

12/10/2015

## M.Sc. Zoology 2015-2017

### Choice Based Credit System

#### Course Structure and Scheme of Examination

#### SEMESTER I

Code	Course	C/E/S	L	T	P	Credit	Marks
CBCSZ-101	Non-chordata	Core	3		0	3	100
CBCSZ - 102	Chordata	Core	3		0	3	100
CBCSZ - 103	Cell Structure and Function	Core	3		0	3	100
CBCSZ - 104	Biochemical & Molecular Techniques and Biostatistics & Bioinformatics	Core	3		0	3	100
CBCSZ - 105	Practical	Core	0		3	3	100
CBCSZ - 106	Practical	Core	0		3	3	100
CBCSZ - 107	Assignment/Skill development	Core				1	100
CBCSZ - 108	Seminar-I	Core				1	100
CBCSZ - 109	Comprehensive viva-voce exam	Virtual credit				4	100
						24	900

**Total Credit Value: #24**

#### SEMESTER II

Code	Course	C/E/S	L	T	P	Credit	Marks
CBCSZ - 201	Cytogenetics and Genetics	Core	3		0	3	100
CBCSZ - 202	Developmental Biology	Core	3		0	3	100
CBCSZ - 203	Histology and Molecular Histochemistry	Core	3		0	3	100
CBCSZ - 204	Biochemistry and Mammalian Physiology	Core	3		0	3	100
CBCSZ - 205	Practical	Core	0		3	3	100
CBCSZ - 206	Practical	Core	0		3	3	100
CBCSZ - 207	Assignment/Skill development	Core				1	100
CBCSZ - 208	Seminar-II	Core				1	100

CBCSZ - 209	Comprehensive viva-voce exam	Virtual credit				4	100
						24	900

**Total Credit Values: #24**

**SEMESTER III**

Code	Course	C/E/S	L	T	P	Credit	Marks
CBCSZ - 301	Animal Behaviour	Core	3		0	3	100
CBCSZ - 302	Immunology and Parasitology	Core	3		0	3	100
CBCSZ - 303	Major Elective-I	Elective C/	3		0	3	100
CBCSZ - 304	Major Elective-II	Elective C/	3		0	3	100
CBCSZ - 305	Practical	Core			3	3	100
CBCSZ - 306	Practical	Elective C			3	3	100
CBCSZ - 307	Assignment/Skill development	Elective C/G	1			1	100
CBCSZ - 308	Seminar-III	Elective C/G				1	100
CBCSZ - 309	Comprehensive viva-voce exam	Virtual credit				4	100
						24	900

**Total Credit Values: #24**

**SEMESTER IV**

Code	Course	C/E/S	L	T	P	Credit	Marks
CBCSZ -401	Taxonomy and Evolution	Core	3		0	3	100
CBCSZ -402	Animal Ecology	Core	3		0	3	100
CBCSZ -403	Major Elective-III	Elective C	3		0	3	100
CBCSZ -404	Major Elective-IV	Elective C	3		0	3	100
CBCSZ -405	Practical	Core			3	3	100
CBCSZ -406	Practical	Elective C			3	3	100
CBCSZ -407	Assignment/Skill development	Elective C/G	1			1	100
CBCSZ -408	Seminar-IV	Elective C/G				1	100

CBCSZ -409	Comprehensive viva-voce exam	Virtual credit				4	100
						24	900

### Major Electives

(Details will be provided with the syllabus for Sem. III & IV)

#### A: Aquatic Biology and Aquaculture

##### SEMESTER III

Code	Course	C/E/S	L	T	P	Credit	Marks
	Aquatic Ecology & Resources		3		0	3	100
	Fish Biology & Physiology		3		0	3	100
	Aquatic Biology & Fish Biology (Practical)				3	3	100

##### SEMESTER IV

Code	Course	C/E/S	L	T	P	Credit	Marks
	Fisheries & Pisciculture		3		0	3	100
	Aquaculture		3		0	3	100
	Fisheries, Pisciculture & Aquaculture (Practical)				3	3	100

#### B: CELLULAR NEUROBIOLOGY AND HUMAN GENETICS

##### SEMESTER III

Code	Course	C/E/S	L	T	P	Credit	Marks
	Cellular Neurobiology		3		0	3	100
	Methods in molecular genetic analysis		3		0	3	100
	Methods in cell and molecular biology				3	3	100

##### SEMESTER IV

Code	Course	C/E/S	L	T	P	Credit	Marks
	Cellular basis of brain function		3		0	3	100
	Human genetics and Cancer		3		0	3	100
	Neurobiology and Human genetics				3	3	100



