

Centre for Human Genetics

School of Health Sciences
Central University of Punjab, Bathinda
M.Sc. Programme in Life Sciences
(Human Genetics)

Semester-1

S.No	Paper Code	Course Title	L	T	P	Cr	% Weightage				
							A	B	C	D	E
1	LSS.501	Research Methodology	2			2	25	25	25	25	50
2	LSS.502	Biostatistics	2	-	-	2	25	25	25	25	50
3	LSS.504	Cell Biology	3	-	-	3	25	25	25	25	75
4	LSS.506	Biochemistry	3	-	-	3	25	25	25	25	75
5	LSS.508	Genetics	3			3	25	25	25	25	75
6	HGS.551	Human Cytogenetics and Human Biochemical Genetics	4			4	25	25	25	25	100
7	.XXX	Interdisciplinary Course-1	2			2	25	25	25	25	50
8	LSS.503	Biostatistics Practical	-	-	2	1	-	-	-	25	25
9	LSS.505	Cell Biology (P)	-	-	2	1	-	-	-	25	25
10	LSS.507	Biochemistry (P)	-	-	2	1	-	-	-	25	25
11	LSS.509	Genetics (P)	-	-	2	1				25	25
12	HGS.552	Human Cytogenetics and human Biochemical Genetics (p)	-	-	2	1	-	-	-	25	25
		Total Sem-1	19	0	10	24					600
Opt any one course from the following Interdisciplinary courses											
1		Basics of Human Genetics	2			2					50
2		Basics of Microscopic Techniques	2			2					50

A: Continuous Assessment: Based on Objective Type Tests

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

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

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

E: Total Marks

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

LSS.501: Research Methodology. Credit Hours: 2. Semester I.

Unit 1 5 Lectures

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

Unit 2 10 Lectures

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

Unit 3 5 Lectures

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

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Unit 4

16 Lectures

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

Suggested Reading:

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

LSS.502: Biostatistics. Credits Hours: 2. Semester I.

Unit 1

6 Lectures

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

Unit 2

8 Lectures

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

Unit 3

8 Lectures

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

Unit 4

14 Lectures

Inferential Statistics: Student's t-test, Paired t-test, Mann-Whitney U-test, Wilcoxon signed-rank, One-way and two-way analysis of variance (ANOVA), Critical difference (CD), Least Significant Difference (LSD), Kruskal-Wallis one-way ANOVA by ranks, Friedman two-way ANOVA by ranks, χ^2 test. Standard errors of regression coefficients, Comparing two regression lines, Pearson Product-Moment Correlation Coefficient, Spearman Rank Correlation Coefficient, Power and sampling size in correlation and regression.

Suggested Reading:

1. Gookin, D. (2007). *MS Word 2007 for Dummies*. Wiley, USA.
2. Harvey, G. (2007). *MS Excel 2007 for Dummies*. Wiley, USA.
3. Johnson, S. (2009). *Windows 7 on demand*. Perspiration Inc. USA.
4. Norman, G. and Streiner, D. (2008). *Biostatistics: The Bare Essentials*. 3/e (with SPSS). Decker Inc. USA.

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5. Sokal, R.R. and Rohlf, F.J. (1994). *Biometry: The Principles and Practices of Statistics in Biological Research*. W.H. Freeman publishers, USA.
6. Thurrott, P. and Rivera, R. (2009). *Windows 7 Secrets*. Wiley, USA.

LSS.504: Cell Biology. Credit Hours: 3. Semester I.

Unit 1 25 Lectures

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

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

Unit 2 15 Lectures

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

Unit 3 17 Lectures

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

Unit 4 15 Lectures

Cell growth and division: Overview of the cell cycle and its control, The molecular mechanisms for regulating mitotic and meiotic events, Amitosis, Cell cycle control, Checkpoints in cell cycle regulation. Cell to cell signaling, Overview of the extra cellular signaling, Identification of cell surface receptors, G-protein coupled receptors and their effectors, Second messengers, Enzyme-linked cell surface receptors, Interaction and regulation of signaling pathways.

Suggested reading:

1. Alberts, B., Bray, D., Lews, J., Raff, M., Roberts, K. and Watson, J.D. (2010). *Molecular Biology of the cell*. Garland publishers, Oxford.
2. Celis, J.E. (2006). *Cell biology: A laboratory handbook*, Vol 1, 2, 3. Academic Press, UK.
3. Gupta, P.K. (2008). *Cytology, Genetics and Evolution*. Rastogi publications, Meerut, India.

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4. Karp, G. (2010). *Cell and Molecular Biology: Concepts and Experiments*. John Wiley & Sons. Inc. New Delhi, India.

LSS.504: Biochemistry. Credits Hours: 3. Semester I.

Unit 1

15 Lectures

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

Unit 2

25 Lectures

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

Unit 3

17 Lectures

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

Unit 4

15 Lectures

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

Suggested Reading:

1. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2010). *Biochemistry*. W.H. Freeman & Company. USA.
2. Brown, T.A. (2006). *Gene Cloning and DNA analysis: In Introduction*. Blackwell Publishing Professional. USA.
3. Haynie, D.T. (2007). *Biological thermodynamics*. Cambridge University. UK.
4. Mathews, C.K., Van Holde, K.E. and Ahern, K.G. (2000). *Biochemistry*. Oxford University Press Inc. New York.
5. Nelson, D. and Cox, M.M. (2008). *Lehninger Principles of Biochemistry*. BI publications Pvt. Ltd. Chennai, India.
6. Ochiai, E. (2008). *Bioinorganic chemistry: A survey*. Academic Press. Elsevier, India.
7. Randall, D. J., Burggren, W. and French, K. (2001). *Eckert animal physiology*. W.H. Freeman & Company. USA.
8. Raven, P.H., Johnson, G.B. and Mason, K.A. (2007). *Biology*. Mcgraw-Hill. USA.
9. Shukla AN (2009). *Elements of enzymology*. Discovery Publishing. New Delhi, India.
10. Voet, D. and Voet, J.G. (2008). *Principles of biochemistry*. CBS Publishers & Distributors. New Delhi, India.

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LSS.505: Genetics. Credits Hours: 3. Semester I.

Unit 1

20 Lectures

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

Unit 2

17 Lectures

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

Unit 3

17 Lectures

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

Unit 4

18 Lectures

Extra-chromosomal inheritance: Chloroplast and Mitochondrial inheritance, Yeast, *Chlamydomonas/Neurospora* and higher plants Chromosomal aberrations: Types of changes– deletions, duplications, inversions, translocations, Change in chromosome number: trisomy and polyploidy. Evolutionary history of bread wheat, Aneuploids–nullisomics, monosomics, and trisomics, Somatic aneuploids, Changes in chromosome structure, Properties of chromosomes for detection of structural changes. Mutations: Spontaneous and induced mutations, Somatic vs germinal mutation.

