

## ZY – 101T: Biochemistry (2 Credits: 30 Lectures)

01	<b>Biomolecules: characteristic features</b>	5L
	Water, structure of liquid water, water as ideal biological solvent, Thermodynamics – free energy, entropy, high energy bonds	
02	<b>Mitochondria and Chloroplast:</b>	5L
	Electron transport, proton translocation, oxidative phosphorylation. Photosynthesis and other processes involving light.	
03	<b>Amino acids, peptides and polypeptides:</b>	6L
	The 3 - D structures of proteins, Ramchandran plot, $\alpha$ helix, $\beta$ sheet, structure of collagen, domain – basic unit of tertiary structure, quaternary structure, Functional diversity of proteins.	
04	<b>Carbohydrates:</b>	3L
	Monosaccharides, disaccharides and polysaccharides, structure and function.	
05	<b>Lipids:</b>	2L
	Chemistry of triglycerides, sterols, quinones and prostaglandins.	
06	<b>Nucleotides:</b>	
	Structure, function, properties and types of Nucleic acid.	2L
	The RNA world.	1L
07	<b>Enzymology:</b>	
	Units, Specific Activity, Coenzymes.	1L
	Kinetics of enzyme catalyzed reactions, Effect of pH, Inhibitor, Activator.	2L
	Regulation of enzyme activities.	
	Isoenzyme: structure and function	2L
		1L

### Reference Books:

Lehninger, Principles of Biochemistry, 4<sup>th</sup> Edition, (2005), David L. Nelson, Michael M. Cox, Publisher- W.H. Freeman and Co.

Biochemistry, 3<sup>rd</sup> Edition, (2005), Donald J. Voet and Judith G. Voet, Publisher-Wiley,

Biochemistry, 6<sup>th</sup> edition (2007), Jeremy M. Berg, John L. Tymoczko, Lubert Stryer, Publisher- W.H. Freeman and Co.

Biochemical Calculations, 2<sup>nd</sup> edition (1968) I.H. Segel, Publisher-John Wiley and Sons.

## ZY – 102T: Cell Biology (2 Credits: 30 Lectures)

01	<b>An overview of cell:</b> cell shapes and types, and introduction to Prokaryotic and Eukaryotic cells.	2L
02	<b>Plasma membrane and cell surface:</b> Structure, chemistry, receptors, transport, endocytosis, exocytosis, pinocytosis and phagocytosis, cell junctions, membrane potential and synaptic transmission, signal transduction, glycocalyx and cell wall.	8L
03	<b>Mitochondria;</b> Structure, function, protein import, <b>Chloroplast</b> – PS I and PS II system, water-splitting complex.	5L
04	<b>Subcellular organelles:</b> (a) Rough and Smooth Endoplasmic reticulum (b) The Golgi complex (c) Lysosomes, (d) Peroxisomes and glyoxysomes, (e) Nucleus	10L
05	<b>Cell cycle:</b> Phases of cell cycle, checkpoints of cell cycle, Molecular basis of regulation of cyclic events occurring at phase transitions, regulation of cell cycle in yeasts, amphibians and mammals	5L

### Reference Books:

The World of the Cell, 7<sup>th</sup> edition (2005), Wayne M. Becker, Lewis J. Kleinsmith, Jeff Hardin. Publisher-Benjamin Cummings.

Molecular Cell Biology, 6<sup>th</sup> edition (2007), Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, Anthony Bretscher, Hidde Ploegh, Paul Matsudaira. Publisher - W. H. Freeman and Co.

Molecular Biology of the Cell, 5<sup>th</sup> edition, (2007), Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter. Publisher - Garland Science.

