



**SCHOOL OF SCIENCES-ZOOLOGY**

**Syllabus: M.Sc. Zoology Semester-III**

**DSC-7: Medical Genetics and Biotechnology (Theory)**

Semester: III	Paper: Discipline Specific Course
Credit: 04	Paper Title: <b>Medical Genetics and Biotechnology (Theory)</b>
Instruction: 4hr/Wk	Paper Code: MSZY301CCT
Internal Assessment: 30	Semester Exam marks: 70
Course Objective	To give an understanding about inheritance principles, technology development and its applications in the field of medicine.
Course Outcome	Basic understanding of the modes of inheritance, mechanism of sex determination and genetic diseases. Acquiring knowledge about recent advances in molecular diagnosis of infectious and non – infectious diseases and therapeutics
<b>UNIT-I</b> Molecular & Biochemical Basis of Mendelian Inheritance:	1.1:Inheritance Patterns - Autosomal Dominant (Hypercholesterolemia), Autosomal Recessive (Cystic fibrosis), X-Linked Dominant (Vit-D resistant rickets), X-Linked Recessive (Duchene Muscular dystrophy), Y-Linked (hypertrichosis in man).
	1.2: Biochemical Basis of Genetic Disorders – Disorders of enzyme defects in Amino acid metabolism, Lipid metabolism, and Carbohydrate associated disorders, Defects in Purine & Pyrimidine metabolism, Lysosomal storage disorders.
	1.3:Chromosomal Disorders – Cri-du-chat syndrome, Down’s syndrome, Patau syndrome, Edwards’s syndrome, Turner’s syndrome, Klinefelter’s syndrome, Uniparental Inheritance (Praderwili&Angelman’s syndrome).
	1.4:Mechanism of Dominance and Recessiveness, Concept of allelic and locus heterogeneity
<b>UNIT-II</b> Non Mendelian Inheritance:	2.1: Sex chromosome, Sex determination in Human (XX-XY), Sex Differentiation, Mosaicism (G6PD Deficiency), Sex Limited and Sex Influenced traits (Pattern baldness in males).
	2.2:Co-dominance, Multiple alleles (ABO blood groups), Lethal alleles (Achondroplasia and Huntington’s disease), Penetrance and Expressivity (polydactyly), Pleiotrophy (Sickle cell anaemia), Phenocopy (Thalidomide syndrome), Mitochondrial Inheritance (Leber Optic Neuropathy).
	2.3:Gene - Gene Interaction – Dominant and Recessive Epistasis (Bombay phenotype and Deaf and Dumb mutism)
	2.4: Multifactorial Inheritance & Quantitative Traits. Hypertension and Diabetes Mellitus Threshold model, Heritability
<b>UNIT-III</b> Diagnosis of infectious and non-infectious diseases:	3.1: Techniques for Diagnosis of Single Gene and Infectious Diseases – PCR, Nucleic acid hybridisation techniques, Sequencing based methods. DNA/RNA based diagnosis of Hepatitis, CML – Bcr/Abl, HIV - CD 4 receptor and Covid by RT PCR
	3.2: Techniques for Diagnosis of Chromosomal Disorders – Karyotyping, FISH, SKY.
	3.3:Prenatal Diagnostic Method – Invasive techniques – Amniocentesis, Fetoscopy, Chorionic Villus Sampling, Non-invasive Technique-Ultrasonography, X-ray, TIFFA, NIPT, Double marker, Triple marker, Quadruple marker test.
	3.4: Prenatal prevention and management of genetic diseases - Preimplantation genetic Diagnosis, In vitro fertilisation, Intracytoplasmic Sperm Infusion.
<b>UNIT-IV</b> Biologics & Nanomedicine:	4.1:DNA/RNA based therapy – Ex vivo, In vivo, In situ gene therapy strategies Gene augmentation, Prodrug therapy, Ribozymes, Protein Aptamers, Intrabodies, Triple Helix Forming Oligonucleotides, Antisense Therapy



	4.2: Cell and Tissue Engineering: Encapsulation Technology and Therapeutics (Diabetes, Hypothyroidism, and Hemophilia) Bio artificial organs, Artificial cells for Hemophilia, Phenylketonuria, and Diabetes.
	4.3: Gene Products – Humulin, Erythropoietin, Growth Hormone/Somatostatin, tPA, Interferon and Recombinant Vaccines
	4.4: Nano medicine – Nanoparticles, Nano devices – medical micro robotics, Nano robotics, Microbiovers, Nano medicine and Nano surgery – for cancers and neurological disorders.

