CVM UNIVERSITY

MASTER OF SCIENCE

(APPLIED GENETICS)

PROGRAMME

Under Choice Based Credit Scheme

Structure with Effect From: 2020-21

M. Sc. Applied Genetics Programme Details

Postgraduation / Master degrees course in Applied Genetics offer advanced knowledge in developing and understanding mechanisms for genetic processes such as inheritance, mutation and variation. This knowledge is very much useful for the benefits of living organisms especially human and animals.

Students will learn to develop models for understanding genetic patterns, including practices such as bioinformatics and qualitative genetics. Students will explore issues such as gene therapy and cytogenetics, honing transferrable skills through practical activities including DNA sampling, experiment design, lab testing, fieldwork, and case studies.

The experience gained by the student will be utilized in various industries, including agriculture, Diagnostics, healthcare and biopharmaceuticals. Your expertise would make you suitable for consultancy for NGOs and private SMEs, or in public policy and as a genetic counselor. Students can also enter in research, developing new techniques for understanding biological processes at molecular level (Doctoral research).

Programme Objectives (POs):

By cultivating talents and promoting all round personality development through multi-dimensional education a spirit of self-confidence and self-reliance will be infused in the student. The student will be instilled with values of professional ethics and be made ready to contribute to society as responsible individuals.

1. Knowledgeable persons in concerned subjects.
2. Qualified and employable candidates in careers related to teaching and research that require Post graduation.
3. Individuals with aptitude and skill in research.
4. Persons having innovative ideas and necessary training to initiate unique start-ups.
5. Young leaders who offer their service to the betterment of the community.

Programme Specific Outcomes (PSOs):

Individuals having in-depth knowledge in different branches of Genetics. Employable candidates in careers related to teaching in Biology in universities and colleges. Individuals with aptitude and skill in research in different applied branches of Genetics as well as related disciplines. Persons

having innovative ideas and necessary training to initiate unique start-ups in molecular diagnostics and Genetic counselling.

At the end of the two year programme the student will acquires deep understanding of various aspects of applied genetics such as Mendelian genetics, population genetics, human genetics, animal and microbial genetics, etc,. The student will be equipped to take up a suitable position in academia or industry and to pursue a career in research if so desired.

Programme Structure:

The M.Sc. Applied Genetics programme is a two-year course divided into four-semesters. A student is required to complete hundred credits for the completion of course and the award of degree. A student has to accumulate twenty-five credits in each of the four semesters.

PART ONE	FIRST YEAR	SEMESTER - I	SEMESTER - II
PART TWO	SECOND YEAR	SEMESTER - III	SEMESTER - IV

Course Credit Scheme

SEMESTER - I

Course Type	Course Code	Name of Course	T/P	Credits	Exam Duration (Hrs)	Components of Marks		
						Internal	External	Total
						Total/ Passing	Total/ Passing	Total/ Passing
Core Course	PG01CGEN01	Principles of Genetics	T	4	3	30/10	70/28	100/40
	PG01CGEN02	Bioanalytical Techniques and Instrumentation	T	4	3	30/10	70/28	100/40
	PG01CGEN03	Cell Biology	T	4	3	30/10	70/28	100/40
	PG01CGEN04	Practicals based on PG01CGEN01 and PG01CGEN02	P	4	3	30/10	70/28	100/40
	PG01CGEN05	Practicals based on PG01CGEN03 and PG01EGEN0X	P	4	3	30/10	70/28	100/40
	PG01CGEN06	Comprehensive Viva	P	1			50/20	50/20
Elective Course	PG01EGEN01	Fundamentals of Biochemistry and Bioenergetics	T	4	3	30/10	70/28	100/40
	PG01EGEN02	Model Organisms Genetics	T	4	3	30/10	70/28	100/40

	PG01EGEN03	Human Physiology	T	4	3	30/10	70/28	100/40
	PG01EGEN04	Methods and Applications of Transgenic Plants	T	4	3	30/10	70/28	100/40
Total Credits				25				650

SEMESTER- II

Course Type	Course Code	Name of Course	T/P	Credits	Exam Duration (Hrs)	Components of Marks		
						Internal	External	Total
						Total/ Passing	Total/ Passing	Total/ Passing
Core Course	PG02CGEN01	Cytogenetics	T	4	3	30/10	70/28	100/40
	PG02CGEN02	Basics of Microbial Genetics	T	4	3	30/10	70/28	100/40
	PG02CGEN03	Immunology	T	4	3	30/10	70/28	100/40
	PG02CGEN04	Practicals based on PG02CGEN01 and PG02CGEN02	P	4	3	30/10	70/28	100/40
	PG02CGEN05	Practicals based on PG02CGEN03 and PG02EGEN0X	P	4	3	30/10	70/28	100/40
	PG02CGEN06	Comprehensive Viva	P	1			50/20	50/20
Elective Course	PG02EGEN01	Biostatistics	T	4	3	30/10	70/28	100/40
	PG02EGEN02	Forensic Genetics	T	4	3	30/10	70/28	100/40
	PG02EGEN03	Toxicology	T	4	3	30/10	70/28	100/40
	PG02EGEN04	Population Genetics	T	4	3	30/10	70/28	100/40
Total Credits				25				650

Course Wise Content Details for M.Sc. (Applied Genetics) Programme

CHARUTAR VIDYAMANDAL UNIVERSITY
VALLABH VIDHYANAGAR
SEMESTER - I
M.SC. APPLIED GENETICS
SYLLABUS EFFECTIVE FROM: JUNE-2020-21

PG01CGEN01: Principles of Genetics

Course Objectives:
The objectives of this course are to make students understand basic principles of Genetics. Genetic concepts provide the framework for the study of Modern Biology. The Science of genetics includes the rules of inheritance in cells, individuals and populations and the molecular mechanisms by which genes control the growth, development and appearance of organisms.

Course Learning Outcomes:
Unit 1: Students should be able to acquire basic knowledge on Mendelism (Laws of inheritance), Modes of inheritance and different types of crosses.

Unit 2: Students should be clear about various genetic interactions, dominance, multiple alleles and overview of mutations.

Unit 3: Students should understand the process of linkage, Crossing over and Chromosome mapping, Sex determination and sex linkage.

Unit 4: Student should know about transposable genetic elements and Extrachromosomal Inheritance as well as imprinting phenomena with examples.

Contents:

Unit-1: Mendelian Genetics, Deviation from Mendelism and inheritance of complex trait:

- Introduction to genetics.
- Law of segregation, Independent Assortment, Monohybrid Cross, Dihybrid Cross, trihybrid Cross, Test cross, back cross.
- Complex patterns of inheritance, qualitative and quantitative traits, Inbreeding and resemblance between relatives, Genes and environment.
- Modes of inheritance.

Unit-2 : Gene Interaction and Multiple Alleles:

- Types of gene interactions, Molecular basis of gene interaction, Epistasis.
- Dominance: complete dominance, incomplete dominance, codominance, over-dominanace; Molecular basis of dominance.
- Lethal genes and their action, Pleiotropy.
- Multiple alleles: ABO blood groups in human, Rh blood group system, Fur colour in rabbits, characteristics of multiple alleles.
- Mutation: Classification, Methods of inducing mutations & CIB technique, mutagenic agents and induction of mutation.

Unit-3 : Linkage, Crossing over and Chromosome mapping

- Linkage, Crossing over
- Cytological basis of crossing over, Molecular mechanism of crossing over
- Chromosome mapping: two factor crosses, three factor crosses
- Chromosome maps.
- Sex determination and sex linkage: Mechanism of sex determination, Environmental factors and sex determination, molecular basis of sex determination, sex differentiation: *Chlamydomonas,* sex linked inheritance.