## C: Endocrinology

### SEMESTER III

Code	Course	C/E/S	L	T	P	Credit	Marks
	Comparative Endocrinology		3		0	3	100
	Endocrine Physiology		3		0	3	100
	General & Comparative Endocrinology & Endocrine Physiology (Practical)				3	3	100

### SEMESTER IV

Code	Course	C/E/S	L	T	P	Credit	Marks
	Male Reproductive Endocrinology		3		0	3	100
	Female Reproductive Endocrinology		3		0	3	100
	Reproductive Endocrinology (Practical)				3	3	100

## D: Entomology

### SEMESTER III

Code	Course	C/E/S	L	T	P	Credit	Marks
	General Entomology & Insect Morphology		3		0	3	100
	Insect Anatomy & Physiology		3		0	3	100
	General Entomology (Practical)				3	3	100

### SEMESTER IV

Code	Course	C/E/S	L	T	P	Credit	Marks
	Insect Taxonomy, Ecology & Development		3		0	3	100
	Applied Entomology		3		0	3	100
	Insect Taxonomy, Ecology & Development & Applied Entomology (Practical)				3	3	100



**SEMESTER I**  
**CBCSZ- 101: NON CHORDATA**  
(Credits 3)

**UNIT I**

- 1. Protozoa**
  - 1.1 Nucleus and reproduction
  - 1.2 Theories of the origin of metazoans
- 2. Porifera:** Aquaferous system
- 3. Cnidaria:** Polymorphism in Siphonophora
- 4. Annelida**
  - 4.1 Adaptive radiation in polychaetes
  - 4.2 Trochophore larva

**UNIT II**

- 5. Insecta**
  - 5.1. Importance and taxonomic richness of insects**
  - 5.2. Internal anatomy and physiology**
    - 5.2.1 Nervous system
    - 5.2.2 Endocrine system and function of hormones
    - 5.2.3 Circulatory system: heart and haemolymph
    - 5.2.4 Respiratory system: Aerial respiration and Aquatic respiration
    - 5.2.5 Digestive system: Structure of gut and Digestion of food
    - 5.2.6 Excretory system and waste disposal: Malpighian tubules and Nitrogen excretion
    - 5.2.7 Reproduction: Female and male systems; Oogenesis and spermatogenesis
  - 5.3. Insects as friends and foes**
  - 5.4. General methods of insect pest management**

**UNIT III**

- 6. Insecta**
  - 6.1. Sensory system**
    - 6.1.1 Tactile mechanoreceptor and position receptor
    - 6.1.2 Compound eye
  - 6.2. External anatomy**
    - 6.2.1 Segmentation and tagmosis
    - 6.2.2 Integument: structure and functions of cuticle, sclerotization
- 7. Mollusca:** Nervous system
- 8. Arthropoda**
  - 8.1 Evolutionary significance of Trilobites
  - 8.2 Crustacean larval and their significance

**UNIT IV**

- 9. Echinodermata:** larval forms and their significance
- 10. Salient features and affinities of**
  - 10.1 Placozoa
  - 10.2 Mesozoa
  - 10.3 Rotifera



- 10.4 Phoronida
- 10.5 Sipunculata
- 10.6 Hemichordata

## **CBCSZ-102: Chordata**

(Credits 3)

### **UNIT I**

- 1. Characteristic features and affinities of Protochordata and Cyclostomata**
- 2. Origin of the following**
  - 2.1 Fish
  - 2.2 Amphibian
  - 2.3 Reptile
  - 2.4 Bird
  - 2.5 Mammal

### **UNIT II**

- 3. Adaptive radiation in vertebrates**
  - 3.1 Aquatic
  - 3.2 Terrestrial
  - 3.3 Aerial
  - 3.4 Arboreal
  - 3.5 Fossorial
- 4. Parental care in amphibians**
- 5. Skull in reptiles**
- 6. Migration in birds**
- 7. Flightless birds**

### **UNIT III**

- 8. Comparative anatomy**
  - 8.1 Respiratory system: Characters of respiratory tissue, external and internal respiration,
  - 8.2 comparative account of respiratory organs
  - 8.3 Evolution of heart
  - 8.4 Evolution of aortic arches and portal systems
  - 8.5 Comparative account of jaw suspensorium and vertebral column

### **UNIT IV**

- 9. Comparative anatomy**
  - 9.1 Comparative account of limbs and girdles
  - 9.2 Evolution of urinogenital system in vertebrates
  - 9.3 Comparative account of organs of olfaction and taste
  - 9.4 Comparative anatomy of brain and spinal cord (CNS)
  - 9.5 Comparative account of peripheral and autonomic nervous system
  - 9.6 Comparative account of lateral line system