### Medical Genetics & Biotechnology (Practical)

Semester-III	Paper: Discipline Specific Course (Practical)
Credits: 2	Paper title: <b>Medical Genetics &amp; Biotechnology Lab</b>
Instructions: 4h/wk	Paper code: MSZY301CCP
IA Marks: 15	Semester Exam Marks: 35
Course Objective	Practical approach and skill development in the basics of genetics and medical biotechnology.
Course Outcome	Construction of pedigrees for identifying the modes of inheritance and estimating recurrence risk. Skill development in cell culturing, human chromosome analysis and polymerase chain reaction.
<b>Practicals</b>	1: Pedigree Construction - Mode of Inheritance & Pedigree Analysis – Risk assessment using Baye's Theorem
	2: Heritability & Linkage Analysis – Recombination frequency
	3: Cell culturing and Karyotyping
	4: PCR based mutation detection (ACE gene polymorphism)

#### References Books:

1. Gardner. et.al., Principles of Genetics, Wiley (8<sup>th</sup> ed.)
2. Griffith. et.al., Introduction to Genetic Analysis, WH Freeman & Co (12<sup>th</sup> Edition)
3. Prajapat. R. et.al., Fundamentals of medical Biotechnology, Nova Science Publishers Inc
4. H.T. Robert, Principles of Genetics, McGraw Hill Education
5. Brown. T.A., Gene Cloning and DNA Analysis, Wiley-Blackwell.
6. Turnpenny. P., Elements of Medical Genetics, Elsevier (16<sup>th</sup> ed.)
7. Satyanarayana. U., Biotechnology, Books & Allied Ltd.
8. Nussbaum. R.L., Medical Genetics in Medicine, Elsevier Health – INR (8<sup>th</sup> ed.)



**DSC-8: Developmental Biology (Theory)**

Semester: III	Paper: Discipline Specific Course
Credit: 04	Paper Title: <b>Developmental Biology (Theory)</b>
Instruction: 4hr/Wk	Paper Code: MSZY302CCT
IA: 30	Semester Exam marks: 70
<b>Course Objective</b>	This course will introduce the principles and concepts of genetics, epigenetics, metabolism, growth, morphogenesis and differentiation in developing organisms.
<b>Course Outcome</b>	Analyze and discuss the genetic, cellular, and tissue control of development, Compare and contrast developmental strategies of model organisms, Read primary literature critically and explain strengths and weaknesses
<b>UNIT-I Gametogenesis and early embryogenesis</b>	1.1: Gametogenesis, fertilization and early development: Production of gametes
	1.2: Cell surface molecules in sperm-egg recognition in animals; polyspermy, zygote formation.
	1.3: Cleavage, blastula formation, embryonic fields.
	1.4: Gastrulation and formation of germ layers in animals.
<b>UNIT-II Morphogenesis and organogenesis</b>	2.1: Embryogenesis, concept and functions of primary organizer, neural induction.
	2.2: Differential gene expression during formation of germ layers.
	2.3: Morphogenesis and organogenesis in animals: axes and pattern formation in Amphibia and chick,
	2.4: Role of genes in pattern formation in amphibian and chick (body axes)
<b>UNIT-III Post embryonic development</b>	3.1: Organogenesis: eye lens induction, limb development
	3.2: Regeneration in vertebrates; differentiation of neurons.
	3.3: Post embryonic development: larval formation, metamorphosis.
	3.4: Environmental regulation of normal development.
<b>UNIT-IV Sex Determination</b>	4.1: Chromosomal Sex Determination: The Mammalian Pattern: Primary and Secondary Sex Determination, Primary Sex Determination in Mammals
	4.2: The developing gonads, Mechanisms of mammalian primary sex determination: The ovary pathway: Wnt4 and R-spondin1, The testis pathway.
	4.3: Environmental Sex Determination: Temperature-Dependent Sex Determination in Reptiles
	4.4: The aromatase hypothesis for environmental sex determination, Estrogens, aromatase, sex reversal, and conservation biology, location-Dependent Sex Determination