Unit-4 : Transposable elements and Extrachromosomal Inheritance:

- Types of transposable elements, structure, genetic organization.
- General mechanism of transposition.
- Criteria for extrachromosomal inheritance
- Cytoplasmic organelles and symbionts; maternal effects in snails, streptomycin resistance in *Chlamydomonas*.
- Mitochondrial mutations in yeast, Kappa particles in *Paramecium*.
- Plasmid inheritance in *Mirabilis jalpa*, male sterility in plants.
- Imprinting

Reference Books:

1. Strickberger M.W. Genetics. Third Edition. Prentice-Hall of India Pvt. Ltd, New Delhi, 2005. ISBN: 81-203-0949-9.
2. Emund W. Sinnot, L. C. Dunn & T. Dobzhansky. Principles of Genetics, Tata Mcgraw Hill Publishing Company Limited, New Delhi, ISBN: 978-0070994133.
3. P. K. Gupta, Genetics. Rastogi Publications, Meerut, India., ISBN: 81-7133-842-9.
4. Gardner E. J., Simmons M. J. & Snustad D. P. Principles of Genetics. Eighth edition. John Wiley & Sons Inc. ISBN 9971-51-346-3.
5. Klug W. S. & Cummings M. R. Concepts of Genetics. Seventh edition. Pearson Education. ISBN 81-317-0811-X.

6. Stent G. S. & Calendar R. Molecular Genetics: An Introductory Narrative. Second edition CBS Publishers and Distributors, New Delhi ISBN 81-239-0857-1.
7. Streips U. And Yasbin R. Modern Microbial genetics, Wiley-Liss, USA. ISBN: 0-471-38665-0.
8. Molay S., Cronan J. & Frifelder, D. Microbial Genetics Narosa Publishing House, New Delhi. ISBN: 81-7319-697-4.
9. Genetics by B. D. Singh

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PG01CGEN02: Bioanalytical Techniques and Instrumentation

Course Objectives:

The course will enable the students to understand the principle and working of visualization techniques, separation techniques, spectroscopic techniques for analysis of the samples and principles and applications of tracer techniques in biology. Principles and applications of different types of microscopy, principle & application of cytophotometry and flow cytometry, centrifugation, electrophoresis chromatography, spectroscopy, radioactivity, radiation counters, x-ray diffraction will be known to the students.

Course Learning Outcomes:

Unit 1: Deals with the knowledge of different types of microscopes such as Light microscope, Compound microscope, Dark field, Bright field, Stereo microscope, Confocal, Phase contrast microscope, Fluorescent microscope, Transmission Electron Microscopy (TEM) and Scanning Electron Microscopy (SEM). It also deals with the principle and application of cytophotometry and flow cytometry.

Unit 2: Enrich the concept and application for separation of molecules by different types of centrifugation techniques. Knowledge of separation by horizontal and vertical gel electrophoresis is also anticipated. The separation of molecules by different types of chromatographic techniques will be learnt.

Unit 3: Explore the consideration of principle and analysis of samples by different spectroscopic techniques such as UV, Visible, IR (including FTIR and ATR), AAS, NMR, Mass, MALDI-TOF, fluorescence, CD spectroscopy etc. will be learnt.

Unit 4: Gather the concept of radioactivity autoradiography, different types of counters used to trace the radiation will be studied. The principle and application of x-ray diffraction methods to study the structure of biopolymer will be known.

Contents:

Unit I

Visualization techniques:

Principle of working and applications of bright field & dark field microscopy, phase contrast microscopy, fluorescence microscopy, confocal microscopy, scanning and transmission electron microscopy, scanning tunneling microscopy, atomic force microscopy. Principle and applications of cytophotometry and flow cytometry.

Unit II

Separation techniques:

Basic principle and application of analytical and preparative centrifugation, settling time & velocity, types of rotor, sedimentation coefficient, relative centrifugal force (RCF) differential, density and ultracentrifugation.

Principle and applications agarose and 2D gel electrophoresis. Capillary electrophoresis and its applications. Native-PAGE, SDS-PAGE

Principle, methodology and applications of gel–filtration, ion–exchange and affinity chromatography; Thin layer and High-Performance Thin Layer Chromatography. Gas chromatography, High performance liquid chromatography and FPLC.

Unit III

Spectropscopy

Basic principle of electromagnetic radiation, instrumentation and applications of UV, Visible, IR (including FTIR and ATR), AAS, NMR, Mass, MALDI-TOF, fluorescence and CD spectroscopy.

Unit IV

Principle and applications of tracer technique in biology:

Concept of radioactivity, rate of radioactive decay; units of radioactivity- uses of radioisotopes in life sciences and biotechnology; autoradiography; cerenkov radiation; radiation dosimetry; ionization and scintillation-based detection of radioactivity.

Principle of biophysical methods used for analysis of biopolymer structure: X-ray diffraction.

Reference Books:

1. Instrumental method of chemical analysis: Sharma B K
2. Instrumental methods of analysis: D A Skoog
3. An introduction to practical Biochemistry: Plummer
4. Instrumentation: Chatwal and Anand
5. Modern experimental Biology: Boyer

6. Freifelder D. M. Physical Biochemistry- Application to Biochemistry and Molecular Biology, 2nd ed., W.H. Freeman, 1982.
7. Wilson & Walker. Principles and Techniques in Practical Biochemistry. 5th ed. Cambridge Univ. Press, 2000.
8. West & Todd. Biochemistry. 4th ed. Oxford and IBH.
9. Horst Friebolin. Basic One and Two-dimensional spectroscopy. VCH Publ, 1991.
10. Murphy D. B. Fundamental of Light Microscopy & Electron Imaging. 1st ed. Wiley-Liss, 2001.
11. R. Marimuthu – Microscopy and Microtechnique, MJP Publishers, 2015.

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PG01CGEN03: Cell Biology

Course Objectives:

The major objective of this paper is to develop clear understanding of various aspects of cell biology along with diverse metabolic pathways existing at cellular level in relation to survival and propagation. This course enables the students to understand the structure and function of cell organelles, protein transport mechanism, intracellular signalling mechanism and acquainted with cell cycle, its regulation and apoptosis.

Course Learning Outcomes:

Unit 1: The students will understand the evolution of the cell, Cell as a unit of living organisms. They will learn structural details of prokaryotic and eukaryotic cells, their cell wall, cell membrane and other outer appendages.

Unit 2: The students can gain knowledge for molecular organization of Mitochondria, Chloroplast. Will know the ultrastructure and functions of Nucleus, Endoplasmic reticulum, Golgi complex, Lysosomes and other microbodies. They will also gain the knowledge of Protein sorting: organelle biogenesis and protein secretion, synthesis and its intracellular traffic, vesicular traffic in the secretary pathways

Unit 3: Will get the information for cytoskeleton topography which include the role of Microtubule and its dynamics, motor proteins, Microfilament and its functions, Intermediate filaments and their functions, Cilia and centrioles

Unit 4: Will be acquainted with overview of the Cell cycle and its control, the molecular mechanisms for regulating mitotic events, checkpoints in cell cycle regulation and signalling pathways which regulate apoptosis process

Contents

Unit I

The origin and Evolution of cells: Evolution of metabolism, Diversity of cell size and shapes, Structure of Prokaryotic and Eukaryotic cells, Single cell to multicellular organism

The Structure of cell membrane: The fluid Mosaic Model, Membrane lipids and Proteins, The Glycocalyx, Transport across plasma membrane.

Endocytosis: Phagocytosis and Receptor mediated endocytosis)

Cell walls and extracellular matrix & Cell Matrix Interactions

Cell-Cell interactions: Adhesion protein, Tight junctions, gap junctions and plasmodesmata.

Unit II

Cell Organelles: Molecular organization of Mitochondria, Chloroplast, Ultrastructure and Functions of Nucleus

Molecular Organization and functions of Endoplasmic reticulum, Golgi complex, Lysosomes (Protein sorting and transport, Types of vesicular transport and their functions), Microbodies: Peroxisomes, Ribosomes.