Karp (2010). Cell and Molecular Biology. John Wiley

Krebs et al. (2014). Lewin's Genes XI. Jones & Bartlett Learning

Cooper (2007). The Cell: A molecular Approach. ASM Press

## ZY – 103T: Fundamentals of Molecular Biology (2 Credits: 30 Lectures)

- 01 **Genome organization:** 12L
- C value paradox and genome size, Cot curves, repetitive and non-repetitive DNA sequence, Cot  $\frac{1}{2}$  and Rot  $\frac{1}{2}$  values, Pseudogenes, Gene families, Gene clusters, Super-families
- Organelle genome
- Structure of chromatin, nucleosome, chromatin organization and remodeling, higher order organization - chromosome, centromere, telomere
- Histone and its effect on structure and function of chromatin
- 02 **DNA Replication:** 8L
- DNA replication in *E. coli*, Origin of replication, types of *E. coli* DNA polymerases, details of replication process, regulation of replication, connection of replication to cell cycle.
- Different models of replication for linear and circular DNA, replication features of single stranded phages.
- Eukaryotic DNA replication, multiple replicons, eukaryotic DNA polymerases, ARS in yeast, Origin Recognition Complex (ORC), regulation of replication
- 03 **DNA damage and repair:** 4L
- Different types in DNA damages,
- Different DNA repair systems: Nucleotide excision repair, Base excision repair, mismatch repair, recombination repair, Double strand break repair, transcriptional coupled repair
- 04 **Recombination:** 3L
- Homologous and site specific recombination, Models for homologous recombination: The Holliday model, double strand break repair model, Proteins involved in recombination: RecA, RuvA, B, C, Gene conversion
- Mobile DNA elements:** 3L
- 05 Transposable elements in bacteria, IS elements, composite transposons, replicative, non-replicative transposons, Mu transposition
- Controlling elements in Tn A and Tn 10 transposition, SINES and LINES. Retroviruses and retrotransposon

**Reference books:**

Genes IX, 9<sup>th</sup> edition (2008), Benjamin Lewin, Publisher - Jones and Barlett Publishers Inc.

Molecular Biology of the Gene, 5<sup>th</sup> Edition (2004), James D. Watson, Tania Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Lodwick. Publisher - Pearson Education, Inc. and Dorling Kindersley Publishing, Inc.

Molecular Biology, 4<sup>th</sup> Edition (2007), Weaver R., Publisher-McGraw Hill Science.

Molecular Biology of the Cell, 4<sup>th</sup> Edition (2004), Bruce Alberts, Dennis Bray, Julian Lewis, Martin Raff, Keith Roberts, and James D. Publisher-Watson Garland Publishing.

Essential Cell Biology, 2<sup>nd</sup> Edition (2003) Bruce Alberts, Dennis Bray, Karen Hopkin, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter, Publisher-Garland Publishing.

Fundamentals of Molecular Biology, (2009), Pal J.K. and Saroj Ghaskadbi, Publisher - Oxford University Press.

### **ZY – 104T: Introduction to Developmental Biology (2 Credits: 30 Lectures)**

01	<b>Basic concepts of Developmental Biology:</b>	5L
	Model systems: Fish, Frog, Chick, Mouse, <i>Drosophila</i> and <i>Arabidopsis</i>	
02	<b>Types of eggs and cleavage patterns:</b>	5L
	Concepts in Pattern formation, animal vegetal axis, gradients, origin and specification of germ layers.	
03	<b>Cell–cell interaction and cell signaling:</b>	5L
	Cell –cell interaction and cell signaling during morphogenesis in early embryo; gastrulation, neurulation and primordial organ rudiments, Origin and fate of neural crest cells.	
04	<b>Differentiation:</b>	5L
	Cellular basis of differentiation, trans-differentiation, metaplasia and regeneration. Stem cells and their role in development	
05	<b>Growth and post embryonic development:</b>	5L
	Apoptosis, aging and senescence, abnormal development.	
06	<b>Evolution and development confirmative study.</b>	5L

#### **Reference Books:**

Developmental Biology, 8<sup>th</sup> edition (2006), S.F. Gilbert. Publisher - Sinauer Associates Inc.

Principles of Development, 3<sup>rd</sup> edition (2007), Lewis Wolpert, Publisher- Oxford University Press.  
An Introduction to Embryology, 5<sup>th</sup> edition (2004), B. I. Balinsky. Publisher - Thomas Asia Pvt. Ltd  
Developmental Biology, (2001), R. M. Twyman, Publisher - Bios Scientific Publishers LTD.

