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UNIVERSITY OF MYSORE

Estd. 1916

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No.AC.2(S)/401/13-14

Dated: 24-05-2014

NOTIFICATION

Sub: Distribution of Credits matrix in Genetics and revision of syllabus.

Ref: 1. Proceedings of Faculty of Science & Technology Meeting held on14-02-2014.
2. Proceedings of the Meeting of Academic Council held on 29-03-2014.

The Board of Studies in **Genetics (PG)** at its meeting held on 30-11-2013 has resolved to recommend Distribution of Credit matrix and revision of syllabus in M.Sc Genetics from the academic year 2014-15

The Faculty of Science and Technology and the Academic Council at their meetings held on 14-02-2014.and 29-03-2014 respectively approved the above proposals and the same is hereby notified.

The copy of the Distribution of Credits matrix in of Genetics (PG) is annexed herewith.

REGISTRAR. 24/5/2014

University of Mysore
MYSORE

To

1. The Registrar (Evaluation), University of Mysore, Mysore.
2. The Chairperson, BOS/DOS in Genetics MGM
3. The Dean, Faculty of Science & Technology, DOS in Zoology, MGM.
4. The Principals of the Affiliated Science Colleges.
5. The Deputy/Assistant Registrar (Evaluation), University of Mysore, Mysore.
6. Sri Narasimha Murthy, Statistician, E.B. UOM, Mysore.
7. The Supdt AC.1 & AC.2, A.B., Academic Section / PMEB, UOM., Mysore.
8. The P.A. to the Vice-Chancellor/Registrar/Registrar(Evaluation), UOM., Mysore.
9. The Case Worker, AC.7, Academic Section, University of Mysore, Mysore.
10. The Section Guard File(Supdt.AC.2), A.B., A.C., UOM.
11. The Schedule File.

UNIVERSITY OF MYSORE
Department of Studies in Zoology
CREDIT MATRIX FOR M.Sc. GENETICS PROGRAM 2014-15

SEMESTER	HARDCORE	SOFTCORE	OPEN ELECTIVE	TOTAL
I	16	04 (08)	-	**20**
II	12	06 (10)	04	**22**
III	14	08 (12)	04	**22**
IV	08	04/06 (08)	04	**12** (14)
	50	**22** (38)	**04** (12)	**76**

Semester I : 20 Credits

Paper code	Title of the Course	HC/SC/OE	L	T	P	Credit	Name of the Faculty
	Transmission Genetics	HC	3	0	1	4	
	Chromosome Genetics	HC	3	0	1	4	
	Gene Structure and Function	HC	3	0	1	4	
	Cell Biology	HC	3	0	1	4	
	Molecular Cytogenetics	SC	4	0	0	4	
	Histology and Histopathology	SC	3	0	1	4	Faculty from Zoology

Any one of 4 credits soft course can be opted by the M.Sc.Genetics students

Semester II (18**/22**)

Paper code	Title of the Course	HC/SC /OE	L	T	P	Credit	Name of the Faculty
	Molecular Cell Biology	HC	3	0	1	4	
	Population Genetics and Evolution	HC	3	0	1	4	
	Genome Genetics	HC	3	0	1	4	
	Gene Regulation	SC	4	0	0	4	
	Biological Chemistry	SC	2	0	0	2	
	Ethology and Wild life Biology	SC	3	1	0	4	Faculty from Zoology
	Basic Genetics	OE	3	0	1	4	

Any 6 credits of the 10 credits of the soft courses can be opted by the M.Sc.Genetics students

Semester III 22

Paper code	Title of the Course	HC/SC /OE	L	T	P	Credit	Name of the Faculty
	Genetic Engineering	HC	3	0	1	4	
	Genes and Development	HC	3	0	1	4	
	Advanced Human Genetics	HC	3	0	1	4	
	Scientific presentation skills	HC	1	1	0	2	All Teachers
	Immunology and Cancer Genetics	SC	4	0	0	4	
	Biostatistics and Bioinformatics	SC	4	0	0	4	
	Biodiversity	SC	3	1	0	4	Faculty from Zoology
	Human genetics	OE	3	0	1	4	

Any 8 credits of the 12 credits of the soft courses can be opted by the M.Sc.Genetics students

Semester IV 12/14

Paper code	Title of the Course	HC/SC /OE	L	T	P	Credit	Name of the Faculty
	Major Project	HC	0	2	6	8	All Teachers
	Medico-Environmental impact on Development	SC	4	0	0	4	
	Genetics of Plants and Microbes	SC	2	0	0	2	
	General and Molecular Endocrinology	SC	3	1	0	4	
	Principles of Gene cloning	OE	3	0	1	4	

Any 4/6 credits of the 10 credits of the soft courses can be opted by the M.Sc.Genetics students

UNIVERSITY OF MYSORE

SYLLABUS

M.Sc., IN GENETICS

Credit based Choice Based continuous evaluation pattern System

DEPARTMENT OF STUDIES IN ZOOLOGY
MANASAGANGOTRI
MYSORE – 570 006
2014-15

SCHEME OF THE STUDY

CREDITS MATRIX FOR M.Sc. GENETICS PROGRAM 2014-15
Credit based Choice Based continuous evaluation pattern System

SEMESTER	HARDCORE	SOFTCORE	OPEN ELECTIVE	TOTAL
I	16	04 (08)	-	**20**
II	12	06 (10)	04	**22**
III	14	08 (12)	04	**22**
IV	08	04/06 (08)	04	**12** (14/18)
	50	**22** (38)	**04** (12)	**76**

Semester I : 20 Credits

Paper code	Title of the Course	HC/SC/OE	L	T	P	Credit	Name of the Faculty
1.1	Transmission Genetics	HC	3	0	1	4	
1.2	Chromosome Genetics	HC	3	0	1	4	
1.3	Gene Structure and Function	HC	3	0	1	4	
1.4	Cell Biology	HC	3	0	1	4	
1.5	Molecular Cytogenetics	SC	4	0	0	4	
1.6	Histology and Histopathology	SC	3	0	1	4	Faculty from Zoology

Any one of 4 credits soft course can be opted by the M.Sc. Genetics students

Semester II (18**/22**)

Paper code	Title of the Course	HC/SC /OE	L	T	P	Credit	Name of the Faculty
2.1	Molecular Cell Biology	HC	3	0	1	4	
2.2	Population Genetics and Evolution	HC	3	0	1	4	
2.3	Genome Genetics	HC	3	0	1	4	
2.4	Gene Regulation	SC	4	0	0	4	
2.5	Biological Chemistry	SC	2	0	0	2	
2.6	Ethology and Wild life Biology	SC	3	1	0	4	Faculty from Zoology
2.7	Basic Genetics	OE	3	0	1	4	

Any 6 credits of the 10 credits of the soft courses can be opted by the M.Sc. Genetics students

Semester III 22							
Paper code	Title of the Course	HC/SC /OE	L	T	P	Credit	Name of the Faculty
3.1	Genetic Engineering	HC	3	0	1	4	
3.2	Genes and Development	HC	3	0	1	4	
3.3	Advanced Human Genetics	HC	3	0	1	4	
3.4	Scientific presentation skills	HC	1	1	0	2	All Teachers
3.5	Immunology and Cancer Genetics	SC	4	0	0	4	
3.6	Biostatistics and Bioinformatics	SC	4	0	0	4	
3.7	Biodiversity	SC	3	1	0	4	Faculty from Zoology
3.8	Human genetics	OE	3	0	1	4	
Any 8 credits of the 12 credits of the soft courses can be opted by the M.Sc.Genetics students							
Semester IV 12/14/18							
Paper code	Title of the Course	HC/SC /OE	L	T	P	Credit	Name of the Faculty
4.1	Major Project	HC	0	2	6	8	All Teachers
4.2	Medico-Environmental impact on Development	SC	4	0	0	4	
4.3	Genetics of Plants and Microbes	SC	2	0	0	2	
4.4	General and Molecular Endocrinology	SC	3	1	0	4	
4.5	Principles of Gene cloning	OE	3	0	1	4	
Any 4/6 credits of the 10 credits of the soft courses can be opted by the M.Sc.Genetics students							

ELIGIBILITY FOR ADMISSION TO THE POST-GRADUATE DEGREE COURSE IN GENETICS

(1)The candidates must have studied any Bachelor degree in Life science including Medicine, Pharmacy, Dental, BE in Biotechnology, Agriculture and Veterinary Sciences from any University / Institution recognized by UGC/ ICAR/AICTE/ Medical Council.