Unit III

The cytoskeleton: The nature of cytoskeleton, Intermediate filaments, Microtubules: Organization of tubules, assembly and organization within the cells, microtubule motors and movements, cilia and flagella: structure and function.

Cell signalling: Signalling molecules and their receptors, Functions of cell surface receptors, pathways of intracellular signal transduction, signal transduction and cytoskeleton.

Unit IV

Cell growth and division: Overview of the Cell cycle and its control, the molecular mechanisms for regulating mitotic events, Cell cycle control in mammalian cells, Checkpoints in cell cycle regulation, regulators of cell cycle progression-MPF, cyclins and CDKs, Inhibitors of cell cycle progression; M-phase and cytokinesis.

Programmed Cell Death: Difference between necrosis, apoptosis and necroptosis, Caspases, Central regulators of apoptosis (Bcl-2 family), signalling pathways that regulate apoptosis.

Reference Books:

- The cell: A molecular approach-Geoffrey M Cooper and Robert E. Hausman
- Cell Biology-Karp
- Molecular Biology of the cell- Alberts
- Molecular Cell Biology-Lodish et al.

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PG01EGEN01: Fundamentals of Biochemistry and Bioenergetics

Course Objectives:

The major objective of this paper is to develop clear understanding of various aspects of biochemistry which includes properties of biomolecules, their metabolism and regulation. This course content enables students to better understand concept of bioenergetics and its importance in cellular metabolism. Moreover, useful to understand key role of water in metabolism which maintain acid base equilibrium at cellular level as well as an importance of physiological buffers.

Course Learning Outcomes:

Unit 1: Will have learnt carbohydrates, their types and properties. Further, will be acquainted with central metabolic pathways for carbon metabolism in bacteria enlisting differences with eukaryotic systems and their regulation in diverse physiological conditions.

Unit 2: Understands types of amino acids and their properties. Moreover, will have gathered understanding of inorganic and organic nitrogen assimilation and its regulation. Also knows role of glutathione in cellular redox regulation and biochemistry of glutamate overproducing strains. Will understand biochemical basis of nucleotides and its metabolism.

Unit 3: Will understand details of lipid, its metabolism and regulation along with biochemical basis of lipid accumulation at cellular level.

Unit 4: Will have learnt basic concepts of bioenergetics and its importance in cellular metabolism. The students will be aware with different electron carriers compounds and their role in ATP generation. Moreover, gain in depth knowledge of Water and Acid-Base Equilibrium.

Contents:

Unit I

Carbohydrates and Glycobiology: Monosaccharide - structure of aldoses and ketoses, ring structure of sugars, conformations of sugars, mutarotation, anomers, epimers and enantiomers, structure of biologically important sugar derivatives, oxidation of sugars. Formation of disaccharides, reducing and nonreducing disaccharides. Polysaccharides – homo- and heteropolysaccharides, structural and storage polysaccharides. Structure and role of proteoglycans, glycoproteins and glycolipids (gangliosides and lipopolysaccharides).

Carbohydrate metabolism: Glycolysis, Gluconeogenesis, PP Pathway, Citric acid cycle- steps involved, amphibolic nature, anaplerotic reactions, Coordinated regulation of glycolysis and gluconeogenesis, Glycogen synthesis

Unit II

Amino acids: Structure of amino acids, physical, chemical and optical properties of amino acids, Classification of amino acids, Peptides and Proteins, Secondary, tertiary and Quaternary structure of proteins

Protein metabolism: Nitrogen metabolism, Biosynthesis of amino acids, molecules derived from the amino acids, amino acid oxidation and production of urea

Nucleotides and Nucleic acids: Structure of major species of RNA - mRNA, tRNA and rRNA. Nucleic acid chemistry – UV absorption, effect of acid and alkali on DNA.

Nucleotides metabolism: Biosynthesis and Degradation of Nucleotides

Unit III

Lipids - fatty acids, glycerol, ceramide. Storage lipids - triacyl glycerol and waxes, Structural lipids in membranes – glycerophospholipids, galactolipids and sulpholipids, sphingolipids and sterols, structure, distribution and role of membrane lipids, Lipids as signals, cofactors and pigments

Lipid Metabolism: Biosynthesis of fatty acids, Triacylglycerol, membrane lipids and cholesterol, Fatty acid catabolism

Unit IV

Bioenergetics: The laws of thermodynamics, concept of entropy and free energy; ATP synthesis and hydrolysis, Biological oxidation: oxygenases, hydrolases, dehydrogenases, free energy changes and redox potentials, Gibbs energy

The mitochondrial respiratory chain, order and organization of carriers, proton gradient, iron sulphur proteins, cytochromes and their characterization, ATP- synthetase complex, Chemiosmotic theory of Energy Coupling, Inhibitors of ETC

Water and Acid-Base Equilibrium: Ionization of Water, Weak Acids, and Weak Bases, buffering against pH Changes in Biological Systems: Henderson and Hassebach equation, Buffers and their importance, pKa of amino acid and their relevance, Importance of discontinuous buffer system used in SDS PAGE, Water as a Reactant

Reference Books:

- Lehninger's Principles of Biochemistry: D. L. Nelson and M. M. Cox, Macmillan, Worth Pub. Inc., NY.
- Chemistry of Biomolecules by S. P. Bhutani, Ane Books Pvt. Ltd. CRC Press
- Biochemistry: Lubert Stryer WH Freeman & Co., NY.
- Harper's Biochemistry: R. K. Murray and others. Appleton and Lange, Stanford.
- Text book of Biochemistry with clinical correlations by Delvin.

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PG01EGEN02: Model Organisms Genetics

Course Objectives:

The basic principles of genetics have been elucidated largely by studies using a small number of species: from the peas used by Mendel to more recent examples such as the zebrafish. In this course highlights many of these key species that have become model organisms, including the yeast (*Saccharomyces cerevisiae*), the nematode (*Caenorhabditis elegans*), the fruit fly (*Drosophila melanogaster*), and the mouse (*Mus musculus*). Students should know Why were these species chosen to study genetics? What important findings in genetics have these studies yielded? How do you 'do' genetics in these model systems? How can experiments with these species help us to understand the basis of human genetic disease?

Course Learning Outcomes:

Unit 1:

Students should know various Model systems in Genetic analysis.

Unit 2:

Student should understand life cycle and Genetic techniques associated with *C. elegans*.

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Unit 3:
Highlights advantages and Life cycle of Arabidopsis and mouse

Unit 4:
Gains knowledge about life cycle and advantages of *Saccharomyces cerevisiae*.

Contents:

Unit I
Model systems in Genetic Analysis: Bacteriophage, *E. coli, Neurospora crassa*, yeast, Arabidopsis, maize, Drosophila, *C. elegans*, Zebra fish, *Homo sapiens*- General outline of life cycle, importance in Genetic analysis.
The Fruit Fly *Drosophila melanogaster*: Introduction, Advantages of *D. melanogaster* as a model genetic organism.
The Bacterium *Escherichia coli* : Advantages of *E. coli* as a model genetic organism, The *E. coli* genome, Life cycle of *E. coli*, Genetic techniques with *E. coli.*
Unit II
The Nematode Worm *Caenorhabditis elegans*: Advantages of *C. elegans* as a model genetic organism, Life cycle of *C. elegans*, The *C. elegans* genome, Genetic techniques with *C. elegans*.
Unit III
The Plant *Arabidopsis thaliana*: Advantages of Arabidopsis as a model genetic organism, The Arabidoposis genome, Life cycle of Arabidopsis, Genetic techniques with Arabidopsis,
The Mouse *Mus musculus*: Advantages of the mouse as a model genetic organism, Life cycle of the mouse, The mouse genome, Genetic techniques with the mouse.
Unit IV
The Yeast *Saccharomyces cerevisiae*: Advantages of yeast as a model genetic organism, Life cycle of yeast, The yeast genome, Genetic techniques with yeast.
Functional genomics and animal models in human disease: An overview; cDNA/gene cloning; site-directed mutagenesis; mammalian tissue culture; cell line transfections; functional assays; Use of model organisms, methods for generation of transgenic animals/ knock in, knock out models (microinjection, ES cell transformation); mutagenesis; RNAi approach; Some examples.