### **Books Recommended**

1. Barnes: Invertebrate Zoology (4<sup>th</sup> ed 1980, Holt Saunders International)





2. Barnes: The Invertebrates – A Synthesis (3<sup>rd</sup>ed 2001, Blackwell)
3. Hunter : Life of Invertebrates (1979, Collier Macmillan)
4. Marshall: Parker & Hashwell Textbook of Zoology, Vol I (7<sup>th</sup>ed 1972, Macmillan)
5. Moore : An Introduction to the Invertebrates (2001, Cambridge University Press)
6. Harvey *et.al* : The Vertebrate Life (2006)
7. Colbert *et.al* : Colbert's Evolution of the Vertebrates : A History of the Backboned Animals through time (5<sup>th</sup>ed, 2002, Willey-Liss)
8. Hildebrand : Analysis of Vertebrate Structure (4<sup>th</sup>ed, 1995, John Willey)
9. Jordan & Verma : Chordate Zoology (1998, S.Chand)
10. Kotpal: The Birds (4<sup>th</sup>ed, 1999, Rastogi Publications)
11. McFarland *et.al* : Vertebrate Life (1979, Macmillan Publishing)
12. Parker & Hashwell : Textbook of Zoology, Vol.II (1978, ELBS)
13. Romer & Parsons : The Vertebrate Body (6<sup>th</sup>ed 1986, CBS Publishing Japan)
14. Sinha, Adhikari & Ganguli : Biology of Animals Vol.II (1988, New Central Book Agency)
15. Young : The life of Vertebrates (3<sup>rd</sup>ed 2006, ELBS/Oxford)
16. Singh: Advances in Fish Research, Vol. I, II and III (Fisheries and Fish Biology: Ed DattaMunshi) (1993, 1997and 2004, Narendra Publishing House Delhi)

## CBCSZ 103: CELL STRUCTURE AND FUNCTION

(Credits 3)

### UNIT I

#### 1. Viruses

- 1.1 Structure and replication
  - 1.1.1 Bacteriophage (Lambda phage)
  - 1.1.2 Animal DNA virus (SV 40)
  - 1.1.3 Retroviruses (HIV)

#### 2. Prokaryotes

- 2.1. Bacteria
  - 2.1.1 Structure and reproduction of *E. coli*
  - 2.1.2 Plasmids and their functions

### UNIT II

#### 3. Eukaryotes

##### 3.1 Cell membrane

- 3.1.1 Lipid bilayer and membrane proteins
- 3.1.2 Transport across the cell membrane
  - 3.1.2.1 Diffusion, osmosis and measurement of osmotic pressure
  - 3.1.2.2 Active transport: mechanism, energy calculations

##### 3.2 Targeting and sorting of proteins

- 3.2.1 Signal peptide and SRP dependent targeting of translational complex
- 3.2.2 Processing of proteins in RER
- 3.2.3 Processing through Golgi complex: targeting to plasma membrane and lysosome
- 3.2.4 Targeting of nuclear and mitochondrial proteins




### UNIT III

#### 3.3 Mitochondria

- 3.3.1 Structure: assemblies of respiratory chain and  $F_0 F_1$  - ATPase
- 3.3.2 Oxidative phosphorylation: mechanism and chemiosmotic concept
- 3.3.3 Concept of free energy and bioenergetics of high energy phosphate compounds.

#### 3.4 Cell signaling- Basic concepts

- 3.4.1 Chemical mediators
- 3.4.2 Cell surface and Intracellular receptors

### UNIT IV

#### 3.5 Apoptosis- Basic concepts

- 3.5.1 Mechanism: initiation, execution and phagocytosis
- 3.5.2 Cellular homeostasis, development and diseases

#### 3.6 Cell transformation and malignancy

3.7 Cell - cell adhesion Collagen and Non-collagen components of extra cellular matrix of animal cells, Fibronectins and Integrins, Cell adhesion proteins & their types.