(2) The candidates must have completed bachelor degree with an aggregate of 45% marks excluding languages (Relaxable to 40% for SC & ST candidates)

Entrance Test: Compulsory. 50% marks of the entrance test and 50% marks of the bachelor degree examination excluding languages will be considered for preparing the merit list at the time of admission.

I SEMESTER

GEN - H1.1: TRANSMISSION GENETICS

Theory 48 Hrs.

UNIT 1 8 Hrs.

Introduction: Brief overview of systems commonly used in genetic studies, a) T4 phage, b) *Escherichia coli,* c) *Neurospora crassa*, d) *Saccharomyces cerevisiae,* e) *Caenorhabditis elegans*, f) *Drosophila melanogaster,* g) Mouse,h) *Arabidopsis*.

UNIT II 8 Hrs.

Mendelism: a) Brief overview of Mendels work (Law of segregation, Law of independent assortment) b) Principle of equivalence of reciprocal hybrids, c) Application of laws of probability (Product and Sum rule) d) Chi-square test and its application in analysis of genetic data e) Pattern of inheritance in haploid organisms like *Chlamydomonas* and *Neurospora.*

UNIT III 8 Hrs.

Extensions of Mendelian principles: a) Incomplete dominance b)Codominance c) Interaction of genes (Epistasis, Supressors) d) Lethal alleles e) Penetrance and expressivity f) Plieotropy g) Phenocopy.

UNIT IV 8 Hrs.

Fine structure of gene : Evolution of gene concept - Definition of factors, alleles, multiple alleles, pseudoalleles, Beadle and Tatum's One gene one enzyme concept, One gene one polypeptide concept, Complementation test, Intragenic complementation, Cistron, Recon and Muton Eg. lz gene in *Drosophila* (Lozenge gene), rII locus in T4 phage

UNIT V 8 Hrs.

A) Sex linked inheritance: In *Drosophila* and Humans, Inheritance of sex limited and sex influenced traits.

B) Linkage and crossing over: a) Concept of linkage-Experiments of Bateson and Punnet, Morgans experiment, b) Genetic recombination and construction of linkage maps in *Drosophila*, c) Interference and coincidence

UNIT VI 8 Hrs.

A) Extra nuclear inheritance: a) Organelle heredity: Chloroplast-Variegation in 4'Oclock plant and mutation in Chlamydomonas; Mitochondria-Poky in Neurospora, Petite in Saccharomyces, b) Maternal effect- Shell coiling in Limnaea, c) Infectious heredity in Paramecium (Kappa Particle).

B) Behavioural Genetics: a) Inheritance of behavioral traits, b) Nest cleaning behavior in honey bees c) circadian rhythm in *Drosophila* d) Genetic dissection of behavior using mutations in *Drosophila,* e) Genetic basis of behaviour in man.

PRACTICALS: **4X16 = 32 Hrs.**

1. Study ofmorphology of *Drosophila melanogaster , D. ananassae* and *D. nasuta* – Wing, Sex comb, Genital plate and Bristles.
2. Field trip- collection of *Drosophila* flies and categoration
3. Study of mutants of *Drosophila melanogaster* – Dominant, Recessive, Autosomal, Sex-linked and Multiple mutations, Balancers.
4. Genetic crosses and analysis of P_1, P_2, F_1, F_2& test cross progeny in *Drosophila*
   (a) Monohybrid, (b) Dihybrid, (c) Sex linked inheritance
5. Study of some of the qualitative and quantitative traits in humans.

GEN - H1.2: CHROMOSOME GENETICS

THEORY **48 Hrs.**

UNIT I **8 Hrs.**

An over view of different types of Microscopy – Light, Phase contrast, Polarization, Fluorescence, Electron and Confocal microscopy. (Visualization of cells and subcellular components by light microscopy, resolving powers of different microscopes, microscopy of living cells, different fixation and staining techniques for EM, freeze-etch and freeze-fracture methods for EM, image processing methods in microscopy).

UNIT II **8 Hrs.**

Cell division: Overview of chromosomal dynamics during (a) Mitosis (b) Meiosis (c) Amitosis (d) Endomitosis and (e) cMitosis and their significance.

UNIT III **8 Hrs.**

A) **Chromosomal theory of inheritance** – Experimental evidences, Types of chromosomes, Banding techniques, Karyotyping and its importance.

B) **Numerical variations in chromosomes**: (a) Aneuploidy – cytogenetic consequences with examples from Drosophila and Man (b) Euploidy – cytogenetic consequences. Ex. Raphanobrassica, Wheat.

UNIT IV **8 Hrs.**

Chromosomal structural rearrangements: (a) Cytogenetic implications of Deletions, Duplications, Inversions, Translocations, Centric fusion and Centric fission (b) Evolution of new Karyotypes: Ex. *Drosophila virilis* group (c) Practical applications of rearrangements: Balancers, Ring chromosomes, Attached X-chromosome in *Drosophila*.

UNIT V **8 Hrs**

Special chromosomes: a) Structural organization and significance of Polytene chromosomes b) Lampbrush chromosomes and implications of their study in genetic research c) Behaviour during cell division and Population dynamics of B Chromosomes

UNIT VI **8Hrs.**

Effects of radiations on chromosomes: (a) Types of radiations (b) Radiation detection (c) Dosimetry (d) Ultraviolet radiations and their importance (d) Ionizing radiations and their cytogenetic effects – Target theory and its modified concepts (e) Effect of radiation on health

PRACTICALS: **16x4=64Hrs.**

1. Study of Polytene chromosomes of :
   (a) *Drosophila melanogaster*
   (b) *Drosophila ananassae*
   (c) *Drosophila nasuta*
2. Study of metaphase chromosomes of
   (a) *Drosophila melanogaster*
   (b) *Drosophila ananassae*
   (c) *Drosophila nasuta*
   (d) *Drosophila albomicans*
3) Study of inversion in *Drosophila ananassae* and *Drosophila nasuta*
4) Study of meiotic chromosomes in mouse.

GEN-H1.3: CELL BIOLOGY

THEORY **48 Hrs.**

UNIT I & II **16 Hrs.**

A) Overview of Cells and their functional specialization: Prokaryotic cells – Bacteria, Mycoplasma; Eukaryotic specialized cells – Neurons, Retinal cells, gametes, blood cells, muscle cell.

B) Molecular architecture of eukaryotic cell: (a) Biomembranes –composition, structure, fluid mosaic model. (b) Basic functions: permeability, osmotic principles, carrier proteins, channel proteins, passive transport, active transport, membrane pumps, multidrug resistance transport protein, pinocytosis, phagocytosis, receptor mediated endocytosis, transcytosis, electrical properties of membranes.

UNIT III **8 Hrs.**

A) Endoplasmic Reticulum (ER): Protein secretion, targeting proteins into ER, insertion of proteins into ER membrane, export of proteins and lipids from the ER, fate of misfolded proteins.

B) Golgi complex: Ultrastructural organization, protein glycosylation within Golgi, lipid and polysaccharide metabolism in Golgi, protein sorting and export from the Golgi.

UNIT II **8 Hrs.**

A) **Mitochondria:** Ultrastructure, inner membrane, transport proteins, Electron transport chain, electron transporting complexes, P/O ratio, Q cycle, oxidative phosphorlyation, uncouplers and inhibitors, mechanism of ATP synthesis, Mitchell's hypothesis. Synthesis and targeting mitochondrial proteins. coupled reaction, group transfer, biological energy transducers.

B) **Chloroplast:** Ultrastructure, synthesis and targeting of chloroplast proteins.

UNIT III **8 Hrs.**

A) **Lysosomes:** Lysosomal acid hydrolases, mechanism of membrane resistance to lysosomal enzymes, pathways and mechanisms of intracellular digestion, lysosomal secretion/defecation, lysosomal storage diseases.

B) Microbodies and their function: Peroxisomes, Glyoxizomes, Sperosomes.

UNIT IV **8 Hrs.**

A) **Nucleus:** Structure of nuclear envelope, Nuclear pore complex, Nuclear export and import of proteins, structure and function of Nucleolus.

B) **Microtubule based organelles:** Ultrastructure and dynamics of ciliary and flagellar movement, Cytoskeleton assembly and regulation of cytoskeleton filament.

