

# **Scheme and Syllabus**

**For**

## **M. Sc. Zoology (CBCS)**

**Applicable from Session 2021-2022 to onwards**

**Department of Zoology**

**School of Life Sciences**

**Guru Ghasidas Vishwavidyalaya, Bilaspur (CG)**

*Bhary*

*S.K.*

*Devi*

**Post Graduate Program: M. Sc. Zoology (CBCS)**  
**Offered by the Department of Zoology, School of Life Sciences**

1. Name of the Program : Master of Science in Zoology
2. Specializations available : Biochemistry and Molecular Biology,  
Fish Biology,  
Mammalian Reproductive Physiology and Endocrinology, and  
Toxicology.
3. Program Specifications  
School of studies: School of Life Sciences  
Department: Department of Zoology  
Program: M.Sc. in Zoology  
Date of approval in Board of Studies: 24/12/2021
4. Mode of study: Full time (semester system)  
Class room teaching; experiential learning; tutorials; project  
assignments and dissertation work.

**Purpose of the Program:**

The Master of Science degree program in Zoology provides students the opportunity to enhance their knowledge and competence in the diverse field of animal science and encourages students to get indulged in the subject. Another focus of this program is to motivate students towards research. Students are encouraged to get involved in dissertation projects under the guidance of faculty mentors that address topics related to animal health, environment, nutrition, physiology, production, and behavior. The attainment of a master's degree also qualifies students to pursue further specialized training and gain entrance to professional schools, or to pursue a doctorate.

**Learning outcomes:**

- Students will be able to identify the major groups of organisms with an emphasis on animals and be able to classify them within a phylogenetic framework.
- Students will be able to compare and contrast the characteristics of animals that differentiate them from other forms of life.
- Students will be able to use the evidence of comparative biology to explain how the theory of evolution offers the only scientific explanation for the unity and diversity of life on earth.
- Students will be able to understand the concepts of physiology, nutrition, health and economics with reference to animals.
- Students will be able to explain the mechanisms and role of reproductive physiology, Immunology, toxicology & neurobiology in health & disease
- Students will be able to apply the scientific method to questions in biology by formulating testable hypotheses, gathering data that address these hypotheses, and analyzing those data and will be able to demonstrate critical thinking and problem solving skills in Biostatistics course.
- Students will be able to explain how organisms function at the level of the gene, genome, cell, tissue, organ and organ-system.
- Students will be able to demonstrate proficiency in the experimental techniques and methods of analysis appropriate for their area of specialization within biology.

**Semester-wise Theory Papers/ Practical  
Masters of Science in Zoology (CBCS)  
Department of Zoology, School of Life Science**

Course Opted	Course Code	Name of the Course	T-L-D /Week	Credits	CCA	ESE	Total
<b>Semester – I<sup>st</sup></b>							
CC 1	ZOPATT1	Comparative Anatomy of Vertebrates	T-3	3	30	70	100
CC 1	ZOPALT1	Comparative Anatomy of Vertebrates	L-4	2	30	70	100
CC 2	ZOPATT2	Cell Biology	T-3	3	30	70	100
CC 2	ZOPALT2	Cell Biology	L-4	2	30	70	100
CC 3	ZOPATT3	Endocrinology	T-3	3	30	70	100
CC 3	ZOPALT3	Endocrinology	L-4	2	30	70	100
OE 1	ZOPATO1	To be drawn from the pool of OE	T-3	3	30	70	100
OE 1	ZOPALO1	To be drawn from the pool of OE	L-4	2	30	70	100
	<b>*Certificate</b>	UACE, VAC, CC, OCC and others offered by university					
			<b>28H/W</b>	<b>20</b>	<b>240</b>	<b>560</b>	<b>800</b>
<b>Semester II<sup>nd</sup></b>							
CC 4	ZOPBTT1	Biochemistry and Molecular Biology	T-3	3	30	70	100
CC 4	ZOPBLT1	Biochemistry and Molecular Biology	L-4	2	30	70	100
CC 5	ZOPBTT2	Basic Mammalian Physiology	T-3	3	30	70	100
CC 5	ZOPBLT2	Basic Mammalian Physiology	L-4	2	30	70	100
CC 6	ZOPBTT3	Animal behavior	T-3	3	30	70	100
CC 6	ZOPBLT3	Animal behavior	L-4	2	30	70	100
DSE: 1	ZOPBTD1	Molecular Genetics	T-3	3	30	70	100
DSE: 1	ZOPBLD1	Molecular Genetics	L-4	2	30	70	100
RM	ZOPBTA1	Research Methodology	T-2	2	30	70	100
	<b>*Certificate</b>	UACE, VAC, CC, OCC and others offered by university					
			<b>30H/W</b>	<b>22</b>	<b>270</b>	<b>630</b>	<b>900</b>
<b>Semester III<sup>rd</sup></b>							
CC 7	ZOPCTT1	Developmental Biology	T-3	3	30	70	100
CC 7	ZOPCLT1	Developmental Biology	L-4	2	30	70	100
CC 8	ZOPCTT2	Regulatory Mammalian Physiology	T-3	3	30	70	100
CC 8	ZOPCLT2	Regulatory Mammalian Physiology	L-4	2	30	70	100
CC 9	ZOPCTT3	Evolution, Environmental Biology and Sustainable Development	T-3	3	30	70	100
CC 9	ZOPCLT3	Evolution, Environmental Biology and Sustainable Development	L-4	2	30	70	100
DSE: 2	ZOPCTD1	Brain function and Mental Awareness	T-3	3	30	70	100
DSE: 2	ZOPCLD1	Brain function and Mental Awareness	L-4	2	30	70	100
	<b>*Certificate</b>	UACE, VAC, CC, OCC and others offered by university					
			<b>28H/W</b>	<b>20</b>	<b>240</b>	<b>560</b>	<b>800</b>
<b>Semester IV<sup>th</sup></b>							
CC 10	ZOPDTT1	Biotechniques	T-3	3	30	70	100

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CC 10	ZOPDLT1	Biotechniques	L-4	2	30	70	100
DSE: A	ZOPDTD1	Biochemistry of Intermediary Metabolism and Enzymology	T-3	3	30	70	100
DSE: A	ZOPDLD1	Biochemistry of Intermediary Metabolism and Enzymology	L-4	2	30	70	100
DSE: A	ZOPDTD2	Molecular Biology of Information Pathway: Nucleic Acids	T-3	3	30	70	100
DSE: A	ZOPDLD2	Molecular Biology of Information Pathway: Nucleic Acids	L-4	2	30	70	100
DSE: B	ZOPDTD3	Neuroendocrinology, Non-Classical Hormones and Signaling	T-3	3	30	70	100
DSE: B	ZOPDLD3	Neuroendocrinology, Non-Classical Hormones and Signaling	L-4	2	30	70	100
DSE: B	ZOPDTD4	Mammalian Reproduction, Fertility and Sterility	T-3	3	30	70	100
DSE: B	ZOPDLD4	Mammalian Reproduction, Fertility and Sterility	L-4	2	30	70	100
DSE: C	ZOPDTD5	Fish Anatomy, Physiology and Biotechnology	T-3	3	30	70	100
DSE: C	ZOPDLD5	Fish Anatomy, Physiology and Biotechnology	L-4	2	30	70	100
DSE: C	ZOPDTD6	Fish Culture, Capture Fishery and Fish Pathology	T-3	3	30	70	100
DSE: C	ZOPDLD6	Fish Culture, Capture Fishery and Fish Pathology	L-4	2	30	70	100
DSE: D	ZOPDTD7	Mechanism of Toxicity	T-3	3	30	70	100
DSE: D	ZOPDLD7	Mechanism of Toxicity	L-4	2	30	70	100
DSE: D	ZOPDTD8	Reactive Metabolites and Defense System in Biology	T-3	3	30	70	100
DSE: D	ZOPDLD8	Reactive Metabolites and Defense System in Biology	L-4	2	30	70	100
Dissertation	ZOPDDD1	Based on DSE Elected (I/II/III/IV)	D-14	7	80	120	200
	*Certificate	UACE, VAC, CC, OCC and others offered by university					
			<b>35H/W</b>	<b>22</b>	<b>260</b>	<b>540</b>	<b>800</b>

1. Discipline Specific Electives (DSE) in forth semester for each session will be offered to students on the basis of availability of faculty and infrastructure.
2. Offering of DSE in any particular session will be decided after a formal meeting of all faculty members of Department of Zoology.
3. Each student may study any one out of the given electives (A, B, C and D). Elective papers will be distributed among the students on the basis of merit/choice.
4. The project work/dissertation will be carried out in the field of respective elective papers opted by the students.
5. Open Elective Courses will be offered by department in first semester is fundamental of public health / Applied Zoology.

**Abbreviations:**

CC= Core Course

DSE= Discipline Specific Electives

DSE: II = Mammalian Reproductive Physiology and Endocrinology

DSE: III= Fish Biology

CCA= Continuous Comprehensive Assessment

UACE= University Additional Credit Electives,

CC= Certificate Courses,

OE= Open Elective

DSE: I= Biochemistry and Molecular Biology

DSE: IV= Toxicology

ESE= End-Semester Examinations

VAC=: Value Added Course

OCC=: Online certificate Courses

**Prof. S K Prasad**

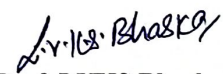
**(External Expert)**

  
**Dr. Rohit Seth**

**(Member)**

  
**Dr. S K Verma**

**(Member)**

  
**Prof. LVKS Bhaskar**

**(HOD)**

## Department of Zoology, GGV, Bilaspur (CG)

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### POs Post-Graduate Programme

<b><u>PO1</u></b>	<b>Knowledge:</b> Knowledge will be provided on basics and advance fields of the core and applied disciplines to fulfil the professional requirements
<b><u>PO2</u></b>	<b>Critical Thinking:</b> Develop critical thinking on appropriate knowledge of living beings/ organisms, non-living components and environmental basis of life, which will enable students for critical analysis of day-to-day problems.
<b><u>PO3</u></b>	<b>Skill &amp; Application Development:</b> Skill based knowledge on theoretical and methodological understandings of use of different descriptive and inferential statistical tools and techniques for application of biological materials in food, health, medicine & Environment for sustainable development of the society.
<b><u>PO4</u></b>	<b>Inter-disciplinary &amp; Multi-disciplinary Approach:</b> Understanding of the vital connections of flora, fauna and the physical environment so is to enable to integrate and synthesized
<b><u>PO5</u></b>	<b>Ethics:</b> Internalization of and sensitiveness to sound professional ethics for use in day-to-day life in the society.
<b><u>PO6</u></b>	<b>Problem Solving &amp; Employability:</b> Special skill through vocational trainings, field visits, entrepreneurial and career development approach to develop capability to handle various problems and development of scientific temperament in research and development issues in the society.

### PSOs M.Sc Zoology Programme

<b><u>PSO1</u></b>	To provide the knowledge about the mechanisms involved in evolutionary life processes from basic up to the molecular level for understanding relationship of variations in phenotypic classes of animals and their phylogenetic positions.
<b><u>PSO2</u></b>	To develop analytical skills in research methodology and assessment techniques using bioinformatics and biostatistical tools and strategies to manipulate the same in the benefit of the mankind.
<b><u>PSO3</u></b>	To develop proficiency in biochemistry and molecular biology, in wide range of disciplines such as physiology, health sciences, environmental management involving teaching and Research.

**SEMESTER I  
CORE 1**

**ZOPATT1: COMPARATIVE ANATOMY OF VERTEBRATES**

**Course outcome**

1. Study origin, integument, and skeletal system in vertebrates.
2. Explore the structure and function of the digestive system.
3. Understand respiratory and circulatory systems in vertebrates.
4. Examine the urogenital system and reproductive organs.
5. Study the nervous system and its evolution in vertebrates.

Develop and understand of the application of comparative anatomy in current scientific method/ literature.

**Course Outcomes and their mapping with Programmed Outcomes:**

CO	PO						PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	2	2	1	1	2	2	1	2
CO2	3	2	2	1	1	2	2	1	2
CO3	3	2	2	1	1	2	2	1	2
CO4	3	2	2	1	1	2	2	1	2
CO5	3	2	2	1	1	2	2	1	2

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

**Unit I: Origin, integument and skeletal system:** Origin of chordates and vertebrates; Development, structure and function of vertebrate integument and its derivatives (gland, scale, feathers and hair); Axial and appendicular skeleton of vertebrates and their modifications; Comparative account of jaw suspensorium and vertebral column.

**Unit II: Digestive system:** General structure of digestive system in vertebrates; Modifications in relation to feeding habit, Length and surface area, internal folds, supplementary diverticulae; Accessory digestive glands; Comparative anatomy of alimentary canal in vertebrates, Dentition.

**Unit III: Respiratory and Circulatory system:** Characters of respiratory tissue; Comparative account of respiratory organs in vertebrates; Evolution of heart, aortic arches and portal systems in vertebrates; Blood and its circulation in different vertebrate groups.

**Unit IV: Urogenital system:** Types and evolution of kidney tubules in different vertebrate groups; Urinary duct and bladder; General plan of gonads; Accessory reproductive organs in different group of vertebrates.

**Unit V: Nervous system:** Comparative account of the brain in relation to its functions in vertebrates; Comparative anatomy of spinal cord, peripheral and autonomous nervous system in vertebrates; Evolution and anatomy of electroreception and lateral line system.

### **Books Recommended**

1. Hildebrand (1995) Analysis of Vertebrate Structure, John Wiley.
2. Kotpal (2003) Modern Text Book of Zoology Vertebrates, Rastogi Publications.
3. Nigam (1983) Biology of Chordates, S Chand.
4. Romer and Parsons (1986) The Vertebrate Body, 6<sup>th</sup> Ed. Saunders.
5. Saxena S and Saxena RK (2008) Comparative Anatomy of Vertebrates, 2<sup>nd</sup> Ed.
6. Kent GK and Carr RK (2015) Comparative Anatomy of Vertebrates, 9<sup>th</sup> Ed.
7. Kardong K (1995) Vertebrate Comparative Anatomy Function Evolution, 4<sup>th</sup> Ed.
8. Singh S (2013) A Text Book of Comparative Anatomy of Vertebrates

**Percent Change From Previous Syllabus: 10.0 %**

**SEMESTER I  
CORE 1**

**ZOPALT1: COMPARATIVE ANATOMY OF VERTEBRATES**

1. Identification, Classification and study of distinguish features of the representative examples of different classes of vertebrates.
2. Study of permanent slides showing whole mount of vertebrate scales.
3. Comparative study of histological slides of skin in different group of vertebrates.
4. Study of available permanent slides of different vertebrate organs.
5. Demonstration of brain and heart of different vertebrates through alternative methods of dissection.
6. Comparative study of vertebra, limbs and girdles of different vertebrate groups.
7. Study of afferent and efferent arteries of fish.
8. Study of cranial nerves of fish.

**Course Objectives:**

To learn the basic of vertebrates anatomy to understand how different anatomies function have evolved and develop.