3.8 Cell junctions (occluding, Anchoring & Gap junctions)

#### Books Recommended

##### Cell Structure and Function

1. Alberts et al: Molecular Biology of the Cell (5th ed 2008, Garland)
2. Lodish et al: Molecular Cell Biology (6th ed 2007, Freeman)
3. Stryer: Biochemistry (6<sup>th</sup> ed. 2006, Freeman)
4. Michael Jr: Microbiology (1993, Tata McGraw Hill)

## CBCSZ 104: BIOCHEMICAL & MOLECULAR TECHNIQUES, BIostatISTICS AND BIOinformatics

(Credits 3)

### Part A: Biochemical & Molecular Techniques

#### UNIT I

##### 1. Centrifugation

- 1.1 Basic principle
- 1.2 Types of rotors
- 1.3 Clinical, high speed and ultracentrifuge

##### 2. Spectrophotometry

- 2.1 Types of spectrophotometer
- 2.2 Beer-Lambert's law, molar extinction coefficient
- 2.3 Principles of UV- Vis spectrophotometry

##### 3. Electrophoresis

- 3.1 Principle
- 3.2 Agarose and polyacrylamide gel

##### 4. Chromatography



- 4.1 Principle and types
- 4.2 Column chromatography
  - 4.2.1 Gel filtration
  - 4.2.2 Ion exchange & Affinity chromatography

## UNIT II

### 5. Methods in molecular biology and Recombinant DNA techniques

- 5.1 Western blotting & In situ hybridization
- 5.2 DNA foot printing & Electrophoretic Shift Assay (EMSA)
- 5.5 DNA sequencing
- 5.1 Restriction enzymes
- 5.2 Cloning vectors
- 5.3 Preparation and screening of cDNA and genomic DNA libraries
- 5.4 Southern and Northern hybridizations
- 5.5 Polymerase chain reaction: principle and applications

### 6. Types of microscope and their biological applications

- 6.1 Bright-field microscope
- 6.3 Phase contrast microscope
- 6.4 Fluorescence microscope
- 6.5 Confocal microscope
- 6.7 Transmission and scanning electron microscope

## UNIT III

### Part B: Biostatistics

- 7. The mean, mode, median, Standard deviation and Standard error of classified Data
- 8. Hypothesis testing: Chi Square test, f -Test
- 9. Student's t test
- 10. Analysis of variance (one way and two way ANOVA)
- 11. Correlation & Regression

## UNIT IV

### Section C: Bioinformatics

- 12. Bioinformatics: Definition, history and scope
- 13. Analysis of DNA and protein sequences; molecular and genomic databases (e.g., GENE BANK, SWISS-PROT and other databases)
- 14. Introductory ideas on use of databases for sequence retrieval, similarity search and sequence alignment.
- 15. Bioinformatics in drug discovery

### Books recommended

#### Biochemical & Molecular Techniques

- 1. Boyer: Modern Experimental Biochemistry and Molecular biology (2nd ed 1993, Benjamin/Cumin)
- 2. Freifelder: Physical Biochemistry ( 2nd ed 1982, Freeman)
- 3. Holme and Peck: Analytical Biochemistry ( 3rd ed 1998, Tata McGraw Hill)
- 4. Plummer: An Introduction to Practical Biochemistry (3rd ed 1990, Tata-McGrawHill)

5. Switzer and Garrity: Experimental Biochemistry ( 92nded 1999, Freeman)
6. Wilson and Walker: Principles of Biochemical and Molecular Biological Techniques (6<sup>th</sup> ed 2006, Cambridge University Press)

### **Bioinformatics**

1. Barnes & Gray: Bioinformatics for geneticists (2003, Wiley)
2. Lesk: Bioinformatics (2<sup>nd</sup>ed 2006, Oxford)
3. Westhead et al: Bioinformatics Instant Notes (Indian ed 2003, Viva Books)
4. Mount, Bioinformatics (2<sup>nd</sup>ed 2006, CBS)
5. Hunt and Livesey: Functional Genomics (2006, Oxford)
6. Campbel: Discovering Genomics, Proteomics and Bioinformatics (2006, LPE)

## **LABORATORY EXERCISES**

### **CBCSZ 105: NON CHORDATA & CHORDATA**

(Credits 3)

#### **Part A: Non Chordata&Chordata (Credit 1.5)**

##### **Non Chordata**

1. Preparation of permanent slides
  - 1.1 Protozoa: *Paramecium* (whole mount) and demonstration of food vacuoles, etc.
  - 1.2 Cnidaria: *Bougainvillea*, *Sertularia*, etc.
  - 1.3 Arthropoda: Cyclops, Megalopa/Zoea, spiracles of cockroach, etc.
  - 1.4 Mollusca: Glochidium larva, etc.
  - 1.5 Echinodermata: Spheredium, pedicellaria, tubefeet
2. Dissections
  - 2.1 Arthropoda: Salivary glands of cockroach, etc.
  - 2.2 Mollusca: nervous system of *Mytilus* and *Aplysia/Sepia*
3. Study of museum specimens
  - 3.1 Porifera
  - 3.2 Cnidaria
  - 3.3 Annelida
  - 3.4 Arthropoda
  - 3.5 Mollusca
  - 3.6 Echinodermata