PRACTICALS: **16x4 =64 Hrs.**

1) Visit to University IOE lab and learning the principles, working methods and applications modern instruments
2) Study of different cell types
3) Measurement of cells
4) Study of meiotic chromosomes in grasshopper.
5) Study of meiotic anomalies
6) Staining and study of cell organelles.
7) Effect of membrane modifying agents on erythrocyte membrane.
8) Study of translocations (Rheo/Cockroach/Scorpion)

GEN-H1.4: GENE-STRUCTURE AND FUNCTION

THEORY **48 Hrs.**

UNIT I **8 Hrs.**

Nucleic acids:

A) Nucleic acids store and convey genetic information – Experiments of Griffith, Avery, MacLeod and McCarty, Hershey and Chase, and Fraenkel Conrat.

B) Overview of structure of nucleic acids, Properties of nucleic acid - Tm, Cot curve, Chargaff's rule, nearest neighbour base frequency analysis, Double Helix, Biosynthesis of nucleic acid.

C) Forms of DNA, DNA bending, supercoiling, repetitive sequences, palindromic sequence.

D) Structure of rRNA and tRNA (clover leaf model, stem loop, cruciform)

UNIT II **8 Hrs.**

Replication of DNA:(a) Patterns of replication: Experiments of Messelson and Stahl, Taylor (b) Enzyme and non enzyme components of replication machinery (c) Replication process: i) Initiation of replication process: Origin of replication in Prokaryotes and Eukaryotes, Regulation of initiation in relation to cell division. ii) Elongation: coordinated synthesis of Leading and Lagging strands. iii) Termination: End replication problem-Protein priming in viruses, telomerase in eukaryotes (d) Fidelity in replication: Selection, proof reading, mismatch repair**.**

UNIT III & IV **16 Hrs.**

A) Mutability of DNA and Repair:(a) Factors causing post replicative DNA damages-intrinsic and extrinsic. (b) Repair of DNA damages: (i) Direct reversal of DNA damages: Photoreactivation, Alkyl transferases (ii) Excision repair: Nucleotide excision-Uvr ABC system, Base excision and AP nuclease pathway (iii) Transcription coupled repair (iv) SOS repair (v) Translesion synthesis.

B) Recombination:(a) Homologous recombination : (i) Models of Recombination - Holliday model, Meselson and Radding's Model, Double strand break model (ii)Genetic consequence of homologous recombination*.* (iii) Protein Machinery of homologous recombination.

UNIT V **8 Hrs.**

Transcription: (a) cis components-promoter, enhancers, operator, silencers (b) RNA polymerases (c) Transcription mechanism-Initiation, Elongation and Termination in Prokaryotes and Eukaryotes (d) Post transcriptional modifications of transcripts (i)Prokaryotes: mRNA, rRNA, tRNA. (ii) Eukaryotes: mRNA (G-cap, Poly-A tail, Splicing – Reliable recognition of splice sites, ESE sequences, SR proteins, RNA editing), rRNA and tRNA splicing.

UNIT VI **8 Hrs.**

Translation:(a) Genetic code: genetic and biochemical analysis of genetic code, features of Genetic code, *evolution of genetic code.* (b) Ribosomes: Molecular

anatomy and regulation of ribosome biogenesis (c) Enzymes of translation: AminoAcyl tRNA synthetase, Peptidyl transferase (d) Translation process and factors: initiation, elongation (selection against incorrect Amino Acyl tRNA), and termination (e) Translation dependent regulation of mRNA & protein stability (Posttranslational modification of proteins).

PRACTICALS: **16X4 =64 Hrs.**

1) Estimation of DNA by Diphenylamine reaction.
2) Estimation of RNA by Orcinol reagent.
3) Thin layer chromatography: Eye pigments in *Drosophila*
4) Paper Chromatography of amino acids.
5) Study of isozymes/proteins by native/SDS Polyacrylamide gel electrophoresis
6) PCR amplification of DNA (Add)

GEN – S 1.5: MOLECULAR CYTOGENETICS

THEORY **64 Hrs.**

UNIT I & II **16 Hrs.**

A) Mutations: (a) Key concepts (b) Forward mutations: (i) at DNA level – Transition & Transversion (ii) at protein level – silent, synonymous, missense, nonsense, frameshift mutations. (c) Reverse mutations: (i) Exact reversion (ii) Equivalent reversion (d) Intragenic suppressors: (i) Frameshift of opposite sign and second site within a gene (ii) Second site missense mutation (e) Extragenic suppression: (i) Nonsense suppression (ii) Missense suppression (iii) Frameshift suppression (iv) Physiological suppression. (f) Lethal mutation (g) Loss of function mutation (h) Gain of function mutation (i) Amorphic, hypomorphic and isoallelic mutations.

B) Chemical mutagens: (a) Base analogues (b) Nitrous acid (c) Hydroxylamine (d) Hydrazine (e) Alkylating agents (f) Detection of mutations – (i) Bacteria: replica plating technique, Ames test (ii) *Drosophila*: Sex-linked recessive lethals, autosomal recessive lethals, dominant lethal test (iii) Small mammals: Micronucleus test, dominant lethal assay, Host mediated assay.

UNIT III **8 Hrs.**

A) Molecular organization of Eukaryotic chromosome - Nucleosomes, Telomeres, Kinetochore, Centromere, Histone and Non-Histone proteins
B) Heterochromatin - Constitutive and facultative heterochromatin- Properties and functions. .

UNIT IV & V **16 Hrs.**

A) Molecular Mechanisms of cell division.
B) Molecular Regulation of cleavage.
C) Molecular organization of centrosome and spindle.
D) Dynamic instability of microtubules during metaphase and anaphase.
E) Role of Motor proteins and segregation of chromosome.

F) Molecular interaction and regulation of male and female reproductive cells
G) Molecular basis of cell migration and Cell affinity.

UNIT VI **8 Hrs.**

Imprinting of Genes, Chromosomes and Genomes: (a) Definition, Exception to the principle of equivalence of reciprocal hybrids (b) Pronuclear transplantation experiments in mouse (c) Uniparental chromosomal disomies in mouse (d) Human triploids (e) Sex determination in Coccids (f) X-chromosome inactivation in Marsupial females (g) Molecular mechanisms.

UNIT VII & VIII

Sex determination and dosage compensation **16 Hrs.**

a) Chromosomal basis of sex determination**:** (a) Simple systems: Eg: XX/XY, XX/XO, ZZ/ZW (b) Multiple systems: Ex. *Paratylotropidia,Drosophila*, Heteroptera and Homoptera (c) Parthenogenesis: Ex. Honey bees and wasps. d) Chromosomal and Molecular basis of sex determination in *C elegans*, *Drosophila* and Man*.* e) Molecular basis of dosage compensation in *C elegans*, *Drosophila* and Man*.*

GEN – S 1.6 Histology and Histopathology

Theory **48 Hrs.**

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1) Alberts, B, Johnson, J Lewis, M. Raff, K Roberts and P. Watter. 2008. Molecular Biology of the cell . Garland Science, New York.
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3) Hollander A (Editor) 1971-76 Chemical mutagens: Principles and Methods of their detection. Vols. 1-3, Plenum Press New York.
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5) Snustad D P, M J Simmons and J P Jenkins, 1997. Principles of Genetics. John Wiley and Sons, INC.
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II SEMESTER

GEN – H 2.1: MOLECULAR CELL BIOLOGY

THEORY **64hrs**

UNIT I **16Hrs.**

A) Eukaryotic cell cycle & its regulation:a) Phases of cell cycle b) Regulation: (i) Check points (ii) cell intrinsic core regulators of checkpoints- Cyclins and Cdks, CAKs, CKIs, MPF, APC. and regulation at check points (Add) (iii) Cell intrinsic mediators of regulation- Activators (myc, Ras), Inhibitors (Rb, DNA damage P^{53} dependent and independent inhibitors) (iv) Extracellular signals –Growth factors (mitogens, contact inhibition, cell anchorage) c) Specific regulators at Meiosis, regulation of oocyte meiosis.

Unit II **16hrs**

A) Cell death :1.) **Programmed** Apoptosis v/s necrosis b) Discovery of cell death genes in *C.elegans*& homologous pathway in mammals c) Caspases – action, inhibition by Survival signals (Trophic factors, neurotrophins) and activation by death signals (TNF, Perforin/granzyme pathway, Mitochondrial permeability). 2) **Alternative Cell Death Mechanisms** (Autophagic, Necroptosis, Shedding, Cornification, Entosis) and significance

UNIT III **16 Hrs.**

A} Cellular interactions: a)**Cell junctions** – Occluding (tight, septate), Anchoring (Adherens, focal adhesion, desmodomes) Communicating (gap, plasmodesmata), c) Cell adhesion – CAMs, Cadherins (Ca + dependent) NCAMs (Ca+ independent) cell adhesion.