### ZY – 105T: General Genetics (2 Credits: 30 Lectures)

- |    |  |     |
|----|--|-----|
| 01 | <b>Review of Mendelian &amp; Non-Mendelian inheritance:</b>  | 6 L |
|    | Mono/dihybrid inheritance, types of dominance, multiple allelism, Pleiotropy, epistasis, inheritance related sex, probability and exercises for solving analytical and numerical problems on Mendelian and non-Mendelian inheritance patterns                                  |     |
| 02 | <b>Quantitative Genetics:</b>  | 4L  |
|    | Polygenic traits and mode of inheritance, analysis of variation: genetic and environmental factors influencing quantitative traits, Heritability, Inbreeding and consequences, consanguinity, exercises for solving analytical and numerical problems on polygenic inheritance |     |
| 03 | <b>Linkage and mapping in eukaryotes:</b>  | 4L  |
|    | Detection of linkages, construction of linkage maps in diploids and their characteristics, co-efficient of coincidence, outline of other mapping techniques  |     |
| 04 | <b>Cytogenetics:</b>   | 2L  |
|    | Variation in chromosomal structure and number and genetic consequences   |     |
| 05 | <b>Cytoplasmic inheritance:</b>  | 2L  |
| 06 | <b>Microbial Genetics:</b>   | 8L  |
|    | Recombination in bacteria and gene mapping – Transformation, Conjugation, Transduction (Generalized and Specialized); General principles and genetics of bacteriophages including RNA phage  |     |
| 07 | <b>Population Genetics:</b>  | 4L  |
|    | Basic concepts, terminologies, Hardy-Weinberg principles and applications, changes in allelic frequencies, exercises for solving population genetic problems .   |     |

#### Reference Books:

Genetics: Analysis & Principles – by Brijjer R S (2018) McGraw Hill  
Principles of Genetics -- by Gardner E.J., Simmon M. J., Snustad D.P.(2006)8<sup>th</sup> ed. Wiley  
Concepts of Genetics – by Klug W.S., Cummings M.R., Sepnker C.A., Palladins M.A. (2015) 11<sup>th</sup> edition, Pearson Publ.

Genetics – by Strickberger M.W. (2015) (3<sup>rd</sup> Indian edition) Pearson Education  
 iGenetics: A molecular approach – by Russel P.J. (2016) Pearson Education  
 Genetics – by Fairbanks D.J. and Andersen W.R. (1999), Brooks-Cole Publ Co.  
 Microbial Genetics – by Maloy S.R., Cronan J.E., Freifelder D. (1994), Jones & Bartlett Publ.  
 Principles of Genetics – by Gardner E.J. 8<sup>th</sup> edition (2006) John Wiley & Sons.  
 Microbial Genetics, (1987), David Freifelder, Publisher-Jones & Bartlett  
 General Genetics, (1985), Leon A. Snyder, David Freifelder, Daniel L. Hartl Publisher- Jones and Bartlett.  
 Genetics, 3<sup>rd</sup> edition, Monroe W. Strickberger, (1968), Publisher - Macmillan Publishing Co.

### ZY – 106T: Animal Physiology (2 Credits: 30 Lectures)

- 01 **Digestion:** Composition and functions of saliva, Mechanical and chemical digestion in mouth, Mechanical and chemical digestion in stomach, Composition and functions of pancreatic juice, Functions of liver : role and composition of bile, Mechanical and chemical digestion in small and large intestine 4L  
 Digestion of carbohydrate, Digestion of protein, Digestion of lipids, Digestion of nucleic acids  
 Absorption in small and large intestine, Hormonal and neural regulation of digestion (Examples from Invertebrate and Vertebrate animals )
- 02 **Respiration:** Pulmonary ventilation, Pressure change during pulmonary ventilation, Breathing pattern and modified respiratory movements, Lung volumes and capacities, Exchange of oxygen and carbon dioxide, Gas laws, Transport of oxygen and carbon dioxide (Examples from Invertebrate and Vertebrate animals ) 3L  
 .
- 03 **Circulation:** Cardiac cycle, Heart sounds, Cardiac output, Regulation of heart rate, Heart valves and circulation of blood, Factors affecting blood flow, Circulatory routes: the systemic circulation, the hepatic circulation, the pulmonary circulation , exercise and the heart, homeostatic imbalances 4L  
 . (Examples from Invertebrate and Vertebrate animals )
- 04 **Muscle Physiology:** Types of muscles, microanatomy of skeletal muscle, transmission of impulse across neuromuscular junction, sarcotubular system, role of calcium in contraction, Molecular basis of muscle contraction Calcium receptors, Calmodulin and calcium pump. , muscle metabolism, proteins of sarcomere, Types of contraction-Summation, Trappe, isotonic and isometric contraction. Sliding filament theory of muscle contraction. (Examples from Invertebrate and Vertebrate animals ) 6L  
  