Be familiar with new development in the field of comparative vertebrate anatomy.

To indicate the contribution that comparative anatomy of vertebrates can make to the overall discussion of evolution.

Help student skin a knowledge base for understanding vertebrate anatomy and evolution by explaining to them the basic structures and organization of anatomical system there development and function and their modification in the major transitions in vertebrate evolution.

**Course Outcomes:**

Describe the major architectural features of the integumentary skeletal nervous muscular digestive respiratory circulatory excretory and reproductive systems.

Develop an understanding of the application of comparative anatomy in current scientific method /literature.

**Percent Change From Previous Syllabus: 10.0 %**



**SEMESTER I**

**CORE 2**

**ZOPATT2: CELL BIOLOGY**

**Course outcome**

1. Understand the structure and function of prokaryotic and eukaryotic cells, including the cell membrane, organelles, and cellular processes.
2. Comprehend the organization of nucleic acids, chromatin, and chromosomes, including nucleosome structure and nucleolus biogenesis.
3. Gain knowledge of the cytoskeleton and its components, such as microtubules, microfilaments, and intermediate filaments.
4. Understand protein sorting mechanisms, vesicular transport, and protein targeting to different cellular compartments.
5. Acquire knowledge about cell communication, signaling pathways, cell interactions, apoptosis, and the cell cycle, with a focus on cancer biology.

**Course Outcomes and their mapping with programmed Outcomes:**

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	2	1	2	1	1	2
CO2	3	3	3	2	1	2	1	1	2
CO3	3	3	3	2	1	2	1	1	2
CO4	3	3	3	2	1	2	1	1	2
CO5	3	3	3	2	1	2	1	1	2

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

**Unit 1: Basic structure of prokaryotic and eukaryotic cell:** Ultrastructure of cell membrane (Fluid mosaic model), membrane proteins and lipids, mitochondria, assemblies of respiratory chain and F<sub>0</sub> F<sub>1</sub>-ATPase, golgi complex, endoplasmic reticulum and lysosome; structure and functions of centrosome; Cell junctions: Tight and gap junctions, Desmosomes.

**Unit 2: Nucleic acids:** Chemical and Physical structure; Chromatin/Chromosome: Nucleosome and higher order structure (Solenoid to Metaphase chromatid); Nucleolus: Structure and biogenesis of ribosomes.

**Unit 3: Cytoskeleton:** Organization of microtubules, microfilaments and intermediary filaments; Protein sorting and mechanisms of vesicular transport: Signal peptide and SRP dependent targeting of translational complex; targeting to plasma membrane and lysosome; targeting of nuclear and mitochondrial proteins.

**Unit 4: Transport across the cell membrane:** Channels and transporters, diffusion, osmosis and measurement of osmotic pressure; Active transport: mechanism and related calculations; Cell signaling molecules and receptors, Signal transduction pathways (DAG and cAMP); Cell interactions: Apoptosis and necrosis.

**Unit 5: Cell cycle and cancer:** Mitotic and Meiotic cell divisions and their significance, spindle apparatus and synaptonemal complex, cell cycle and its regulation, labeling index and cell cycle duration measurement, cell synchronization and cell cycle inhibitors; Cancer (Concept of oncogenes and tumor suppressor genes with special referencetop53, Retinoblastoma and Ras and APC).

### **Books Recommended**

1. Alberts et al. (2008) Molecular Biology of the Cell, 5<sup>th</sup> Ed. Garland Publishing House.
2. Cooper GM (2004) The Cell, 3<sup>rd</sup>Ed. ASM Press.
3. Hardin et al. (2012) Becker's World of the Cell, 8<sup>th</sup> Ed. Pearson Benjamin Cummings.
4. Karp (2008) Cell and Molecular Biology-Concepts and Application, 5<sup>th</sup> Ed. John Wiley.
5. Lewin B (2008) Genes IX, Jones and Bartlett Publishers.
6. Lodish et al (2016) Molecular Cell Biology. 8<sup>th</sup> Ed. W.H. Freeman.
7. Tamarin RH (2004) Principles of Genetics. Tata McGraw-Hill Publishing Comp. Ltd.
8. Watson et al. (2007) Molecular Biology of the Gene. 6<sup>th</sup> Ed. Benjamin Cummings.

**Percent Change From Previous Syllabus: 10.0 %**

**SEMESTER I**  
**CORE 2**

**ZOPALT2: CELL BIOLOGY**

1. Preparation of permanent slide to demonstrate DNA by Feulgen reaction
2. Preparation of permanent slide to demonstrate DNA and RNA by MGP
3. Preparation of permanent slide to demonstrate muco-polysaccharides by PAS reaction
4. Preparation of permanent slide to demonstrate proteins by mercurio-bromophenol blue/Fast green
5. Study of mitosis in onion root tip
6. Study of meiosis in grasshopper testis
7. Study of permanent slides: Leptotene, Zygotene, Pachytene, Diplotene and Diakinesis.
8. Study of permanent slides: Prophase, Metaphase, Anaphase and Telophase; Barr body.

**Course Objective:**

To study the structure and function of different component of prokaryotic and eukaryotic cell.  
To study basics of cancer, tumor processing and cell communication.

**Course Outcomes:**

Students will develop ability to understand how a cell works in molecular level.

Develop in-depth knowledge of components of cell and their working.

Students will develop understanding about how different components pass through the plasma membrane differently.

**Percent Change From Previous Syllabus: 05 %**

**SEMESTER I  
CORE COURSE 3**

**ZOPATT3: ENDOCRINOLOGY**

**Course outcome**

CO1: Major objective is to explain hormone synthesis, secretion and difference from other physiological secretion.

CO2: Role of hormones in regulation of homeostasis via autocrine, paracrine, and endocrine modes of delivery, following negative and positive feedback mechanism.

CO3: Explanation of molecular mechanism of hormonal action based on the types of receptor.

CO4: It will explain various endocrinological principle which helps in determination of pathophysiological disorders.

CO5: It will help in understanding the basis and consequences of specific endocrine discrepancies.

**Course Outcomes and their mapping with Program outcomes:**

CO	PO						PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	-	-	-	1	3	-	-
CO2	3	3	-	-	-	1	3	-	-
CO3	3	3	1	-	-	2	3	2	-
CO4	3	2	2	1	-	2	3	1	-
CO5	3	1	1	1	-	2	3	3	-

Weightage: 1-Slightly; 2-Moderately; 3-Strongly

**Unit 1: Introduction to Endocrine System:** Classes of hormones; Mechanism of hormone action: Protein hormones, membrane receptors, G-proteins, cyclic AMP signaling cascade, PKC signaling pathway, steroid hormones (genomic and nongenomic pathways)

**Unit 2: Hypothalamo-hypophysial System:** General organization; Neurohypophysial hormones: oxytocin and vasopressin; Neural control of adenohypophysis: Hypophysiotropic hormones and actions; Adenohypophysial hormones: Chemistry and physiological roles of somatotropin and prolactin; Glycoprotein hormones: FSH, LH and TSH and Pro-opiomelanocortin: ACTH, MSH.

**Unit 3: Thyroid hormones:** Biosynthesis, control of secretion and physiological role of thyroid hormones; Parathyroid: Parathormone, calcitonin and vitamin D in calcium homeostasis; Endocrine pancreas: biosynthesis and physiological actions of insulin and glucagon.

**Unit 4: Gonadal hormones:** Structure of mammalian testis and ovary; Spermatogenesis and structure of sperm; Physiological role of androgens; Oogenesis and structure of egg; Steroid hormone biosynthetic pathways; Ovary: organization and physiological role of estrogen, progesterone, relaxin and inhibin; Estrous and menstrual cycle; Hormones of pregnancy; Parturition; Hormonal control of lactation.

**Unit 5: Adrenal cortex:** Organization mineralocorticoid and glucocorticoid hormone: control of secretion, rennin-angiotensin system; Adrenal medulla: catecholamine biosynthesis, release and physiological role.

### **Books Recommended**

1. Bentley (1998) Comparative Vertebrate Endocrinology, Cambridge University Press.
2. Norris (2007) Vertebrate Endocrinology, 4<sup>th</sup> Ed. Academic Press.
3. Hadley (2007) Endocrinology, 6<sup>th</sup> Ed. Prentice Hall.
4. Brooks and Marshall (1995) Essentials of Endocrinology, Blackwell Science.
5. Turner and Bagnara (1984) General Endocrinology, Saunders.
6. Larson (2002) Williams Textbook of Endocrinology, 10<sup>th</sup> Ed. Saunders.

**Percent Change From Previous Syllabus: 20.0 %**

**SEMESTER I  
CORE COURSE 3**

**ZOPALT3: ENDOCRINOLOGY**

1. Handling, sexing, numbering and maintenance of rat
2. General survey of endocrine glands in rat
3. Study of vaginal smear preparation in rat
4. Study of the following using permanent slides:
  - a. Endocrine glands and reproductive organs of rat
  - b. Gonads (testis and ovary from fish to birds)
  - c. Thyroid of fish (pharyngeal and ectopic) and reptile
  - d. Adrenal homologues (interrenal and chromaffin tissues) in fish and reptile
  - e. Cell types pituitary
  - f. Hypothalamo-neurohypophysial system
5. Demonstration of frog metamorphosis by models and charts
6. Demonstration of ELISA-based hormone assay

**Course Objective:**

To explain how hormones are synthesized, secreted and different from other physiological secretion. Their role in regulation of homeostasis of all physiological processes via autocrine, paracrine, and endocrine modes of delivery, following negative and positive feedback mechanisms. It also explains the molecular mechanism of hormonal action based on the types of receptors.

**Course Outcomes:**

It will explain various endocrinological principles which help in the determination of pathophysiological basis and consequences of specific endocrine disorders.

**Percent Change From Previous Syllabus: 20.0 %**

**SEMESTER I  
OPEN ELECTIVE 1**

**ZOPATO1: FUNDAMENTALS OF PUBLIC HEALTH**

**Course outcome**

1. Understand concepts of health, disease, and dimensions of health.
2. Learn methods for measuring health and disease, including risk measurement and morbidity and mortality indicators.
3. Explore epidemiology of infectious diseases, including agent biology, pathogenesis, and public health strategies.
4. Analyze health inequalities, including poverty, discrimination, and their impact on health outcomes.
5. Study national health programs addressing various diseases and healthcare challenges.

**Course Outcomes and their mapping with Programme Outcomes:**

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	2	1	1	1
CO2	3	3	3	2	2	2	1	1	1
CO3	3	3	3	2	2	2	1	1	1
CO4	3	3	3	2	2	2	1	1	1
CO5	3	3	3	2	2	2	1	1	1

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

**Unit 1: Concepts of Health:** Concepts of Health & Disease; Dimensions of Health: Physical dimension, Mental dimension, Social dimension, Spiritual dimension, Emotional dimension, Vocational dimension; Outbreaks, epidemics and pandemics; History of public health; Determinants of Health; Indicators of Health.

**Unit 2: Measuring Health and disease:** Causation of diseases; Risk measurement, Measurement of morbidity and mortality: Incidence, Prevalence, Age-adjustment and survival analysis, use of morbidity and mortality; Comparing disease occurrence: Risk difference, Attributable fraction, Population attributable risk, Relative risk, Attributable risk.

**Unit 3: Epidemiology of infectious diseases:** Infectious diseases; agent biology, epidemiology, pathogenesis and pathology, clinical presentation and management; public health strategies and mechanisms.

**Unit 4: Inequalities and Disparities in Health:** Poverty, discrimination, vulnerability, income inequality and impact on health outcome, measuring poverty, measuring health inequalities.

**Unit 5: National Health Programs:** National Rural Health Mission, National Vector Borne Disease Control Program, Malaria eradication program, Reproductive and Child Health Program, National AIDS Control Program, Revised National Tuberculosis Control Program, National Leprosy Eradication Program, National Program for Control of Blindness, National Program for Prevention and Control of Cancer, Diabetes, Cardiovascular Diseases and Stroke, Integrated Management of Neonatal and Childhood Illness.

**Books Recommended**

1. Berkman LF, Kawachi I & Glymour MM. Social Epidemiology. New York: Oxford University Press, 2014.
2. Nambiar Devaki, Arundati Muralidharan The social determinants of health in India: concepts, processes, and indicators. Springer Publication. New Delhi. 2017
3. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.
4. Nelson K E: Infectious disease epidemiology: theory and practice
5. Griessecke J: Modern infectious disease epidemiology
6. Green J, Thorogood J, Qualitative methods for Health research, Sage Pub, 2004
7. Catherine Pope, Nicholas Mays, Qualitative Research in Health Care, John Wiley & Sons, 2008
8. Collins, C., Green, A., 2014. Valuing Health Systems: A Framework for Low and Middle-Income Countries. SAGE Publications.
9. Gupta, R.P., 2016. Health Care Reforms in India: Making Up for the Lost Decades. Elsevier India.

**Percent Change From Previous Syllabus: 100 % (Newly introduced)**



**SEMESTER I  
OPEN ELECTIVE 1**

**ZOPALO1: FUNDAMENTALS OF PUBLIC HEALTH**

1. Questionnaire design for epidemiological studies
2. The Michigan Alcohol Screening Test (MAST)
3. AUDIT questionnaire: screen for alcohol misuse
4. Calculation of risk ratio
5. Estimation of disease prevalence
6. Calculation of incidence
7. Calculating the sample size for surveys
8. Analysis and interpretation of epidemiological data

**Course Objectives:**

Students will be introduced to the field of public health. To provide an overview of prevention and health promotion methods. To comprehend the causes and consequences of disease and health-related states. To comprehend the state of health and disease on a global and national level.

**Course Outcomes:**

Students will gain sufficient knowledge and skills in a variety of public health topics. Develop a workforce to take on public health responsibilities in specific geographic areas. Develop a comprehensive understanding of the epidemiological transitions of programs specific to each region of the country in order to prioritize public health challenges for policymaking.

**Percent Change From Previous Syllabus: 100 % (Newly introduced)**

**SEMESTER I  
OPEN ELECTIVE 2**

**ZOPATO2: APPLIED ZOOLOGY**

**Course Outcomes:**

1. To get a basic understanding of parasite biology and human health
2. To know about various diseases caused by protozoans and helminthes.
3. To know the biology, damage and control caused by insect pests.
4. To know about insect vectors and their medical importance.
5. To learn about breeding of common poultry and carp fish species.

**Course Outcomes and their mapping with Programme Outcomes:**

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	2	1	2	1	1	1
CO2	3	3	3	2	1	2	1	1	1
CO3	3	3	3	2	1	2	1	1	1
CO4	3	3	3	2	1	2	1	1	1
CO5	3	3	3	2	1	2	1	1	1

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

**Unit 1: Introduction to Host-parasite Relationship:** Host, Parasitism, Symbiosis, Commensalism, Reservoir, Zoonosis.

**Unit 2: Parasitic Protozoa & Helminthes:** Life history and pathogenicity of *Entamoeba histolytica*, *Plasmodium vivax* and *Trypanosoma gambiense*. Parasitic life history and pathogenicity of *Ancylostoma duodenale* and *Wuchereria bancrofti*.