Reference Books:

Genetics: A Conceptual Approach, 4 th Edition by Benjamin A. Pierce, ISBN-13: 978-1-

4292-3250-0.

Strickberger M.W. Genetics. Third Edition. Prentice-Hall of India Pvt. Ltd, New Delhi, 2005. ISBN: 81-203-0949-9.

Emund W. Sinnot, L. C. Dunn & T. Dobzhansky. Principles of Genetics, Tata Mcgraw Hill Publishing Company Limited, New Delhi, ISBN: 978-0070994133.

P. K. Gupta, Genetics. Rastogi Publications, Meerut, India., ISBN: 81-7133-842-9.

Gardner E. J., Simmons M. J. & Snustad D. P. Principles of Genetics. Eighth edition. John Wiley & Sons Inc. ISBN 9971-51-346-3.

Klug W. S. & Cummings M. R. Concepts of Genetics. Seventh edition. Pearson Education. ISBN 81-317-0811-X.

Stent G. S. & Calendar R. Molecular Genetics: An Introductory Narrative. Second edition CBS Publishers and Distributors, New Delhi ISBN 81-239-0857-1.

Streips U. And Yasbin R. Modern Microbial genetics, Wiley-Liss, USA. ISBN: 0-471-38665-0.

Molay S., Cronan J. & Frifelder, D. Microbial Genetics Narosa Publishing House, New Delhi. ISBN: 81-7319-697-4.

Genetics by B. D. Singh

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PG01EGEN03: Human Physiology

Course Objectives:

The goal of this course is to develop understanding for the fundamental concepts of physiology of nutrition and digestion. To Develop understanding of blood vascular system. Develop the fundamental concepts of physiology of respiration. Develop basic understanding of nervous system and its interactions with other systems. Familiarize students with renal physiology and reproductive systems.

Course Learning Outcomes:

Unit 1: Student will be able to know about the nutrition and types of foods. They will understand metabolism of carbohydrates, proteins and lipids and students will enable to understand the digestion and absorption of these components. Students will also know about the types, properties and contraction relaxation process in muscles tissue.

Unit 2: Student will be able to learn the physiology of respiration i.e. exchange of respiratory gases, transport of respiratory gases in blood and overview of respiratory disorders. Students will also learn circulatory system, components of blood, blood clotting mechanism and about the types of blood groups.

Unit 3: To understand the organisation of nervous system, structure and types of neurons. Student will be able to understand the signal transmission, membrane potential and synapses. Students will learn about neurotransmitters and overview of disorders of nervous system.

Unit 4: Understanding for Excretory system; ultrafiltration, reabsorption and secretion as transport mechanisms involved in urine formation. Understand the role of kidney in body water, electrolyte and acid-base balance. Student will enable to understand the physiology of reproductive system. Hormonal regulation of female reproductive cycle. Student will able to understand the Birth control methods.

Unit I:

Physiology of Nutrition and Digestion: The essential nutrients, types of food, vitamins, minerals, water and the concept of 'balanced diet'. An overview of human digestive tract. Physiological role of digestive juices. Digestion and absorption of carbohydrates, proteins and fats, Neural and endocrine regulation of gastro-intestinal movement and secretion.

Physiology of Muscular System:

An overview of the muscular tissue: types of muscle tissue, properties and functions of the muscle tissues. Skeletal muscle tissue and types. Contraction and relaxation processes and metabolism of skeletal muscle fibres.

Unit II:

Physiology of Respiration: An overview of human respiratory system, Respiratory movements and the exchange of respiratory gases at pulmonary surfaces, Neural and humoral control of respiration. Transport of respiratory gases in blood

Physiology of Circulation: An overview of human circulatory system. The myogenic heart. Pacemaker system and conducting fibers, Neural, humoral and pharmacological regulation of cardiac amplitude and frequency, Cardiac cycle, cardiac output, blood pressure and regulation, Blood-components and functional significance. Blood coagulation and factors involved in coagulation. Haemopoiesis and blood groups, Lymph- composition and dynamics.

Unit III:

Physiology of Nervous System: An overview of the human nervous system and organization. Structure of neuron, types of neurons, neuralgia, myelination. Electrical signals and signal transmission. Membrane channels, resting and action potentials, propagation of nerve impulses, synapses and types, synaptic knobs and synaptic potentials. Neurotransmitters: Physiological role of acetyl choline, aminoacids, GABA, catecholamines, nitric oxide and neuropeptides. General properties of sensory receptors, chemical senses, hearing and vision.

Unit IV:

Physiology of Excretory Systems: An overview of human urinary system. The functional anatomy of human kidney and the functional units. Ultrafiltration, reabsorption and secretion as transport mechanisms involved in urine formation. Physiological roles of aldosterone, anti-diuretic hormone and renninangiotensin system in renal functions.

Physiology of Reproductive Systems: An overview of organization of human male and female reproductive systems. Histological features of male and female gonads. The process of gametogenesis (spermatogenesis and oogenesis). Phases and hormonal regulation of female reproductive cycles. Birth control: Physiology of birth control methods.

Reference Books:

- Animal physiology by Verma, Tyagi and Aggarwal, Pub. S. Chand & Company Ltd. New Delhi. ISBN-81-219-0351-3.
- A textbook of Animal physiology by A. K. Berry, Emkay Publications, Delhi. ISBN-81-85712-03-4.
- Animal physiology by Mohan P. Arora, Himalaya publishing House. ISBN-81-7866-723-1.
- Animal physiology by Goyal and Shastry, Rastogi Publications. ISBN-81-7133-864-X.
- Tortora, G. J.: Principles of Anatomy and Physiology. John Wiley & Sons,Inc.
- Guyton, A.C and Hall J.E.: Textbook of Medical Physiology. W.B.Saunders Co. Philadelphia.
- Chatterjee, C.C.: Human Physiology (Vol. I, II, III). Medical & Allied Agency.
- James A. Wilson: Principles of Anatomy and Physiology. Macmillan Publishing Co.

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SYLLABUS EFFECTIVE FROM: JUNE-2020-21

PG01EGEN04: Methods and Applications of Transgenic Plants

Course outline:

These topics would be taught with emphasis on going methods and applications of genetics manipulation in plants and crops. Through the use of transgenics, one can produce plants with desired traits and even increased yields. After being introduced to the topics students will cover 'methods available for plant transformation through *Agrobacterium* mediated. Students will also study about the role of precise genome modification in crops, role of vectors and markers in gene expressions. The students are expected to read, research and discuss papers related to the topics.

Unit I
Students should get information about various methods of plant transformation.

Unit II
Highlights different methods for Precise genome modification in crops.

Unit III
Students should know Vectors, promoters and markers used in Transgenic plants

Unit IV
Provides information related to characterization of transgenic plants, Applications of plant transgenic technology

Unit I

Methods of plant transformation: Genetic modification by plant breeding versus genetic engineering, stable and transient transformation, *Agrobacterium tumefaciens* and *Agrobacterium rhizogenes* mediated transformation, microprojectile bombardment, agrolistics, in-planta transformation.

Unit II

Precise genome modification in crops: Transformation by homologous recombination, gene editing nucleases, site specific recombination using zinc-finger nucleases, chloroplast transformation and maternal inheritance, gene containment.

Unit III

Vectors, promoters and markers used in Transgenic plants: Constitutive, tissue-specific and inducible promoters, deletion analysis, isolation of promoter, transcription initiation site determination, selectable and screenable markers, marker free transgenics.