 Myasthenia gravis. Neuromuscular transmission influenced by toxins, drugs. Muscular disorders: Hypo tonicity, Hypertonicity, Fibrillation and Denervation Hypersensitivity. Red and White fibers and muscle function, Duchenne s muscular dystrophy, **Myasthenia Gravis, Muscular Dystrophy, Fibromyalgia** . (Examples from Invertebrate and Vertebrate animals )
- 05 **Osmoregulation:** Osmolarity, ionic composition in ECF and ICF, Osmoregulatory challenges and osmoregulation in fresh water, marine and terrestrial animals, role of 3L

chloride cells in osmoregulation, extreme regulators, osmoregulation in marine air breathing animals, nitrogenous wastes. (Examples from Invertebrate and Vertebrate animals )

- 06 **Excretion:** General outline of excretion in invertebrates, Anatomy of nephron , GFR, tubular reabsorption and secretion, urea cycle, counter current multiplier, counter current exchanger, regulation of blood volume and blood pressure, production of urine (Examples from Invertebrate and Vertebrate animals ) 4L
- 08 **Nerve Physiology:** Ultra structure of neuron, Electrical signals in neurons, Ion channels, resting membrane potential, graded potential, Generation of action potential, propagation of nerve impulses, Signal transmission at synapses, Electrical synapses, chemical synapses, Neurotransmitters and neuropeptides, Axonal Transport Electrical properties of nerve: Conductivity, Summation, Inflatigability, All or none law 3.3 Ionic concentration in the cytoplasm (Donnan equilibrium system), Local circuit theory and Saltatory conduction, **Structure of Neurotransmitter Receptors , Multiple Sclerosis, Epilepsy .** (Examples from Invertebrate and Vertebrate animals ) 6L

### Reference Books:

Principles of animal physiology. (2006), C. D. Moyes and P. M. Schulte. Publisher - Pearson Education Inc. and Dorling Kindersley Publishing Inc.

Text book of Medical Physiology. 10<sup>th</sup> edition (2001),. A. C. Guyton and J. E. Hall. Publisher - W. B. Saunders Company, Philadelphia. -

Principles of Anatomy and Physiology, 11<sup>th</sup> edition (2006), G. J. Tortora and B. Derrickson. Publisher-John Wiley and Sons Inc.

Endocrinology, 5<sup>th</sup> edition (2008), Mac. E. Hadley. Publisher-Pearson Education Inc. and Dorling Kindersley Publishing Inc.

Comparative Vertebrate Endocrinology. 3<sup>rd</sup> edition (1998), P. J. Bentley. Publisher-Cambridge University Press.

Vertebrate Endocrinology. 3<sup>rd</sup> edition (1997), D. O. Norris. Publisher- Academic Press: An imprint of Elsevier.

The World of the Cell, 7<sup>th</sup> edition, (2005), Wayne M. Becker, Lewis J. Kleinsmith, Jeff Hardin., Publisher - Benjamin Cummings.

Molecular Cell Biology, 6<sup>th</sup> edition (2007). Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, Anthony Bretscher, Hidde Ploegh, Paul Matsudaira, Publisher-W. H. Freeman.

Molecular Biology of the Cell, 5<sup>th</sup> edition (2007). Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter. Publisher - Garland Science.

## **BASIC ENTOMOLOGY (2C T +1C P)**

### **Theory -30L**

- 1 Scope and Importance of Entomology: Services rendered by insects to human being. External Morphology, The Cuticle, Segmentation and Tagmosis, Head and its appendages, Thorax and its appendages, Abdomen and its appendages.
- 2 Insect Development (Generalized insect), Metamorphosis Growth, Life history patterns and phases, Process and control of moulting Voltinism, Diapause,
- 3 Insect defense -Defense by hiding, Secondary lines of defense, Mechanical defence, Chemical defence, Collective defences in gregarious and social insect, Defense by mimicry, Collective defenses in gregarious and social insects. Insect Defence: Defence by hiding, Secondary line of defence
- 4 Collection, Preservation and Rearing of Insects
- 5 Insect biodiversity, The Science of Insect taxonomy: Prospectus and need Taxonomy and management of insect biodiversity Taxonomy of Insects: (Apterygote and pterygote orders) Distinguishing characters, general biology, habits and habitats of Insect orders and economically important families contained in them.
- 6 Insect Societies: Subsociality in insects, Eusociality in insects, Inquilines and parasites of social insects, Evolution and maintenance of eusociality.
- 7 Venomous insects and allergens.
- 8 Insects and their role in forensic investigations
- 9 Soil arthropods and their management.