B) Cell-Cell signaling –concept ofquorum sensing, endocrine, synaptic, autocrine, cellular response to signalling molecules (specificity, concentration, memory), Nitric Oxide signaling. Cell Surface receptors: a) G-protein linked-structure, mechanism, Cyclic AMP mediated b) Enzyme linked -Receptor tyrosine kinases c) signaling through regulated proteolysis - Wnt-β catenin pathway. d) Synaptic signaling - Signaling at neuromuscular junction (transmitter gated ion channels, spatial and temporal summation).

PRACTICALS: **16X4 =64 Hrs.**

1) Determination of blood glucose in clinical samples
2) Determination of serum cholesterol in clinical samples
3) Studies on sperm viability and abnormality in Rat by using Eosin stain.
4) Studies on apoptosis by using DNA ladder assay
5) Immunodiffusion/Radial immunodiffusion
6) Isolation of mono nuclear phagocytes.
7) Study of selective permeability of the plasma membrane using an artificial membrane
8) Differential centrifugation using rat liver extract

GEN – H 2.2: POPULATION GENETICS AND EVOLUTION

THEORY **48 Hrs.**

UNIT I &II **16 Hrs.**

Evolutionary theories: a) Overview of history and evolutionary thought b) Lamarckism and its limitations c) Darwinism and its limitations d) Mendelian and Biometrician controversy e) Population Genetics and Birth of NeoDarwinism: (i) Mendelian Population (ii) Gene pool (iii) Allele frequencies and genotype frequencies (iv) Hardy-Weinberg Genetic equilibrium and its Applications f) Evolutionary forces that affect the allelic frequencies- (i) Mutation (ii) Migration (iii) Selection – Stabilizing selection, Directional selection, disruptive selection, Balancing selection, Frequency dependent selection, Density dependent selection, Group and kin selection, Selection coefficient, Selective value, Selection in natural populations (iv) Genetic drift (v) Nonrandom mating.

UNIT III **8 Hrs.**

A) Inbreeding and Heterosis: (a) Measurement of inbreeding -inbreeding coefficient, Panmictic index (b) Inbreeding pedigree (c) Assortative and Disruptive mating (d) Heterosis- examples and mechanism.

B) Human evolution: Anatomical, Geographical and Cultural evolution of *Homo sapiens*, Peopling of continents (Europe, Africa, Asia).

UNIT IV **8 Hrs.**

Isolating mechanisms: Classification – (a) Geographic isolation (b) Reproductive isolation – (i) Premating isolation – Climatic, Seasonal, Habitat, Ethological (ii) Post mating isolation – gametic mortality, zygotic mortality, Hybrid inviability, Hybrid sterility, Hybrid breakdown (c) Origin of reproduction isolation – Muller's view, Dobzhansky view.

Unit V **8 Hrs.**

Speciation: (a) Species types and Species categories (b) Concepts of species (c) Models of speciation (d) Based on distribution- sympatric, allopatric, stasipatric (e) Based on genetic drift – Genetic revolution, Genetic transilience, Founder-flush theory (f) Hybridization and speciation (g) Phyletic gradualism and punctuated equilibrium (h) Molecular aspect of speciation -speciation genes.

UNIT VI **8 Hrs.**

Molecular Evolution: (a) Patterns of change in nucleotide and amino acid sequences (b) Molecular clock (c) Neutral theory of molecular evolution (d) Conversion of genetic distance into divergence time (e) Emergence of Non-Darwinism.(f) Kinds of molecular data used in phylogenetic analysis (g) Phylogenetic considerations based on nucleotide and amino acid data (h). Construction of phylogenetic tree.

PRACTICALS: **16X4 = 64 Hrs.**

1) Study of few examples of analogous and homologous organs.
2) Experiments on genetic drift - Population size, sampling error.
3) Experiments on natural selection, male selection and female selection.
4) Study of Quantitative characters: Sternoplurals - mean, standard deviation.
5) Study of population genetics problems.
6) Studies on sympatric species
7) Construction of dendrograms using different species data set.
8) Mating behavior in *Drosophila*

GEN – H 2.3: GENOME GENETICS

THEORY **48 Hrs.**

UNIT I &II **16 Hrs.**

Organization of genomes:

A) Introduction: Genome, Genomics, Omics and importance

B)Prokaryotes - Bacteriophages, Bacteria, Viruses

C) Eukaryotic organelle genomes - Chloroplast and Mitochondria

D) Eukaryotic nuclear genomes (General features, C-value paradox, types of coding and noncoding sequences and Split Genes)

E) Mobile genetic elements in Prokaryotes (bacteria) and Eukaryotes (*Drosophila,* maize and humans).

UNIT III **8 Hrs.**

Mapping genomes:

A) Genetic mapping – i) Cross breeding and pedigree analysis, ii)DNA markers - RFLPs, SSLPs, SNPs

B) Physical mapping - Restriction mapping, Fluorescent *in situ* hybridization, Radiation hybrid mapping and Sequence tagged site mapping.

UNIT IV &V **16 Hrs.**

Genomics:

A) Genome projects: The Human genome project, HapMap Project, The 1000 genome project, and The ENCODE Project.

B) Structural genomics:Assembly of a contiguous DNA sequence- shotgun method, clone contig method, and whole –genome shotgun sequencing

C) Understanding a genome sequence: locating the genes in a genome sequence, determining the functions of individual genes and by studying the activity of a protein coded of an unknown gene

D) Functional genomics:Study of transcriptome (By sequence analysis, and Microarray analysis) and Proteome – (Protein profiling - 2DGE, HPLC, MALDI, Mass Spectrophotometry, Interacting proteins by phage display and Yeast two hybrid system).

E) Comparative genomics of Bacteria, organelles and eukaryotes (Human, *Drosophila*, Yeast, *Arabidopsis*, *Caenorhabditiselegans*)

UNIT VI **8 Hrs.**

Pattern of genome evolution:

a) The origin of genomes- Origin of macromolecules, RNA worldandDNA world

b) Acquisition of new genes (By gene duplication) and Gene families – (Types, Pseudogenes, Origin of gene families (lateral gene transfer, allopolyploidy)

c) Synthetic genomes and their applications

PRACTICALS: **16X4 =64 Hrs.**

1) Genetic mapping byRFLP analysis.

2) Physical mapping of bacteriophage genome / recombinant DNA clone/plasmid genome byRestriction mapping.

3) Homology sequence analysis using Blast(Blast n, Blast p, Blast x), Fasta, Flavours

4) Identifying gene features through DNA sequence analysis and primer designing.

5) Multiple sequence alignment and phylogenetic tree construction.

6) Whole genome sequence analysis using software.

7) Protein 3D structure visualization by Rasmol

8) Performing protein 3D structure modeling using a template.

GEN - S2.4: GENE REGULATION

THEORY **64 Hrs.!!**

UNIT I **8 Hrs.**

A. Introduction, Inducible and repressible systems, House-keeping genes, Levels of control of gene activity.

B. Transcriptional control in Prokaryotes: The Operons - Lactose operon (Allosteric control), Arabinose operon - Positive and negative control, Galactose operon - Alternate start points.

UNIT II **8 Hrs.**

A. Regulation beyond transcription initiation, premature termination of transcription - Tryptophan operon (*trp* attenuator) and Histidine operon (*His* attenuator).

B. Cis acting elements and Transacting factors: Structural and functional motifs,Helix-turn-Helix, Helix-loop-Helix. C. Regulation in Lambda Phage - Lytic and lysogenic cycle induction (Logic of lambda), Autoregulation. D. i) Ribosomal proteins as translational repressors (ii) rRNA-nucleotide sensing system (iii) Riboswitches.

UNIT III **16 Hrs.**

A) **Gene regulation in eukaryotes:** Basic considerations, Britten and Davidsons model, Transcription factors, Response elements, Structural domains and motifs - Leucine Zipper and Zinc finger motifs, HLH and HTH motifs.

B) Transcriptional activators: Recruitment of different transcription machinery proteins by activators, Activators recruit neucleosome modifiers and insulators, Activators work in combinatorial way (eg. Human B interferon, Yeast Mating type switching).