### Developmental Biology (Practical)

Semester: III	Paper: Discipline Specific Course
Credit: 02	Paper Title: <b>Developmental Biology Lab</b>
Instruction: 4hr/Wk	Paper Code: MSZY352CCP
Internal Assessment: 15	Semester Exam marks: 35
<b>Course Objective</b>	Practical approach and skill development in the basics of genetics and medical biotechnology.
<b>Course Outcome</b>	Construction of pedigrees for identifying the modes of inheritance and estimating recurrence risk. Skill development in cell culturing, human chromosome analysis and polymerase chain reaction.
<b>Practical</b>	1: Study of developmental stages of Frog - whole mounts and sections through permanent slides – cleavage stages, blastula, gastrula, neurula, tail bud stage, tadpole external and internal gill stages.
	2: Study of the different types of placenta- histological sections through permanent slides or photomicrographs.
	3: Preparation and examination of permanent slides of gametes - frog/rat - sperm and ova.
	4: Study of fate maps with the help of charts and other sources

#### References Books:

1. Slack.J.M.W., Essential Developmental Biology, Wiley-Blackwell (3<sup>rd</sup> ed.)
2. Wolpert.L., Principles of Development, Oxford University Press(4<sup>th</sup> ed.)
3. Gilbert.SF., Developmental Biology, Sinauer Associates (11<sup>th</sup> ed.)
4. Subramoniam, T., (2013). Molecular Developmental Biology, Alpha Science Intl Ltd (2<sup>nd</sup> ed.)
5. Balinsky. B.I., An Introduction to Embryology, Cengage Learning India (5<sup>th</sup> ed.)
6. Kalthoff. K., Analysis of Biological Development, II Edition, McGraw-Hill Publishers (2<sup>nd</sup> ed.)

### DSC-9: Endocrinology (Theory)

Semester: III	Paper: Discipline Specific Course
Credit: 04	Paper Title: <b>Endocrinology (Theory)</b>
Instruction: 4hr/Wk	Paper Code: MSZY303CCT
Int. Asst.: 30	Semester Exam marks: 70
Course Objective	To inculcate the awareness and impart knowledge of the control and regulation of body functions and the maintenance of homeostasis involving the endocrine and neuro-endocrine system
Course Outcome	Students will gain knowledge of the distribution, morphology/anatomy of endocrine glands and their role in physiology of reproduction. Upon completion of the course, the student will be able to: Describe how the endocrine system functions and the process hormonal regulation and their dysregulations could be understood.
<b>UNIT-I</b> History and Scope of Endocrinology	1.1: Introduction, Brief History and principle of endocrinology; Chemical integration and endocrine regulation of homeostasis
	1.2: Classification of hormones (peptides, steroid hormones, amino acid derivatives and fatty acid derivatives), Chemical nature of hormones
	1.3: Biosynthesis of hormones (hormonogenesis), Mechanism of hormones secretions; Regulation of hormone production (Types of regulators)
	1.4: Transport and distribution, Mechanism of hormones action, Signalling (autocire/paracrine and endocrine).
<b>UNIT-II</b> Endocrine system & Glands-I	2.1: General organization of endocrine system, interrelationship of endocrine glands and secretions, cascades and feedback loops in endocrine system
	2.2: Pituitary gland: Anterior pituitary- structural organization, characteristics and hormone secretion, function of hormones, control over gonadal function and development, hypothalamic control
	2.3: Pituitary gland: Posterior pituitary (neurohypophysis)- structural organization, neurons and hormones, neuro-hypophyseal hormones, mechanism of secretion and control over gonadal function and development
	2.4: The hypothalamo- hypophyseal axis, Interrealationship of hypothalamus and pituitary gland, concepts of feed-back inhibition and feed-forward activation, synthesis and storage of oxytocin and vasopressin
<b>UNIT-III</b> Endocrine system & Glands-II	3.1: Thyroid gland: structural organizations, synthesis, secretion and metabolism of thyroid hormones, metabolic effects of thyroid, effects on reproduction and its functions.
	3.2: Parathyroid Glands- position, morphology and structural organization, synthesis, secretion and metabolism of parathyroid hormone and its functions
	3.3: Thyroid hormones- synthesis, secretion and transport. Physiological and metabolic functions of thyroid hormones, Thyroid hormone related disorders. Parafollicular C-cells
	3.4: Adrenal glands: structural organizations of adrenal glands, adrenal chromaffin tissue and cell types, hormones of adrenal glands, cortical and medullary hormones secretion and their functions, control of synthesis physiological role of cortical hormones and action, synthesis, and actions of catecholamines,

<b>UNIT-IV</b> Neuro-endocrine system & other Glands	4.1:Neuro-endocrine system and its regulation: organization and homeostatic role, major neuro-endocrine axes and functions, hypothalamo-hypophyseal interactions with the gonads, adrenal and other endocrine organs
	4.2:Neuroendocrine organs and cells including the thymus, kidneys, liver, prostate, pineal, skin, cervix, ovaries and testicles, neuro-endocrinology of reproduction
	4.3:Endocrine Pancreas: Structure of pancreas, pancreatic hormones and their functions, structure and cell types, Islets of Langerhans, secretion and metabolism of Insulin, glucagon and other pancreatic hormones, cellular actions of Insulin and Glucagon, biosynthesis and functions
	4.4: Gastro-intestinal hormones: endocrine cells, gastrin, CCK and mechanism of secretin, Gonadal hormones: male and female sex steroids: structure and functions.

