, SKY, COBRA-FISH, CM-FISH, FIBRE-FISH, GISH, PRINS.

Unit-III

Human chromosome nomenclature for G-banded chromosome, Neoplasia, *In situ* hybridization, Microarray.

Books Recommended:

1. Aruni, A., Wilson and Ramadass, P. (2011). Animal Cell Culture. MLIP Publishers, Chennai, India.
2. Freshney, R.I. (2000). Culture of Animal Cells: A Manual of Basic Techniques. Wiley Liss, Inc., New York, USA, 4th ed.
3. Gerson, S.L. (1999). Principles of Clinical Cytogenetics. Humana Press, Totowa, USA.
4. Purandaare, H. and Chakravarty, A. (2000). Human Cytogenetic Techniques and Clinical Applications. Bhalani Publishing House, Mumbai, India.
5. Roif-Dieter (1999). Diagnostic Cytogenetics. Springer-Verlag, New York.
6. Schaffer, L.G., McGowan-Jordan, J. and Schmid, M. (2013). ISCN-2013. Karger Publishers, Germany.
7. Stephens, D. (2006). Cell Imaging. Scion Publishing Limited, Oxfordshire, UK.
8. Vanjak-NovaKovic, G. and Freshney, R.I. (2006). Culture of Cells for Tissue Engineering. Wiley-Liss, New York, USA.
9. Wegner, R.D. (1999). Diagnostic Cytogenetics. Springer-Verlag, New York, USA.

M.Sc. (Hons. School) Human Genetics (Semester-III)
(Credit Based Continuous Evaluation Grading System)

HGP-521 LAB ROTATIONS-II

Credits: 0-0-6

The students will have laboratory attachments with different faculty members and they will be evaluated for the techniques they have learnt during the semester.

M.Sc. (Hons. School) Human Genetics (Semester-III)
(Credit Based Continuous Evaluation Grading System)

HGL-531 GENETIC ENGINEERING-II

Credits: 3-0-0

Unit-I

High capacity vectors, Artificial chromosomes, Expression of cloned genes in *E. coli*, yeast and higher eukaryotic cells, Baculovirus-based expression systems, Different methods of introducing cloned genes into mammalian cells, Generation of competent cells, Analysis of gene expression using reporter gene assays.

Unit-II

Genomic and cDNA libraries and their construction; Random, arrayed and ordered libraries; EST libraries, Subtractive libraries, Screening of libraries based on different vectors; Methods and concepts, Chromosome walking, Chromosome jumping, Protein interaction study methods; Two hybrid screening, Phage display.

Unit-III

Genetic engineering of mammalian stem cells; Stem cell culture, Uses of human embryonic stem cells, Gene targeting in mouse ES cells, Transposon technology; Sleeping beauty mediated and Piggy Bac system, Genome editing technology, Cre-Lox system, Recombination-mediated cassette exchange, Homozygous embryonic stem cells.

Books Recommended:

1. Dale, J.W. and von Schantz, M. (2007). From Genes to Genomes: Concepts and Applications of DNA Technology. John Wiley and Sons, UK, 2nd ed.
2. Glick, B.R., Pasternak, J.J. and Patten, C.L. (2010). Molecular Biotechnology: Principles and Applications of Recombinant DNA. ASM Press, 4th ed.
3. Howe, C. (2007). Gene Cloning and Manipulation. Cambridge University Press, 2nd ed.
4. Kiessling, A. and Anderson, S.C. (2006). Human Embryonic Stem Cells. Jones and Bartlett Learning Publishers, 2nd ed.
5. Nicoll, D.S.T. (2008). An Introduction to Genetic Engineering. Cambridge University Press, 3rd ed.

M.Sc. (Hons. School) Human Genetics (Semester-III)
(Credit Based Continuous Evaluation Grading System)

HGL-532 HUMAN GENETICS RESEARCH AND REGULATION

Credits: 3-0-0

Unit-I

Background of research on Human Genetics, Need for protection of human subjects in research, Development of medical oaths and research codes.