C}Transcriptional repression : Mechanism - Competition, inhibition, direct repression, indirect repression

UNIT IV **8 Hrs.**

Gene Regulation by Chromatin remodeling: Histone & DNA modifications , (acetylation, deacetylation, methylation, Histone phosphorylation, 'Histone Code') chromosome condensation by condensins. ,Gene silencing by heterochromatinization (telomeric effect). Differential gene regulation by Polycomb and Trithorax proteins

UNIT V **8 Hrs.**

Regulation after transcription initiation: A)Alternative mRNA splicing Mechanism and its significance eg *sxl* gene, B) Translational control as in (i) rRNA/GcN4, (ii) Ferritin and transferrin mRNA, c)RNA interference miRNA and siRNA d) mRNA localization &translational regulation during development.

UNIT VI **16Hrs.**

Epigenetics : a) Introduction to concept and definition of Epigenetics and Epigenetic Memory, Epigenetic Landscape

b) Imprinting of Genes, Chromosomes and Genomes: (i) Pronuclear transplantation experiments in mouse (ii) Sex determination in Coccids

c) Molecular basis of epigenetics – (i)DNA methylation , Histone modifications, Non-coding RNAs, eg. X-chromosome inactivation in mammals (ii)Epigenetics and diseases (Syndromes, infections, cancer), (iii) Epigenetic reprogramming (mammals) Epigenome, Epigenotypes

GEN S2.5: BIOLOGICAL CHEMISTRY 32 Hrs

UNIT I **8 Hrs**

Principles of Biochemistry:

a) Structure of atoms, molecules and chemical bonds,

b) Stablizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction).

c) Principles of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics, colligative properties).

UNIT II & III **16 Hrs**

a) Carbohydrates: i) Overview of Classification, Stereochemistry – D and L, anomer, epimer, chair and boat conformations ii) Digestion of carbohydrates – role of amylases, gluconeogenesis iii) Pathways of degradation of monosaccharides (glycolysis, pentose phosphate pathway, TCA cycle).

b) Proteins : i) Overview of Classification of amino acids, structure and properties of peptide bond ii) Over view of structure and classification of proteins (a) primary structure- Determination of protein sequence, Types of bonding, determination of S.S. bond position, Anfinsen's experiment, (b) Secondary structure – α helix, β sheet and β bend, Prediction of secondary structure of proteins, Chou and Fasman algorithm, Helix forming amino acids, Helix breakers (c) Tertiary and quaternary structures – Myoglobin and hemoglobin iv) Pathways of degradation of protein**:**, Proteases, general catabolic reactions of amino acids – decarboxylation, deamination, transamination, Ubiquitination,.

c) Lipids: Structure of Fatty acids – essential fatty acids, Triacyl glycerols, phospholipids, Liposomes. Pathways of lipid degradation – lipases and phospholiphases, β- oxidation pathway.

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Unit IV **8 Hrs.**

a) Enzymes: IUB - nomenclature, classification, Localization, isolation, purification and characterization ii) Enzyme kinetics- - (In brief) enzyme assay, kinetic assay, coupled assay, end-point assay, Michaelis - Menten equation (Derivation not necessary) Vmax and Km and their determination by Lineweaver, Nature of active site of enzymes, factors affecting catalyses Ex - Aspartyl transcarbamylase as an allosteric enzyme iii) Isoenzymes Ex. LDH iv) Regulation of enzyme activity – feed back regulation.

b) Hormones: classification, mechanism of action of group I and II hormones, Hypothalamic and pituitary hormones, thyroid hormones, Adrenal gland hormones and hormones of gonads

GEN- S 2.6: ETHOLOGY AND WILD LIFE BIOLOGY

(From Zoology Faculty)

GEN- OE2.7: BASIC GENETICS

THEORY **48 Hrs.**

UNIT I **8 Hrs.**

Rules of Inheritance:-Milestones in genetics, levels of genetics (classical, molecular and population) Mendelian genetics, Mendelian laws of inheritance – Monohybrid and dihybrid cross, Examples In pea plants, Drosophila and human,

Test cross, Patterns of inheritance, Probability of inheritance – Punnet's Square, concept of gene – past and present.

UNIT II **8 Hrs.**

Chromosomes as genetic material:- Structure and types of chromosomes, Chromosome theory of inheritance, Mitosis, Meiosis, polytene chromosome, endoreduplication and puffing

UNIT III **8 Hrs.**

DNA as the genetic material -Experimental evidences, Structure and types of DNA, DNA replication – semiconservative replication, origin and units of replication, proof reading; gene expression:transcription, genetic code, translation: mechanism, post–translation modifications; DNA recombination: concept and models.

UNIT IV **8 Hrs.**

Genome organization - i)**Prokaryotes** - Bacteriophages, Bacteria, Viruses; ii) **Eukaryotic nuclear genomes:** General features,C-value paradox, types of coding and noncoding sequences and Split Genes iii) **Eukaryotic organelle genomes** - Chloroplast and Mitochondria iv) **Jumping genes**: Mobile genetic elements in Prokaryotes (bacteria) and Eukaryotes (*Drosophila,* maize and humans).

UNIT V **8 Hrs.**

Genetic basis of heritable change – Mutation and its effects, Forward mutations: - at DNA level and) at protein level, Reverse mutations, Loss of function mutation,Gain of function mutation, Classification of chromosomes and Karyotyping, chromosomal variations – types with relevant examples, Chromosomal syndromes with examples, Genetic basis of evolution; NeoDarwinism: concept, Hardy-Weinberg law of genetic equilibrium and destabilizing forces: (i) Natural selection (ii) Mutation (iii) Genetic drift (iv) Migration (v) Meiotic drive, micro- and macroevolution, punctuated equilibrium.

UNIT VI **8 Hrs.**

Animal development – Basic concepts of development, Embryogenesisand Genes involved in early development in *Drosophila,* Genetics of imagnal discs and transdetermination, **Basic body axis formation -***Drosophila* (Anterior/posterior, terminal group genes, Dorso/ventral axis) **Evolution of body plan** - Levels of organization, Body symmetry, Differentiation of germ layers, Formation of body cavities, Segmentation, Cephalization, Limb formation..

Practicals **16X4 =64 Hrs.**

1) Study of polytene chromosomes of *Drosophila melanogaster.*
2) Study of mutants of *Drosophila melanogaster*
3) Dissection and mounting of Imaginal discs of *Drosophila.*
4) Study of Quantitative characters: Sternoplurals and acrostichals of *Drosophila*.
5) Isolation of cellular DNA by rapid method.
6) Demonstration ofmonohybrid, dihybrid and sex linked inheritance

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III SEMESTER

GEN - H3.1: GENETIC ENGINEERING

THEORY **48 Hrs.**

UNIT I & II **16 Hrs.**

Principles of Genetic Engineering:a) Historical account, Definition and Objectives, b) Components of gene cloning - Nucleic acids (principles of isolation, purification and quantification), DNA modifying enzymes (Restriction and modification enzymes, Other nucleases, Polymerases, Ligase, Kinases and Phosphatases), Cloning vectors (Plasmids, Phages, Cosmids, Artificial chromosomes and Expression vectors) and Cloning hosts (*E. coli, Saccharomyces,* Plant and animals cells), c) Gene transfer (Physical, microinjection and vector mediated methods) and cloning methods (Directional cloning and TA cloning methods), d) Gene Screening and isolation - Strategies, DNA libraries (Genomic DNA, cDNA and expression libraries), Probe Selection and labeling, Hybridization (principles of hybridization) gene screening (colony, plaque, dot, northern, Southern blot screening, antibody screening)

UNIT III & IV **16 Hrs.**

PCR and DNA sequencing: a)PCR – Principle, Methodology, Types - RT-PCR, RAPD, AFLP, ISSR, inverse PCR and Real time PCR and their applications. b) DNA sequencing methods - Maxam and Gilbert's method, Sanger's method, Automated DNA sequencing method, Capillary gel electrophoresis for DNA sequencing and NGS recent methods of DNA sequencing and their applications.

UNIT V **8 Hrs.**

DNA Engineering techniques: a) Gel electrophoresis of nucleic acids (agarose, pulse-field) b) Blotting of macromolecules and hybridization, c) Oligonucleotide synthesis, d) Promoter characterization, e) DNA fingerprinting, f) Site directed mutagenesis, g) *In vitro* translation (*E.coli*, wheat and reticulocytes).

UNIT VI **8 Hrs.**

Applications of Genetic Engineering: a) Production of Transgenic organisms, b) Human health (Production of vaccines, biomolecules, diagnostic kits and molecular medicine) c) Biosafety d) Intellectual Property Rights (patenting, trade secrets, copy right, trade and their regulations) e) Risks and ethics of GMO products.