Suggested Reading:

1. Anthony, J.F., Miller, J.A., Suzuki, D.T., Richard, R.C., Gilbert, W.M. (1998). *An introduction to Genetic Analysis*. W.H. Freeman publication, USA.
2. Atherly, A.G., Girton, J.R., McDonald, J.F. (1999). *The science of Genetics*. Saundern College publication.
3. Snusted, D.P., Simmons, M. J. (2010). *Principles of Genetics*. John Wiley & Sons, New York.
4. Gupta, P.K. (2009). *Genetics*. Rastogi publications, Meerut, India.
5. Gupta, P.K (2008). *Cytology, Genetics and Evolution*. Rastogi publications, Meerut, India.
6. Jocelyn, E.K., Elliott, S.G., Stephen, T.K. (2009). *Lewin's Genes X*. Jones & Bartlett Publishers, USA.

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7. Schaum, W.D. (2000). *Theory & problems in Genetics by Stansfield, out line series* McGrahill, USA.
8. Tamarin, R.H. (1996). *Principles of Genetics, International edtn.* McGrawhill, USA.

HGS.551: Human Cytogenetics and Human Biochemical Genetics. Credits Hours: 4. Semester I.

Unit 1 18 Lectures

Microscopy: History and principles of microscopy, Micrometry, Light microscopy, Phase Contrast, Bright Field and Dark Field microscopy, Scanning and Transmission Electron microscopy, Scanning Probe microscopy, Fluorescence microscopy, Live cell imaging, In-vivo imaging techniques.

Unit 2 18 Lectures

General features of Human Chromosome and Chromosome staining: Chromatin structure, Constitutive and Facultative Heterochromatin, Centromeres, Telomere and its maintenance, Nuclear Organization Region (NOR), Sister Chromatid Exchanges (SCE), Mosaicism, Structure of Human X and Y chromosome, Chromosome Banding Techniques, Human Artificial Chromosome.

Dosage compensation and In Situ Hybridization: Sex determination and dosage compensation in *Caenorhabditis*, *Drosophila* and mammals, Fluorescent in situ hybridization (FISH), Comparative Genomic Hybridization (CGH) mapping technique, Whole Chromosome Painting.

Unit 3 18 Lectures

The concept of Biochemical Polymorphism: enzyme and protein polymorphisms; Effects of multiple gene loci on protein structure, Molecular structure, biosynthesis and genetics of the ABH antigens, Rh antigens and MN antigens.

Normal Biochemical Polymorphisms and Variants: Quantitative and qualitative variation of enzymes, Haemoglobin variants, Effects of Single Amino Acid Substitutions i.e. Sickle cell disease, unstable haemoglobins, Genetics of steroid and insulin receptors.

Unit 4 18 Lectures

Disorders due to Abnormal Variants of lysosomal enzymes, lipids and DNA nitrogenous bases: Disorders of Lysosomal enzymes–Tay- Sachs disease and Mucopolysaccharidoses, Disorders of Lipoprotein and lipid metabolism – Hyper Lipoproteinemia; Disorders of Purine metabolism- Lesch Nyhan syndrome; Disorders of Pyrimidine metabolism – Orotic Aciduria

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. Klug, W.S., Cummings, M.R., Spencer, C.A. and Palladino, M.A. (2012). *Concepts of Genetics*. Pearson.
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 Cytogenetics, Narendra Publishing House, India

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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.
13. . Murray, R.K., Bender, D., Botham, K., M., Kennelly, P. J., Rodwell, V. W. and Weil, P.A. (2012). *Harpers Illustrated Biochemistry*. McGraw-Hill Medical.
14. Nelson, D. and Cox, M.M. (2013). *Lehninger Principles of Biochemistry*. W.H. Freeman.

Opt any one course from the following Interdisciplinary courses

Basics of Human Genetics Credits Hours: 2. Semester I.

Unit 1

18 Lectures

Chromosomal analysis and Genetic assessment: Classification of Genetic Disorders, Human Chromosomes, The Life Cycle of a Somatic Cell, Mitosis, Meiosis, Medical Applications of Chromosomes, Drawing of a pedigree, consanguinity.

Unit 2

18 Lectures

Common chromosomal disorders and Mendelian disorders: Down syndrome, Edwards syndrome, Patau's syndrome and other trisomies, Structural aberrations, Single gene disorders: autosomal and sex chromosomal, Multifactorial disorders.

Suggested Reading:

1. Emery and Rimoin's, et al., 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. Motulsky. 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)

Basics of Microscopic Techniques Credits Hours: 2. Semester I.

Unit: 1

8 Lectures

Basic concepts of microscopy: Magnification; Resolution and resolving powers of different microscope; Field number; Identification of parts of light microscope; visualization of cells and subcellular components by light microscopy, microscopy of living cells; image processing methods in microscopy.

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Unit: 2

10 Lectures

Principles of Fluorescence and Fluorescence Microscopy

Electron microscopy: Scanning and Transmission electron microscope. Different fixation and staining techniques for EM, freeze-etch and freeze-fracture methods for EM.

Suggested Reading:

1. Suzanne Bell and Keith Morris (2009). *An Introduction to Microscopy*. CRC Press., Boca Raton, FL 33487, USA
2. Kiernan J.A., I. Mason (2002). *Microscopy and Histology for Molecular Biologists: A User's Guide*. Portland Press.
3. A. Méndez-Vilas (2009). *Microscopy: advances in scientific research and education*. Formatex Research Center
4. A. Mendez-Vilas (2012). *Current microscopy contributions to advances in science and technology*. Formatex Research Center.
5. Prakash Singh Bisen and Anjana Sharma (2012). *Introduction to Instrumentation in Life Sciences*. CRC Press taylor and francis
6. Rafael Yuste (2011). *Imaging: A Laboratory Manual*. Cold spring Harbor Laboratory Press

LSS.503: Biostatistics - practical. Credit Hours: 1. Semester I.

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

LSS.505: Cell Biology – Practical. Credit Hours: 1. Semester I.

1. Preparation of mitotic & meiotic chromosomes.
2. Study of structure of cell organelles through electron micrographs.
3. Instrumental methods for cell biology-centrifugation, chromatography.
4. Bacterial staining and identification.
5. Sectioning of tissues (Plant and animal).
6. Histochemical techniques (Fixing, Processing, Staining).

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

LSS.507: Biochemistry – Practical. Credit Hours: 1. Semester I.

1. Preparation of Solutions, buffers, pH setting etc.
2. Amino acid and carbohydrate separations by paper & thin layer chromatography.
3. Quantitative Estimation of Proteins, Sugars, total lipids and amino acids.
4. Assay and estimation of different enzymes e.g. invertase, amylases, acid and alkaline phosphatases in plant seeds.
5. Principle and application of electrophoresis, Native, SDS PAGE.
6. Estimation of total phenolic compounds.
7. Extraction and estimation of vitamins.