Unit-II

International guidelines and regulations for conducting Human Genetics research – [Declaration of Helsinki](#), Universal Declaration on the Human Genome and Human Rights, International Ethical Guidelines for Biomedical Research involving Human Subjects (CIOMS-WHO), The Declaration of Inuyama, Concepts of and issues in Reprogenetics, Consumer genetics, Personal genomics, Public health and Community genetics, Regenerative medicine, Organ transplantation, Euthanasia, Intellectual Property Rights.

Unit-III

National regulatory frameworks regarding Genetically-modified organisms, Human Genetic modification, Reproductive genetic testing, Cloning, Genetic Engineering Approval Committee (GEAC), Drugs and Cosmetics Act, The Patents Act, The Medical Termination of Pregnancy Act, The Preconception and Prenatal Diagnostic Techniques Act, The Transplantation of Human Organs Act.

Readings Recommended:

1. Drugs and Cosmetics Act, (1940, amended 2003).
<http://indianmedicine.nic.in/html/pharma/adrugsnoti.pdf>.
2. DBT and ICMR: Guidelines for Stem Cell Research and Therapy (2007).
http://icmr.nic.in/stem_cell/Stem_cell_guidelines.pdf.
3. Ethical Guidelines for Biomedical Research on Human Participants (2006).
http://icmr.nic.in/ethical_guidelines.pdf.
4. ICMR: Ethical Guidelines for Biomedical Research on Human Subjects: Statement of Specific Principles for Human Genetics and Genomics Research (2006).
5. Ethical Guidelines for Biomedical Research on Human Participants (2006).
http://icmr.nic.in/ethical_guidelines.pdf
6. Ministry of Health, Good Clinical Practices (GCP), (2001),
<http://unpan1.un.org/intradoc/groups/public/documents/APCITY/UNPAN009867.pdf>.
7. Indian Council of Medical Research, Guidelines for Preparing Standard Operating Procedures (SOP) for Institutional Ethics Committee for Human Research.
http://www.icmr.nic.in/ethics_SOP.pdf.
8. Statement on Gene Therapy Research (adopted by the Human Genome Organisation, HUGO).

M.Sc. (Hons. School) Human Genetics (Semester-III)
(Credit Based Continuous Evaluation Grading System)

9. Universal Declaration on the Human Genome and Human Rights
<http://www.unesco.org/new/en/social-and-human-sciences/themes/bioethics/human-genome-and-human-rights/>
10. World Medical Association: Declaration of Helsinki (Ethical Principles for Medical Research Involving Human Subjects).
11. WIPO: World Intellectual Property Organization (www.wipo.int).
12. WTO: Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) is part of the agreements of the World Trade Organization (www.wto.org).

M.Sc. (Hons. School) Human Genetics (Semester-IV)
(Credit Based Continuous Evaluation Grading System)

HGL-552 APPLIED HUMAN MOLECULAR GENETICS

Credits: 3-0-0

Unit-I

Principles and strategies in identifying disease gene, Genetic and physical mapping of human genome, Mapping and cloning of human disease genes, Direct and indirect DNA testing and its applications, DNA-based diagnosis of genetic diseases, Population screening.

Unit-II

Comparative genomic hybridization (CGH), DNA chips, DNA dragnets, Principles and application of denaturing high pressure liquid chromatography (dHPLC), Multiplex ligation-dependent probe amplification (MLPA), Mass spectrometry (MS), Tandem mass spectrometry (TMS), Matrix assisted laser desorption/ionization time of flight (MALDI-TOF), Next generation sequencing (NGS) and its applications.

Unit-III

Molecular genetics of retinoblastoma, Glaucoma, Marfan syndrome, DMD, Cystic fibrosis, Huntington's disease, Complex human diseases like NIDDM, Hypertension, Cardiovascular disorders, Obesity, Molecular genetics of mitochondrial disorders.