**Unit 3: Insects of Economic Importance:** Biology, damage and control caused by *Helicoverpa armigera*, *Pyrilla perpusilla* and *Papilio demoleus*, *Callosobruchus chinensis*, *Sitophilus oryzae* and *Tribolium castaneum*.

**Unit 4: Insects of Medical Importance:** Medical importance and control of *Pediculus* (head louse), *Anopheles*, *Culex* and *Aedes* mosquitoes, *Xenopsylla cheopis*.

**Unit 5: Poultry farming and Fish technology:** Principles of poultry breeding, Management of breeding stock and broilers, Processing and preservation of eggs; Major and minor carps of economic importance; Induced breeding and transportation of fish seed.

**Books Recommended**

1. Park, K. Preventive and Social Medicine. XVI Edition. B.B Publishers. (2007)
2. Arora, D. R and Arora, B. Medical Parasitology. II Edition. CBS Publications and Distributors. (2001)
3. Kumar, Robbins & Cotran. Pathologic Basis of Disease. Elsevier; 9th edition. (2014)
4. Atwal, A.S. Agricultural Pests of India and South East Asia, Kalyani Publishers. (1986)
5. Dennis, H. Agricultural Entomology. Timber Press (OR). (2009)
6. Dunham R.A. Aquaculture and Fisheries Biotechnology Genetic Approaches. CABI publications, U.K. (2004)
7. Pedigo, L.P. Entomology and Pest Management, Prentice Hall. (2002)
8. Shukla and Upadhyay. Economic Zoology. Rastogi Publication (2016)
9. Jhingran. V.G. Fish and fisheries of India. Hindustan Publishing Corporation (1997)
10. Khanna. S.S, An introduction to fish biology and fisheries. Surjeet Publication (2019)
11. K.P. Shrivastava, G.S. Dhaliwal. A textbook of Applied Entomology. Kalyani Publication (2013)

**Percent Change From Previous Syllabus: 100 % (Newly introduced)**

**SEMESTER I  
OPEN ELECTIVE 2**

**ZOPALO2: APPLIED ZOOLOGY**

1. Study of *Plasmodium vivax*, *Entamoeba histolytica*, *Trypanosoma gambiense*, *Ancylostoma duodenale* and *Wuchereria bancrofti* and their life stages through permanent slides/photomicrographs or specimens.
2. Study of arthropod vectors associated with human diseases: *Pediculus*, *Culex*, *Anopheles*, *Aedes* and *Xenopsylla*.
3. Study of insect damage to different plant parts/stored grains through damaged products/photographs.
4. Identifying feature and economic importance of *Helicoverpa* (*Heliothis*) *armigera*, *Papilio demoleus*, *Pyrilla perpusilla*, *Callosobruchus chinensis*, *Sitophilus oryzae* and *Tribolium castaneum*.
5. Visit to a poultry farm. Submission of visit report

**Course Objectives:**

To introduce the methodology and perspectives of applied branches of zoology with a view of educating youngsters on the possibilities of self-employment.

**Course Outcomes:**

To get a basic understanding of human health and parasite biology & insects of economic importance and learn the basic principles involved in the culture and breeding of common poultry and fish species.

**Percent Change From Previous Syllabus: 100 % (Newly introduced)**

**SEMESTER II  
CORE COURSE 4**

**ZOPBTT1: BIOCHEMISTRY AND MOLECULAR BIOLOGY**

**Course outcomes**

1. Students will be aware about the law of thermodynamics in living system and understand the concept of bioenergetics during central metabolism of carbohydrates and lipid that involve as source of free energy.
2. Students will have a clear idea about the types of amino acids and protein structure, as well as their relation with function.
3. Students will know about the mechanism that how enzymes work via kinetics of enzymatic reaction and their regulation.
4. The students will get knowledge about the structure of DNA in association with chromosomes and molecular mechanism of DNA replication.
5. The students will also get knowledge about the metabolism of RNA and protein synthesis.

After completion of course, students will be able to recognize and interpret the structural and functional aspects of molecules and their interactions that give rise to the supramolecular complexes such as organelles and cells. Students will have the ability to perform laboratory techniques used in molecular biology and biochemistry.

**Course Outcomes and their mapping with Programme Outcomes:**

CO	PO						PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	3	3	2	3
CO2	3	3	2	2	2	3	3	2	3
CO3	3	3	2	2	2	3	3	2	3
CO4	3	3	2	2	2	3	3	2	3
CO5	3	3	2	2	2	3	3	2	3

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

**Unit 1: Laws of thermodynamics and their applications:** Concept of free energy and calculations based on free energy change; Metabolism: Concept of metabolic pathways; Energy transduction: glucose and fatty-acids as energy source; Glycolysis and Krebs cycle; Feeder pathway of glycolysis; Mechanism and chemiosmotic concept of ATP synthesis, bioenergetics of ATP and other high energy phosphate compounds; Digestion, mobilization, and transport of fats;  $\beta$ -oxidation; NADPH producing pathway: Pentose phosphate pathway.

**Unit 2: Protein:** Primary structure, peptide bond, Secondary structure,  $\alpha$ -helix,  $\beta$ -pleated sheet and bends, prediction of secondary structure, Ramachandran plot, tertiary structure, forces stabilizing tertiary structure, Domains and motifs-Quaternary structure.

**Unit 3: Enzymes:** Enzyme kinetics, lowering of activation energy, derivation of Michaelis-Menten equation, related calculations and Michaelis-Menten and Lineweaver-Burk plots; Mechanism of action, active site, substrate binding, transition state analogues and abzyme: Acid-base and covalent catalysis; Concepts of regulation of enzyme activity.

**Unit 4: Nucleic acids:** Structure, folding motifs, conformational flexibility and supercoiling; Mechanism of DNA replication: DNA polymerases, origin of replication and formation of primosome, replication fork and replisome, termination of replication; DNA damage and repairing mechanism.

**Unit 5: Mechanism of transcription:** RNA polymerases, formation of pre-initiation complex at RNA *pol* II promoter: Processing of hnRNA: Capping, Poly(A) tailing, splicing; Genetic code and mechanism of translation: Role of ribosomes and tRNAs, formation of initiation complex; Elongation and termination: Post translational modification.

### Books Recommended

1. Nelson et al (2004) Lehninger: Principles of Biochemistry, 3<sup>rd</sup> Ed. Pearson.
2. Zubay et al (1995) Principles in Biochemistry, 2<sup>nd</sup> Ed. WCB.
3. Strayer (2002) Biochemistry, 5<sup>th</sup> Ed.
4. Lodish et al (2007) Molecular Cell Biology, 6<sup>th</sup>Ed.Freeman and Company.
5. Voet and Voet (2004) Biochemistry, John Wiley.
6. Alberts et al. (2008) Molecular Biology of the Cell, 5<sup>th</sup> Ed. Garland Publishing House.
7. Cooper GM (2004) The Cell, 3<sup>rd</sup>Ed. ASM Press.
8. Price and Stevens (1988) Fundamentals of Enzymology, 2<sup>nd</sup> Ed. Oxford University Press.

**Percent Change From Previous Syllabus: 05.00 %**

**SEMESTER II  
CORE COURSE 4**

**ZOPBLT1: BIOCHEMISTRY AND MOLECULAR BIOLOGY**

1. Preparation of extract for enzyme assay (alkaline phosphatase)
2. Study of alkaline phosphatase activity
3. Standard curve preparation
4. Effect of enzyme concentration and determination of total and specific activity
5. Effect of temperature on enzyme activity
6. Effect of time on enzyme activity
7. Effect of substrate concentration on enzyme activity
8. Determination of  $K_m$  and  $V_{max}$  by Michaelis-Menten and Lineweaver-Burk Plot
9. DNA isolation
10. RNA isolation
11. Reverse transcriptase polymerase chain reaction
12. Western blotting
13. Northern blotting

**Course Objective:**

To build comprehensive working knowledge of biomolecules and their role in specific molecular transformations. To enable the students to develop an integrated approach for understanding the various life science problem at the molecular level.

**Course Outcomes:**

Students will recognize and interpret the structural and functional aspects of molecules and their interactions that give rise to the supramolecular complexes such as organelles and cells. Students will have the ability to perform laboratory techniques used in molecular biology and biochemistry.

**Percent Change From Previous Syllabus: 05.00 %**

**SEMESTER II**

**CORE COURSE 5**

**ZOPBTT2: BASIC MAMMALIAN PHYSIOLOGY**

**Course outcome**

CO1: Main objective is to explain cell to cell association and interaction; to learn structure and function of various types of tissues

CO2: Understand the role of different biomolecules and nutritional importance of balance diet. Understand the process of digestion and absorption.

CO3: Understand the physiology at cellular and system levels and role of respiration. Understand the mechanism and regulation of breathing, oxygen consumption and determination of respiratory quotient.

CO4: Learn the role of heart in blood circulation. Determination of blood groups. To learn pathophysiological condition for heart failure and heart attack.

CO5: To understand role of kidney in maintaining fluid homeostasis.

**Course Outcomes and their mapping with Programme Outcomes:**

CO	PO						PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	-	-	-	1	3	-	-
CO2	3	3	-	-	-	1	3	-	-
CO3	3	3	1	-	-	2	3	2	-
CO4	3	2	2	1	-	2	3	1	-
CO5	3	1	1	1	-	2	3	3	-

Weightage: 1-Slightly; 2-Moderately; 3-Strongly

**Unit 1: Integumentary system:** Cell junction: tight junctions, adherens junctions, desmosomes, hemidesmosomes and gap junctions; Epithelial and connective tissue; Structure, type and function of skin, accessory structure of skin, aging.

**Unit 2: Digestion:** Anatomy of gastrointestinal tract; Digestive glands (salivary, gastric, liver and gall bladder, pancreatic and intestinal gland); Digestion of fat, protein and carbohydrate, nucleic acid; absorption of nutrients, regulation of digestion and absorption; balanced diet, vitamins.

**Unit 3: Respiration:** Anatomy of respiratory system, pulmonary ventilation, respiration, gaseous exchange, lung volume and capacity, control of respiration, basal metabolic rate, respiratory quotient; Respiratory disorders: hypoxia, dyspnoea.

**Unit 4: Cardiovascular:** Function, properties and component of blood, formation of blood cell, hemostasis, blood group; Structure and function of heart, origin and conduction of cardiac impulse, cardiac cycle and ECG, myocardial infarction, circulatory routes, hemodynamic.

**Unit 5: Excretion:** Structure and function of kidney, glomerular filtration, tubular reabsorption and secretion, urine formation, transportation, storage and elimination; Kidney function tests, buffer system.



**Recommended**

1. Ganong (2005) Review of Medical Physiology, 22<sup>nd</sup> Ed. Lang Medical Publications.
2. Guyton and Hall (2006) Text Book of Medical Physiology, 11<sup>th</sup> Ed. W.B. Saunders.
3. Keel et al (1989) Samson Wright's Applied Physiology, 13<sup>th</sup> Ed. Oxford Press.
4. Murray et al (1989) Harper's Illustrated Biochemistry, 27<sup>th</sup> Ed. Appleton and Lange.
5. Tortora GJ and Derrickson B (2012) Principles of Anatomy and Physiology, Volume I-II, 13<sup>th</sup> Ed. John Wiley & Sons, Inc.
6. Chatterjee CC (2018) Human Physiology, Volume I-II, 12<sup>th</sup> Ed. CBS Publication.
7. Walker R (2014) Mammalian Physiology
8. Verma et al (2000) Animal Physiology, Chand (S.) & Co Ltd, India

**Percent Change From Previous Syllabus: 05.00 %**

**SEMESTER II  
CORE COURSE 5**

**ZOPBLT2: BASIC MAMMALIAN PHYSIOLOGY**

1. Study of histological slides: Salivary gland, Liver, Pancreas, Stomach and Intestine.
2. Glucose estimation
3. Amylase assay in the given sample
4. Determination of blood groups (ABO and Rh factor)
5. Erythrocyte counting
6. Total leucocytes counting in blood
7. Study of histological slides: Kidney, Heart and Lungs
8. Study of Kidney, Heart and Lungs with models/PPT
9. Assessment of kidney function test

**Course Objective:**

To study morphological, structural, functional and metabolic aspects of mammals.  
To create awareness among students about their health.

**Course Outcomes:**

Students will understand the physiochemical basis of how each system operates and build also they will understand the functioning of each system. The knowledge can be applied to the understanding of everyday activities of human body.

**Percent Change From Previous Syllabus: 05.00 %**

**SEMESTER II  
CORE COURSE 6**

**ZOPBTT3: ANIMAL BEHAVIOUR**

**Course Outcomes:**

CO1: Understanding an overview of animal behavior and key survival strategies like kin selection and inclusive fitness, cooperation, and alarm call.

CO2: Understanding the ways how different animals select and maintain their habitats along with the ways they build their homes.

CO3. Developing compassion towards other animals as well as other individuals, & group selection strategies.

CO4. Evaluating other individuals of the society and decision-making.

CO5. Devising conservation strategies for different animal species. Learning and instincts: conditioning, habituation, sensitization, and reasoning.

**Course Outcomes and their mapping with Programme Outcomes:**

CO	PO						PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	2	-	3	2	3	1	2
CO2	1	3	1	2	1	2	2	1	2
CO3	3	2	1	2	2	1	2	2	-
CO4	3	2	2	1	2	1	1	2	3
CO5	2	3	2	1	1	1	2	3	1

Weightage: 1-Slightly; 2-Moderately; 3-Strongly

**Unit 1: Introduction to animal behavior:** History of the study of animal behavior; Patterns of behavior; Genetic basis of behavior: Development of bird song; Learned behavior and types of learning.

**Unit 2: Specific behavior pattern:** Habitat selection and foraging behavior; Animal signals and communication; Social dominance and concept of territoriality; Fixed action pattern-characteristics and evolutionary features; Mimicry: mimetic releaser and code breakers.

**Unit 3: Control of behavior (a):** Neural control: Control of hippocampal pyramidal cell discharges; Perceptual mechanisms: Behavioral and cellular responses to novel and repeated stimuli; Motivational systems: Neural mechanisms involved in a cat's attack on a rat;

Hypothalamic mechanisms for motivational and species-Typical behavior; Behavior of hippocampal neurons during conditioning.

**Unit 4: Control of behavior (b):** Hormonal control: Hormones classes: Peptides or proteins, steroids, monoamines and lipid based hormones. Hormonal control of social behavior; Hormonal control of behavior in a lizard; Pheromonal regulations and biological rhythms.

**Unit 5: Parental care, mating and courtship behavior, altruism:** Parental care; Sexual selection: intra sexual selection (male rivalry); inter-sexual selection (female choice); sperm competition; mate guarding; consequences of mate choice for female fitness; monogamous verses polygamous sexual conflict; Reciprocal altruism; group selection; kin selection and inclusive fitness; Sociality in animal systems; Social organization in honey bees.