##### **Insects**

1. Study of external morphology of cockroach
2. Internal anatomy of cockroach
  - 2.1 Alimentary canal
  - 2.2 Salivary apparatus: dissection and *in toto* stained preparation
3. Dissection of frontal ganglion, brain, corpora cardiac (CC), corpora allata (CA) and recurrent nerve
4. Dissection and mounting of prothoracic gland
5. Dissection of male and female reproductive systems of cockroach
6. Study of external morphology of honey bee and dissection of sting apparatus





7. Study of following using permanent slides/specimens: L. S. of teleotrophic and polytrophic ovarioles, T. S. of testis, and brain showing median neuro secretory cells (MNSC), whole mount of head of louse, CC & CA, and *Chironomous* larva

### **Chordata**

1. Study of external features of *Branchiostoma* and permanent preparation of its oral hood, velum and pharyngeal wall
2. Study of whole mount preparations of following proto-chordates
  - 2.1 *Doliolum*, *Pyrosoma*, *Salpa* and *Oikopleura*
  - 2.2 T.S. through pharynx, gonads and post anal region of *Branchiostoma*
  - 2.3 T.S. and L.S. through proboscis of *Balanoglossus*
3. Permanent preparation of test and neural complex of *Herdmania*
4. Fossorial adaptation and urino-genital system of rat
5. Study of adaptive features of following:
  - 5.1 Amphibians
  - 5.2 Reptiles
  - 5.3 Birds
  - 5.4 Mammals

### **Fish Biology**

1. Classification of the following locally available fishes using key
  - 1.1 Carps: *Catlacatla*; *Labeorohita*, *Cirrhinamrigala*
  - 1.2 Catfishes: *Heteropneustesfossilis*, *Clariasbatrachus*
2. Dissection and display of accessory respiratory organs of
  - 2.1 *Clarias batrachus*
  - 2.2 *Channa sp.*
  - 2.3 *Heteropneustes fossilis*
3. Study of larvivorous fishes through museum specimens
4. Mounting of respiratory epithelium of accessory respiratory organs of *H. fossilis* and air bladder epithelium of carp
5. Study of museum specimens of fishes having electric organs, venomous organs and airbreathing organs
6. Study of T.S. of gills, accessory respiratory organs and swim bladder from prepared slides

## **CBCSZ106: BIOCHEMICAL AND MOLECULAR TECHNIQUES**

(Credits 3)

### **Biochemical and Molecular Techniques**

1. Verification of Beer's law and preparation of absorption spectrum of riboflavin
2. Demonstration of separation of protein by SDS-polyacrylamide gel electrophoresis
3. Isolation of plasmid, restriction digestion and determination of size by agarose gelelectrophoresis
4. pH meter and determination of pH of a buffer
4. Demonstration of DNA amplification by polymerase chain reaction
6. Isolation of genomic DNA by spooling/ precipitation method and its quantitation
7. Agarose gel electrophoresis
8. Isolation and identification of lipids by TLC
9. Determination of amino acids by paper chromatography



10. Estimations of fractionated molecules through spectrophotometric methods
  - 10.1 Protein by Biuret/Folins method
  - 10.2 DNA by diphenylamine method
  - 10.3 RNA by orcinol method

### **Bioinformatics & Biostatistics**

1. Use of search engines (Google, Altavista, Dogpile, Meta-crawler)
2. Demonstration of web-pages related to biological information (NCBI, ExPasy)
3. Hands on practice to features of following databases: GenBank, PDB, DIP, PubMed, Toxnet, OMIM, Fly Base, etc.
4. Hands on practice to features of following software packages/tools: BLAST, Clustal-W, PHYLIP
5. Estimation of mean, median, mode, standard error and standard deviation
6. Demonstration of correlation
7. Working on examples of  $X^2$  (Chi square) test for hypothesis testing



**SEMESTER II**  
**ZOM201: CYTOGENETICS AND GENETICS**  
(Credits 3)

**UNIT I**

**1. Eukaryotic chromatin structure and chromosome organization**

- 1.1 Classes of DNA
- 1.2 Chromosomal proteins: histones, non-histone proteins and scaffold/matrix proteins
- 1.3 Nuclear matrix and organization of interphase nucleus
- 1.4 Centromere, kinetochore and telomere
- 1.5 Metaphase chromosome banding

**2. Giant chromosome: Polytene chromosome & Lampbrush chromosome**

**3. Cell division**

- 3.1 Mitosis
  - 3.1.1 Role of maturation promoting factor and its regulation
  - 3.1.2 Chromosomal movement
  - 3.1.3 Exit from mitosis
  - 3.1.4 Cytokinesis
- 3.2 Meiosis
  - 3.2.1 Chromosome pairing and recombination
  - 3.2.2 Genetic regulation