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

LSS.509: Genetics - Practical. Credit Hours: 1. Semester I.

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

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

LSS.552: Human Cytogenetics and Human Biochemical Genetics. Credit Hours: 1. Semester I.

1. Cell counting by using hemocytometer.
2. Calculation of cell doubling time.
3. Human lymphocyte culture.
4. Karyotyping of normal and abnormal chromosome sets.

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5. Identification of inactivated X chromosome as Barr body and drumstick.
6. Chromosome banding.
7. FISH

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

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Semester 2												
S.No	Paper Code	Course Title	L	T	P	Cr	% Weightage					E
							A	B	C	D	E	
1	LSS.510	Human Physiology	3	-	-	3	25	25	25	25	75	
2	LSS.512	Immunology	2	-	-	2	25	25	25	25	50	
3	HGS.513	Human Embryology and Developmental Genetics	3	-	-	4	25	25	25	25	75	
4	LSS.515	Molecular Biology	3	-	-	3	25	25	25	25	75	
5	LSS.517	Techniques in Life Sciences	2	-	-	2	25	25	25	25	50	
6	HGS.518	Evolution, Environment and Ecology	3	-	-	3	25	25	25	25	75	
7	LSS.XXX	Interdisciplinary course-2	2			2	25	25	25	25	50	
8	LSS.511	Human Physiology (P)	-	-	2	1	-	-	-	-	25	
9	LSS.516	Molecular Biology			2	1					25	
10	LSS.599	Seminar			1	1					25	
			19	0	9	24					600	
Opt any one course from the following Elective courses												
11	HGS.519	Genetic Diseases and Therapies	3	-	-	3	25	25	25	25	75	
12	HGS.520	Human Population Genetics	-	-	2	1	25	25	25	25	75	
Opt any one course from the following Interdisciplinary courses												
13	LSS.XXX	Genetic counseling and Prenatal Diagnosis	2			2					50	
14	LSS.XXX	Basics of Population Genetics	2			2					50	

A: Continuous Assessment: Based on Objective Type Tests

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

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

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

E: Total Marks

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

LSS.510: Human Physiology. Credit Hours: 3. Semester II.

Unit: 1

18 Lectures

Digestive system: Digestion, absorption, energy balance, BMR.

Epithelial Barrier Function, Regulation of Swallowing and Gastric Emptying and Small/ Large Bowel. Gastro-intestinal Secretions and accessory glands

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

Excretory system: Comparative physiology of excretion, Kidney, Urine formation, Urine

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concentration, Waste elimination, Micturition, Regulation of water balance, Blood Volume, Blood pressure, Electrolyte balance, Acid-base balance. Renal Function and Hemodynamics

Unit: 2

18 Lectures

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

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

Unit: 3

12 Lectures

Nervous system: Neurons, action potential, Gross neuroanatomy of the brain and spinal cord, Central and peripheral nervous system, Neural control of muscle tone and posture.

Sense organs: Vision, hearing and tactile response.

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

Unit: 4

8 Lectures

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

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.
3. Guyton. (2007). *Textbook of medical physiology*. 11th Edition. Elsevier India Pvt. Ltd. New Delhi.
4. Hill, R.W, Wyse, G. A. and Anderson, M. (2008). *Animal physiology*. Sinauer Associates Inc. USA.
5. Khurana. (2006). *Textbook of medical physiology*. Elsevier India Pvt. Ltd.
6. Murray, R.K. (2009). *Harper's illustrated biochemistry*. Jaypee Publishers, New Delhi, India.
7. Tyagi, P. (2009). *A textbook of Animal Physiology*. Dominant Publishers and distributors, New Delhi, India.
8. Silverthorn D, (2011) *Human Physiology*, Pearson; 6th edition.
9. Sherman V. (2013) *Vander's Human Physiology*. McGraw-Hill 13th edition.

LSS.512: Immunology. Credit Hours: 2. Semester III.

Unit: 1

10 Lectures

Immune system: Recognition of self and nonself, Humoral immunity-immunoglobulins, basic structure, classes and subclasses, structural and functional relationships, nature of antigen, antigen-antibody reaction, estimation of affinity constants. Molecular mechanisms of antibody diversity and Cellular immunity: Organization of genes coding for constant and variable regions

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of heavy chains and light chains. Mechanisms of antibody diversity, class switching. Lymphocytes, cytokines, interferons, Interlukins, antigen recognition-membrane receptors for antigens.

Unit: 2

16 Lectures

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

Unit: 3

12 Lectures

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

Unit: 4

14 Lectures

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

Suggested Reading:

1. Kindt, T.J., Osborne, B.A. and Goldsby, R.A. (2007). *Kuby Immunology* .7th Edition. W.H. Freeman, USA.
2. Abbas. (2008). *Cellular and Molecular immunology*. CBS Publishers & Distributors, India.
3. Charles, A. and Janeway, J.R. (1994). *Immunobiology: The immune system in health and disease*. Blackwell Publishing, USA.
4. Delves, P.J., Roitt, I.M. and Seamus, J.M. (2006). *Roitt's essential immunology (Series–Essentials)*. Blackwell Publishers, USA.
5. Elgert, K.D. (2009). *Immunology: Understanding the immune system*. Wiley-Blackwell, USA.
6. Paul, W.E. (1993). *Fundamental immunology*. Raven Press, SD, USA.
7. Sawhney, S.K. and Randhir, S. (2005). *Introductory practical biochemistry*. Alpha Science International Ltd. New Delhi, India.
8. Tizard. (2008). *Immunology: An Introduction*. Cengage Learning, Thompson, USA.

HGS.513: Human Embryology and Developmental Genetics . Credit Hours: 4. Semester II.

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Unit: 1 18 Lectures

Reproductive Physiology: Structure and Functions of Adult Human Reproductive organs, Reproductive Endocrinology, Gametogenesis: Formation of male and female gametes, Embryogenesis: Fertilization, Gastrulation and Implantation of Embryo, Lactation.

Unit: 2 18 Lectures

Basic concepts of development: Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development.

Unit: 3 18 Lectures

Regulation of Organ Development: Genetic and molecular control of development of limbs, Gastrointestinal system and cardiovascular system; Genetics of sex determination in humans and development of urogenital system; Programmed cell death and role of cell death in formation of digits and joints, Genetic and molecular control of development of head and neck region, Formation of nervous system.