PRACTICALS: 16X4 =64 Hrs.

1) Demonstration of instruments & calculations for making of stock andworking solutions.
2) Isolation of DNA from Blood (Human) and Tissue (Drosophila) by phenol-chloroform extraction method
3) *In vitro* DNA synthesis by PCR method and cloning by TA cloning method (Ligation, competent cell preparation andTransformation).
4)Isolation of recombinant DNA, Restriction digestion, electrophoresis and demonstration of southern blotting.
5) Isolation of Blood mRNA, quantification, cDNA conversion and quantification of the expression of any known gene.
6) Demonstration and interpretations of Reading of DNA sequences.
7) Expression of recombinant proteins and gel electrophoresis

GEN – H3.2: GENES AND DEVELOPMENT

THEORY 48 Hrs.

UNIT I 16 Hrs.

A) Introduction: a) Issues in developmental Biology b) Mechanisms regulating developmental process (i) morphogenetic determinants (ii) Cell Cell Interaction
Pattern Formation: Cell aggregation and differentiation in Dictyostelium (delete); a) Laying down the primary body axis- i) *Drosophila* (Anterior/posterior, terminal group genes, Dorso/ventral axis) ii) Amphibians (Dorso/ventral) iii) Left –right axis in mammals. b) Segmentation genes: Gap genes, Pairule genes, Segment polarity genes in *Drosophila*. c) Homeotic Selector genes in flies, mammals (Hox code).

Unit II 16hrs

Morphogenesis: a)Gastrulation: Morphogenetic movements and selective affinities of cells (b) Molecular regulators of mesodermal migration (fibronectin) **(Addition)**
b)Neurogenesis i). Notch signaling- a skin/nerve regulatory switch in flies. ii). Axonal path finding: Attractants and repulsive signals – (long range and short range), Target selection and forming the synapse. Retinal axon pathfinding c) (i) mesoderm patterning (ii) vertebrate heart development

UNIT III 16 Hrs.

A) Limb development: i) limb bud formation & specification (FGF, Hox, Tbx, genes, retinoic acid) ii) Digit formation- A/P axis specification and ZPA, Cell death in digit formation.

B) Metamorphosis and Regeneration: a) Molecular mechanism of ecdysone action-cellular choice between apoptosis and differentiation. b) Molecular responses to thyroid hormone during metamorphosis (Amphibians). c) Blastema formation and differentiation during regeneration.

C) Developmental mechanisms of evolutionary changes a) Genetic mechanisms- Heterotopy, Heterochrony, Heterometry, Heterotypy. b) Homologous genetic pathways of development

PRACTICALS: 16X4 =64 Hrs.

1. Live observation of *Drosophila* embryogenesis.
2. Dissection and mounting of Imaginal discs of *Drosophila.*
3. Study of gene expression during development with lac-Z reporter gene in Embryos.
4. Reporter gene Lac-Z expression in imaginal discs.
5. Targeting gene expression to different tissues using Gal4-UAS system.
6. Study of homeotic and maternal effect mutations.

8) Observation of GFP tagged reporter expression in embryos, imaginal disc and others.

GEN – H3.3: ADVANCED HUMAN GENETICS

THEORY 48 Hrs.

UNIT I 8 Hrs.

Genetic mapping of Mendelian traits:(a) History of human genetics, Pedigree, Pattern of inheritance. (b) Identifying recombinants and non-recombinants in pedigrees (c) Somatic cell fusion, cell hybrids and Radiation hybrids, (d) Genetic and physical map distances, (e) Two-point mapping - LOD score analysis (f) Multipoint mapping (g) Homozygosity mapping.

UNIT II 8 Hrs.

Genetic mapping of complex traits:(a) Difficulties in mapping complex traits (b) Allele sharing methods- Affected sib pair analysis (c) Allelic association mapping (d) Linkage disequilibrium mapping e) Transmission disequilibrium test (f) Whole genome scan and mapping (g) Integration of Cytogenetic, genetic and physical maps.

UNIT III &IV 16 Hrs.

Genetic basis of syndromes and disorders:Monogenic diseases (Cystic fibrosis and Marfan syndrome), b) Inborn errors of metabolism (Phenylketonuria and Mucopolysaccharidosis), c) Neurogenetic disorders (Charcot-Marie-Tooth syndrome and Parkinson disease), d) Genetic disorders of Haemopoetic systems (Sickle cell anemia and Thalassemias), e) Genetic disorders of eye (Retinitis pigmentosa, Glaucoma and Cataracts), f) Muscle genetic disorders (Duchenne and Becker Muscular Dystrophy), g) Genome imprinting syndromes (Prader-Willi & Angelman syndromes, Beckwith-Wiedeman syndrome, h) Genetic disorders in skeleton and skin, i)) Congenital heart diseases, j) Learning disorders, k) Genetics of Infertility, l) Cognitive disabilities, Schizophrenia and Anxiety disorders, m) Complex syndromes (Atherosclerosis, Diabetes mellitus, Rheumatoid Arthritis), n) Mitochondrial syndromes.

UNIT V &VI **16 Hrs.**

Diagnosis, Counseling, Therapy and Ethics: a) Prenatal diagnosis: (i)Noninvasive methods - radiation, Ultrasonography and Fetal echocardiography (ii) Invasive methods- Maternal serum screening, Amniocentesis,Chorionic villus sampling andFetoscopy, b)Technology in reproductive assistance c)Genetic counseling: Definition, Components, Psychotherapeutic counseling, Decision making, risk assessment and counseling in Mendelian and multifactorial syndromes, d) Gene therapy, e) Management of genetic disorders, f) Models of eugenics, human right, human genetics and legal, social and ethical considerations.

PRACTICALS: **16x4 = 64 Hrs.**

1) Barr body and Dermatoglyphics analysis
2) Creation of pedigrees and study on patterns of inheritance
3) Induction of Human leukocyte culture,Preparation of Human chromosomes and G banding
4) Karyotyping of normal chromosomes and syndromes
5) Studies on phenotypes of different diseases and syndromes
6) DNA Isolation from Blood, quantification, PCR amplification and molecular diagnosis of genetic diseases
7) DNA fingerprinting by PCR
8) Study of Cancer cells

GEN – H 3.4

SCIENTIFIC PRESENTATION SKILLS **32 Hrs.**

Theory **16 Hrs.**

Unit I **16 Hrs.**

A) Scientific Report writing

How and when to write,the first draft, revision and when to finish, Different types of science writing, The parts of a research paper- Title, Keywords, Classification Numbers, Authors, Affiliations, Abstract, Table of Contents, Introduction, Methodology, Results, Discussion, Conclusions, Data illustrations (Tables, Figures, Photographs, Schemes etc), Acknowledgements, Appendices; References, Footnotes and Endnotes, Bibliography, Structures of other types of science writing, Tips for writing

B) Presentations skills

Presentation Technology- Styles of presentation; Generation of Presentation Components of effective Preparation - Story telling principles; Rehearsal Techniques, Establishing connection with the audience: P3 principle; Role of Enthusiasm; Emotion;Humor; Sustain with pace & participation, How to End on a Powerful note: need to summarize; Importance of Questions and Answers session, Concept of Continuous improvement through persistence.

Unit II
Seminar presentations by all the students **16x 4 Hrs.**
Evaluation by all faculty

GEN-S3.5: CANCER AND IMMUNO GENETICS

THEORY **64 Hrs.**

UNIT I **8 Hrs.**
Overview and Cells of the Immune system: (a) Historical account (b) Types of immunity - Innate immunity: Anatomic barriers, Physiologic barriers, Phagocytic barriers, Microbial antagonism, Inflammation, PRRs, TLRs and PAMPs. Acquired immunity: Naturally acquired and artificially acquired (c) Humoral and cell mediated immunity (d) Complement system: components, activation and biological consequences.

UNIT II **8 Hrs.**
Tissues of immune system: primary and secondary lymphoid organs. Biology of cells of the immune system: Hematopoesis, Stem cells, NK cells, Macrophages, T Lymphocytes, B-Lymphocytes, Dendritic cells.

UNIT III **8 Hrs.**
Antigens, and Immunoglobulins: (a) Factors influencing immunogenicity (b) Haptens (c) Classes of immunoglobulins (d) Structure of IgG (e) Kinetics of immunoglobulin synthesis (f) Genetic basis of immunoglobulin diversity (g) MHC molecules – Types and structure, (h) Clonal selection and immunological memory (i) Antigen recognition – exogenous pathway, endogenous pathway, cross presentation.