**Books recommended:**

1. Alcock (2009) Animal Behavior: An Evolutionary Approach, 9<sup>th</sup> Ed, Sinauer Asso.
2. Kaushik M P (2015) Animal Behavior, Kalyani Publication.
3. Mathur R (2005) Animal Behavior, Rastogi Publications.
4. Richard et al (2013) Thompson: The Neural Control of Behavior, Academic Press.
5. Manning A and Dawkins MS (2012) An Introduction to Animal Behavior, 6<sup>th</sup>Ed. Cambridge University Press.
6. Drickamer and Vessey (1986) Animal Behavior – Concepts, Processes and Methods, 2<sup>nd</sup> Ed. Wadsworth.
7. Shukla et al (2011) Economic Zoology, Biostatistics and Animal Behavior, Rastogi Publication.
8. Mandal FB (2015) Text book of Animal Behavior, 3<sup>rd</sup> Ed. PHI Learning.

**Percent Change From Previous Syllabus: 50.0 %**

**SEMESTER II  
CORE COURSE 6**

**ZOPBLT3: ANIMAL BEHAVIOUR**

1. Study of individual and social behavioral patterns of a troop of monkeys.
2. Courtship behavior in the fruit fly.
3. Study the different behavior of laboratory rats.
4. Nest making behavior of birds.
5. Habitat preference behavior in insects.
6. Habituation in earthworms/mosquito larvae.
7. Locomotory behavior of dipteran larvae (fruit fly): Locomotion on different types of substrata (writing paper, plastic sheet and sand paper) & Effects of light intensity and light quality on the rate of locomotion.
8. Study of interspecific association between cattle and egrets.
9. Territorial behavior in stray dogs.

**Course Objective:**

Ethology focuses on behavior under natural conditions, and viewing behavior as an evolutionarily adaptive trait. Understanding how genes and the environment come together to shape animal behavior is also an important underpinning of the field. Genes capture the evolutionary responses of prior populations to selection on behavior.

**Course Outcomes:**

Students will understand the ways how animal interact with other organisms and the physical environment.

**Percent Change From Previous Syllabus: 50.0 %**

**SEMESTER II  
DSE 1**

**ZOPBTD1: MOLECULAR GENETICE**

**Course outcome**

1. Understand classical genetics: Mendel's laws, chromosomal basis of inheritance, and sex determination.
2. Explore modern gene concepts: Transcriptome, proteome, gene regulation in prokaryotes and eukaryotes.
3. Study gene mutations, mapping methods, and detection techniques.
4. Investigate RNA interference, gene therapy, and detection/treatment of genetic disorders.
5. Examine genetic engineering applications: Cloning, recombinant DNA, DNA sequencing, transgenic animals.

**Course Outcomes and their mapping with Programme Outcomes:**

CO	PO						PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	3	3	2	3
CO2	3	3	2	2	2	3	3	2	3
CO3	3	3	2	2	2	3	3	2	3
CO4	3	3	2	2	2	3	3	2	3
CO5	3	3	2	2	2	3	3	2	3

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

**Unit 1: Classical genetics:** Properties and evolution of genetic material flow of genetic information; Mendel's laws and their chromosomal basis of inheritance; Extensions of Mendelian principles: Dominance relationships, epistasis, pleiotropy, expressivity and penetrance; Linkage and crossing over; Sex linked, sex-limited and sex influenced character; Sex determination; dosage compensation in *Drosophila*.

**Unit 2: Modern gene concept:** Concepts of transcriptome and proteome, gene duplication–gene families, interrupted gene, pseudogenes and transposable genetic element; Regulation of gene activity in *lac* and *trp* operons of *E. coli*; Introduction to gene regulation in eukaryotes; Organization of a typical eukaryotic gene.

**Unit 3: Gene mutation:** Types and molecular basis, manipulation of genes, site-specific mutagenesis, reporter genes expression, genomic expression profiling; Methods for detection of induced mutations; Methods of gene mapping: 2 and 3- point test cross in *Drosophila*,

Gene mapping in human by linkage analysis in pedigrees, ordered and unordered tetrad analysis.

**Unit 4: RNA interference:** siRNA, shRNA, miRNA; Therapeutic use of RNA interference. Detection of sickle cell anemia, thalassemia, cystic fibrosis, haemophilia, muscular dystrophy; Gene therapy: *Ex vivo* and *in vivo* therapy, strategies and delivery.

**Unit 5: Applications and implications of genetic engineering:** Restriction enzymes, cloning vectors; production of recombinant DNA molecules; Preparation and screening of cDNA library; DNA sequencing: PCR and RT PCR; Gene transfer and transfection methods, transgenic animal production-DNA integration; Use of cre/loxP in transgenic animal production; Somatic cloning.

### Books Recommended

1. Brown (2006) Genomes, 3<sup>rd</sup>Ed. Garland Science.
2. Gardner et al (2006) Principles of Genetics, John Wiley.
3. Griffith et al (2008) Modern Genetic Analysis, Freeman.
4. Karp (2010) Cell and Molecular Biology, John Wiley and Sons.
5. Krebs et al (2011) Lewin's Genes X, Jones and Bartlett.
6. Lewin (2010) Genes X, Jones and Bartlett.
7. Lodish et al (2008) Molecular Cell Biology, Freeman.
8. Pierce (2012) Genetics – A Conceptual Approach, Freeman.

**Percent Change From Previous Syllabus: 05.0 %**

**SEMESTER II**  
**DSE 1**

**ZOPBLD1: MOLECULAR GENETICE**

**Genetics**

1. Basic principle of experimental animal handling and ethical issues and bio safety for molecular biology work.
2. Identification of different embryonic stages of *Drosophila*.
3. Extraction of DNA from animal tissue/blood.
4. Extraction of RNA from animal tissue.
5. Study of sex chromatin in human female from buccal epithelial and hair bud cells
6. Examination of wild type (males and females) and mutants of *Drosophila*
7. Sex linked inheritance in *Drosophila melanogaster*
8. Separation of protein on native and /denaturation gel (PAGE) / western blotting
9. Temporary squash preparation of polytene chromosomes from salivary glands of *Drosophila* larvae

**Course Objective:**

To study the Mendelian genetics, linkage analysis, genetic engineering, methods of cloning and their use, analysis of pedigree.

**Course Outcomes:**

Students will understand the basis of genetics through Mendelian genetics.

Develop in-depth knowledge of how genes are arranged in a chromosome, develop understanding about pedigree analysis, cloning techniques and lethal genetic disorder.

Students will develop understanding about how we can produce an organism with desired genome.

**Percent Change From Previous Syllabus: 05.0 %**



**SEMESTER II  
COMPULSORY PAPER**

**ZOPBTA1: RESEARCH METHODOLOGY**

**Course outcome**

1. Understand the basics of research, including its meaning, objectives, process, criteria for good research, defining research problems, principles of research design, and developing a research plan.
2. Learn about different types of scientific communication, such as research papers, reviews, and letters to the editor, and understand the components of a research paper, including titles, abstracts, introduction, materials and methods, results, discussion, figures, tables, and handling referees' comments.
3. Explore research ethics involving human participants and laboratory animals, including general ethical principles, institutional ethics committees, ethical guidelines for human subjects, and guidelines for the use of animals in scientific research.
4. Gain knowledge of data analysis methods, including data collection techniques, graphical representation of data, measurement of central tendency (mean, median, mode), measurement of dispersion (range, mean deviation, standard deviation), and standard error.
5. Understand statistical analysis concepts, including variance, coefficient of variation, correlation, regression, significance tests (t-test, chi-square test), analysis of variance (ANOVA), elementary probability concepts

**Course Outcomes and their mapping with Program Outcomes::**

CO	PO						PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	2	1	1	3	1	3	1	2
CO2	2	3	-	3	-	2	2	1	2
CO3	2	3	-	3	-	3	-	2	-
CO4	2	3	1	-	2	3	1	2	3
CO5	3	1	3	2	1	1	3	1	1

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

**Unit 1: Introduction to research**

Meaning of research, objectives of research, research process, criteria of good research, defining the research problem, basic principles of research design, developing a research plan.

**Unit 2: Basics of scientific communication**

Types of scientific communication: research papers, review, letter to editor; Constituents of research paper: title, running title, authorships, abstracts, keywords, introduction, materials and methods, results, discussion, acknowledgements, referees, figures, table components, communication with the editors, handling referees comments, galley proofs; Plagiarism.

### **Unit 3: Research ethics involving human participants or laboratory animals**

Ethics and biomedical research: General principles on ethical considerations involving human subjects. Institutional ethics committee: its organization and functions, general ethical issues. Ethical guidelines for experimental animals: Sources of experimental animals, anesthesia and euthanasia, laboratory animal ethics, animal ethics committee, its organization and functions, ethical guidelines for use of animals for scientific research, CPCSEA guidelines.

### **Unit 4: Data analysis for statistics**

Methods of data collection; Graphical representation of data; Measurement of central tendency: Definition, characteristics, types, merits and demerits; Measurement of dispersion: Range, Mean deviation, Standard deviation, Standard error.

### **Unit 5: Statistical analysis**

Variance, Coefficient of variation, Correlation and Regression and their coefficients; Test of significance: Student t- test, Chi-square test; ANOVA; Elementary idea of probability.

### **Suggested readings**

1. National Ethical Guidelines for Biomedical and Health Research involving human participants ICMR, New Delhi 2017.
2. Guidelines for care and use of animals in scientific research. Indian National Science Academy, New Delhi.
3. Research Methodology, methods and techniques by C.R. Kothari (2009).
4. Biostatistics: A foundation for analysis in health sciences, 9<sup>th</sup> Ed. Wayne W Daniel (2008).
5. Computer fundamentals, Pradip K Singha and Priti Singha (BPB Publication).

**Percent Change From Previous Syllabus: 100 % (Newly introduced)**

**SEMESTER III  
CORE COURSE 7**

**ZOPCTT1: DEVELOPMENTAL BIOLOGY**

**Course Outcome:**

CO1: Major objective is to provide student with a sound coverage of mammalian reproductive biology with in framework of human biology.

CO2: Study will be achieved by learning fundamental of structure and function of male and female reproductive tract.

CO3: Gametogenesis, fertilization early embryonic fetal development till birth of young one will be focused.

CO4: It will provide important function to consider sexual differentiation and development.

CO5: Aspects of infertility and current reproductive technology will be inculcated.

**Course Outcomes and their mapping with Programme Outcomes:**

CO	PO						PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	1	-	-	1	3	-	-
CO2	3	3	1	-	-	1	3	-	-
CO3	3	3	2	-	-	3	3	2	2
CO4	3	2	1	-	-	2	3	1	2
CO5	3	1	3	1	-	3	3	3	2

Weightage: 1-Slightly; 2-Moderately; 3-Strongly

**Unit 1: Fertilization and development:** Biochemical aspect of fertilization; penetration and activation of egg and early development; Fate maps; embryonic induction and differentiation; Hormonal control of metamorphosis in amphibians; Neuro endocrine control of insect metamorphosis; Biochemistry and mechanism of action of hormones during metamorphosis.

**Unit 2: Early embryonic development:** Origin of anterior and posterior polarity; Generation of dorso-ventral polarity; Maternal effects of genes; the homeotic selector genes for segmental identity-bithorax and antennapedia complex.

**Unit 3: Organogenesis:** Development of vertebrate limb; Development of heart and kidney; Organizer, inductive tissue interactions in developments, Primary embryonic induction, Regional specificity in induction; Differentiation of Vertebrate lens.

**Unit 4: Genetic errors of human development:** Nature of human syndromes-pleiotropy, genetic heterogeneity, phenotypic variability, gene expression and human disease-inborn errors of nuclear RNA processing, inborn errors of translation; teratogenesis-environmental assaults on human development- teratogenic agents like alcohol, retinoic acid etc.

**Unit 5: Regeneration:** Epimorphic regeneration of reptile (salamander) limb; Morphollaxis regeneration in hydra; embryonic stem cells and their applications. Programmed cell death: apoptosis, autophagy and necrosis.

**Reference Books:**

1. Balinsky BI An Introduction to Embryology, W B Saunders Co., Philadelphia (Latest edition).

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2. Karp G and Berrill NJ. Development, McGraw Hill, New York (Latest edition).
3. Saunders JW. Developmental Biology, MacMillan Co., London (Latest edition).
4. Gilbert SF Developmental Biology, Sinamer Associates Inc. USA (Latest edition).
5. Oppenheimer SB Introduction to Embryonic Development, Allyn and Bacon (Latest edition).
6. Regeneration in vertebrates by C S thornton. The University of Chicago press.

**Percent Change From Previous Syllabus: 30.0 %**

**SEMESTER III  
CORE COURSE 7**

**ZOPCLT1: DEVELOPMENTAL BIOLOGY**

1. Study of frog embryonic development through models
2. Collection of frog spawns and observation of different developmental stages
3. Study of spiral cleavage in eggs of snail
4. Effect of vitamin A in tadpole tail regeneration
5. Study of embryonic development in chick through slides
6. Window preparation to study chick embryo development
7. Study of expression of developmental genes in larval imaginal discs
8. Preparation of Sperm slide.

**Course Objective:**

Major objective is to provide student with a sound coverage of mammalian reproductive biology within framework of human biology. Study will be achieved by learning fundamental of structure and function of male and female reproductive tract, gametogenesis, fertilization early embryonic fetal development till birth of young one.

**Course Outcomes:**

It will provide important function to consider sexual differentiation and development, infertility and current reproductive technology.

**Percent Change From Previous Syllabus: 10.0 %**

**SEMESTER III  
CORE COURSE 8**

**ZOPCTT2: REGULATORY MAMMALIAN PHYSIOLOGY**

**Course outcome**

CO1: To explain the development and role of bones and muscles. To learn various type of bone and importance of joints. Study functioning of muscle fibers and role of muscle proteins.

CO2: Understand the structure of nervous system. Significance of CSF and BBB.

CO3: Understand the physiology and control of nervous system. Synapse and role of neurotransmitters.

CO4: Learn the role of immune system. Type of immune cells and immunity.

CO5: To understand concept of hypersensitivity, complement system, vaccination and autoimmunity.

**Course Outcomes and their mapping with Programme Outcomes:**

CO	PO						PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	2	3	-	-	1	1	-	-	3
CO2	2	3	-	-	1	1	-	-	3
CO3	2	3	-	-	1	2	-	-	3
CO4	2	3	-	-	1	2	-	-	3
CO5	2	3	-	-	1	2	-	-	3

Weightage: 1-Slightly; 2-Moderately; 3-Strongly

**Unit 1: Skeletal system:** Structure and function of bone, bone formation; Axial skeletal: skull and vertebral column; Appendicular skeletal: pectoral and pelvic girdle, limbs, joints.

**Muscular system:** Type function and properties of muscles, skeletal muscle tissue; Contraction and relaxation, control of muscle tension, muscle proteins.

**Unit 2: Nervous system:** Type of nervous tissue: neuron and glia; Structure of brain, cerebrospinal fluid, neural network, cranial nerves, blood brain barrier, spinal cord anatomy, spinal nerves.