Unit: 4 18 Lectures

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

Suggested reading:

1. Green, D. R. & Reed J. C. (2010). *Apoptosis: Physiology and Pathology*. Cambridge press, UK.
2. Milunsky, J. & Milunsky, A. (2010). *Genetic Disorders and the Fetus: Diagnosis, Prevention & Treatment*. Willey Blackwell India, New Delhi.
3. Nussbaun, R., Roderick, R. M. and Huntington, F.W.(2007). *Genetics in Medicine*. Saunders Elsevier Philadelphia.
4. Prakash, G. (2007). *Reproductive Biology*. Narosa Publication House Pvt. Ltd., New Delhi.
5. Sadler, T.W., Tosney, K., Chescheir, N.,C., Imseis, H., Leland, J. and Sadler-Redmond, S.,L. (2011). *Langman's Medical Embryology (Longmans Medical Embryology)*. Lippincott Williams and Wilkins.
6. Schaefer, B.D. (2013). *Medical Genetics: An integrated Approach*. McGraw Hill Education, New Delhi.
7. Tyagi R. (2011). *Understanding Evolutionary Biology*. Discovery Publication House Pvt. Ltd., New Delhi.

LSS.515: Molecular Biology. Credit Hours: 3. Semester II.

Unit: 1 14 Lectures

Structure, Conformation, Denaturation, Renaturation of Nucleic acids: Carrier of genetic information, Chemical structure of DNA and base composition, Watson-Crick model, Supercoiled DNA, Different forms of RNA: mRNA, tRNA, rRNA and other Types of RNA.

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Organelle DNA: mitochondria and chloroplast DNA. Chromosome Structure, Chromatin and the Nucleosome: Genome Sequence and Chromosome Diversity, Chromosome Duplication and segregation, The nucleosome, Chromatin structure: euchromatin, heterochromatin, Constitutive and facultative heterochromatin, Regulation of chromatin structure and nucleosome assembly, Nucleolus.

Unit: 2 14 Lectures

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

Unit: 3 14 Lectures

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

Unit: 4 10 Lectures

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

Suggested Reading:

1. Fasman, G.D. (1989). *Practical Handbook of Biochemistry and Molecular Biology*. CRC Press, Taylor and Francis Group, UK.
2. Gupta, P.K. (2005). *Cell and Molecular Biology*. Rastogi publications, Meerut, India.
3. James, D.W., Baker, T.A., Bell, S.P., Gann, A. (2009). *Molecular Biology of the Gene*. Benjamin Cummings, USA.
4. Jocelyn, E.K., Elliott, S.G., Stephen, T.K. (2009). *Lewin's Genes X*. Jones & Bartlett Publishers, USA.
5. Johnson, A., Lewis, J., Raff, M. (2007). *Molecular Biology of the Cell*. Garland Science, USA.
6. Lodish, H., Berk, A., Chris, A.K. and Krieger, M. (2008). *Molecular Cell Biology*. W.H. Freeman, USA.
7. Sambrook, J., Fritish, E.F., Maniatis, T. (2000). *Molecular cloning: A laboratory manual*. Cold Spring Harbor Laboratory Press, New York.

LSS.517: Techniques on Life Sciences. Credit Hours: 2. Semester II

Unit 1 10 Lectures

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

Unit: 2

6 Lectures

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

Unit: 3

10 Lectures

Nucleic acids: Isolation, purification and analysis of nucleic acids. Electrophoresis: Principle of gel electrophoresis, polyacrylamide gel electrophoresis (PAGE and SDS-PAGE), agarose gel electrophoresis, pulse field gel electrophoresis (PFGE) and 2-Dimensional gel electrophoresis. Polymerase chain reaction (PCR): Principle, types and applications, PCR based markers: RAPDs, SSRs, SNPs, ISSRs, and SCARs etc. Blotting techniques: Southern, Northern, Western, Dot blotting and hybridization, DNA fingerprinting.

Unit: 4

10 Lectures

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

Suggested Reading:

1. Brown, T.A. (2010). *Gene cloning and DNA analysis: An Introduction*. 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.

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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.

HGS.518 Evolution, Environment and Ecology Credit Hours: 3. Semester II

Unit 1 18 Lectures

Origin of cells and evolution: Lamarckism, Darwinism, natural selection and evolutionary synthesis; concepts of variation, adaptation, struggle, fitness and natural selection; Spontaneity of mutations; the evolutionary synthesis.

Origin of basic biological molecules; Abiotic synthesis of organic monomers and polymers; concept of Oparin and Haldane; Experiment of miller (1953).

The evolutionary time scale; Eras, periods and epoch; Major events in the evolutionary time scale; Origin of cells and unicellular evolution; stages in primate evolution including Homo; molecular divergence and molecular clocks and origin of new genes and proteins.

Unit: 2 12 Lectures

Environment: Biotic and abiotic interactions; concept of habitat and niche; resource partitioning and character displacement; types of species interactions and environmental pollution; global environmental change; biodiversity: status, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches; principles of conservation.

Unit: 3 14 Lectures

Population Ecology and Community Ecology: Characteristics of a population; population growth curves; life history strategies (r and K selection); concept of metapopulation – demes and dispersal, age structured populations; community structure and attributes; levels of species diversity and its measurement; edges and ecotones.

Unit: 4 12 Lectures

Ecological Succession and Ecosystem Ecology: Types, mechanism and changes involved in ecological succession; concept of climax; ecosystem structure and ecosystem function; energy flow and mineral cycling (C,N,P); primary production and decomposition, major terrestrial biomes.

Suggested reading:

1. Futuyma, D.J. (2009). *Evolution*. Sinauer Associates Inc. USA.

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- Gargaud, M., Lopez-Garcia, P., and Martin, H. (2011). *Origins and Evolution of Life*. Cambridge University Press, UK.
- Stanford, C., Allen, J. S. and Anton, S.C. (2012). *Biological Anthropology*. Person Education USA.
- Odum, E., Barrick, M. and Barret, G.W. (2005). *Fundamentals of ecology. 5 Edition*. Thomson Brooks/Cole Publisher, USA.
- Pandey, B.N. and Jyoti, M.K. (2012). *Ecology and environment*. APH Publishing Corporation, New Delhi.
- Sharma, P.D. (2009). *Ecology and environment*. Rastogi Publications. New Delhi.

Opt any one course from the following Elective courses

HGS.519 Clinical and Medical Genetics

Credit Hours: 3. Semester II

Unit 1

0 Lectures

Genetics in medical Practice: Genetic Principles and their application in medical practice, Case studies (Interacting with patients, learning family history and drawing pedigree chart), Syndromes and disorders: Definition and their genetic basis.

Unit: 2

6 Lectures

Human Genetic Disorders of Nervous system and Eye : Neurogenetic disorders- Charcot-Marie tooth syndrome, Spino-muscular atrophy, Alzheimer's disease & Syndromes due to triplet repeat expansion, Parkinson's disease, Prion diseases, Colour Blindness, Retinitis pigmentosa, Glaucoma & Cataracts.