### **ZY107 P Lab Exercise in Entomology .**

1. Study of Orders of insects and their identification using taxonomic keys. Keying out families of insects of different major Orders.
2. Field visits to collect/see insects of different orders.
3. Study of head sclerites and mouth parts in insects
4. Study of insect segmentation, various tagmata and their appendages.
5. Observation of permanent mounts of different body parts and their taxonomic importance including male and female genitalia.
6. Rearing and preservation of insects.
7. Study of Symbionts from insects.
8. Study of sting apparatus in Honey bee.
9. Effect of Insecticides/pesticides on Gut histology and anatomy of insects.
10. Study of different types of wings and flight muscles in insects

### **Reference Books:**

Chapman RF. 1998. *The Insects: Structure and Function*. Cambridge Univ. Press, Cambridge.

David BV & Ananthkrishnan TN. 2004. *General and Applied Entomology*. Tata-McGraw Hill, New Delhi.

Duntson PA. 2004. *The Insects: Structure, Function and Biodiversity*. Kalyani Publ., New Delhi.

Evans JW. 2004. *Outlines of Agricultural Entomology*. Asiatic Publ., New Delhi.

- Richards OW & Davies RG. 1977. *Imm's General Text Book of Entomology*. 10th Ed. Chapman & Hall, London.
- Saxena RC & Srivastava RC. 2007. *Entomology: At a Glance*. Agrotech Publ. Academy, Jodhpur.
- Snodgrass RE. 1993. *Principles of Insect Morphology*. Cornell Univ. Press, Ithaca.
- Chu HF. 1992. *How to Know Immature Insects*. William Brown Publ., Iowa.
- Peterson A. 1962. *Larvae of Insects*. Ohio University Press, Ohio.
- Stehr FW. 1998. *Immature Insects*. Vols. I, II. Kendall Hunt Publ., Iowa.
- Mani, M.S. Introduction to high altitude Entomology (1962). Methuen and Co. Ltd. 36 Essex street W.C. 2, London.
- Mani, M.S. Ecology and Biogeography of High altitude Insects (1968). Dr. W. Junk N.V. Publishers- the Hague.
- Srivastava, K.P. Text Book of Applied Entomology Volume-II (2005).
- Gullan, P.J. and Cranston, P. The Insects, an outline of Entomology, 3rd Edition (2005). Blackwell, Publishing Ltd., USA.

**ZY – 101P: Laboratory exercises in Cell Biology and Biochemistry**

**3 Credits: 45H = 15P x 3 H**

**Biochemistry**

**(Any 7 or 8 laboratory exercises from the list below)**

- 01 **Basic and standardization Methods. (2P)**
1. Acid, Alkali preparation standardization and Formal titration
  2. pH, buffers, buffering capacity
- 02 **Estimation of micromolecules. (4P)**
3. Estimation of inorganic phosphate
  4. Estimation of sugar (glucose)
  5. Estimation of Amino acid (Tyrosine)
  6. Estimation of Base (Guanine)
- 03 **Estimation of macromolecules. (3P)**
7. Estimation of carbohydrates (starch)
  8. Estimation of proteins
  9. Estimation of nucleic acids (DNA)
- 04 **Separation of micromolecules by paper chromatography. (3P)**
10. Sugars
  11. Amino acids
  12. Bases

05 **Enzyme kinetics. (3P)**

13. Units specific activity of an enzyme
14. Effect of substrate concentration
15. Effect of pH and temperature.

**Cell Biology**

- 1 Subcellular fractionation: nuclei, mitochondria cytosol & assaying functional identification of mitochondria. **(2P)**
- 2 Mitosis/ Meiosis **(1P)**
- 3 Preparation of blood smears: Cell type identification and differential counts. **(1P)**
- 4 Study of Phagocytosis / Pinocytosis. **(2P)**
- 5 EM – interpretation of cellular ultrastructure. **(1P)**
- 6 To study lipid solubility of membrane. **(1P)**