**UNIT II**

**4. Human cytogenetics**

- 4.1 Karyotype and nomenclature of metaphase chromosome bands
- 4.2 Chromosome anomalies and diseases
  - 4.2.1 Types of chromosomal anomalies
  - 4.2.2 Common syndromes caused by aneuploidy, mosaicism, deletion and duplication
  - 4.2.3 Chromosomal anomalies in malignancy (chronic myeloid leukemia and retinoblastoma)
  - 4.2.4 Fragile site and X-linked mental retardation

**UNIT III**

**5. Mendel's laws and their chromosomal basis**

**6. Extensions of Mendelism**

- 6.1 Dominance relationships
- 6.2 Epistasis
- 6.3 Pleiotropy

**7. Methods of gene mapping**

- 7.1 3-point test cross in *Drosophila*
- 7.2 Gene mapping in bacteria by transformation and conjugation

**8. Quantitative inheritance: Concept of polygene & polygenic inheritance**

**UNIT IV**

**9. Gene mutation and DNA repair**

- 9.1 Types of gene mutations
- 9.2 DNA damage and repair



10. **Nature of the gene and its function**
  - 10.1 Fine structure of gene (*rII* locus)
  - 10.2 Regulation of gene activity in *lac* operon of *E. coli*
  - 10.3 Organization of a typical eukaryotic gene
  - 10.4 Non-coding genes
11. **Mitochondrial DNA: Organization & properties**

#### Books Recommended

1. Alberts et al: Molecular Biology of the Cell (2008, Garland)
2. Bostock & Sumner: Eukaryotic Chromosome (1987, North-Holland)
3. Cassimeris et al: Lewin's Cells (2011, Jones Bartlett)
4. Gardner et al: Principles of Genetics (2006, John Wiley)
5. Griffith et al: Modern Genetic Analysis (2008, Freeman)
6. Hartl & Jones: Essential Genetics: A Genomic perspective (2009, Jones & Bartlett)
7. Karp: Cell and Molecular Biology (2010, John Wiley & Sons)
8. Krebs et al: Lewin's Genes X (2011, Jones & Bartlett)
9. Lodish et al: Molecular Cell Biology (2008, Freeman)
10. Pierce: Genetics – A Conceptual Approach (2012, Freeman)
11. Russell: Genetics (2010, Benjamin Cummings)
12. Snustad & Simmons: Principles of Genetics (2012, John Wiley)

## CBCSZ 202: DEVELOPMENTAL BIOLOGY (Credits 3)

### UNIT I

1. Introduction to Development: Generation of new cells and organs.
2. Cell-Cell communication in development, cell adhesion, cell migration, cell signaling, paracrine factors.
3. Fertilization: The mechanism: External fertilization in Sea Urchins, polyspermy and its restriction, internal fertilization in Mammals.
4. Cleavage: Pattern of cleavage, fate map, cleavage and axis formation in *C. elegans*.

### UNIT II

5. Early development in Fish and Amphibians: Axis fate in Zebra fish, Amphibian cleavage and Gastrulation, mechanism of Amphibian axis fate.
6. Early development in Birds: Gastrulation in Avian embryo, Axis fate
7. Mammalian Gastrulation; Mammalian Axis fates.
8. Formation of neural tube, differentiation of Neurons and formation of the Brain.

### UNIT III

9. Development of Eye and Cutaneous Appendages.
10. Neural Crest Cells, Pattern generation in nervous system.
11. The Somites and their Derivatives.
12. Development of Bones.
13. Development of Heart and formation of Blood vessels.
14. Development of Digestive Tube and its Derivatives.



15. Formation and development of Limbs

#### UNIT IV

- 16. Metamorphosis.
- 17. Regeneration in Flat worms, Hydra, Salamander
- 18. Cancer
- 19. Environment and Development
- 20. Developmental Mechanisms of Evolutionary Change

## CBCSZ 203: HISTOLOGY AND MOLECULAR HISTOCHEMISTRY

(Credits 3)

### UNIT I

#### 1. Fixation and tissue processing

- 1.1 Types of fixatives
- 1.2 Chemistry of fixation
- 1.3 Choice of fixatives
- 1.4 Dehydration
- 1.5 Clearing and embedding

#### 2. Microtomy

- 2.1 Types of microtome
- 2.2 Sectioning of paraffin blocks
- 2.3 Cryosectioning
- 2.4 Vibratome