Unit: 3

10 Lectures

Patterns of Single Gene Inheritance: Haematopoietic systems-Sickle cell Anemia, Thalassemias and Haemophilias, Muscle genetic Disorders- Duchenne Muscular Dystrophy, Becker Muscular Dystrophy, Cystic Fibrosis, Tay Sach's Syndrome & Marfan Syndrome; Genetics of diseases due to Inborn errors of metabolism: Phenylketonuria, galactosemia & mucopolysaccharidosis.

Unit: 4

10 Lectures

Multifactorial Disorders: Polygenic susceptibility to a disease, genetics of complex diseases like Hypertension, Linkage studies, Association studies, Linkage versus association Genome-wide Association studies

Suggested reading:

- Atherly, A.G., Girton, J.R., McDonald, J.F. (1999). *The Science of Genetics*. Saunders College publication, Philadelphia, USA.
- Francis, R.C. (2012). *Epigenetics: How Environment shapes our genes*. WW Norton & Co.
- Milunsky A, Milunsky J (2009). *Genetic Disorders and the Fetus: Diagnosis, Prevention and Treatment*. Wiley-Blackwell publishers.
- Nussbaum, R.L., McInnes, R. Mc., Willard, H.F. (2009). *Genetics in Medicine*. Elsevier Inc., Philadelphia.
- Read A and Donnai D (2010). *New Clinical Genetics*. Scion Publishing Lmt., Oxfordshire, UK.
- Patch, H.S.C. (2009). *Genetics for the Health Sciences*. Scion Publishing Ltd., UK.

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HGS.520 Human Population Genetics Credit Hours: 3. Semester II

Unit 1 0 Lectures

Hardy-Weinberg Equilibrium: Historical emergence, Application and subdivisions of human population genetics, 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, Selection coefficient and fitness, Heterozygous advantages, Inbreeding and its consequences; Inbreeding coefficient of a population

Unit: 2 6 Lectures

Kinetics of changes of Gene Frequencies: Non-recurrent and recurrent mutation, mutation pressure and estimation of rates, Genetic load, Selection coefficient and fitness, Heterozygous advantages, Equilibrium between mutation and selection, Dynamics of migration and genetic drifts. Linkage in man; Direct and indirect analysis of linkage, Pedigree method: y and u statistics, Sib pair analysis, Lod-score calculations.

Unit: 3 10 Lectures

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

Unit: 4 10 Lectures

Inheritance of Complex Traits: Quantitative Genetic analysis; Broad-Sense Heritability and Narrow-Sense Heritability.

Suggested reading:

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.

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Interdisciplinary Courses

Genetic Counseling and Prenatal Diagnosis. Credit Hours: 2. Semester-II

Unit-1 14 Lectures

Genetic Counseling: History taking, Examination, Genetic Counseling in Clinical Genetics, Determining Recurrence Risks, Population Screening for Genetic Diseases, Reproductive decision making

Unit-2 14 Lectures

Prenatal Diagnosis: Indications for Prenatal Diagnosis, Preliminaries to Prenatal Diagnosis, Procedures for Obtaining Fetal Tissue, Ultrasonography, Laboratory Studies, Psychosocial issues.

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

Basics of Population Genetics Credit Hours: 2. Semester-II

Unit-I: Introduction to Neuroscience 8 Lectures

Hardy-Weinberg Equilibrium: Historical emergence, Application and subdivisions of human population genetics, 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, Selection coefficient and fitness, Heterozygous advantages, Inbreeding and its consequences.

Unit-II: Brain Cells 6 Lectures

Kinetics of changes of Gene Frequencies: Non-recurrent and recurrent mutation, mutation pressure and estimation of rates, Genetic load, Selection coefficient and fitness, Heterozygous advantages, Equilibrium between mutation and selection, Dynamics of migration and genetic drifts

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.

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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.

LSS.511: Human Physiology – Practical. Credit Hours: 1. Semester II.

1. Determination of hemoglobin in the blood by various methods.
2. Measurement of Blood Pressure, Pulse rate and Heart rate.
3. Digestive enzymes analysis.
4. Respiratory function: Tidal volume.
5. Sense organs and muscle reflexes.
6. Urine analysis.
7. Blood glucose estimation.
8. RBC, WBC count from human blood.
9. Extraction and estimation of acid phosphatases from serum.
10. Electrophoresis of egg proteins.

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

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

LSS.516: Molecular Biology Practical - Credit Hours: 1. Semester II.

1. Isolation of genomic DNA from bacteria (E.coli) and human blood, Quantification of DNA using spectrophotometric method.
2. RNA isolation.
3. cDNA synthesis.
4. RT-PCR.
5. Isolation of plasmid DNA from bacteria.

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6. Transformation of bacteria using CaCl₂ heat shock method-Competent cell preparation.
7. Digestion of DNA using restriction endonucleases, Resolution and molecular weight estimation of fragmented DNA using agarose gel electrophoresis.
8. Construction of restriction map by single and double digestion, Designing DNA probe, Southern blot hybridization (demonstration only).
9. 1 Amplification of known DNA sequences by Polymerase Chain Reaction.
*More practicals may be added/modified from time to time depending on available faculties/facilities.

LSS.559: Seminar on emerging topics – Credit Hours: 1. Semester II.

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Semester-3											
S.No	Paper Code	Course Title	L	T	P	Cr	% Weightage				
							A	B	C	D	E
15	HGS.601	Basic Bioinformatics	3	-	-	3	25	25	25	25	75
16	HGS.603	Biosafety, Bioethics and intellectual Property Rights	4	-	-	4	25	25	25	25	100
17	LSS.604	Microbiology	3	-	-	3	25	25	25	25	75
18	HGS.606	Clinical and Medical Genetics	-	-	-	3	25	25	25	25	75
19	HGS.602	Basic Bioinformatics (P)	-		2	1	10	15	15	10	25
20	LSS.605	Microbiology (P)			2	1					25
21	HGS.607	Clinical and Medical Genetics (P)			2	1					25
22	HGS.600	Dissertation Research			16	8					200
			12	0	6	24					600

A: Continuous Assessment: Based on Objective Type Tests

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

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

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

E: Total Marks

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

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LSS.601: Ecology and Environment. Credit Hours: 2. Semester III.

Unit: 1 **14 Lectures**

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

Unit: 2 **14 Lectures**

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

Unit: 3 **18 Lectures**

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

Unit: 4 **8 Lectures**

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

Suggested Reading:

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

LSS.603: Evolutionary and Developmental Biology. Credit Hours: 4. Semester III.

Unit: 1 **20 Lectures**

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

Unit: 2 **16 Lectures**

Paleontology and molecular evolution: The evolutionary time scale, Eras, periods and epoch, Major events in the evolutionary time scale, Origins of unicellular and multicellular organisms,

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Stages in primate evolution including *Homo sapiens*. Concepts of neutral evolution, Molecular divergence and molecular clocks, Molecular tools in phylogeny, Classification and identification; Origin of new genes and proteins; Gene duplication and divergence.