Books Recommended

1. Brandon, C. and Tooze, J. (1999). Introduction to Protein Structure. Garland Publishers, London.
2. Brown, T.A. (2002). Genomes. Oxford Scientific Publications, London
3. Brown, T.A. (2005). Genetics, A Molecular Approach. Bios Scientific Publishers Ltd., Oxford, 3rd ed.
4. Brown, T.A. (2006). Genomes 3. Bios Scientific Publishers Ltd., Oxford, 3rd ed.
5. Brown, T.A. (2010). Gene Cloning and DNA Analysis: An Introduction. Blackwell Publishing Co., Oxford, 6th ed.

6. Gleck, B.R. and Pasternack, J.R. (2003). *Molecular Biotechnology: Principles and Applications of Recombinant DNA*. ASM Press, Washington.
7. Korf, B.R. (2007). *Human Genetics and Genomics*. Blackwell Scientific Publication, USA, 3^{rs} ed.
8. Lewin, B. (2008). *Genes-IX*. Jones and Barlett Publishers, Inc., USA.
9. Schena, M. (2003). *Microarray Analysis*. Wiley-Liss, New York.
10. Strachan, T. and Read, A. (2010). *Human Molecular Genetics*. Garland Publishers, London. 4th ed.
11. Sudbery, P. Sudbery I (2009). *Human Molecular Genetics*. Pearson Education, UK. 3rd ed.
12. Wilson, K. and Walker, J. (2000). *Practical Biochemistry, Principles and Techniques*. Cambridge University Press, 5th ed.

M.Sc. (Hons. School) Human Genetics (Semester-IV)
(Credit Based Continuous Evaluation Grading System)

HGL-554 STRUCTURAL BIOLOGY AND PHARMACOGENOMICS

Credits: 3-0-0

Unit-I

Structures of proteins — Primary, secondary and tertiary, Basic dipeptide unit, Conformational variables, α -helix, β -sheet and their prediction from primary sequence, Common three-dimensional folds/motifs found in proteins (e.g., three-helix bundle, zinc finger, etc.).

Unit-II

Basic principles of conformational analysis, Theoretical and experimental methods for the determination of sizes of proteins, Physical nature of non-covalent interactions, Conformational properties of proteins, Introduction to Ramachandran plot.

Unit-III

Pharmacogenomics of obesity-related hypertension, Diabetes and other cardiovascular diseases, Basics of drug discovery, Role of functional genomics in new drug discovery and drugable genome, Genome-guided identification and validation of drug targets, Role of SNPs in drug discovery and development.

Books Recommended

1. Brandon, C. and Tooze, J. (1999) Introduction to Protein Structure. Garland Publishers, London.
2. Hartl, D.L. and Jones, E.W. (2005). Genetics: Analysis of Genes and Genomes. Jones and Barlett Publishers, Massachusetts.
3. Jain, K.K. (2001). Drug Discovery: Current Trends and Future Prospects. Urch Publishers, London.
4. Leach, A.R. (2001). Molecular Modelling. Principles and Applications. Addison Wesley Longman, Essex.
5. Nelson, D.L. and Cox, M.M. (2008). Lehninger's Principles of Biochemistry. W.H. Freeman and Co., New York.

M.Sc. (Hons. School) Human Genetics (Semester-IV)
(Credit Based Continuous Evaluation Grading System)

HGL-580 BIRTH DEFECTS

Credits: 3-0-0

Unit-I

Syndromes and dysmorphology, Birth defects, Diagnostic approach to the dysmorphic patients, CHARGE and VACTERAL association, Evaluation of dysmorphology: Pregnancy history, Birth history, Medical history, Developmental history, Family history, Physical features.