Unit IV

Characterization of transgenic plants: Screening of transformants- copy number determination, expression of transgene at RNA and protein level, analysis of metabolites using biochemical methods, homozygosity of transformants in progeny, position effect, transgene silencing, field trials and risks, global status of GM crops, regulatory committee.

Applications of plant transgenic technology:Transgenic crops for resistance against biotic and abiotic stresses. Engineering crops for male sterility and modification of flower colour, flowering, fruit ripening and senescencec. GM crops for nutritional quality and quantity.Molecular pharming; Metabolic engineering and hairy root culture for secondary plant products; Global status and biosafety of transgenic plants.

Reference Books

- Ashwani Kumar and Sudhir K Sopory. "Recent advances in plant biotechnology and its applications" I.K. international publishers, 2008
- Adrian Slater, Nigel W. Scott, Mark R. Fowler. "Plant biotechnology:the genetic manipulation of plants" Oxford University Press, 2008.
- Ramalingam Sathiskumar, Sarma Rajeev Kumar and Jagdeesan Hema. Advances in Plant Transgenics: Methods and Applications. Springer Nature Singapore Pte Ltd.2019. ISBN 978-981-13-9623-6.
- Sandeep Kumar, Pierluigi Barone, Michelle Smith. Transgenic Plants: Methods and Protocols.Springer New York, 2018.ISBN- 1493987771, 9781493987771.
- Hau-Hsuan Hwang, Stanton B. Gelvin. Agrobacterium biology and its application to transgenic plant production.Published In: Frontiers in Plant Sciences and Frontiers in Microbiology.ISSN-1664-8714.
- Hammond, J., McGarvey & Yusibov, V. (Eds.). 2000. Plant Biotechnology- New Products and Applications. Springer-Verlag, Heidelberg, Germany. Joyner, A.L.2000. Gene Targeting - A Practical Approach. Oxford University Press, Oxford.
- Molecular Cloning: A Laboratory Manual (Cold Spring Harbor)-M. R. Green, J. Sambrook.
- An Introduction to Genetic Engineering-Desmond S.T. Nicholl-Cambridge University Press.
- Principles of Gene Manipulation and Genomics-SandyB. Primrose, Richard Twyman-7th Edition; Blackwell Publishing.
- Gene Cloning and DNA Analysis: An Introduction-T. A. Brown-John Wiley & Sons.
- Principles of Plant Breeding, Allard RW –Wiley.

PG01CGEN04: Practicals based on PG01CGEN01and PG01CGEN02

List of Practicals

1. Basic laboratory rules, hazards and first aid
2. Introduction to pH, buffer preparation, molar, normal and percent solutions.
3. Calculations for making stock solution
4. Demonstration of Barr bodies
5. Problems based on Mendelian genetics
6. To solve the problems related to Mendelian genetics
7. DNA estimation by DPA method
8. RNA estimation by orcinol method
9. Isolation of chromosomal DNA
10. To solve the problems related to Mendelian genetics
11. Separation of proteins by PAGE
12. Separation of amino acids by TLC
13. Separation of cells by density gradient centrifugation
14. Determination of partition coefficient

PG01CGEN05: Practicals based on PG01CGEN03 and PG01EGEN01

List of Practicals

1. Study of Cell structure (Eukaryotic & Prokaryotic)
2. Study of Meiosis and Mitosis
3. Estimation of Reducing Sugar in Jaggery by Cole's Method
4. Estimation of Protein by Folin-Lowry Method
5. Estimation of Reducing Sugar by DNS Method
6. Total Sugar Estimation by Phenol Sulphuric acid estimation
7. Estimation of RNA by Orcinol Method
8. Localization of Cell Organelle and Determination of Chlorophyll and Carotenoids
9. Estimation of Amino Acid (Proline)
10. Estimation of Amino Acid (Methionine from Food Grains)

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PG02CGEN01: Cytogenetics

Course Objectives:

Cytogenetics is the study of chromosome, via microscopic analysis of the karyotype. This paper will include theory and techniques in human chromosome analysis. Methods used to identify and analyse individual cytogenetic alterations: banding and nomenclature of banding, Pathology of human chromosomes: nomenclature of aberrant karyotypes; Common syndromes due to numerical chromosome changes; Common syndromes due to structural alterations translocations, duplications, deletions, microdeletion, fragile sites; Common chromosome abnormalities in cancer, Fluorescent in situ hybridization (FISH).

Course Learning Outcomes:

Unit 1. Is able to describe the cell division and various staining and banding techniques for the identification of human chromosomes. It also describes advance methods for chromosomal analysis.

Unit 2. Understand and investigate the cause and effect of chromosome abnormalities and associated human diseases. Students should be able to diagnose and interpret pathology of human chromosomes (chromosome aberrations, trisomy, rearrangements etc.).

Unit 3. Understands theoretical and practical aspects of cancer, pregnancy and cell lines.

Unit 4. Is able to describe various applied aspects of cytogenetics in plants, dairy animals and human.

Contents:

Unit I

Introduction, chromosomal staining, banding and FISH techniques: An over view of Cell cycle, Mitosis and Meiosis, Global structure of Chromosomes, ISCN nomenclature system
Image Analysis System: Charge-coupled device cameras, Image analysis Systems.
Interpretation and reporting of chromosomal analysis Conventional staining (Giemsa and aceto-orcein), Giemsa banding, Quinacrine banding, Constitutive heterochromatin banding Reverse banding, Nucleolar organizing region staining

Sister chromatid exchange Miscellaneous/Other banding Techniques. Applications of fluorescence *in situ* hybridization to chromosome analysis Latest techniques- Fiber FISH, Spectral karyotyping and Chromosomal painting (WCP & PCP).

Unit II

Cytogenetics:

Collection , transport and storage of samples for cytogenetic analysis Morphology and classification of human chromosomes

Numerical chromosomal aberrations (Aneuploidy and Euploidy)

Structural chromosomal abnormalities (Translocations, Inversions, Deletions, Insertions Duplications, Dicentric and sochromosomes, Ring chromosomes, Chromosomes breaks, gaps and fragile sites, Marker chromosomes).

Unit III

Cytogenetics of pregnancy, cancer and cell lines:

Lymphocyte culture, Amniotic fluid cell culture,

Chorionic villus culture, Establishing fibroblast culture,

Cytogenetic analysis of human sperm, oocyte and embryo,

Chromosomal abnormalities in malignant disease (CML, AML, ALL etc.), Cytogenetic characterization of various cell lines.

Unit IV

Applications of cytogenetics in Humans, Domestic animals & Plants

Humans:

Individual with clinical features of Genetic diseases during the following: (Embryonic period, Neonatal period, During early childhood level, During puberty and secondary sexual development, During adulthood, During infertility or reproductive failure)

Domestic animals: Normal chromosomal complements in cattle, buffalo, sheep, goat, horse, pig, cat, dog and poultry; Importance of cytogenetic investigations in domestic animals.

Plants : Role of cytogenetics in plants, Types of polyploidy, Artificial induction of polyploidy in plants, Polyploidy in Triticum spelta, Gossypium hirsutam and Triticosecale wittmack, Phenotypic effects of polyploidy.

Genotoxicity testing.