Unit: 3

18 Lectures

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

Unit: 4

18 Lectures

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

Suggested Reading:

1. Darwin, C.R. (1911). *On the origin of species by means of natural Selection, or preservation of favoured races in the struggle for life*. Hurst Publishers, UK.
2. Dawkins, R. (1996). *The Blind Watchmaker*, W.W. Norton & Company Jones and Bartlett Publishers.
3. Futuyma, D.J. (2009). *Evolution*. Sinauer Associates Inc. USA.
4. Hake, S. and Wilt, F. (2003). *Principles of Developmental Biology*. W.W. Norton & Company, New York, USA.
5. Hall, B.K. and Hallgrimsson, B. (2007). *Strickberger's Evolution*. Jones and Bartlett Publishers, India.
6. Lewin, R. (2004). *Human Evolution - An Illustrated Introduction*. Wiley-Blackwell, USA.
7. Scott, F. and Gilbert, S.F. (2010). *Developmental Biology*. Sinauer Associates, Inc. USA.
8. Slack, J.M.W. (2005). *Essential Developmental Biology*, Wiley-Blackwell, USA.

LSS.604: Microbiology. Credit Hours: 3. Semester III.

Unit: 1

16 Lectures

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

Unit: 2

16 Lectures

Growth, nutrition & control: Phases in bacterial growth, Growth Curve, Calculation of G-time, Physical and environmental requirements of growth, Microbial nutritional requirements, Types of culture media. Physical and Chemical methods, Antimicrobial drugs, Antibiotic assays, Drug resistance in bacteria.

Unit: 3

6 Lectures

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

Unit: 4

16 Lectures

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

Suggested Reading:

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

Elective Course – 3

LSS.651: Cancer Biology. Credit Hours: 2. Semester III.

Unit: 1

6 Lectures

Biology and classification of cancer: Classification, Phenotype of a cancer cell, Causes of cancer –DNA tumor viruses, RNA tumor viruses, Cell cycle and its control-role of protein kinases, Checkpoints, Kinase inhibitor and cellular response, Different forms of cancers, Diet and cancer screening and early detection, Tumor markers, Molecular tools for early diagnosis of cancer.

Unit: 2

10 Lectures

Genetic basis of cancer: Oncogenes, Tumor suppressor genes, Aberrations in signaling pathways, Oncogenic mutations in growth promoting proteins, Mutations causing loss of growth-inhibition and cell cycle control, Role of carcinogens and DNA repair in cancer.

Unit: 3

10 Lectures

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Oncogenesis and Apoptosis: Intracellular proteolytic cascade, Cascade of caspase proteins, Adapter proteins, Bcl-2, IAP family proteins, Extra cellular control of cell division, Tumor necrosis factor and related death signals.

Unit: 4

10 Lectures

Metastasis and Cancer therapy: Heterogeneity of metastatic phenotype, Metastatic cascade, Basement membrane disruption, Three step theory of invasion, Proteinase and tumor cell division, Different forms of cancer therapy, Chemotherapy, Radiation therapy, Detection of cancers, Prediction of aggressiveness of cancer, Advances in cancer detection, Use of signal targets towards therapy of cancer, Gene therapy.

Suggested Reading:

1. Dimmock, N.J. and Primrose, S.B. (2005). *Introduction to modern virology*. Bookbarn International, UK.
2. Ford, C.H.J., Casson, A.G. and Macdonald, F. (2004). *Molecular biology of cancer*. Bios Scientific Publishers, USA.
3. King, R.J.B. and Robins M.W. (2006). *Cancer Biology*. Prentice Hall, USA.
4. Margaret, A.K. and Peter, J.S. (2005). *Introduction to the cellular and molecular biology of cancer*. Oxford University Press, USA.
5. Neoptolemos, L.J. (1994). *Cancer: A molecular approach*. Blackwell Publishing, USA.
6. Phillis, R., Goodwin, S. and Palladino, M.A. (2002). *Biology of cancer*. Benjamin-cummings Publishing Company, USA.

LSS.653: Physiology and Molecular Biology of stress. Credit Hours: 2. Semester III.

Unit: 1

10 Lectures

Environmental Stresses and stress factors: Definition, Significance, Types, Stress- as perceived by plants and animals. **Responses of plants towards biotic factors:** Choice between fight or flight, acquired vs induced tolerance, Plant defense system, Genetic basis, understanding R genes, Systemic plant defense responses.

Unit: 2

10 Lectures

Responses towards abiotic factors: Stresses involving water deficit, High and low temperature stress, Salinity stress, Drought stress, Anoxia and Heavy metal stress, Role of osmotic adjustments towards tolerance, Altitude Stress, understanding of genetic basis.

Unit: 3

8 Lectures

Signaling under stress conditions: Perception, Transduction and response trigger, Induction of specific gene expression, Stress proteins, Convergence and divergence of signaling pathways, ABA as stress hormone, ABA the phenomenon of cross adaptation.

Unit: 4

8 Lectures

Genetic engineering and production of plants for improved stress tolerance: Physiological approach, Mutant approach, Wild relatives approach, Contrasting genotypes approach, Getting clue from sub - relative approach, contrasting genotypes approach, Getting clue from sub-lethal stress application, Lower organisms etc insect, nematodes, virus, bacteria,

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phytoplasma and fungus resistant plants, Success of plant breeding vs modern genetic modifications, Raising of stress tolerant genotypes through genetic engineering. **High throughput analysis techniques in stress biology:** Transcriptome analysis, Proteome analysis, Microarray, SAGE etc.

Suggested Reading:

1. Grissem, W. and Jones, R.L. (2000). *Biochemistry and Molecular Biology of Plants*. American Society of Plant Physiologists, USA.
2. Hopkins, W.G. and Hüner, N.P.A. (2004). *Introduction to plant physiology*. J. Wiley, USA.
3. Orcutt, D.M. and Nilsen, E.T. (2000). *Physiology of Plants Under stress*. J. Wiley, USA.
4. Galun, E. and Breiman. (1997). *Transgenic Plants*. World scientific Publishing, Chennai, India.
5. Hopkins, W.G. (2007). *Plant Biotechnology*. Infobase Publications Inc.. USA.
6. Chrispeels, M.J. and Sadava, D.E. (2002). *Plant, Genes and Crop Biotechnology*. American Society of Plant Biologists, USA.
7. Pessaraki et al. (2002). *Handbook of Plant and Crop Physiology*. Marcel Dekker, USA.
8. Primrose, S. B. and Twyman, R. (2006). *Principles of gene manipulation and genomics*. Blackwell Publishing Professional, Society of Plant Biologists, USA

LSS.655: Environmental Microbiology. Credit Hours: 2, Semester –III

Unit: 1

6 Lectures

Environment and Ecosystems: Definitions, biotic and abiotic environment. Environmental segments. Composition and structure of environment. Concept of biosphere, communities and ecosystems. Ecosystem characteristics, structure and function. Food chains, food webs and trophic structures. Ecological pyramids.