UNIT IV **8 Hrs.**
Vaccines: Principles of vaccination, primary and secondary responses, antibody engineering, Monoclonal antibodies and their applications, antigen-antibody interactions, congenital and acquired immunodeficiency. Autoimmunity and autoimmune diseases, Hypersensitivity. Detection of antigens/molecules using ELISA, RIA, western blot.

UNIT IV **8 Hrs.**
Biology of Neoplasm: (a) Development and causes of cancer: types of cancer, development of cancer, causes of cancer, properties of cancer cells, transformation of cells in culture (b) Tumor viruses: Hepatitis B Viruses, SV40 and Polioviruses, Papilloma viruses, Adenoviruses, Herpes viruses, Retroviruses.

UNIT V **8 Hrs.**
Genetics of cancer: Genetic rearrangements in progenitor cells, (a) Oncogenes: Retroviral oncogenes, proto-oncogenes, oncogenes in human cancer, functions of

oncogene products (b) Tumor suppressor genes: Functions of tumor suppressor gene products, roles of oncogenes and tumor suppressor genes in tumor development (c) Cancer as a multistep process (d) Cancer therapy: early detection and prevention, molecular diagnosis, treatment. virus-induced cancer, metastasis, cancer cell lines, interaction of cancer cells with normal cells

UNIT VI **8 Hrs.**

Cancer Treatment: present and Future, Cancer therapy: Current Therapies
Therapies based on understanding the Loss of Cell cycle control and Genetic instability of cancer cells. New Therapies, immunotherapy, gene therapy, Rational tailored medical treatments. Cancer drugs.

GEN - S3.6: BIOSTATISTICS AND BIOINFORMATICS

THEORY **64 Hrs.**

UNIT-I **16 Hrs.**

Biostatistics : Measures of central tendency: Mean, Median, Mode. Measures of dispersion: Range, Mean deviation, Variance and Standard deviation. probability distributions (Binomial, Poisson and normal); Sampling distribution; Difference between parametric and non-parametric statistics; Heritability, measurement of variability; Hypothesis Testing: Errors level significance, Confidence Interval Tests based on student t , F and Chi-square (x2), Analysis of Variance: one way and two way, Ancova, Correlation and regression: Correlation, Correlation coefficient, Univariate and Multivariate analysis, Simple linear regression, Logistic regression, Computational statistical analysis (SPSS).

UNIT-II **16 Hrs.**

Databases: Introduction to Bioinformatics Databases, Importance of databases, Nucleic acid Sequence databases, NCBI, EBI, DDBJ. Protein Sequence Databases, UNIPROT, SWISS-PROT, PIR. Structure Databases, PDB. Bibliography Databases - PUBMED. Secondary Databases.CATH, SCOP, PRODOM, PROSITE, introduction to sequence submission seawares webin, seqin, sakura. genome databases, proteomic databases. Metalobalomic Databases.
Predictive methods using DNA sequences. Introduction to Bioinformatics software's. Gene prediction Strategies. Gene prediction programs. ORF Mapping, CpG Plot, Primers, Primer Designing, Restriction Enzyme digestion, Expressed sequence tag,,
Predictive methods using Protein sequences, Protein prediction strategies, Secondary structure prediction, Posttranslational modifications, Proteolytic enzyme digestion, helical wheel, and protein expression analysis. Identifying domains, Protein function prediction.

UNIT III **16 Hrs**

Protein structure and Modeling: Protein Structure prediction, Intrinsic Tendency of Amino Acids to Form β Turns. Molecular Visualization, Pdb File Format, RASMOL Display Styles Wire Frame. Ball And Stick, Space Fill, Ribbons, Cartoons. Homology modeling, Three- Dimensional structure prediction, comparative modeling, Construction of initial model, refining the Model, Manipulating the model.

Structure based drug designing: Introduction to basic concepts, Molecular recognition by receptor and ligand design, Generation of Rational Approaches in Drug design, Introduction to drug designing, Discovering a drug, Target identification and validation, Identifying the lead compound, Optimization of lead compound.

Docking methods: Introduction, three dimensional description of binding site environment and Energy calculation, Automatic Docking Method, Three Dimensional database search Approaches, Automated structure Construction methods, . AUTODOCK, Argos Lab,

UNIT IV **16 Hrs**

Demonstrations: EMBOSS, ORF FINDER,RASMOL SPDBV, AUTODOCK, ARGOS LAB, EXPASY SERVER PROTEOMICS AND DRUG DESIGNING SOFTWARES.

GEN –OE3.6: HUMAN GENETICS

THEORY **48 Hrs.**

UNIT I **8 Hrs.**

Basics of human genetics:

(a) History of human genetics, Pedigree, Pattern of inheritance. (b) Identifying recombinants and non-recombinants in pedigrees (c) Somatic cell fusion, cell hybrids and Radiation hybrids, (d) Genetic and physical map distances, (e) Two-point mapping - LOD score analysis.

UNIT II **8 Hrs.**

Genetic mapping of complex traits:(a) Difficulties in mapping complex traits (b) Allele sharing methods- Affected sib pair analysis (c) Allelic association mapping (d) Linkage disequilibrium mapping e) Transmission disequilibrium test (f) Whole genome scan and mapping (g) Integration of Cytogenetic, genetic and physical maps.

UNIT III &IV **16 Hrs.**

Genetic basis of syndromes and disorders:

a) Monogenic diseases (Cystic fibrosis and Marfan syndrome), b) Inborn errors of metabolism (Phenylketonuria and Mucopolysaccharidosis), c) Neurogenetic disorders (Charcot-Marie-Tooth syndrome and Parkinson disease), d) Genetic disorders of Haemopoetic systems (Sickle cell anemia and Thalassemia), e) Genetic disorders of eye (Retinitis pigmentosa, Glaucoma and Cataracts), f) Muscle genetic disorders (Duchenne and Becker Muscular Dystrophy), g) Genome imprinting syndromes (Prader-Willi & Angelman syndromes, Beckwith-Wiedeman syndrome, h) Genetic disorders in skeleton and skin, i)) Congenital heart diseases, j) Learning disorders

k) Genetics of Infertility, l) Cognitive disabilities, Schizophrenia and Anxiety disorders, m) Complex syndromes (Atherosclerosis, Diabetes mellitus, Rheumatoid Arthritis), n) Mitochondrial syndromes.

UNIT V &VI **16 Hrs.**

Diagnosis, Counseling, Therapy and Ethics:

a) Prenatal diagnosis: (i)Noninvasive methods- X- radiation, Ultrasonography and Fetal echocardiography (ii) Invasive methods- Maternal serum screening, Amniocentesis,Chorionic villus sampling andFetoscopy, b)Technology in reproductive assistance

c)Genetic counseling: Definition, Components, Psychotherapeutic counseling, Decision making, risk assessment and counseling in Mendelian and multifactorial syndromes, d) Gene therapy, e) Management of genetic disorders, f) Models of eugenics, human right, human genetics and legal, social and ethical considerations.

PRACTICALS: **16x4 = 64 Hrs.**

1) Barr body and Dermatoglyphics analysis
2) Creation of pedigrees and study on patterns of inheritance.
3) Induction of Human leukocyte culture.
4) Preparation of Human chromosomes and G banding.
5) Karyotyping of normal chromosomes and syndromes.
6) Studies on phenotypes of different diseases and syndromes.
7) DNA Isolation from Blood and quantification
8) PCR amplification and molecular diagnosis of genetic diseases

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Biostatistics and Bioinformatics

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3. Bioinformatics :sequence, structure and databanks, des higgins & willie tylore:– 2000: oxford university press.
4. Bioinformatics sequence & genome analysis, david. w. mount, cold serving harbor laboratory
5. Proteomics from protein sequence to function ,by ennington sr 0 / dunn mj
6. Proteomics from protein sequence to function , by pennington sr
7. Purifying proteins for proteomics a laboratory manual ,by richard j simpson

8. Discovering genomics proteomics & bioinformatics ,by malcolm campbell / laurie j heyer
9. Guidebook on molecular drug design ,by claude cohen n
10. Molecular modelling & drug design,by anand solomon k
11. Drug design ,by morris sylvin
12. Introduction to drug design ,by Pandeya sn / dimmock jr

IV SEMESTER

GEN - H 4.1: MAJOR PROJECT WORK 256 Hrs.

GEN - S4.2: MEDICO-ENVIRONMENTAL IMPACT ON DEVELOPMENT 64 Hrs.

UNIT I 16 Hrs.