Reference Books:

- Cell Biology, Genetics, Molecular Biology, Evolution and Ecology by P S Verma and V K Agraval (Multicolour/14th Edition) Published by S. Chand and company Ltd., New Delhi (ISBN: 81-219-2442-1).
- Human Cytogenetics: Constitutional analysis by D. E. Rooney. Oxford University Press. New York (ISBN: 0-19-96384-3 (Hbk.)).
- Essential of Human Genetics (4th edition) by S. M. Bhatnagar, M. L. Kothari and L. A. Mehta (ISBN: 81-250-1426-8).
- Genetics in Medicine (3rd Edition) by Thompson and Thompson, W B Saunders and company, West Washington square, Philadelphia, PA-19105 (ISBN: 0-7216-8857-8).
- Genetics (2nd Edition) by Jan M Friedman, Fred J Dill, Michael R Hayden and Barbara
- McGillivray, B I Waverly Pvt. Ltd., New Delhi, Noida, U.P. (ISBN: 81-7431-025-8).
- Essential of Modern Genetics by V C Shah. Nirav Prakashan, Ahmedabad.
- Cytogenetics in Animal reproduction by W. C. D. Hare and Elizabeth L. Singh, published by Commonwealth Agricultural Bureaux (ISBN: 0 85198 444 4)

- The AGT Cytogenetics Laboratory Manual Barch, Margaret J. / Knutsen, Turid./ Spurbeck, Jack L. (eds.) 3rd edition, Lippincott_raven Publishers, Philadelphia, 1997 ISBN 0-397-51651-7 (New updated edition is about to release)
- Human Cytogenetics: Malignancy and acquired abnormalities. A Practical Approach. 3rd edition, Oxford University Press, 2001, ISBN 1-19-963842-X (Hardback) / ISBN 1-19-963841-1 (Paperback).
- Verma, Ram S. / Babu, Arvind, Human Chromosomes, Principles and Techniques 2nd edition, Mc Graw-Hill, Inc., New York, 1995, ISBN 0-07-105432-4
- Hema Purandare & Amit Chakravarty, Bhalani Publishing House, Mumbai. Human Cytogenetic Techniques & Clinical Applications, 2000, ISBN 81 85578 41 9
- Lisa G. Shaffer, Marilyn L. Slovak, Lynda J. Campbell. International System for Human Cytogenetic Nomenclature: ISCN 2009, S. Karger Publishers, ISBN 978-3-8055-8985-7
- Borgaonkar, Digamber S., Chromosomal Variation in Man: A Catalog of Chromosomal Variants and Anomalies 8th edition, Wiley-Liss, New York, 1997, ISBN 0-471-24332-9

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PG02CGEN02: Basics of Microbial Genetics

Course Objectives:

The objectives of this course are to take students through basics of microbial genetics covering different types of mutations, plasmid biology, prokaryotic genetics and agrobacterium genetics. On covering the course the student will be exposed to concepts of mutation, DNA damage and repair, plasmid biology, microbial and phage genetics.

Course Learning Outcomes:

Unit 1: Students will know that genome is transient and mutation keeps on happening. They will know the types mutation and different mechanisms involved in their repair.

Unit 2: Students should be clear about types of plasmids, their compatibility regulation of copy number and segregation. Students will also learn about phage genetics and recombination.

Unit 3: Students should have understood the types and process of transformation, conjugation and transduction at the end of this unit

Unit 4: Here student should have learnt Agrobacterium genetics, types of restriction modification systems and different types of transposable elements.

Contents:

UNIT -1

Mutation, DNA damage and Repair

Spontaneous mutations (Random v/s Adaptive nature of mutation; Mutation rate and its determination, Types of DNA damage and their consequences (spontaneous and chemical induced deamination, radiation induced DNA damage, loss of nitrogen bases, alkylation, intra and inter strand cross linking) , DNA repair pathways (Mis-match repair in prokaryotes and eukaryotes, Nucleotide excision repair in prokaryotes and in eukaryotes, base excision repair, recombinational repair, SOS pathway, specific repair of oxidative DNA damage, repair of pyrimidine dimers, repair of alkylation induced damage and adaptive response and other specific repair mechanisms).

UNIT –II

Plasmid Biology, Phage Genetics & Recombination

Types of plasmids, compatibility, regulation of plasmid copy number & plasmid segregation

T-series, complementation and Fine structure analysis, biology of lambda phages.

Types of recombination, Different models of recombination, Molecular mechanism of homologous recombination in eukaryotes, Mating type switching, Site specific recombination and its biological significance.

UNIT -III

Genetic exchange in prokaryotes

Natural transformation in *Bacillus subtilis*, Transformation by inducing artificial competence, Gene linkage and mapping by transformation.

Generalized transduction in T4 bacteriophage, Specialized transduction, homologous recombination with recipient's chromosome, measuring transduction (co-transduction of markers, marker effects, abortive transduction, transduction of plasmids). Applications of transduction.

F-factor mediated Conjugation in *E. coli*, Hfr conjugation and chromosomal transfer, F-prime conjugation and merodiploids, Conjugation of fertility inhibited F-like plasmids, Non conjugative mobilizable plasmids, chromosomal mobilization of non-F plasmids, Interrupted mating and conjugational mapping.

UNIT-IV

Agrobacterium genetics, Restriction Modification Systems, Transposable Elements

Ti plasmid, Interkingdom gene transfer (Key early experiments, vir regulon, protein secretion apparatus, conjugation model of T-DNA transfer, Integration products)

Types of RM systems, Role of RM systems, salient features and insights into evolution of diverse types of Restriction endonucleases and Methyl transferases, Regulation of RM systems.

Types of bacterial transposable elements; Structure, genetic organization and mechanism of transposition of Tn5, Tn3, phage Mu, Tn7, IS911, Integrons, Retrotransposons, conjugative and mobilizable transposons, Assays of transposition.

Reference Books

1. Lewin's Genes X: Jocelyn E. Krebs
2. Molecular Biology of the Gene 6th Edition-Watson et al.
3. Modern Microbial Genetics 2nd Edition-Uldis Streips and Ronald Yasbin
4. Microbial genetics 2nd Edition-Stanley Molay, John Cronan and David Freifelder.
5. Molecular Genetics of Bacteria 3rd Edition-Snyder and Champness.
6. Molecular Genetics: An Introductory Narrative 2nd Edition-Stent and Calender
7. Principles of Genetics 6th Edition- Snustad and Simmons
8. Molecular Biology of the Cell 5th Edition-Alberts et al.

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PG02CMIC03: Immunology

Course Objectives:

The objective of this course is to understand various components of the host immune system; their structure, organization and role in defence mechanism. The student will gain knowledge to understand the operational mechanisms which underlie the host defence system. It would make them clear to understand genetic organization and expression of receptors to show immune response. They will also learn the role of immune system in health and diseases.

Course Learning Outcomes:

Upon successful completion of the course, the student will learn:

Unit 1: Will be able to understand the types of immunity and basic components of immune system; the role played by complement system as an interface between innate and adaptive immunity.

Unit 2: Will be able to understand the genetic organization of the genes meant for expression ofimmune cell receptors and the basis of the generation of their diversity. The principle of antigen-antibody interactions and methods to measure them will become clear to students.

Unit 3: Will be able to understand the importance of MHC molecule in an individual's immunity to various antigens, the mechanism of antigen processing and presentation. They will be able to understand the mechanism of B and T cell activation and memory generation.

Unit 4: The students will gain knowledge about the mechanism of cell mediated immunity.

They will learn about the cytokines, important biopharmaceuticals and their role in modulation of immune response. The students will also learn how body shows different kinds of immune response to different infections.