**Unit 3: Electrical signal in neurons:** Axonal and synaptic transmission: Membrane potential and action potential; Types of synapses and synaptic knobs; Excitatory and inhibitory post-synaptic potential; Chemical transmission; Neurotransmitters (acetylcholine, catecholamines, serotonin and GABA), neuropeptides.

**Unit 4: Lymphatic system and immunity:** Lymphatic system: structure and function; Immunity: innate and adaptive immunity, Immune cells: types and production, Immune tolerance; Humoral immunity: Antigen and hapten, primary and secondary response, Immunoglobulins: types, structure and functions, Generation of antibody diversity, Class switching, somatic hypermutation, Concept of clonal selection.

**Unit 5: Cell mediated immunity:** T cell receptor, T helper cell and lymphocyte activation, role of cytotoxic T cell, perforin and granzymes; Regulation of immune responses and Hypersensitivity; Major histocompatibility complex (MHC), Complement system; Antigen: processing and presentation, concept of vaccination; Autoimmunity.

**Books Recommended**

1. Ganong (2005) Review of Medical Physiology, 22<sup>nd</sup> Ed. Lang Medical Publications.
2. Guyton and Hall (2006) Text Book of Medical Physiology, 11<sup>th</sup> Ed. W.B. Saunders.
3. Keel et al (1989) Samson Wright's Applied Physiology, 13<sup>th</sup> Ed. Oxford Press.
4. Murray et al (1989) Harper's Illustrated Biochemistry, 27<sup>th</sup> Ed. Appleton and Lange.
5. Tortora GJ and Derrickson B (2012) Principles of Anatomy and Physiology, Volume I-II, 13<sup>th</sup> Ed. John Wiley & Sons, Inc.

**Percent Change From Previous Syllabus: 10.00 %**

**SEMESTER III  
CORE COURSE 8**

**ZOPCLT2: REGULATORY MAMMALIAN PHYSIOLOGY**

1. Study of skin with the help of chart and models
2. Study of muscle with the help of chart and models
3. Study of appendicular skeleton system with the help of model
4. Study of axial skeleton system with the help of model
5. Total and differential leucocytes counting in blood
6. Study of histological slides
7. Study of brain by model/chart
8. To study functioning of brain by rotarod
9. To study functioning of brain by light and dark chamber

**Course Objective:**

To study physiological and metabolic aspects of systems and their regulations.

To study the interaction between immune systems and their components with various systems of the body.

**Course Objective:**

To explain how hormones are synthesized, secreted and different from other physiological secretion. Their role in regulation of homeostasis of all physiological process via autocrine, paracrine, and endocrine modes of delivery, following negative and positive feedback mechanism. It also explains molecular mechanism of hormonal action based on the types of receptor.

**Course Outcomes:**

It will explain various endocrinological principle which helps in determination of pathophysiological basis and consequences of specific endocrine disorder.

**Course Outcomes:**

Students acquire knowledge about how immune system communicates with different systems of the body. Different sensory systems works and how they affect behavior.

**Percent Change From Previous Syllabus: 10.00 %**



**SEMESTER III  
CORE COURSE 9**

**ZOPCTT3: EVOLUTION, ENVIRONMENTAL BIOLOGY AND SUSTAINABLE DEVELOPMENT**

**Course Outcomes:**

1. Students will develop understanding about how life began from non-living things by evolutionary process including natural selection and speciation.
2. Students will develop understanding how evolution progresses affects population in individual level by studying population genetics.
3. Students will be able to understand about the difference between biotic and abiotic factors of environment and how energy and food flow between them,
4. Students will understand how population evolve, grow and interact within and between two species, i.e., intra and Interspecific competition.
5. Students will understand the concept of sustainable development, biodiversity conservation and human impact on global environmental changes.

**Course Outcomes and their mapping with Programme Outcomes:**

CO	PO						PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	2	3	2	3	3	2	3
CO2	3	3	2	2	2	3	3	2	3
CO3	3	3	2	2	2	3	3	2	3
CO4	3	3	2	2	2	3	3	2	3
CO5	3	3	3	2	2	3	3	2	3

Weightage: 1-Slightly; 2-Moderately; 3-Strongly

**Unit 1: Life's Beginnings:** Chemogeny, RNA world, Biogeny, Origin of photosynthesis, Evolution of eukaryotes; An overview of evolutionary thoughts: Lamarckism, Darwinism and Neo Darwinism; Modern synthetic theory; Evolution of horse, Geological time scale, Sources of variations: Heritable variations and the its role in evolution. Neutral theory, Molecular clock, Phylogenetic trees, Convergent and divergent evolution.

**Unit 2: Population genetics:** Hardy-Weinberg equilibrium (statement and derivation of equation); Evolutionary forces upsetting H-W equilibrium: Mutation, Natural selection. Genetic Drift mechanism, Role of Migration and Mutation in changing allele frequencies. Isolating mechanisms: Concepts of species and models of speciation, Adaptive radiation/macroevolution (exemplified by Galapagos finches).

**Unit 3: Ecosystem dynamics:** Ecological hierarchy in nature, Biotic and abiotic factors of environment, Ecosystem functioning-concept of trophic level, food chain, food web, ecological pyramids, energy flow in ecosystem, ecological efficiency.

**Unit 4: Population ecology:** Population dynamics, Population growth form, r- and k- selections and carrying capacity, Biological communities and species interactions, Types of interactions between two species, Interspecific competition.

**Unit 5: Human impact on the environment and sustainable development:** Concept of sustainable development, Environmental degradation (habitat destruction, fragmentation, biological invasions) and management, Forest, water and mineral resources, Biodiversity conservation and concept of ecosystem services, Global environmental changes (ozone depletion, acid deposition, greenhouse gas emissions and global warming), Environmental impact assessment.

### **Books Recommended**

1. Bergstorm CT and Dujatkin LA (2012) Evolution 1<sup>st</sup> Ed. WW Norton and Co.
2. Freeman S and Herron JC (2016) Evolutionary Analysis. Pearson Education Ltd, India.
3. Futuyma DJ (1997) Evolutionary Biology, 3<sup>rd</sup> Ed. Sinauer Associates.
4. Gillespie JH (1998) Population Genetics: a Concise Guide, John Hopkins Univ Press.
5. Hall BK and Hallgrimson B (2008) Stirckberger's Evolution, 4<sup>th</sup> Ed. Jones and Barlett.
6. Page RDM and Holmes EC (1998) Molecular Evolution: A Phylogenetic Approach. Blackwell Sc.
7. Kardong K (2004) An Introduction to Biological Evolution, McGraw Hill.
8. Smith JM (1998) Evolutionary Genetics 2<sup>nd</sup> Ed. Oxford University Press.

**Percent Change From Previous Syllabus: 05.00 %**

**SEMESTER III  
CORE COURSE 9**

**ZOPCLT3: EVOLUTION, ENVIRONMENTAL BIOLOGY AND SUSTAINABLE DEVELOPMENT**

1. Study of quantitative inheritance in *Drosophila*: sternopleural bristle phenotypes in *D. melanogaster*
2. Demonstration of natural selection under laboratory conditions by making competition between red eyed and white eyed *D. melanogaster*
3. Demonstration of Hardy-Weinberg equilibrium in human populations by taking examples of MN and ABO blood group systems
4. Study of inversion polymorphism in *Drosophila*
5. Study of sexual isolation between two closely related and sympatric species of *Drosophila*: *D. bipectinata* and *D. malerkotliana*.
6. Study of Zoo and Phytoplanktons in pond water
7. Preparation of temporary slides of Zooplanktons
8. Calculation of biodiversity indices
9. Physiochemical analysis of water
10. Estimation of aquatic: primary productivity using dark and light bottles
11. Study of species interactions

**Course Objective:**

To study how evolution progresses and affects population in individual level.

**Course Outcomes:**

Students will develop understanding about how evolution affects natural selection.  
Students will develop understanding about how speciation occurs due to evolution.  
Students will develop understanding about population genetics.

**Percent Change From Previous Syllabus: 05.00 %**

**SEMESTER III**  
**DISCIPLINE SPECIFIC ELECTIVE: 1**

**ZOPCTD1: BRAIN FUNCTION AND MENTAL AWARENESS**

**Course Outcomes:**

CO1: Understanding the evolution of the nervous system from lower phyla to higher phyla and systematic study of different brains from the representative classes.

CO2: Exploring the embryological development of the nervous system including genetic factors responsible for the formation of the brain and spinal cord and understanding of the anatomical and structural organization of the nervous system and its components.

CO3: Imparting knowledge regarding neurophysiology, electrical properties of neurons, and propagation of nerve impulses

CO4: Understanding the mechanism of neurotransmission and neuromodulation along with the molecular mechanisms of transmission of the neural message.

CO5: Detailed understanding of the hypothalamic control of various physiological processes and exploring the details of various mental disorders and diseases associated with the brain; Challenges involved in the treatment of impaired mental conditions.

**Course Outcomes and their mapping with Programme Outcomes:**

CO	PO						PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	2	1	1	3	1	3	1	2
CO2	2	3	-	3	-	2	2	1	2
CO3	2	3	-	3	-	3	-	2	-
CO4	2	3	1	-	2	3	1	2	3
CO5	3	1	3	2	1	1	3	1	1

Weightage: 1-Slightly; 2-Moderately; 3-Strongly

**Unit 1: Early embryonic development & Evolution of the nervous system:** Major events in early embryonic development, cleavage, formation of blastula and gastrula; Embryonic origin of the nervous system.

**Unit 2: Anatomy of the Brain:** Organization of the nervous system; Subdivisions of the nervous system; The scalp, skull and meninges; Cerebrospinal fluid; Central, autonomic and peripheral nervous system.

**Unit 3: Neuron:** An overview of the nervous system, anatomy of the neuron, classification and type of the neurons; structure and function of dendrite & axon; ultrastructure and properties of the synapse.

**Unit 4: Biological Imperatives – The Hypothalamus:** Regulation of Biological rhythm, sleep, temperature, thirst and drinking, hunger and feeding.

**Unit 5: Mental Awareness: Advances and challenges in neuroscience:** Advances: Parkinson's disease; Pain; Epilepsy; Major Depression; Manic-Depressive Illness. Challenges: Addiction; Alzheimer's Disease; Learning Disorders; Stroke; Neurological Trauma; Anxiety Disorders; Schizophrenia; Neurological AIDS; Multiple Sclerosis; Down Syndrome; Huntington's Disease; Tourette Syndrome; Brain Tumors; Amyotrophic Lateral Sclerosis.

### **Books Recommended**

1. Gilbert, Developmental Biology (7th Edition) Sinauer Publication, 2006
2. Sanes, Development of the Nervous System (2nd Edition), Academic Press, 2006
3. Siegel, Basic Neurochemistry (7th Edition) Academic Press, 2006
4. Kendel, Principles of Neural Science (4th edition), McGraw Hill, 2000
5. Richard F. Thompson: The Brain – A Neuroscience Primer (2<sup>nd</sup> Ed. 1993, W. H. Freeman & Company)
6. Squire, Fundamental Neuroscience (3rd Edition), Elsevier, 2008
7. Bear, Neuroscience-Exploring the Brain, Lippincott, 2007

**Percent Change From Previous Syllabus: 100 % (Newly introduced)**

**SEMESTER III**  
**DISCIPLINE SPECIFIC ELECTIVE: 1**

**ZOPCLD1: BRAIN FUNCTION AND MENTAL AWARENESS**

1. Comparative study of brain of lower and higher vertebrates.
2. Dissection of Chicken Brain
3. Dissection of Goat Brain
4. Histology and sectioning of major areas in the brain.
5. Brief introduction of the staining techniques and stains used in brain Histology.
6. Anatomical mapping of major hypothalamic centers.
7. Study of pituitary and pineal cell types through prepared slides.
8. Hands on training in Electrophysiology: Understanding of electrophysiological techniques from microelectrodes to devices and from recording modes to data analysis; Brain slice electrophysiology (field recordings and patch clamp).
9. Some important behavioural techniques in neuroscience:  
(a). Rotarod (b). Morris water maze (c). 8 Arm radial maze or T – Maze
10. Study of MRI and CT-SCAN images for diagnosis of various neurological conditions

**Course Objectives:**

This hands-on laboratory exercises is designed to engage the students in common techniques used in neuroscience research. Chicken and Goat brain dissections will be done to explore the anatomy of the brain, enabling students to understand the brain circuitry. Students will learn histological techniques as well. Neurophysiological experiments will be done to study brain function and behavior.

**Course Outcomes:**

Students will understand anatomical parts of the brain and relate structure with the functioning of the brain. Students will develop a deep knowledge of behavioral neuroscience through lectures, laboratory exercises, and readings on numerous and diverse behavioral neuroscience topics. They will also develop an understanding of various neurological defects by reading MRI and CT-SCAN from normal and persons suffering from neurological defects.

**Percent Change From Previous Syllabus: 100 % (Newly introduced)**

**SEMESTER IV  
CORE COURSE 10**

**ZOPD TT1: BIOTECHNIQUES**

**Course outcome**

1. Understand microscopy principles, including image formation, types of objectives, and various types of microscopes such as light, phase contrast, fluorescence, confocal, transmission, and scanning electron microscopes.
2. Explore spectroscopy techniques, including colorimetry, UV-visible spectrophotometry, fluorimetry, atomic absorption spectrophotometry, and ELISA applications.
3. Study centrifugation principles, types of centrifuges, rotor care, and the sedimentation of cellular organelles.
4. Learn about electrophoresis principles, types, factors affecting migration, isoelectric focusing, PAGE, agarose gel electrophoresis, and blot techniques such as Southern, Northern, and Western blots.
5. Understand microtomy principles, fixation techniques, tissue processing, microtome types, and histological stains such as hematoxylin and eosin.

**Course Outcomes and their mapping with program Outcomes:**

CO	PO						PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	3	3	2	3
CO2	3	3	2	2	2	3	3	2	3
CO3	3	3	2	2	2	3	3	2	3
CO4	3	3	2	2	2	3	3	2	3
CO5	3	3	2	2	2	3	3	2	3
CO6	3	3	2	2	2	3	3	2	3

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

**Unit 1: Microscopy:** Property of light, image formation, types of objectives, numerical aperture, limit of resolution, magnification; Structure, function and application of light (Bright-field and dark field) microscope, phase contrast microscope, fluorescence microscope, confocal microscope, transmission and scanning electron microscope.

**Unit 2: Spectroscopy:** Principle, structure, functioning and applications of colorimetry, UV-visible spectrophotometry, fluorimetry and atomic absorption spectrophotometry; ELISA.

**Unit 3: Centrifugation:** Principle of centrifugation, types of centrifuges and their applications, types and caring of rotors; determination of centrifugal force, sedimentation of cellular organelles.

**Unit 4: Electrophoresis and Chromatography:** Electrophoresis: Principle, types of electrophoresis, factors affecting migration, isoelectric focusing of proteins; PAGE and agarose gel electrophoresis; Blot techniques: Southern, Northern and Western. Chromatography: Basic principle and application; Planar chromatography, Gas chromatography, High performance liquid chromatography, Ion exchange and affinity chromatography.