#### 3. Staining of paraffin sections

- 3.1 Principle and methods of staining
- 3.2 Histological stains: haematoxylin and eosin

### UNIT II

#### 4. Principles and methods of histochemical localization and identification of:

##### 4.1 Carbohydrate moieties

- 4.1.1 Glycogen and glycoproteins with oxidizable vicinal diols by periodic acid Schiff method
- 4.1.2 Glycoproteins with carboxyl groups and/or *O*-sulphate esters by alcian blue methods
- 4.1.3 Role of lectin in carbohydrate histochemistry

##### 4.2 Protein end groups

- 4.2.1 General protein localization by bromophenol blue method
- 4.2.2  $-NH_2$  groups by Ninhydrin-Schiff method
- 4.2.3  $-S-S-$  groups by performic acid-Schiff and performic acid-alcian blue methods

### UNIT III

##### 4.3 Lipids moieties

- 4.3.1 General lipids by Sudan black B method
- 4.3.2 Neutral lipids by Sudan III and Sudan IV methods
- 4.3.3 Differentiation of neutral lipids from acidic lipids by Nile blue sulphate method



#### 4.4 Nucleic acids

4.4.1 Methyl green pyronin-Y for DNA and RNA

4.4.2 Feulgen reaction for DNA

#### 4.5 Enzyme activity

4.5.1 Principles of enzyme histochemistry

4.5.2 Acid and alkaline phosphatases by metal precipitation and azo dye methods

### 5. **Basic principles of immunohistochemistry and fluorescence staining**

### 6. **In situ hybridization**

## UNIT IV

### 7. **Gross Histology of tissue types:**

7.1 Connective tissue

7.2 Cartilage

7.3 Bone

7.4 Cerebrum, cerebellum and spinal cord

7.5 Heart

7.6 Kidney

7.7 Liver

7.8 Gall bladder

7.9 Lungs

7.10 Testis and ovary

7.11 Thyroid gland

#### **Books recommended**

##### *Histology & Histochemistry*

1. Bancroft & Stevens: Theory and Practice of Histological techniques (2013, Churchill-Livingstone)
2. Casselman: Histochemical techniques (1959, John Wiley)
3. Pearse: Histochemistry: Theoretical and Applied (Vol. I, II & III) (4<sup>th</sup> ed 1980-1993, Churchill-Livingstone)
4. Kiernan: Histological and Histochemical Methods (4<sup>th</sup> Ed. Scion 2008)

## **CBCSZ204: BIOCHEMISTRY & MAMMALIAN PHYSIOLOGY**

(Credits 3)

### **Part A: BIOCHEMISTRY**

#### UNIT I

### 1. **Protein structure**

1.1 Primary structure

1.2 Secondary structure:  $\alpha$ -helix,  $\beta$ -pleated sheet

1.3 Tertiary structure: forces stabilizing tertiary structure

1.4 Quaternary structure: sub unit interaction and significance

### 2. **Enzymes**

2.1 Classification and nomenclature

2.2 Enzyme kinetics: Michaelis-Menten and Lineweaver-Burk plots, applications of  $K_m$

2.3. Mechanism of action

2.3.1 Active site & substrate binding.



- 2.3.2 Chemical catalysis (chymotrypsin)
- 2.3.3 Regulation of enzyme activity

## UNIT II

### 3. Metabolism

- 3.1 Concept of metabolic pathways and cycles
- 3.2 Central energy transduction mechanism

### 4. Nucleic acids

- 4.1 Structure
- 4.2 Mechanism of DNA replication
  - 4.2.1 DNA polymerases
- 4.3 Transcription
  - 4.3.1 RNA polymerases and mechanism of RNA synthesis
- 4.4 Processing of hnRNA: Capping Poly(A) tailing & Splicing
- 4.5 Genetic code
- 4.6 Mechanism of translation
  - 4.6.1. Role of ribosomes and tRNAs
  - 4.6.2 Mechanism of transition in prokaryotes & comparison with their of eukaryotes.