Unit-II

Prenatal cytogenetics, Amniocentesis, Chorionic villus sampling, Percutaneous umbilical cord sampling, Stillbirth and neonatal death, Spontaneous abortion, Advanced maternal age, Abnormal ultrasound findings – Nuchal thickening, Positive maternal serum marker screen, Indications for prenatal diagnosis, Genetic basis and clinical manifestations of Congenital malformations: Neural tube defects, Teratogenic effects, Basic principles of teratogenicity.

Unit III

Developmental genetics: Developmental gene families, Limb as developmental model, Normal development and errors of morphogenesis, Developmental genes and cancer, Positional effect and developmental genes, Sexual differentiation and determination, Twinning.

Books Recommended:

1. Fundukian, L.J. (2010). Pearls of Dysmorphology. The GALE Encyclopedia of Genetic Disorders. China Translation & Printing Services Limited, China, Vol. I and II, 3rd ed.
2. Gersen, S.L. and Keagle, M.B. (2005). The Principles of Clinical Cytogenetics. Humana Press, 2nd ed.
3. Hartl, D.L. (2014). Essential Genetics: A Genomic Perspective. Jones and Barlett Learning, USA, 6th ed.
4. Lahiri, K. and Muranjan, M.N. (Eds.) (2005). Clinical Genetics. Jay Pee Brothers India.
5. Lupski, J.R. and Stankiewicz, P. (2006). Genomic Disorders: The Genomic Basis of Disease. Humana Press, New Jersey.
6. Mueller, R.F. and Young, I.D. (2001). Emery's Elements of Medical Genetics. Churchill Livingstone Inc., 11th ed.
7. Netter, F.H. (2003). Atlas of Human Anatomy. Icon Learning Systems, USA, 3rd ed.
8. Nussbaum, R.L., McInnes, R.R., Willard, H.I. and Boerkoel, C.I. (2001). Thompson and Thompson Genetics in Medicine. W.B. Saunders Co., 6th ed.

9. Pai, G.S., Lewandowski, R.C. and Borgaonkar, D.S. (2003). Handbook of Chromosomal Syndromes. John Wiley and Sons.
10. Pritchard, D.J. and Korf, B.R. (2003). Medical Genetics at a Glance. Blackwell Science.
11. Rimoin, D.L., Connor, J.M., Pyeritz, R.E. and Korf, B.R. (2002). Principles and Practice of Medical Genetics. Churchill Livingstone Inc., Vol. 1-3, 4th ed.
12. Snell, R.S. (2004). Clinical Anatomy. Lippincott Williams and Wilkins, 7th ed.
13. Templeton, N.S. and Lasic, D.D. (Eds.) (2000). Gene Therapy. Marcel Dekker, Inc.
14. Tobias, E.S., Connor, M. and Ferguson, S.M. (2011). Essential Medical Genetics. Wiley Blackwell, 6th ed.
15. Turnpenny, P.D. and Ellaro, S. (2005). Emery's Element of Medical Genetics. Elsevier Churchill Living Stone, 12th ed.
16. Vöneky, S. and Wolfrum, R. (Eds.) (2004). Human Dignity and Human Cloning. Martinus Nijhoff Publishers.

M.Sc. (Hons. School) Human Genetics (Semester-IV)
(Credit Based Continuous Evaluation Grading System)

HGP-581 APPLIED HUMAN MOLECULAR GENETICS PRACTICAL

Credits: 0-0-3

DNA isolation, Amplification of genomic DNA by PCR, Agarose gel electrophoresis of amplified products, Polyacrylamide gel electrophoresis (PAGE), PCR-SSCP analysis, Demonstration of RT-PCR, Biological database searches (MEDLINE, NCBI, ENSEMBL, UCSC, GDB, PDB, HGMD, RetNet).

M.Sc. (Hons. School) Human Genetics (Semester-IV)
(Credit Based Continuous Evaluation Grading System)

HGD-595 DISSERTATION

The topic of the dissertation and the name of the supervisor are to be finalized during Semester-II. Experimental work on dissertation project will begin in Semester-III. The dissertation is to be submitted before theory examinations of Semester IV.