**Unit 5: Microtomy:** Basic principle of fixation, types and chemistry of fixation; Tissue processing: Dehydration, clearing, embedding and block preparation; Types of microtome; Histological stains: hematoxylin and eosin.

#### **Books Recommended**

- 1 Bancroft and Stevens (2002) Theory and Practice of Histological Techniques, Churchill-Livingstone.
- 2 Boyer (1993) Modern Experimental Biochemistry and Molecular Biology, 2<sup>nd</sup> Ed. Benjamin/Cumin.
- 3 Karp (2007) Cell and Molecular Biology, Wiley.
- 4 Lodish et al (2007) Molecular Cell Biology, Freeman.
- 5 Plummer (1990) An Introduction to Practical Biochemistry, 3<sup>rd</sup> Ed. Tata-McGrawHill.
- 6 Pollard and Earnshaw (2002) Cell Biology, Saunders.
- 7 Ruthman (1970) Methods in Cell Research, Bell and Sons.
- 8 Wilson and Walker (2006) Principles of Biochemical and Molecular Biological Techniques, 6<sup>th</sup> Ed. Cambridge University Press.

**Percent Change From Previous Syllabus: 50.0 %**



**SEMESTER IV  
CORE COURSE 10**

**ZOPDLT1: BIOTECHNIQUES**

**Biotechniques**

1. Principle and working of centrifuges using yeast cells.
2. Principle and working of paper chromatography
3. Principle and working of spectrophotometer
4. Cell counting using hemocytometer (by using suitable stain)
5. Demonstration of agarose gel electrophoresis for DNA.
6. Fixation, block preparation, staining and identification of given samples.
7. Demonstration of ELISA for hormonal assay
8. Study and interpretation of electron micrographs/ photographs showing
  - a) DNA replication
  - b) Transcription
  - c) Split genes

**Course Objective:**

The aim of this course is to provide an advanced understanding of standard methodologies in biology that are commonly used in life science research.

**Course Outcomes:**

Student will get acquired with common laboratory techniques and can comfortably handle the instruments. Biotechniques are in high demand in academics, research and industry and play prominent role in biomedical and clinical research.

**Percent Change From Previous Syllabus: 40.0 %**

**SEMESTER IV**  
**DISCIPLINE SPECIFIC ELECTIVE: A**  
*Biochemistry and Molecular Biology*

**ZOPDTD1: BIOCHEMISTRY OF INTERMEDIARY METABOLISM AND ENZYMOLOGY**

**Course outcomes**

1. Students will be aware about the concept of metabolic regulation at molecular to cellular level and understand the role of ATP as an energy currency in various anabolic coupling reaction.
2. Students will have a clear idea about how the homeostasis of carbohydrate and lipids maintained by several regulatory metabolic pathways.
3. This course will provide the knowledge about the principles of globular protein structure, as well as the techniques used for elucidation of structures and approaches to their prediction from sequence. The behavior of proteins in solution and the principles of molecular recognition.
4. Students will know about the mechanism of enzyme action and regulatory intermediates in enzyme-catalyzed reactions and their investigations.
5. Students will learn about the kinetics of enzymatic reaction with single and multiple substrates through several enzyme kinetics equations and plots.
6. The students will also get knowledge about the various enzyme inhibitors and regulation of enzymatic reaction.

**Course Outcomes and their mapping with Programme Outcomes:**

CO	PO						PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	3	3	2	3
CO2	3	3	2	2	2	3	3	2	3
CO3	3	3	2	2	2	3	3	2	3
CO4	3	3	2	2	2	3	3	2	3
CO5	3	3	2	2	2	3	3	2	3
CO6	3	3	2	2	2	3	3	2	3

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

**Unit 1: Overview of Metabolism:** Concept of metabolism, ATP as “Energy Currency of cell”; coupled reaction; Use of reducing equivalents and cofactors; Intermediary metabolism and regulatory mechanism: Transcriptome, Proteome and Metabolome

**Unit 2: Metabolism of Carbohydrates and Lipids:** Glycogenesis Vs glycogenolysis; Glycolysis Vs gluconeogenesis; Krebs cycle; Pentose phosphate pathway; Glyoxylate pathway; Fatty acid: biosynthesis and degradation; Cholesterol: biosynthesis and degradation; Eicosanoids: classification, biosynthesis and functions.

**Unit 3: Amino acids and Protein:** Structure and classification of amino acids; Protein structure: Determination of primary structure: Amino acid composition, N- and C- terminal determination, Amino acid sequence determination; Forces and interactions involved in structural organization of fibrous and globular proteins; Structure function relationship; Protein denaturation; Molecular chaperones and protein folding.

**Unit 4: Overview of Enzymology:** Nomenclature and classification; Mechanism of enzyme action: Enzyme substrate binding, Binding energy, entropy change; Enzyme distribution, diversity and evolution.

**Unit 5: Enzyme Kinetics:** Single substrate reactions: steady state and equilibrium kinetics; Michaelis-Menten equation and plot; Linear kinetic plots: Lineweaver-Burk, Edie-Hofstee, Cornish-Bowden; Multi-substrate reactions: Random sequential, Ordered, Theorel-Chance mechanism, Ping-pong (double reciprocal) mechanism.

**Unit 6: Enzyme inhibition and regulation:** Competitive; non-competitive; un-competitive and mixed inhibitions; Determination of nature of inhibition and  $K_i$  by L-B and Dixon plots; Regulation: allosterism and covalent modifications; Multi-enzyme complex and multifunctional enzymes

#### **Books Recommended**

1. Nelson et al: Lehninger Principles of Biochemistry (7<sup>th</sup> ed, 2018 MacMillan Worth)
2. Berg et al: Biochemistry (5<sup>th</sup> ed 2002, Freeman)
3. Mathews et al: Biochemistry (3<sup>rd</sup> ed 2004, Pearson)
4. Zubay et al: Principles in Biochemistry (2<sup>nd</sup> ed 1995, WCB)
5. Rawn: Biochemistry (1989, Neil Patterson)
6. Bender: Amino acid metabolism (1985, John Wiley)
7. Voet & Voet: Biochemistry Vol I & II (4<sup>th</sup> ed 2011, Wiley)
8. Rafi MD: Biochemistry 2<sup>nd</sup> ed (2014 University Press)

**Percent Change From Previous Syllabus: 100 % (Newly introduced)**

**SEMESTER IV**  
**DISCIPLINE SPECIFIC ELECTIVE: A**  
*Biochemistry and Molecular Biology*

**ZOPDL1: BIOCHEMISTRY OF INTERMEDIARY METABOLISM AND ENZYMOLOGY**

1. Estimation of blood glucose level using glucose oxidase method
2. Estimation of total cholesterol, HDL-cholesterol and triacyl glycerol
3. Estimation of amino acid concentration
4. Studies on quantitation of proteins by various methods: Biuret, Lowry, Bradford, Bromocresol and UV spectrophotometry
5. Studies on the expression of protein by western blotting
6. Tissue collection, storage and processing and preparation of enzyme extract
7. Standardization of the assay procedure
8. Determination of total enzyme activity and specific activity
9. Tissue distribution and sub-cellular distribution of enzyme activity.
10. Kinetic studies

**Course Objective:**

The course aims to provide an advanced understanding of the core principles and topics of protein structure and function. Emphasis is given to chemical structural and functional relationship of proteins and enzyme kinetics and its regulation.

**Course Outcomes:**

The principles of globular protein structure, as well as the techniques used for elucidation of structures and approaches to their prediction from sequence. The behavior of proteins in solution and the principles of molecular recognition. Intermediates in enzyme-catalyzed reactions and their investigations.

**Percent Change From Previous Syllabus: 100 % (Newly introduced)**

**SEMESTER IV**  
**DISCIPLINE SPECIFIC ELECTIVE: A**  
*Biochemistry and Molecular Biology*

**ZOPDTD2: MOLECULAR BIOLOGY OF INFORMATION PATHWAY: NUCLEIC ACIDS**

**Course outcome**

1. Study the structure and function of the eukaryotic genome, including chromatin organization, DNA denaturation and renaturation, and the characteristics and mapping of the human genome.
2. Explore DNA replication, repair, and recombination processes, including DNA polymerases, initiation, various repair systems, and homologous recombination.
3. Understand transcription and its regulation, including RNA polymerases, transcription factors, initiation, elongation, and techniques such as promoter analysis and chromatin immunoprecipitation.
4. Examine post-transcriptional processing and regulation, including splicing mechanisms, RNA editing, and post-transcriptional gene silencing (RNA interference).
5. Learn about genetic engineering tools and techniques, including restriction enzymes, vectors, cloning strategies, screening methods, sequencing, PCR, and applications such as transgenic organisms, gene therapy, and ethical considerations

**Course Outcomes and their mapping with program Outcomes:**

CO	PO						PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	3	3	2	3
CO2	3	3	2	2	2	3	3	2	3
CO3	3	3	2	2	2	3	3	2	3
CO4	3	3	2	2	2	3	3	2	3
CO5	3	3	2	2	2	3	3	2	3
CO6	3	3	2	2	2	3	3	2	3

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

**Unit 1: Eukaryotic genome:** Introduction to structural and functional genomics, Denaturation and renaturation of DNA, unique and repetitive DNA, sequences (LINEs, SINEs), Chromatin organization, Nucleosomes and higher order structures, Histones and non-histone chromosomal proteins, Telomere, Chromatin modifications; Human genome: mapping, characteristics and implications.

**Unit 2: DNA replication, repair and recombination:** DNA polymerases, ARS and initiation in yeast, Eukaryotic chromatin replication and regulation; DNA repair: Multiple DNA repair

system: Mismatch repair, Base excision repair, Nucleotide excision repair, Direct repair; DNA recombination: Homologous genetic recombination, site-specific recombination.

**Unit 3: Transcription and its regulation:** RNA polymerases in eukaryotes, Transcription factors: general and specific, Assembly of pre-initiation complex and initiation. Elongation and elongation factors, Enhanceosomes, Transcriptome, Promoter analysis and characterization, Expression system: transient and stable, Deletion mapping, S1/RNase mapping, Chromatin immunoprecipitation (ChIP), Electrophoretic mobility shift assay, DNase I foot printing.

**Unit 4: Post transcriptional processing and regulation:** Introns: types and mechanisms of splicing, RNA editing, Post transcriptional gene silencing (RNA interference); Catalytic RNA and its role.

**Unit 5: Genetic engineering:** Tools: Restriction enzymes and other enzymes for DNA manipulation, Vector types: cloning and expression, Probes; Cloning strategies: cDNA and genomic libraries, Positional cloning,; Screening of clones: Preparation of probes, Hybridization: Southern, Northern (colony/plaque), immuno-screening; Characterization of clones: Sequencing, Microarray; PCR and its applications, Application: transgenic organisms and genetically modified organisms (GMOs), animal cloning, site-directed mutagenesis, generation of knock-out animals, gene therapy, DNA drugs; Ethical and social issues.

### **Books Recommended**

1. Malacinski: Freifelder's Essentials of Molecular Biology (4th Ed 2005, Narosa)
2. Lewin: Genes IX (2008, Jones and Bartlett)
3. Brown: Genomes (3rd ed 2006, Garland Science)
4. Brown: Gene Cloning and DNA Analysis (2001, Blackwell)
5. Sambrook & Russell: Molecular Cloning (2001, Cold spring Harbor)
6. Primrose: Principles of Gene Manipulation (2001, Blackwell)
7. Asubel et al: Current Protocol in Molecular Biology (1994, Wiley)
8. Lodish et al: Molecular Cell Biology (6th ed 2007, Freeman)
9. Goldsby et al: Kubey Biochemistry (2001, Freeman)
10. Gesteland et al: RNA World (2nd ed 1999, Cold Spring Harbor)

**Percent Change From Previous Syllabus: 100 % (Newly introduced)**

**SEMESTER IV**  
**DISCIPLINE SPECIFIC ELECTIVE: A**  
***Biochemistry and Molecular Biology***

**ZOPDL2: MOLECULAR BIOLOGY OF INFORMATION PATHWAY: NUCLEIC ACIDS**

1. Sterilization techniques, media preparation and agar plate preparation
2. Measurement of growth curve of *E. coli.*, calculation of its generation time and viable cell counting
3. Induction of  $\beta$ -galactosidase in *E. coli*
4. Rapid isolation of plasmid DNA (mini prep. alkaline lysis method)
5. Restriction digestion of plasmid and analysis by agarose gel electrophoresis, determination of insert size
6. Cloning of a DNA fragment
7. Preparation of competent cells, transformation and screening of colonies (blue-white selection)
8. Demonstration: Southern hybridization, PCR

**Course Objective:** The course intends to give basic knowledge about the population genetics as well as the importance of genetic, environmental and social determinants of origin of non-communicable and infectious diseases.

**Course Outcome:** On completion of the course, the students know and are able to use basic genetic concepts and identify Mendelian inheritance patterns. Further students become familiar with different genetic and environmental factors that are important for the origin of both communicable and noncommunicable diseases.

**Percent Change From Previous Syllabus: 100 % (Newly introduced)**

**SEMESTER IV**  
**DISCIPLINE SPECIFIC ELECTIVE B**  
*Mammalian Reproductive Physiology and Endocrinology*

**ZOPDTD3: NEUROENDOCRINOLOGY, NON-CLASSICAL HORMONES AND SIGNALING**

**Course Outcome:**

CO1: Objective is to note about the classification of hormones and chemical signaling mechanisms, hormone synthesis, secretion and transport.

CO2: Hormone receptors and signal transduction processes interactions between the endocrine, nervous and immune systems.

CO3: To study about the effect of hormones at distant cells and target tissues / organs by binding to specific receptor proteins in the target cell, resulting in a change in cell function.

CO4: To enhance knowledge about functions of different hormones, development and growth; maintenance of the internal environment; and regulation of metabolism and nutrient supply.

CO5: Students will gather the idea and knowledge about the hormone binds to the receptor, it results in the activation of a signal transduction pathway that typically activates gene transcription, resulting in increased expression of target proteins; non-genomic effects are more rapid, and can be synergistic with genomic.

**Course Outcomes and their mapping with Programme Outcomes:**

CO	PO						PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	1	1	1	-	-	3	1	-
CO2	3	2	2	3	-	-	3	2	-
CO3	3	3	3	-	-	2	3	3	1
CO4	3	3	2	1	-	1	3	3	1
CO5	3	3	1	2	-	1	3	3	1

Weightage: 1-Slightly; 2-Moderately; 3-Strongly

**Unit 1: Neuroendocrinology - Hypophysiotropic hormones:** Localization, secretion and mechanism of action, TRH, GnRH, CRH, GHRH and PACAP, Somatostatin, Monoamines; Pineal gland- Pinealocytes and Synthesis of Melatonin, biological clock and calendar, Melatonin and photoperiodic measurement.