Contents:

Unit I

- Immunity: Innate and Adaptive, Cells of the Immune system: Haematopoiesis and its regulation
- Cells and organs of the immune system: Primary and secondary lymphoid organs
- Induced Innate immunity: receptors of the innate immunity (TLR and sensing of PAMPs, CLR,RLR and CLR); Inflammatory responses, Natural Killer cells
- Antigens: Immunogenicity versus antigenicity, Epitopes, Haptens.
- Complement system: The Major Pathways of Complement Activation: Classical, alternative and lectin complement pathways, functions of complement, regulation of complement, complement deficiencies, microbial complement evasion strategies

Unit II

- Antibody: Structure of immunoglobulin; classes of immunoglobulins, Signal transduction pathways emanating from the BCR
- The Organization and Expression of Lymphocyte Receptor Genes: Hozumi and Tonegawa's Experiment, Multigene organization of Ig Gene, Mechanism of VDJ recombination, B cell receptor expression: Allelic exclusion,B cell isotype switching and somatic hypermutation; expression of membrane bound and soluble immunoglobulin; T cell receptor genes and expression
- Basics of Antigen-antibody interactions: Immunoprecipitation and agglutination based techniques, Methods to determine affinity of antigen-antibody interactions, Immunofluroscence, FACS

Unit III

- The Major Histocompatibility Complex and Antigen Presentation: The structure and function of MHC molecules, general organization and inheritance of MHC genes, The role and expression Pattern of MHC, Endogenous and exogenous pathway of antigen processing and presentation; presentation of non-peptide antigens.
- B Cell activation: T dependent and T independent B cell responses and memory generation
- T Cell activation: Two signal hypothesis, superantigens, activation and differentiation of T cell into effector and memory cells.T_H1 and T_H2 responses.

Unit IV

- Cell mediated effector response (Generation of effector CTL's, Granzyme and Perforin Mediated Cytolysis, Fas-FasL Mediated Cytolysis, NK cell mediated cytolysis
- Cytokines: properties, receptors, associated diseases, therapeutic applications, cytokine signalling pathways: JAK-STAT and FAS-FASL signalling pathways
- Immune response to infection by viruses, bacteria, fungi and parasite: Mechanism of Immune response and evasion by pathogen

Reference Books

1. Owen, J. A., Punt, J., &Stranford, S. A. (2013). ***Kuby immunology*** (7thEdn). New York: WH Freeman.
2. Murphy, K., & Weaver, C. (2016). ***Janeway's immunobiology*** (9thEdn) Garland Science.
3. Male, D., Brostoff, J., Roth, D., &Roitt, I. (2012). ***Immunology***(8thEdn) *With STUDENT CONSULT Online Access*. Elsevier Health Sciences.
4. Abbas, A. K., Lichtman, A. H., & Pillai, S. (2014). ***Cellular and molecular immunology*** (6thEdn) Elsevier Health Sciences.
5. Relevant review articles / research papers / handouts of latest development in the subject.

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PG02EGEN01: BIOSTATISTICS

Course Objectives:

The course aims to develop competency and expertise in the application of statistical methods applied to biological data obtained in experimental techniques.

Course Learning Outcomes:

Unit 1: Student will be able to know about basic terms and use in biostatistics. They will understand types of data, their organisation and various graphical representation methods to represent data, and will enable students to understand the basic statistics and its importance in research.

Unit 2: Student will be able to calculate various measures of central tendencies, measure of dispersion and measure of kurtosis and skewness and its importance.

Unit 3: To understand the exact method of data analysis for the problem under investigation. Student will be able to perform various hypothesis testing like T-test, F-test, and chi square tests and its application in biological sciences.

Unit 4: Understanding for drawing valid inferences and to plan for future investigations. Student will be able to perform Correlation & regression calculations and its application in Biological sciences. Student will able to perform ANOVA testing.

Contents:

Unit I:
Data Collection and Presentation
Types of Biological Data: Qualitative Data -Nominal, Ordinal, Ranked; Quantitative Data: Discrete and Continuous.
Understanding of Population and sample
Methods of Collection of Data: (i) Experimental Data and (ii) Survey Data- Simple random Sample (with and without replacement), stratified sampling and cluster sampling.
Tables: Frequency Distributions, Relative Frequencies.
Graphical Presentation: Bar charts, Histograms, Frequency Polygons, One way scatter plots, Box plots, two-way scatter plots, line graphs.

Unit II:
Descriptive Statistics
Measures of Central Tendency: Mean, Median and Mode, quartiles, deciles and percentiles (both for raw data and grouped data)
Measures of Dispersion: Range, Interquartile Range, Variance, Standard Deviation and Coefficient of Variation.
Measures of Skewness and Kurtosis.

Unit III:
Statistical hypotheses: Null and Alternative hypotheses.
Statistical Tests: Acceptance region and Rejection Region. Types of errors and power of the test. Goodness of fit tests.
Random Variables: Discrete and Continuous. Some examples from biological sciences.
Probability Distributions: General Normal Distribution, Standard Normal Distribution ; Sampling Distributions- t, chi-square and F distributions.
Significance Tests for Normal Distribution: One sample tests for mean – z test and t-test.
Two sample tests for normal distributions: Tests for means (i) when variances are known (ii) when variances are unknown. Tests for equality of variances.
Paired t-test for equality of means.
Confidence Intervals

Unit IV:
Correlation: Covariance, Calculation of covariance, correlation analysis and correlation Coefficient calculated from ungrouped data.
Regression: Simple linear regressions analysis, regression coefficients, Linear regression line or equation
Analysis of Variance: Completely Randomized Design, Randomized Block Design

References:

- Fundamentals of statistics by S.C. Gupta
- Principles of Biostatistics by Marcello Pagano and Kimberlee Gaurea
- Biostatistics : A Foundation For Analysis in the Health Sciences by Daniel, Wayne (Seventh Edition), Wiley India Pub.

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PG02EGEN02: Forensic Genetics

Course Objectives:
Recent development of forensic genetics through discussion of genetic and statistical issues emerging since the introduction of DNA profiling. DNA profiling has had an enormous impact on forensic science over the past 25 years, by determining whether a person either matches or does not match biological evidence associated with a crime Students develop the skills to interpret the evidence of matching genetic profiles, to perform calculations relevant for parentage determination and the identification of remains, and to consider the implications of familial searching of DNA databases.

Course Learning Outcomes:

Unit 1: Student should be able to know the principles of genetics in forensic medical investigations and explain how these are carried out.

Unit 2: Students gathered information related to human genome projects and DNA Forensic Databases, also understand the Ethical, Legal, and Social Issues Associated with DNA Data banking,

Unit 3: Students should state different types of genetic markers that are used for forensic genetic analysis and critically evaluate and understand problems concerning various types of markers and methods for DNA analyses.

Unit 4: Students would be able to carry out different experiments that are used in forensic genetics and apply statistical calculations for evaluation of results

Contents

Unit I:
Basic of human Genetics, Heredity, Alleles, Mutations and Population Genetics, The concept of Genetics polymorphism, Hardy-Weinberg Law.

Unit II:
Human Genome Project: Introduction, History, Goals, Benefits, Social, Ethical and Legal Issues
DNA Forensic Databases, Ethical, Legal, and Social Issues Associated with DNA Databanking, Benefits of DNA Databanking
Quality control, certification

Unit III:
DNA Profiling: Introduction, History of DNATyping, molecular biology of DNA, variations, polymorphism, DNA Extraction from forensic biology specimens.

DNA typing systems- RFLP analysis, PCR amplifications, sequence polymorphism. Analysis of SNP, YSTR, Mitochondrial DNA, Ancient DNA typing, DNA chips, SNPs.
Forensic Significance/ Applications of DNA profiling: Human, wildlife and agriculture
DNA profiling in India and abroad.
Limitations of DNA profiling.

Unit IV:
DNA Statistics: frequency estimate calculations, interpretations, allele frequency determination.
Paternity/Maternity index, Sibling index, Probability of match.

1. DNAstructure and functions by Richard R. Sinden; Academic Press, Inc. 1994.
2. DNA Profiling and DNA fingerprinting (1999) Edited by Jorg T. Epplen and Thomas Lubjuhn, Birkhauser Verlag, Switzerland.
3. DNA and other Polymorphism in Forensic Science (1990) Henry C. Lee and R.E. Gaensslen; Year book Medical Publishers, Inc.
4. Forensic DNA Profiling Protocols (1998) Patrick J. Lincoln and Jim Thomson; Humana Press, Inc.
5. John M. Butler (2005) Forensic DNA Typing: Biology, Technology, and Genetics of STR Markers Academic Press.
6. Keith In man and Norah Rudin (1997) An Introduction to Forensic DNAAnalysis, CRC Press; NY.
7. Koblinsky et al. (2005) DNA -Forensic and Legal Implications.
8. Saferstein, R. (1982) Science Handbook, Vol. I, II, & III, Prentice Hall New Jersey.
   Kirby : DNA Fingerprinting Technology.