Development and Environment: Developmental symbiosis, b) Embryonic diapause. c) Phenotypic plasticity: Polyphenism – nutritional, seasonal, Diet and DNA methylation, predator induced polyphenism, Environment dependent sexual phenotype, learning - Adaptive nervous system. d) Stress induced gene expression.

UNIT II 16 Hrs.

A) Teratogenesis: Teratogenic agents and their assault on human development- (i)Alcohol, (ii)Retinoic acid, (iii)thalidomide, (iv)endocrine disruptors - DES, Nonylphenol, BPA, DDT, Heavy metals, pathogens etc. (B) Malnutrition –embryonic origin of adult onset illness (Hypertension, diabetes, gene methylation) (Added)

Unit III 16hrs

Developmental anomalies and diseases A) Neoplasia as a disease of altered development (Cell cycle autonomy, Evasion of apoptosis, Invasiveness, Angiogenesis), Differentiation therapy. B) Anomalies (i) Anencephaly - Spinabifida (ii)Cyclopia-Shh mutants (iii) Blindness-Rx mutants (iv) Deafness (V) Progeria

UNIT IV 16 Hrs.

A) Stem cells: Embryonic stem cells – therapeutic cloning, Multipotent adult stem cells, transgenic stem cells. Regeneration Therapy

B) Aging: a) Concept of aging - organismal b) cellular changes during aging (DNA damages, shortened telomere, mitochondrial mutations, oxidative stress) c) Theories of aging**.**

GEN – S4.3: GENETICS OF PLANTS AND MICROBES **32 Hrs.**

UNIT I **8 Hrs.**

Gene regulation in plants: Over view of plants as genetic model systems,Genetics of gene regulation in plants. Genes involved in regulation of flower development. Homeotic genes, Development of dorsal and ventral asymmetry in leaves. Role of KNOX genes in evolution of compound leaf. Types of abiotic stresses and gene regulation during water deficit and heat stress. Plant nodule genes. Mechanism of self-incompatibility in plants.

UNIT II **8 Hrs.**

Applied genetics of plants:

Genetic basis of disease resistance and susceptibility in plants. Molecular basis of host pathogen interaction. Molecular and genetic basis of Crown Gall disease development. Agrobacteruim- Genetics of Ti plasmid. Plant wound genes and control of 'vir' gene expression. Mechanism of T-DNA transfer and their utility in production of transgenic plants.

UNIT III **8 Hrs.**

Microbial Genetics: Over view of Microbes as genetic tools for basic and applied studies. Over view of generalized life cycles of microbes. Non- sexual variation. Significance of haploidy. Heterokaryosis and parasexuality. Tetrad analysis and linkage detection in *Neurospora.* Mitotic recombination in *Neurospora crassa and Aspergillus nidulans,* gene conversion in fungi,Bioremediation and phytoremediation, Biosensors.

UNIT IV **8 Hrs.**

Recombination in bacteria: (a) Conjugation: Discovery, nature of donor strains and compatibility, interrupted mating and temporal mapping, Hfr, F′, heteroduplex analysis, mechanism of chromosome transfer, molecular pathway of recombinations and gene mapping. (b) Transformation: Natural transformation systems, transformation and gene mapping (c) Transduction: Discovery, generalized and specialized transduction, phage P1 and P22 mediated transduction, mechanism of generalized transduction, abortive transduction, mechanism of specialized transduction, sex-duction,

GEN OE4.4: PRINCIPLES OF GENE CLONING 48 Hrs.

THEORY **48 Hrs.**

UNIT I & II **16 Hrs.**

Gene cloning:

a) Historical account, Definition and Objectives, b) Components of gene cloning - Nucleic acids (principles of isolation, purification and quantification), DNA modifying enzymes (Restriction and modification enzymes, Other nucleases, Polymerases, Ligase, Kinases and Phosphatases), Cloning vectors (Plasmids, Phages, Cosmids, Artificial chromosomes and Expression vectors) and Cloning hosts (*E. coli, Saccharomyces,* Plant and animals cells), c) Gene transfer (Physical, microinjection and vector mediated methods) and cloning methods (Directional cloning and TA cloning methods), d) Gene Screening and isolation - Strategies, DNA libraries (Genomic DNA, cDNA and expression libraries), Probe Selection and labeling, Hybridization (principles of hybridization) gene screening (colony, plaque, dot, northern, southern blot screening, antibody screening)

UNIT III & IV **16 Hrs.**

PCR and DNA sequencing: a)PCR – Principle, Methodology, Types - RT-PCR, RAPD, AFLP, ISSR, inverse PCR and Real time PCR and their applications. b) DNA sequencing methods - Maxam and Gilbert's method, Sanger's method, Automated DNA sequencing method, Capillary gel electrophoresis for DNA sequencing and NGS recent methods of DNA sequencing and their applications.

UNIT V **8 Hrs.**

DNA techniques: a) Gel electrophoresis of nucleic acids (agarose, pulse-field) b) Blotting of macromolecules and hybridization, c) Oligonucleotide synthesis, d) Promoter characterization, e) DNA fingerprinting, f) Site directed mutagenesis, g) *In vitro* translation (*E.coli*, wheat and reticulocytes).

UNIT VI **8 Hrs.**

Applications of Gene cloning: a) Production of Transgenic organisms, b) Human health (Production of vaccines, biomolecules, diagnostic kits and molecular medicine) c) Biosafety d) Intellectual Property Rights (patenting, trade secrets, copy right, trade and their regulations) e) Risks and ethics of GMO products.

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Genetics of Plants and Microbes

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UNIVERSITY OF MYSORE
Department of Studies in Zoology
CREDIT MATRIX FOR M.Sc. GENETICS PROGRAM 2014-15

SEMESTER	HARDCORE	SOFTCORE	OPEN ELECTIVE	TOTAL
I	16	04 (08)	-	**20**
II	12	06 (10)	04	**22**
III	14	08 (12)	04	**22**
IV	08	04/06 (08)	04	**12** (14)
	50	**22** (38)	**04** (12)	**76**

Semester I : 20 Credits							
Paper code	**Title of the Course**	**HC/SC/OE**	**L**	**T**	**P**	**Credit**	**Name of the Faculty**

	Transmission Genetics	HC	3	0	1	4	
	Chromosome Genetics	HC	3	0	1	4	
	Gene Structure and Function	HC	3	0	1	4	
	Cell Biology	HC	3	0	1	4	
	Molecular Cytogenetics	SC	4	0	0	4	
	Histology and Histopathology	SC	3	0	1	4	Faculty from Zoology

Any one of 4 credits soft course can be opted by the M.Sc.Genetics students

Semester II (18**/22**)

Paper code	Title of the Course	HC/SC /OE	L	T	P	Credit	Name of the Faculty
	Molecular Cell Biology	HC	3	0	1	4	
	Population Genetics and Evolution	HC	3	0	1	4	
	Genome Genetics	HC	3	0	1	4	
	Gene Regulation	SC	4	0	0	4	
	Biological Chemistry	SC	2	0	0	2	
	Ethology and Wild life Biology	SC	3	1	0	4	Faculty from Zoology
	Basic Genetics	OE	3	0	1	4	

Any 6 credits of the 10 credits of the soft courses can be opted by the M.Sc.Genetics students

Semester III 22

Paper code	Title of the Course	HC/SC /OE	L	T	P	Credit	Name of the Faculty
	Genetic Engineering	HC	3	0	1	4	
	Genes and Development	HC	3	0	1	4	
	Advanced Human Genetics	HC	3	0	1	4	
	Scientific presentation skills	HC	1	1	0	2	All Teachers
	Immunology and Cancer Genetics	SC	4	0	0	4	
	Biostatistics and	SC	4	0	0	4	

	Bioinformatics						
	Biodiversity	SC	3	1	0	4	Faculty from Zoology
	Human genetics	OE	3	0	1	4	
Any 8 credits of the 12 credits of the soft courses can be opted by the M.Sc.Genetics students							
Semester IV 12/14							
Paper code	Title of the Course	HC/SC /OE	L	T	P	Credit	Name of the Faculty
	Major Project	HC	0	2	6	8	All Teachers
	Medico-Environmental impact on Development	SC	4	0	0	4	
	Genetics of Plants and Microbes	SC	2	0	0	2	
	General and Molecular Endocrinology	SC	3	1	0	4	
	Principles of Gene cloning	OE	3	0	1	4	
Any 4/6 credits of the 10 credits of the soft courses can be opted by the M.Sc.Genetics students							