**Unit 2: Non-classical hormones:** Growth factors: cellular origin, secretion and functions, Epidermal growth factor family, Transforming growth factor family, Platelet-derived growth factor, Insulin family (IGF-1 and IGF-II), Nerve growth factor family, Hematopoietic growth factors, Eicosanoids (prostaglandins, thromboxanes and leukotrienes), Leptin.

**Unit 3: Control of hormone secretion:** Synthesis, processing, and sorting of prohormone Precursor, Sequential stages of the regulated secretory pathway, Dense-cored granule Exocytosis, Regulation of exocytosis by calcium and protein kinase C.

**Unit 4: Receptors:** Nuclear receptors, Structure, Families (glucocorticoid, thyroid and estrogen), Activation and recycling; Membrane receptors, Enzyme-linked receptors, Cytokine



receptors, G-Protein coupled receptors, Ligand-gated ion channels; Hormone signaling-Receptor tyrosine kinase pathway, Cytokine receptors pathway, Cyclic AMP pathway.

**Unit 5:** Phospholipid/calcium- protein kinase C pathway, Nitric oxide signaling pathway, MAP kinase pathway; Molecular basis of hormone synergism and antagonism, Glycogen metabolism, Smooth muscle contraction, Termination of hormone action Pathophysiology of hormone receptors, hormone analogues as drug and xeno-estrogens

### **Books Recommended**

1. Bolander: Molecular Endocrinology (Latest Edition)
2. DeGroot and Jameson: Endocrinology (Latest Edition)
3. Larson Williams Textbook of Endocrinology (Latest Edition)
4. Norman and Litwack. Hormones (Latest Edition)
5. Henson and Castracane: Leptin and Reproduction (Latest Edition)
6. Norris and Lopez: Vertebrate Endocrinology (Latest Edition)
7. Brooks and Marshall: Essentials of Endocrinology (Latest Edition)

**Percent Change From Previous Syllabus: 100 % (Newly introduced)**

**SEMESTER IV**  
**DISCIPLINE SPECIFIC ELECTIVE B**  
*Mammalian Reproductive Physiology and Endocrinology*

**ZOPDL3: NEUROENDOCRINOLOGY, NON-CLASSICAL HORMONES AND SIGNALING**

1. *In situ* study of pituitary (portal circulation) and pineal (associated epithalamic complex) gland.
2. Study of pituitary and pineal cell types through prepared slides and charts.
3. Anatomical mapping of hypothalamic centres (SON, PVN, AR, VMO, mammillary nucleus, median eminence).
4. Ascorbic acid depletion bioassay for LH.
5. ELISA/RIA of TSH or gonadotropins.
6. Biochemical estimation of fructose and alkaline and acid phosphatases in seminal vesicle and prostate.
7. Preparation of the sperm slide and study of structure of the sperm.

**Course Objective:**

Objective is to note about the classification of hormones and chemical signaling mechanisms, hormone synthesis, secretion and transport. Hormone receptors and signal transduction processes interactions between the endocrine, nervous and immune systems. To study about the effect of hormones at distant cells and target tissues / organs by binding to specific receptor proteins in the target cell, resulting in a change in cell function.

**Course Outcomes:**

To enhance knowledge about functions of different hormones, development and growth; maintenance of the internal environment; and regulation of metabolism and nutrient supply. Students will gather the idea and knowledge about the hormone binds to the receptor, it results in the activation of a signal transduction pathway that typically activates gene transcription, resulting in increased expression of target proteins; non-genomic effects are more rapid, and can be synergistic with genomic.

**Percent Change From Previous Syllabus: 100 % (Newly introduced)**

**SEMESTER IV**  
**DISCIPLINE SPECIFIC ELECTIVE B**  
*Mammalian Reproductive Physiology and Endocrinology*

**ZOPDTD4: MAMMALIAN REPRODUCTION FERTILITY AND STERILITY**

**Course Outcome:**

CO1: To study the various causes and factor important for the fertility.

CO2: It also deals about the reproductive pathophysiology of sterility.

CO3: The study of such subject may be helpful in establishing the best clinical practices required for a counselling framework to such couple who are close to or facing the problems of sterility.

CO4: The knowledge will also be helpful in providing the different diagnostic techniques used in the fertility clinics and IVF centres.

**Course Outcomes and their mapping with Programme Outcomes:**

CO	PO						PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	2	3	1	3	-	3	3	1
CO2	2	1	3	-	3	1	2	3	-
CO3	3	3	3	2	3	2	3	3	2
CO4	3	3	3	2	3	2	3	3	2
CO5									

Weightage: 1-Slightly; 2-Moderately; 3-Strongly

**Unit 1: Gonadotropins and Reproductive cycles:** Structure, secretion and regulation of gonadotropins, Estrous and Menstrual cycle, Sexual/Gonadal and brain differentiation and behavior; Hormones of sexual behavior, Sites of action of sex hormones Primer pheromones; Estrous cycle disruption, male induction of estrus (whitten effect), male induced pregnancy block (bruce effect), human reproductive pheromones.

**Unit 2: Regulation of gonadal function:** Testicular function Spermatogenesis and hormonal regulation, Sertoli cell, Leydig cell, Cell– cell interactions; Epididymis: organization and function, male accessory sex glands: structural organization and endocrine regulation of prostate, functions of accessory sex glands; Ovarian function Follicular development and selection, oocyte maturation, mechanism of ovulation, hormonal and molecular changes during periovulatory period, factors involved in follicular rupture, follicular atresia, regulation of steroidogenesis.

**Unit 3: Fertilization and Implantation:** Hormonal control of gamete interaction, role of zona proteins, gamete activation, sperm-egg fusion; Hormonal control of puberty and pregnancy. Biology of implantation-Cellular aspects, molecular aspects, markers of developing embryo, cross-talk between embryo and uterus

**Unit 4: Control of male and female fertility (Chemical interference):** Suppression of spermatogenesis, Suppression of hypophysial activity by steroid hormones, Chemicals acting directly on the testis, Prevention of sperm maturation in epididymis, Surgical interference with reference to vasectomy; Inhibition of ovulation with reference to oral contraceptives, mechanical methods with reference to intrauterine devices, interferences and approaches.

**Unit 5: Male and female sterility:** Parameters of male sterility, origin and cause of male sterility, azoospermia, oligozoospermia, varicocele, cryptorchidism; Tubal factors, premature ovarian failure, polycystic ovarian syndrome, luteal insufficiency, endometriosis.

### **Books Recommended**

1. Leung and Adashi (2004) *The Ovary*, Raven Press.
2. Adashi et al. (1996) *Reproductive Endocrinology, Surgery and Technology*, Lippincott Raven Publishers.
3. Findlay (1994) *Molecular Biology of the Female Reproductive System*, Academic Press.
4. Knobil and Neill (1994) *The Physiology of Reproduction*, Vol. I-II, Raven Press.
5. Knobil and Neill (1998) *Encyclopedia of Reproduction*, Vol. 1-4, Academic Press.
6. Lamming (1984) *Marshall's Physiology of Reproduction*, Longman.
7. Hadley ME (2003) *Endocrinology*
8. Yadav BN (2011) *Mammalian Endocrinology*, Vishal Publishing Group.

**Percent Change From Previous Syllabus: 50.0 %**

**SEMESTER IV**  
**DISCIPLINE SPECIFIC ELECTIVE B**  
***Mammalian Reproductive Physiology and Endocrinology***

**ZOPDL4: MAMMALIAN REPRODUCTION FERTILITY AND STERILITY**

1. Demonstration of growth factors in ovary/testis.
2. Preparation and study of permanent slides of male and female reproductive organs.
3. Study of stages of spermatogenesis and spermeogenesis using histological slides of testis.
4. Biochemical estimation of  $3\beta$ -hydroxysteroiddehydrogenase.
5. Study of sperm motility, sperm morphology, and sperm count in rat.
6. Effect of cadmium chloride treatment on testis *in vitro*.
7. Biochemical estimation of succinate dehydrogenase and catalase activity.
8. Study of rat oestrous cycle using vaginal smear preparations.
9. Demonstration of implantation sites by pontamine blue (blue dye reaction) in mouse.
10. Demonstration of vesotomy, tubectomy, hysterectomy, super ovulation & PCOS in rats.
11. Demonstration of antral follicle, corpus luteum, egg isolation, granulosa and theca cells.

**Course Objective:**

To study the various causes and factor important for the fertility. It also deals about the reproductive pathophysiology of sterility.

**Course Outcomes:**

The study of such subject may be helpful in establishing the best clinical practices required for a counseling framework to such couple who are close to or facing the problems of sterility.

The knowledge will also be helpful in providing the different diagnostic techniques used in the fertility clinics and IVF centers.

**Percent Change From Previous Syllabus: 50.0 %**

**SEMESTER IV**  
**DISCIPLINE SPECIFIC ELECTIVE C**  
*Fish and Fisheries*

**ZOPDTD5: FISH ANATOMY, PHYSIOLOGY AND BIOTECHNOLOGY**

**Course Outcomes:**

1. To know about the vital systems in fishes and its physiology.
  2. To know about the food and feeding activity of the fishes.
  3. To get knowledge about the hormones related with reproduction like FSH, LH, etc.
  4. To know about the brain and various receptors found in fishes.
  5. To get knowledge about induced breeding like hypophysation and stripping.
- To use various fish biotechnologies to improve the quality and quantity of fishes like gynogenesis and androgenesis.
- To know about the techniques used in cryopreservation of gametes and embryo for the further use.
- To get knowledge about the transgenic fishes.

**Course Outcomes and their mapping with Programme Outcomes:**

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	2	1	3	1	1	1
CO2	3	3	3	2	1	3	1	1	1
CO3	3	3	3	2	1	3	1	1	1
CO4	3	3	3	2	1	3	1	1	1
CO5	3	3	3	2	1	3	1	1	1

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

**Unit 1: Integumentary and Digestive system:** Integument: General organization of epidermis and dermis and their derivatives; Digestion: Alimentary canal; Digestion and absorption of lipid, protein and carbohydrate.

**Unit 2: Respiratory and Circulatory system:** Respiration: Gill structure; Physiology of gill respiration; Accessory respiratory organs; Structure and function of swim bladder; Circulation: Heart and aortic arches; Regulation of cardiac activity, Hemodynamics; Components of fish blood.

**Unit 3: Excretory and Endocrine system:** Excretion and osmoregulation: Excretion of nitrogenous wastes; Water and ion balance; Endocrine glands and tissues: Structure and functions: Pituitary, Thyroid, Pancreas, Adrenal (chromaffin and inter-renal tissues), Corpuscles of stannius, Urophysis, Ultimobranchial and pineal gland.

**Unit 4: Nervous system:** Brain and cranial nerves, Receptors; Eye: structure, photoreception, Acoustico-lateralis system: Membranous labyrinth, lateral line organs; Chemoreceptors; Electroreceptors.

**Unit 5: Fish reproduction and Biotechnology:** Teleostean gonad; Reproductive cycle; Types and modes of reproduction; Hypothalamo-hypophyseal gonadal axis, Role of environmental factors on gonadal maturation and spawning; Induced breeding; Chromosomal manipulation- Gynogenesis, Androgenesis, Cryo-preservation of gametes and embryo, Transgenic fish.

**Books Recommended**

1. Brown ME (1957) The Physiology of Fishes Vol. I-II, Academic Press.
2. Evans DH (1998) The Physiology of Fishes, CRC Press.
3. Gopakumar et al. (2000) Fifty Years of Fisheries Research in India, Fisheries Division Indian Council of Agricultural Research
4. Gorbman et al (1962) Comparative Endocrinology, John Wiley and Sons, New York, Chichester, Brisbane.
5. Hoar WS and Randall DJ (1971) Fish Physiology Vol. I - XIV, Academic Press.
6. Hughes GM (1967) Comparative Physiology of Vertebrate Respiration, Heinemann Educational Books Ltd.
7. Nilsson S and Holmgren S (1968) Fish Physiology Recent Advances, Croom Helm, London.
8. Norris DO (2020) Vertebrate Endocrinology, 6<sup>th</sup> Ed. Academic Press.
9. Jhingran VG (1985) Fish and Fisheries of India. Hindustan Publishing Corporation, New Delhi.

**Percent Change From Previous Syllabus: 50.0 %**

**SEMESTER IV**  
**DISCIPLINE SPECIFIC ELECTIVE C**  
*Fish and Fisheries*

**ZOPDLD5: FISH ANATOMY, PHYSIOLOGY AND BIOTECHNOLOGY**

1. General anatomical observations of a bony fish.
2. Display of afferent and efferent branchial vessels.
3. Study of available histological slides of different structures/organs.
4. Study of haematological parameters- blood corpuscles, T.C, D.C and Hb content
5. Determination and comparison of hemoglobin content of water-breathing and air breathing fish.
6. Study of ventilation rate and surfacing activity of fish under different experimental conditions.
7. Determination of feeding habit of carps and catfishes by analyses of their gut contents
8. Preparation of permanent stained slides of different endocrine glands and kidney of a teleost.

**Course Objectives:**

To know about the vital systems in fishes and its physiology.

To know about the food and feeding activity of the fishes.

To get knowledge about the hormones related with reproduction like FSH, LH, etc.

To get knowledge about induced breeding like hypophysation and stripping.

To use various fish biotechnologies to improve the quality and quantity of fishes like gynogenesis and androgenesis.

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To know about the techniques used in cryopreservation of gametes and embryo for the further use.  
To get knowledge about the transgenic fishes.

### **Course Outcomes:**

This course work will provide the knowledge about complete biology of fishes. Generally, the carps do not breed in stagnant water; therefore artificial breeding is carried out. This course will provide basic knowledge of induced breeding in fishes. The course will also through light on the biotechniques like cryopreservation and production of transgenic fishes.

**Percent Change From Previous Syllabus: 50.0 %**



**SEMESTER IV**  
**DISCIPLINE SPECIFIC ELECTIVE C**  
*Fish and Fisheries*

**ZOPDTD6: FISH CULTURE, CAPTURE FISHERY AND FISH PATHOLOGY**

**Course outcomes**

7. Students will be aware about the various fishery resources of India, from which we obtain fishes by culture and capture fishery.
8. The fishes use many kinds of food. If scarcity of food is there then, artificial food is given. Students will also be familiar about nutrition and anti-nutritional factors present in the supplementary food provided to the fishes.
9. This course will provide the knowledge about the additives and preservatives used in the food, and also about fish byproducts.
10. Since fish are the best source of our food, therefore we should increase their production by using improved techniques. The course will also highlight on the selection of species of fishes to get maximum benefit.
11. The students will also get knowledge about the various diseases.

**Course Outcomes and their mapping with Programme Outcomes:**

CO	PO						PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	-	-	2	-	-	1	-	-
CO2	3	3	2	-	-	2	-	1	2
CO3	3	-	3	-	-	2	-	1	2
CO4	2	2	2	-	-	3	2	2	2
CO5	3	2	3	2	-	2	-	1	2

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

**Unit 1: Fish culture systems and Pond management:** Pond culture, pen culture, cage culture, running water culture; Different ponds of a fish farm; Formulation and operation of different types of hatcheries; Composite fish farming; Fish culture in paddy fields; Sewage-fed fisheries; Physico-chemical properties of pond water and their maintenance; Manuring and liming; Larvivorous fishes; Weed fishes and their eradication; Aquatic vegetation and its control.