## Part B: MAMMALIAN PHYSIOLOGY

## UNIT III

### 5. Circulation

- 5.1 Blood: Haemopoiesis
- 5.2 Heart
  - 5.2.1 Origin and conduction of cardiac impulse
  - 5.2.2 Cardiac cycle and ECG

### 6. Respiration

- 6.1 Pulmonary ventilation
  - 6.1.1 Respiratory centers: organization and function
  - 6.1.2 Surfactant
- 6.2. Exchange and transport of respiratory gases
- 6.3 Respiratory adjustments
  - 6.3.1 Hypoxia and oxygen therapy
  - 6.3.2 Dyspnea

## UNIT IV

### 7. Excretion

- 7.1 Urine formation and regulation
- 7.2 Acid-base balance and homeostasis
- 7.3 Renal function tests

### 8. Muscle

- 8.1 Types of contraction
- 8.2 Muscle proteins
- 8.3 Mechanism and energetics of muscle contraction





9. **Digestion and nutrition:** Digestion and absorption of macronutrients and their regulation

**Books Recommended**

*Mammalian Physiology*

1. Ganong: Review of Medical Physiology (22<sup>nd</sup> Ed 2005, Lang Medical Publications)
2. Guyton and Hall: Text Book of Medical Physiology (11<sup>th</sup> Ed 2006, W.B. Saunders)
3. Keel et al: Samson Wright's Applied Physiology (13<sup>th</sup> Ed 1989, Oxford Press)
4. Murray et al: Harper's Illustrated Biochemistry (27<sup>th</sup> Ed 1989, Appleton & Lange)
5. West: Best and Taylor's Physiological Basis of Medical Practice (11<sup>th</sup> Ed 1981, Williams and Wilkins)

**Biochemistry**

1. Boyer: Concepts in Biochemistry (3<sup>rd</sup> ed. 2006, Brooks/Cole)
2. Lehninger, Nelson & Cox: Principles of Biochemistry (4<sup>th</sup> ed, 2007, Worth),
3. Murray *et al*: Harper's Biochemistry (25<sup>th</sup> ed. 2000, Appleton & Lange)
4. Stryer: Biochemistry (6<sup>th</sup> ed. 2006, Freeman)
5. Watson et al: Molecular Biology of the Gene (2nd ed 1976, Benjamin/Cummings)
6. Zubay: Biochemistry (1998, McGraw-Hill)

**LABORATORY EXERCISES**

**CBCSZ 205: CYTOGENETICS, GENETICS AND DEVELOPMENTAL BIOLOGY**  
(Credits 3)

**Cytogenetics**

1. Study of meiosis in grasshopper testes by squashing method
2. Temporary squash preparation of polytene chromosomes from salivary glands of *Drosophila/Chironomous* larvae
3. Preparation of human karyotype
4. Study of sex chromatin in human female from buccal epithelial and hair budcells
5. Study of permanent slides for the following:
  - 5.1 Inversions in polytene chromosomes of *Drosophila*
  - 5.2 G-banded and C-banded metaphase chromosomes

**Genetics**

1. Culturing of *E coli* on solid and liquid media
2. Handling of *Drosophila* and study of its life cycle
3. Examination of wild type (males and females) and mutants of *Drosophila*
4. Sex linked inheritance in *Drosophila melanogaster*
5. Monohybrid and di-hybrid crosses in *Drosophila melanogaster*

**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. Study of embryonic development in chick through slides
5. Window preparation to study chick embryo development
6. Whole mount preparation of chick embryos at various stages of development
7. Observation of aristopedia and bithorax mutants of *Drosophila*
8. Study of metamorphosis in *Drosophila* larvae by ligature experiments

## **CBCSZ 206: HISTOLOGY, HISTOCHEMISTRY, BIOCHEMISTRY AND PHYSIOLOGY**

(Credits 3)

### **Histology and Histochemistry**

1. Paraffin sectioning
  - 1.1 Fixation of tissue
  - 1.2 Dehydration, clearing and embedding of tissue
  - 1.3 Sectioning and spreading of sections
2. Histological staining of paraffin sections using haematoxylin and eosin method
3. Histochemical staining of paraffin sections for demonstration of acidic glycoproteins by Alcian blue pH 2.5 method
4. Histochemical staining for lipids using
  - 4.1 Sudan black B method
  - 4.2 Sudan III method
  - 4.3 Sudan IV method
5. Demonstration of immunohistochemical and immunofluorescence methods

### **Biochemistry & Physiology**

1. Preparation of extract for enzyme assay (alkaline phosphatase)
2. Study of alkaline phosphatase activity
  - 2.1 Standard curve preparation
  - 2.2 Effect of enzyme concentration and determination of total and specific activity
  - 2.3 Effect of temperature on enzyme activity
  - 2.4 Effect of time on enzyme activity
  - 2.5 Effect of substrate concentration on enzyme activity
  - 2.6 Determination of  $K_m$  and  $V_{max}$  by Michaelis-Menten and Lineweaver-Burk
3. Differential leucocytes counting in blood
4. Determination of blood groups (ABO and Rh factor)
5. Estimation of ascorbic acid content in lemon extract using titration method
6. Preparation of casein from milk