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PG02EGEN03: Toxicology

Course Objectives:

The course will cover basic toxicology and ecotoxicology, including how toxic substances are taken up in the organisms, distributed, biotransformed and excreted, how toxic substances react with biomolecules and downstream consequenses for the organism, as well as knowledge about toxic substances, e.g. metals, organic contaminants and pesticides. The course aims to provide a general view of the topic by bridging human toxicology and ecotoxicology.

Course Learning Outcomes:

Unit 1:

Upon completion of this unit, the student should have an understanding of basic principles, factors and effect of toxic substances in the body parts.

Unit 2:

Students should gained knowledge of mechanisms of action for toxic substances also understand the exposure, uptake, metabolism, distribution and excretion of toxicants.

Unit 3:

Student should know different categories of toxic substances/ pesticides.

Unit 4:

Students would be able to understand heavy metal toxicity.

Contents

Unit I

- Definition and scope of toxicology: Eco-toxicology and its environmental significance.
- Toxic effects : Basic for general classification & nature. Dose-Response relationship: Synergism and Antagonism, Determination of ED50 & LD50. Acute and Chronic exposures.
- Factors influencing Toxicity. Pharmacodynamics & Chemodynamics, dose conversion between animals and human
- Diagnosis of toxic changes in liver and kidneys : Metabolism of drugs: paracetamol and asprin with their toxic effects on tissues.

Unit II

- Xenobiotics Metabolism: Absorption & distribution. Phase I reactions. Oxidation, Reduction, Hydrolysis and Hydration. Phase II reaction/Conjugation: Methylation, Glutathione and amino acid conjugation. Detoxification.
- Biochemical basis of toxicity: Metabolism of Toxicity : Disturbances of Exitable membrane function. Altered calcium Homeostasis. Covalent binding of cellular macromolecules & Genotoxicity. Tissue specificity of Toxicity.
- Toxicity testing: Test protocol, Genetic toxicity testing & Mutagenesis assays: In vitro Test systems – Bacterial Mutation Test, Ames Test, Fluctuation Tests, *In vivo* Mammalian Mutation tests –DNA repair assays, Chromosome damage test, Evaluation of Apoptosis and necrosis.

Unit III

- Pesticide toxicity: Insecticides : Organochlorines, Anti cholinesterases – Organophosphates and Carbamates, Fungicides. Herbicides, Environmental consequences of pesticide toxicity.
- Biopesticides.
- Food Toxicity: Role of diet in cardio-vascular disease and cancer. Toxicology of food additives.

Unit IV

- Metal Toxicity: Toxicology of Arsenic, mercury, lead and cadmium. Environmental factors, affecting metal toxicity effect of light, temperature & pH.
- Air pollution: Common air Pollutant & their sources. Air pollution & ozone. Air pollution due to chlorofluorocarbons (CFCS) and asbestos.

Reference Books:

1. Klaassen, C. D (8th Eds.). (2013). *Casarett and Doull's toxicology: the basic science of poisons* . New York: McGraw-Hill.
2. John A. Timbrell (4th Edn) (2008) Principles of biochemical toxicology. Taylor & Francis Ltd, London,.
3. Smart, R. C., & Hodgson, E. (4th Eds.). (2013). Molecular and biochemical toxicology. John Wiley & Sons.
4. Relevant review articles / research papers / handouts of latest development in the subject.

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PG02EGEN04: Population Genetics

Course Objectives:

The course will enable the students to understand the importance of genetics at population level. A thorough understanding of the population genetics is necessary to comprehend the evolutionary processes. This course will make the students to understand the forces that have an impact on levels of genetic variations in natural and/or experimental populations for both qualitative and quantitative traits. Various type of DNA markers and the range of tools for their detection to enable advanced studies on molecular population genetics. Population genetics helps in identifying genetic diversity based on the statistical comparisons.

Various factors such as mutation, migration, selection and genetic drift alters gene and genotype frequency. This course are very much useful for the identification of genetic variabilities within the populations. Hardy – Weinberg laws are useful for the identification of lethal alleles in the populations.

Course Learning Outcomes:

Unit 1: Deals with Concept and theories of evolution, Hardy-Weinberg law and its applications in calculating gene and genotype frequencies.

Unit 2: Discussing factors influencing gene and genotype frequencies such as mutation, migration, selection and genetic drift.

Unit 3: Deals with the Molecular population genetics, Molecular evolution (neutral theory, punctuated equilibrium), DNA-based phylogenetic trees, Molecular phylogenetics of *Homo sapiens*

And Molecular clock.

Unit 4: students should understand various selection and breeding Methods in animals. It also provides informations on Inbreeding and assortative mating and construction of Path diagram.

Contents

PG02EGEN04: Population Genetics

UNIT - I

Concept and theories of evolution

Microevolution in Mendelian population

Mendelian Population

Allele frequencies and genotype frequencies

Hardy-Weinberg equilibrium and conditions for its maintenance

Chromosomal, DNA and allozyme polymorphism in natural population

UNIT - II

Deviations from Hardy-Weinberg Equilibrium

Mutation

Selection (Types of selection, selection coefficient, selection in natural populations)

Genetic drift

Migration

UNIT - III

Molecular population genetics

Molecular evolution (neutral theory, punctuated equilibrium)

DNA-based phylogenetic trees

Molecular phylogenetics of *Homo sapiens*

Molecular clock

UNIT - IV

Selection and Breeding Methods in animals

Line Breeding

Ordinary Breeding

Cross Breeding

Artificial selection

Nonrandom breeding

Inbreeding and assortative mating

Path diagram construction and inbreeding coefficient

Reference Books:

- Population Genetics by Rao and Nallari
- Genetics of Populations by Philip W Hedrick
- Genetic Variation and its Maintenance Roberts & DeStefano

PG02CGEN04: Practicals based on PG02CGEN01and PG02CGEN02

List of Practicals

1. Whole blood culture for chromosome preparation

2. To prepare and perform Giemsa staining
3. To perform GTG banding
4. To perform C banding
5. To perform NOR banding
6. To identify banded human chromosomes
7. Conjugation in *E. coli*.
8. Transduction in *E. coli*
9. Transposon assay
10. β-galactosidase induction and assay
11. Isolation and enumeration of bacteriophage
12. Demonstration of Lysogeny

PG02CGEN05: Practicals based on PG02CGEN03 and PG02EGEN01

List of Practicals

To perform total WBC count using Haemocytometer

To Perform Differential Leukocyte count

To learn the technique of Ouchterlony Double Diffusion

To learn the technique of Radial Immunodiffusion

To learn the technique of Immunoelectrophoresis

To perform sandwich Dot ELISA test for antigen

To learn the technique of latex -agglutination

To separate lymphocytes by density gradient method

To convert ungrouped data in to grouped data using Sturge's formula.

To study representation of data by one dimensional diagram.

To study representation of data by two dimensional diagram.

To study representation of data by means of graphs. (Histogram & frequency polygon).

To study the data representation by graphs (Frequency polygon & frequency curve).

To study how to calculate descriptive statistics for the given data. (Mean mode, median, standard deviation and mean deviation).

To study the concept of permutation and combination in practical counting problems.

To study the concept of normal distribution and apply it to practical problems.

To study the concept of estimation (point estimation and interval estimation).

To apply the concept of skewness in the field of biosciences.

To apply the concept of F- test for biological problems.

To apply the concept of χ^2 – test for biological problems.