**Unit 2: Fishery resources of India and Fishing methods:** Inland fisheries- Lakesterine fishery; Riverine fishery; Marine fishery; Estuarine Fishery; Types of fishing gears, Fishing crafts; Modern techniques and equipments for finding and capturing fishes.

**Unit 3: Fish nutrition:** Food and feeding habits of freshwater fishes; Nutrients requirement for various growth stages of freshwater carps and their bioenergetics; Supplementary feed; Anti-nutritional factors.

**Unit 4: Fish by-products, Fish spoilage and preservation:** Fish by products: Liver oils, Fish meal, Fish silage, Fish protein, Shark fins and fin rays, Fish roes, Isinglass, Fish skin, Pearl essence; Ornamental fishes; Fish aquarium: Preparation and maintenance; Bacterial, chemical and enzymatic spoilage, Fish preservation: Drying, Salting, Smoking and Canning; Additives and Preservatives.

**Unit 5: Fish pathology:** Main causes of disease in farmed fish; Preventing diseases through proper management; Common disease symptoms in fish; Symptoms, treatment and control: common diseases caused by viruses, bacteria, fungi, protozoa and crustaceans in fishes; Nutritional diseases in fishes.

#### **Books Recommended**

1. Chakroff M (2015) Freshwater Fish Pond Culture and Management, Sci. Publishers.
2. Davis HS (1956) Culture and Diseases of Game Fishes, University of California Press.
3. Duijn CV (1967) Diseases of Fishes, London Iliffe Books Ltd.
4. Datta-Munshi and Hughes(1992) Air-breathing fishes of India, Oxford and IBH.
5. Hall CB (1994) Ponds and Fish Culture, Agro Botanical Publishers.
6. Hora SL and Pillay TVR (1962) Handbook on Fish Culture in the Indo-Pacific Region, Fisheries Division, Biology Branch, FAO.
7. Jhingran VG (1991) Fish and Fisheries of India. Hindustan Pub. Corporation, New Delhi.
8. Khanna SS and Singh HR (2003) A Textbook of Fish Biology and Fisheries, Narendra Publishing House.
9. Kreuzer R (1974) Fishery products, FAO, Fishing News (Books) Ltd., England.
10. Lagler et al. (2003) Ichthyology, John Wiley.
11. Ribelin WE and Migaki G (1975) The Pathology of Fishes, The Univ. of Wisconsin Press.

**Percent Change From Previous Syllabus: 50.0 %**

### **SEMESTER IV DISCIPLINE SPECIFIC ELECTIVE C *Fish and Fisheries***

#### **ZOPDL6: FISH CULTURE, CAPTURE FISHERY AND FISH PATHOLOGY**

1. Analysis of some important physical and chemical properties of water
2. Collection and identification of plankton, weeds and aquatic plants.
3. Study of weeds and aquatic plants.
4. Study of ornamental, exotic and larvicidal fishes.
5. Study of major carps.
6. Study on modern techniques of fishing.
7. Study of various types of fishing gears.
8. Visit to fish market/fish pond/fish farm/breeding centers.

#### **Course Objectives:**

To know about the basic types of fish culture systems.

To know about the pond management for fish culture, optimum conditions required for fish culture and modern techniques of culture and capture fisheries.

To know about the common fish diseases and its control measures.

To get the knowledge of fishery resources of India like freshwater, marine and brackish.

To know about indigenous and improved fishing gears and crafts

To get the basic idea of fish nutrition and supplementary food for fishes.

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To know about the nutritional and anti-nutritional factors of the fishes

To get knowledge about additives and preservatives used to keep food items preserve for long time

To get idea about various fish byproducts used by human beings

### **Course Outcomes:**

Students will be aware about the various fishery resources of India, from which we obtain fishes by culture and capture fishery. The fishes use many kinds of food. If scarcity of food is there then, artificial food is given. Students will also be familiar about nutrition and anti-nutritional factors present in the supplementary food provided to the fishes. This course will provide the knowledge about the additives and preservatives used in the food, and also about fish byproducts.

Since fish are the best source of our food, therefore we should increase their production by using improved techniques. The course will also highlight on the selection of species of fishes to get maximum benefit. The students will also get knowledge about the various diseases.

**Percent Change From Previous Syllabus: 50.0 %**

**SEMESTER IV**  
**DISCIPLINE SPECIFIC ELECTIVE D**  
*Toxicology*

**ZOPDTD7: MECHANISM OF TOXICITY**

Course outcome

CO1: learn the basic principles of toxicology; learn the toxic effect of various known and unknown compounds and precaution;

CO2: To study the basic concept of toxicology related to research work. Variation in toxic response and selection of model.

CO3: To learn basic principles of signaling pathways and mechanisms of cell death.

CO4: Understand mechanisms of systemic and hepatotoxicity. How to improve hepatic defense system?

CO5: Understand mechanisms of nephrotoxicity. Chronic kidney disease and toxic potential of metals.

CO6: Systemic toxicity induced by xenobiotics and receptor mediated pathways

**Course Outcomes and their mapping with Programme Outcomes:**

CO	PO						PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	1	3	3	-	3	3
CO2	3	3	3	-	3	3	-	3	3
CO3	3	3	3	-	3	3	-	3	3
CO4	3	3	3	-	3	3	-	3	3
CO5	3	3	3	-	3	3	-	3	3
CO6	3	3	3	-	3	3	-	3	3

Weightage: 1-Slightly; 2-Moderately; 3-Strongly

**Unit 1: Introduction to toxicology:** History and scope of toxicology; Different areas of modern toxicology; Classification of toxic substance; various definitions of toxicological significance.

**Unit 2: Exposure and response to toxicants:** Types and characteristics of exposure; routes and site, dose, duration and frequency; Dose–response relationship; LD<sub>50</sub>, LC<sub>50</sub>, TD<sub>50</sub> and therapeutic index, Variation in toxic responses; Aquatic toxicology: Bioaccumulation and biomagnification.

**Unit 3: Modes of chemically induced cyto-toxicity:** General response patterns and morphological aspects for cytopathology; Mechanisms of apoptosis, autosis and necrosis; Atrophy, Hypertrophy, Hyperplasia and Regeneration.

**Unit 4: Hepatic toxicity:** Introduction to the liver and its response to toxicants; Overview of hepatic parenchymal and nonparenchymal cells; Evaluation of hepatotoxicity: Physiological, biochemical and pathological response to toxic injury; Hepatic defence against toxicity; Mechanism of action of hepatotoxicant (CCl<sub>4</sub> /Acetaminophen/ Alcohol)

**Unit 5: Renal toxicity:** Susceptibility of kidney to toxic insult, Clinical aspect of renal injury; Acute and chronic renal failure; Mechanism of glomerulus injury; Biochemical mechanisms of proximal tubules cellular death; Renal toxicity of heavy metals (Hg/ As).

**Unit 6: Xenobiotic-Receptor mediated toxicity:** Ligand-selective activation, receptor mediated toxicity, Species and tissue specific differences in nuclear receptor activity, Estrogen-receptor mediated toxicity, structure and modulation of gene expression, PPAR- $\alpha$  mediated toxicity.

### **Books Recommended**

1. Karen S and Brown TM (2006) Principles of Toxicology, 2<sup>nd</sup> Ed. CRC press.
2. McQueen CA (2018) Com. Toxicology-Vol 1: General principle 3<sup>rd</sup> Ed. Elsevier.
3. McQueen CA (2018) Com. Toxicology-Vol 8: Cellular and Molecular Toxicology 3<sup>rd</sup> Ed. Elsevier.
4. McQueen CA (2018) Com. Toxicology-Vol 9: Toxicology Testings and Evaluation 3<sup>rd</sup> Ed. Elsevier.
5. McQueen CA (2018) Com. Toxicology-Vol 10: Biotransformation 3<sup>rd</sup> Ed. Elsevier.
6. Stanley E. Manahan (2003) Toxicological Chemistry and Biochemistry, 3<sup>rd</sup> Edition, Lewis Publishers, CRC Press Company
7. Barlie FA (2008) Principles of Toxicology Testing, CRC Press, Taylor and Francis.
8. Somasundaram SG (2016) Natural Product Interactions on Genome, CRC Press

**Percent Change From Previous Syllabus: 100 % (Newly introduced)**

**SEMESTER IV**  
**DISCIPLINE SPECIFIC ELECTIVE D**  
*Toxicology*

**ZOPDL7: MECHANISM OF TOXICITY**

1. To study the structure and function of toxins.
2. Quantitative identification of functional groups in given sample.
3. Qualitative identification of functional groups in given sample.
4. Training on different routes of drug administration (Oral, I.M., I.P, SC.)
5. Calculation of LD<sub>50</sub>/LC<sub>50</sub> by given data.
6. Calculation of therapeutic index by given data.
7. Collection of blood samples from rats/mice.
8. Collection of urine and feces samples from rats/mice.
9. To study excretory ability of liver (Kit method).
10. To study synthesis ability of liver (Kit method).
11. Demonstration of choloretic activity of xenobiotics (virtual lab).
12. Assessment of Liver function tests (Kit method).
13. Assessment of Kidney function tests (Kit method).

**Course Objective:**

To study few molecular mechanisms involved in chemically induced toxicity and methods to evaluate general toxicity in laboratory.

**Course Outcomes:**

Students will gain appreciable knowledge and critical thinking to correlate mechanism of chemically induced toxicity in intact body at molecular level. Students will also gain understanding regarding methods to identify toxic responses in various testing models.

**Percent Change From Previous Syllabus: 100 % (Newly introduced)**

**SEMESTER IV**  
**DISCIPLINE SPECIFIC ELECTIVE D**  
*Toxicology*

**ZOPDTD8: REACTIVE METABOLITES AND DEFENSE SYSTEM IN BIOLOGY**

**Course Outcome-**

1. Student will be able to understand toxicology and its scope in life. Learn about oxidative stress, its mechanism, free radical reactions, and reactive metabolites.
2. Detail study of reactive metabolites: reactive oxygen species and reactive nitrogen species, toxicity of reactive metabolites. Different types of antioxidants to cope up with oxidative stress.
3. Study about toxicological consequences of oxidative stress on proteins, DNA, lipids, and signal transduction. Learn about antioxidant defence mechanism.
4. Identify different types of toxicants and create understanding about effects of toxic agents present in environment mainly metal toxicity.
5. Understand about fate of xenobiotics in animal body.

**Course Outcomes and their mapping with Programme Outcomes:**

CO	PO						PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	2	1	2	2	-	1	3
CO2	3	3	2	2	2	2	-	1	3
CO3	3	3	2	1	2	2	-	2	3
CO4	3	3	2	2	2	2	-	1	3
CO5	3	3	2	2	2	2	-	2	3

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

**Unit 1: Free radical reactions and reactive metabolites:** Nature of free radicals; Initiation, propagation and termination of radical reactions; Formation of free radicals in lipids and lipid peroxidation in membranes.

**Unit 2: Reactive metabolites:** Introduction to reactive metabolites: Reactive oxygen species and reactive nitrogen species; Nature and stability of reactive metabolites, Fate of reactive metabolites, Factors affecting toxicity of reactive metabolites. Biological sources of reactive oxygen species: the key role of superoxide anion radical, hydrogen peroxide and hydroxyl radicals.

**Unit 3: Oxidative stress and antioxidant defense:** Definition of oxidative stress; toxicological consequences of oxidative stress on proteins, DNA, lipids and signal transduction. Antioxidant defense mechanism: Enzymatic and Non enzymatic antioxidants; superoxide dismutases, catalases and glutathione peroxidases, glutathione, tocopherols and  $\beta$ -carotene as antioxidants.

**Unit 4: Metal toxicity:** Metal- Ligand interactions in biological fluids, interactions between metal ions and macromolecules: metal - protein interaction, metal - nucleic acid interactions; Induction of heat shock proteins, cytoskeletal effects, hemoxyrin metabolism, metallothionein and its biological functions.

**Unit 5: Fate of xenobiotics in animal body:** Absorption, Distribution, Metabolism (Phase I metabolism: CYP multigene family; Phase II metabolism: Conjugation–Deconjugation reactions; Cofactor supply) and Excretion of xenobiotics.

### **Books Recommended**

1. Klassen CD (2008) Cassarett and Doull's Toxicology: The Basic Science of The Poisons, 7<sup>th</sup> Ed. McGraw Hill Publisher.
2. Timbrell J (2000) Principles of Biochemical Toxicology, 3<sup>rd</sup> Ed. Taylor and Francis.
3. Klaassen and Whatkins (2010) Cassarett and Doull's "Essentials of Toxicology" 2<sup>nd</sup> Ed. McGraw Hill Publisher.
4. Karen S and Brown TM (2006) Principles of Toxicology, 2<sup>nd</sup> Ed. CRC press.
5. Manahan SE (2003) Toxicology, Chemistry and Biochemistry, 3<sup>rd</sup> Ed. CRC Press LLC
6. Pillay VV (2013) Modern Medical Toxicology 4<sup>th</sup> Ed. Jaypee Brothers Medical Publishers
7. Hoggson E (2010) A Textbook of Modern Toxicology, 4<sup>th</sup> Ed. John Wiley and Sons, Inc., Publication.
8. McQueen CA (2018) Comprehensive Toxicology-Vol 2: Hepatic Toxicology 3<sup>rd</sup> Ed. Elsevier Publications.

**Percent Change From Previous Syllabus: 100 % (Newly introduced)**



**SEMESTER IV**  
**DISCIPLINE SPECIFIC ELECTIVE D**  
*Toxicology*

**ZOPDL8: REACTIVE METABOLITES AND DEFENSE SYSTEM IN BIOLOGY**

1. Handling of laboratory animals.
2. Demonstration of toxic effects of given xenobiotic using computer simulation programs/virtual labs.
3. Assessment of antioxidant potential in given sample.
4. To study the structure and function of metal-ligand complexes.
5. Assessment of chelating effect of molecules against selected metals.
6. Assessment of metal induced hematotoxicity.
7. Biochemical assessment of glutathione.
8. Assessment of oxidative stress
9. Histopathological effects of metals on tissues
10. To observe toxic effects on cellular level using electron micrographs of tissues

**Course Objective:**

To be acquainted with the history and scope of toxicology, metal toxicity and occupational health hazards so that student may develop reasoning behind the effect of environment.

**Course Outcomes:**

Student will be able to understand toxicology and its scope in life, to identify different types of toxicants and create understanding about effects of toxic agents present in environment.

**Percent Change From Previous Syllabus: 100 % (Newly introduced)**

**SEMESTER IV**

**ZOPDDD1: DISSERTATION**

Topic will be based on the major elective opted by students. Project will include laboratory/field based work followed by submission of report and an open presentation.