Unit: 2

10 Lectures

Eutrophication: Water pollution and its control: Need for water management. Sources of water pollution. Measurement of water pollution, Eutrophication: Definition, causes of eutrophication, and microbial changes in eutrophic bodies of water induced by various inorganic pollutants. Effects of eutrophication on the quality of water environment, factors influencing eutrophication. Qualitative characteristics and properties of eutrophic lakes. Measurement of degree of eutrophication. Algae in eutrophication, algal blooms, their effects and toxicity, coloured waters, red tides, and cultural eutrophication. Physico-chemical and biological measures to control eutrophication.

Unit: 3

10 Lectures

Effluent treatment techniques: Microbiology of wastewater and solid waste treatment: - Waste-types-solid and liquid waste characterization, physical, chemical, biological, aerobic, anaerobic, primary, secondary and tertiary treatments. Anaerobic processes: Anaerobic digestion, anaerobic filters, and up-flow anaerobic sludge. Treatment schemes for effluents of dairy, distillery, tannery, sugar and antibiotic industries (Types, microbes used, types of Effluent

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Treatment Plants). Bioconversion of Solid Waste and utilization as fertilizer. Bioaccumulation of heavy metal ions from industrial effluents.

Unit: 4

10 Lectures

Bioremediation of Xenobiotics: Microbiology of degradation of xenobiotics in the environment, ecological considerations, decay behaviour, biomagnification and degradative plasmids, hydrocarbons, substituted hydrocarbons, oil pollution, surfactants and pesticides. Genetically Modified Organisms released and its environmental impact assessment and ethical issues. Global environmental problems, Ozone depletion, UV-B, green house effect and acid rain, their impact and biotechnological approaches for management. . Containment of acid mine drainage applying biomining [with reference to copper extraction from low grade ores].

Suggested Reading:

1. Baker, K.H. And Herson D.S. (1994). Bioremediation. MacGraw Hill Inc. N.Y.
2. Ec Eldowney, S. Hardman D.J. and Waite S. (1993). Pollution: Ecology and Biotreatment - Longman Scientific Technical.
3. Ralph Mitchell. A. (1974). Environmental Microbiology edited by John Wiley and Sons. Inc.
4. Advances in Waste Water Treatment Technologies. (1998). Volumes II and I by R. K. Trivedy. Global Science Publication.
5. Lawrence, P., Wacekett, C. and Douglas Hershberger. (2000) Biocatalysis and Biodegradation: Microbial transformation of organic compounds ASM Publications.
7. Christon J. Hurst (2001). A Manual of Environmental Microbiology. 2nd Edition. ASM Publications.

LSS.602: Ecology and Environment – Practical. Credit Hours: 1. Semester III.

1. Ecosystem analysis: Quadrat method- Data collection Methods and species diversity estimations.
 2. Field and Laboratory Investigations: Biomes study.
 3. Biological Monitoring.
 4. Air, water and soil analysis.
 5. Determination of dissolved oxygen concentration of water sample.
 6. Determination of biological oxygen demand (BOD) of sewage sample.
 7. Determination of Chemical oxygen demand (COD) of sewage sample.
 8. Isolation of xenobiotic degrading bacteria by selective enrichment technique.
 9. Test for the degradation of aromatic hydrocarbons by bacteria.
 10. Study on biogenic methane production in different habitats.
 11. Eco-modeling.
- *More practicals may be added/modified from time to time depending on available faculties/facilities.

LSS.605: Microbiology – Practical. Credit Hours: 1. Semester III.

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1. Isolation and pure culture techniques.
2. Staining methods: Simple staining, Negative Staining, Gram Staining, Acid-Fast stain.
3. Standard method for bacteriological water analysis: Presumptive test, confirmed test and completed test.
4. Microbial analysis: Analysis of food/dairy products.
5. Microbial growth studies.
*More practicals may be added/modified from time to time depending on available faculties/facilities.

Elective Course - 3 Practical

LSS.652: Cancer Biology Practical – Credit Hours: 1, Semester III.

1. Culture of cancer cell lines.
2. Cell metastasis.
3. Measurement of MMPs activity.
4. Anticancer drug treatment and apoptosis in cancer cells.
*More practicals may be added/modified from time to time depending on available faculties/facilities.

LSS.654: Physiology and Molecular Biology of stress (P) Credit Hours: 1, Semester III.

1. Membrane Damage and TTC reduction test.
2. Expression of different isozymes.
3. Molecular expression of SOD, APX, CAT, POX, GR, Etc.
4. DNA Damage due to stress.
5. Reactive species localization.
*More practicals may be added/modified from time to time depending on available faculties/facilities.

LSS.656: Environmental Microbiology (P) Credit Hours: 1, Semester –III.

1. Physical analysis of sewage/industrial effluent by measuring total solids, total dissolved solids and total suspended solids.
2. Determination of indices of pollution by measuring BOD/COD of different effluents.
3. Bacterial reduction of nitrate from ground waters
4. Isolation and purification of degradative plasmid of microbes growing in polluted environment.
5. Recovery of toxic metal ions of an industrial effluent by immobilized cells.
6. Utilization of microbial consortium for the treatment of solid waste [Municipal Solid Waste].
8. Biotransformation of toxic chromium (+ 6) into non-toxic (+ 3) by Pseudomonas species.
9. Tests for the microbial degradation products of aromatic hydrocarbons /aromatic compounds

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10. Reduction of distillery spent wash (or any other industrial effluent) BOD by bacterial cultures.
11. Microbial dye decolorization/adsorption.
*More practicals may be added/modified from time to time depending on available faculties/facilities.

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Semester-4											
S.No	Paper Code	Course Title	L	T	P	Cr	% Weightage				
							A	B	C	D	E
1	HGS.608	Genomics for Human Welfare	4	-	-	4	25	25	25	25	100
2	HGS.609	Genetic Screening and Counseling	4	-	-	4	25	25	25	25	100p
3	LSS.600	Dissertation				16					400
			6	0	4	24					600

A: Continuous Assessment: Based on Objective Type Tests

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

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

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

E: Total Marks

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

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LSS.606: Computational Biology and Bioinformatics. Credit Hours: 3. Semester IV.

Unit: 1

12 Lectures

Biological Databases: Nucleotide Sequence Databases, GenBank, DDBJ, EMBL, Sequence Flatfile and submission process, Protein sequence databases, UniProt in detail, Mapping databases, Genomic databases, Protein structure databases, PDB in detail, 3D visualization softwares, Pathway and molecular interaction databases, and Data mining.