### Endocrinology (Practical)

Semester: III	Paper: Discipline Specific Course
Credit: 02	Paper Title: <b>Endocrinology Lab</b>
Instruction: 4hr/Wk	Paper Code: MSZY353CCP
Int. Assessment: 15	5 Semester Exam marks: 35
Course Objective	It aims to develop the better understanding in students through demonstration and practical education to understand the topics.
Course Outcome	Through practical the students will understand how things actually work. Outcomes can be categorised as hands on training.
<b>Practical</b>	1:Histology study of of endocrine glands: pineal, pituitary, thyroid, parathyroid, adrenal, pancreas
	2: Permanent slide preparations of above endocrine glands (one slide each to be submitted at the time of practical examination for Islets of Langerhans in chick or fish)
	3: Identification of Structure, folliculogenesis in fish ovary
	4:Demonstration of following technique: Hypophysectomy in fish. Paper chromatographic separation of gonadal hormones.

#### References Books:

1. Gorbman. A., Comparative Endocrinology, John Wiley & Sons.
2. Norris. D.O., Vertebrate Endocrinology, Lippincott Williams and Wilkins.
3. Bentley. P.J., Comparative Vertebrate Endocrinology, Cambridge University Press (3<sup>rd</sup> ed.)
4. Gardner. D.g., Basic & Clinical Endocrinology, McGraw Hill/Medical, (10<sup>th</sup> ed.)
5. Wilkinson. M. & Brown. R.E., An Introduction to Neuroendocrinology, Cambridge University Press (2<sup>nd</sup> ed.)
6. DeGroot L. J. & Jameson J.L., Endocrinology, Saunders Elsevier Press (5<sup>th</sup> ed.)

### GE-1: Fundamental Concepts of Genetic Counselling (Theory)

Semester: III	Paper: Generic Elective
Credit: 04	Paper Title: Fundamental Concepts of Genetic Counselling
Instruction: 4hr/Wk	Paper Code: MSZY301GET
Int. Assessment: 30	Semester Exam marks: 70
Course Objective	To understand basic unit of inheritance and its association with disorders, diagnosis for estimation of recurrence risk in families and population.
Course Outcome	Awareness about practical scenarios and dilemmas faced in genetic counselling.
<b>UNIT-I</b> Basic Principles of Inheritance	1.1: Genome and Gene organisation.
	1.2: Cell division and Gametogenesis.
	1.3: Inheritance of Traits – Pattern of Inheritance in the Families.
	1.4: Sex Determination.
<b>UNIT-II</b> Genetic Basis of Disorders	2.1: Chromosomal Syndromes
	2.2: Single Gene Disorders
	2.3: Inborn Errors of Metabolism
	2.4: Complex Disorders
<b>UNIT-III</b> Introduction to Genetic Counseling	3.1: Definition, Types, Indications for Genetic Counseling.
	3.2: Premarital, Prenatal and Postnatal Diagnosis of Genetic Diseases.
	3.3: Recurrence risk calculation by probability theory and Bayes' theorem.
	3.4: Skills of Genetic Counsellor in Genetic Counseling.
<b>UNIT-IV</b> Dilemmas in Genetic Counseling	4.1: Psychological Aspects of Genetic Counseling.
	4.2: Scientific Issues and Outcomes in Genetic Counseling.
	4.3: Ethical Dilemmas in Genetic Clinic and Public Interest.
	4.4: Legal and Social Dilemmas in Genetic Counseling.

#### References Books:

1. Gupta. P.K., Genetics, Rastogi Publications (5<sup>th</sup> ed.)
2. Veach. P.M. et. al., Facilitating the Genetic Counseling Process, A Practical Manual, Springer-Verlag New York Inc (2003<sup>rd</sup> ed.)
3. Harper. P.S., Practical Genetic Counseling, Butterworth-Heinemann Ltd (3<sup>rd</sup> ed.)
4. Verma P.S., & Agarwal V.K., Cell Biology, Genetics, Evolution & Ecology, S Chand (Reprint 2006 ed.)