Unit: 2

12 Lectures

Analysis for nucleotide and protein sequences: Gene Prediction methods and programs, RNA secondary structure thermodynamics, Vienna RNAfold, Evolution and origins of sequence polymorphisms, SNP discovery methods and databases, Genotyping, International haplotype map project, 1000 genomes project. Predicting features of individual residues, Predicting function, Neural Networks, Protein structure prediction, Prediction algorithms for pathways and Molecular Interactions, Integrating gene expression data with pathway information.

Unit: 3

14 Lectures

Homology search and Phylogenetic Analysis: Global Vs. local sequence alignments, Dotplots, Scoring matrices, Pairwise sequence alignment, BLAST, Position-Specific scoring and PSI-BLAST, MegaBLAST, BL2SEQ, BLAT, FASTA Vs BLAST, Basics of phylogenetics, Nucleotide substitution models and selection, Distance-matrix-based methods, Neighbor-Joining, Fitch-Margoliash, Outgroups, UPGMA, Minimum Evolution, Maximum Parsimony, Maximum Likelihood, Bayesian Inference, Searching for trees, Rooting trees, Bootstrapping, Likelihood ratio tests.

Unit: 4

16 Lectures

Genomics & Proteomics: Comparative Genomics, Genomic alignments, Gene predictions in genomic alignments, Genome-wide association study, Phylogenetic footprinting, Gene annotation, Gene expression analysis using DNA Microarray, Annotation of array probes, Image processing, Normalizing expression measurements. Major proteomic approaches, Protein analysis by MALDI and SELDI methods, Time of Flight MS in protein analysis, Protein Identification by Mascot, Peptide Mass Fingerprinting, Comparative proteomics, Two-Dimensional Polyacrylamide Gel Electrophoresis.

Suggested Reading:

1. Baxevanis, A.D. and Ouellette, B.F.F. (2004). *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. Mount, D.W. (2005). *Bioinformatics: Sequence and Genome Analysis*. CBS Publishers, New Delhi, India.
5. Ramsden, J. (2010). *Bioinformatics: An Introduction (Computational Biology)*. Springer, India.
6. Ye, S.Q. (2008). *Bioinformatics: A Practical approach*. Chapman & Hall/CRC, UK.

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- Zvelebil, M. and Baum, J. (2007). *Understanding Bioinformatics*, Garland Science, New York, USA.

LSS.608: Radiation Biology – Credit Hours: 3. Semester IV.

Unit: 1

12 Lectures

Interaction of radiation with matter: Different types of radiation, Ionization and excitation, Linear energy transfer, Direct and indirect effects of radiation Radiation chemistry of water. **Biological effects of radiations:** Whole body irradiation and sensitivity of tissue, Units of radiation measurement, and Radiation levels and limits.

Unit: 2

12 Lectures

Cell Survival: Reproductive integrity mechanism of cell killing, Survival curves in mammalian cells. **Radio-sensitivity and cell cycle:** Variation of sensitivity with cell age, Effect of X-rays and high let radiations, and Possible implications in radiotherapy.

Unit: 3

14 Lectures

Heritable effects of radiations: Chromosomal and chromatid aberrations, Point mutations, oligomeric and multi-factorial human diseases, Genetic risk assessment, Doubling dose and mutation component. **Modification of radiation induced damage** Radio-sensitizers, Protectors, Normal tissue radioprotection, Mechanisms of action, Sulfhydryl compounds, WR series, Dose reduction factor (DRF). **Non targeted effects of radiations:** Bystanders effects, Chromosomal instability, and Adaptive response.

Unit: 4

16 Lectures

Mechanisms for the repair of DNA. Repair of DNA breaks, Repair of base damage, photo-reactivation, Excision repair, Post-replication recovery, Base excision repair, nucleotide excision repair (NER), Transcription coupled repair (TCR) and bulk DNA repair. **Influence in signaling pathways:** Radiation - induced gene expression, Signaling abnormalities in cancer, Effects of signaling abnormalities on radiation responses. **Radiation and Cancer:** Initiation, promotion, Progression, Dose response for radiation - induced cancers, Importance of age at exposure and time since exposure, Second tumors in radiation therapy patients.

Suggested Reading:

- Curran B.H. and Starkschall, G. (2012). *Informatics in Radiation Oncology*. CRC Press, USA.
- Hall, E.J. and Giaccia, A. (2011). *Radiobiology for the Radiologist*. Lippincott Williams & Wilkins, USA.
- Forshier, S. (2008). *Essentials of Radiation, Biology and Protection*. Cengage Learning, USA.
- Nias, A. H. W. (1998). *An Introduction to Radiobiology*. John Wiley & Sons, USA.
- Prasad, K. N. (2008). *CRC Handbook of Radiobiology*. CRC Press, Florida, USA.

LSS.607: Computational Biology and Bioinformatics-Practical. Credit Hours: 1. Semester IV.

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1. Introduction to NCBI Taxonomic Browser, NCBI BLAST & TreeBASE.
2. Primer design using PRIMER-3 and PrimerBLAST.
3. Data analysis of DNA Microarray experiments.
4. Multiple Sequence Alignment by MEGA, ClustalX.
5. Determination of genes mapped within a specific chromosomal locus using GeneLoc integration resource.
6. Gene orthologue prediction using Ensembl.
7. Determination of sequence similarity using BL2SEQ and structural similarity using PDB of convergently evolved proteins.
8. Phylogenetic analysis of molecular data using MEGA and PHYLIP (NJ, ML, UPGMA, MP and BI methods).
9. Secondary structure construction of rRNA using Vienna RNAfold.
10. Base calling of electropherograms and contig assembly using Manual/Phred/Phrap.
*More practicals may be added/modified from time to time depending on available faculties/facilities.

LSS.609: Radiation Biology - Practical.

Credit Hour: 1.

Semester IV.

1. To determine the effect of UV rays on *E. coli*. and elucidate cell survival curve.
2. To demonstrate the effect of UV rays on cell division.
3. To determine the value of LD50 of UV radiation using MTT assay.
4. To detect the levels of Reactive oxygen species generated during irradiation.
5. To demonstrate the effect of UV radiation on Antioxidant enzymes, Proteins and DNA.
 - a. Spectrophotometric methods
 - b. Western blotting
 - c. DNA ladder assay and Comet assay
6. To demonstrate the effect of radiation on cell membrane by spectrophotometric method (Lipid peroxidation).
7. To employ Trypan blue exclusion/light microscopy to evaluate healthy live (clear, bright), early apoptotic (irregular shape, shrunken nucleus), and end-stage apoptotic/oncotic (blue-stained) cells.
*More practicals may be added/modified from time to time depending on available faculties/facilities.

LSS 600: Master's Research (Dissertation) – Credit Hours: 16, Semester IV.