**ZY 102 P: Laboratory Exercises in Molecular Biology & Genetics  
(3 Credits: 15 P x 3 H)**

**GENETICS**

- 01 Use of *Drosophila* in genetics and laboratory handling and rearing of flies, mutant identification, sexing of pupae for virgin isolation for crosses, setting up genetic crosses using *Drosophila* mutants and wild type. **(2P)**
- 02 Study of autosomal gene inheritance (monohybrid crosses using suitable mutants along with wild-type flies for F1 and F2 generations) and Chi-square analysis of data of progeny. **(2P)**
- 03 Estimation of gene frequencies in human population and analysis of heterozygote frequencies. **(1P)**
- 04 Preparation of analysis of human pedigree (including traits concerning penetrance, pleiotropy and cases of mutation and consanguinity). **(1P)**
- 05 Preparation of analysis of human pedigree (including traits concerning penetrance, pleiotropy and cases of mutation and consanguinity). **(1P)**
- 06 Preparation of analysis of human pedigree (including traits concerning penetrance, pleiotropy and cases of mutation and consanguinity). **(1P)**

**Molecular Biology**

**(Any 7 or 8 laboratory exercises from the list below)**

- 01 Spectrophotometric analysis of nucleotides and amino acids. **(1P)**
- 02 Purification of DNA from bacterial cells. **(1P)**

- 03 Quantitation of DNA and Agarose gel electrophoresis. **(1P)**
- 04 Denaturing agarose gel electrophoresis. **(1P)**
- 05 Purification of RNA from bacterial cells. **(1P)**
- 06 Quantitation of RNA and agarose gel electrophoresis. **(1P)**
- 07 Demonstration of plasmid DNA in *E. coli*. **(1P)**
- 08 Transformation of *E. coli* with plasmid DNA. **(1P)**
- 09 Purification of plasmid DNA. **(1P)**
- 10 Restriction Endonuclease digestion and mapping. **(1P)**
- 11 Protein gel electrophoresis (2P)
  - a) Native Polyacrylamide gel electrophoresis.
  - b) SDS-Polyacrylamide gel electrophoresis.

**ZY – 104 P Laboratory exercises in Developmental Biology and Animal Physiology (3 Credits : 15P x 3H)**

**Developmental Biology**

- 1 Patterns of cleavages in starfish. Amphioxus, *Onepidula*, insects (slides) **(1P)**
- 2 Study of embryonic and post-embryonic development using frog egg as a model system. **(2P)**
- 3 Mounting of chick embryos and preparation of permanent mounts. **(1P)**
- 4 Gross anatomy and histology of chick embryos till 96 h. **(1P)**
- 5 Experiments in regeneration in Hydra or Planaria. **(1P)**
- 7 Filter paper ring method for *in vitro* culturing of chick Embryo. **(1P)**

**Animal Physiology**

**(Any 7 or 8 laboratory exercises from the list below)**

- |   |  |           |
|---|--|-----------|
| 1 | Measurement of tidal volume and vital capacity.                                    | <b>1P</b> |
| 2 | Determination of the maximal heart rate and target zone heart rate for exercise    | <b>1P</b> |
| 3 | Determination of Glomerular Filtration Rate by creatinine clearance in vertebrates | <b>1P</b> |
| 4 | Determination the effect of salinity on oxygen consumption of crab                 | <b>1P</b> |
| 5 | Study of skeletal mass   | <b>1P</b> |

6	Study the structural and physiological abnormalities of heart by electrocardiogram and echocardiogram	2P
7	Separation and identification of patho-physiological proteins	1P
8	Estimation of cholesterol in blood	1P
9	Estimation of glucose in given sample	1P

### ZY – 201 T: Metabolic Pathways (2 Credits = 30 Lectures)

01	<b>Metabolic strategies:</b> Organization, clustering of enzymes, kinetic regulation, energy charge	2L
02	<b>Carbohydrate metabolism:</b> Glycolysis, glycogenolysis, gluconeogenesis, pentose phosphate pathway, glucuronic acid pathway (emphasis on regulation)	3L
03	<b>Fat metabolism:</b> Structure and characteristics of fatty acids, Mobilization of lipid from adipose tissue Carnitine shuttle, $\beta$ -oxidation of unsaturated and saturated fatty acid and its regulation. Propionyl Co-A metabolism, regulation of $\beta$ -oxidation fatty acids, Genetic Disorders associated with Fat metabolism. Biosynthesis and significance of ketone bodies. Biosynthesis of palmitate and its regulation. Acetyl Co-A shuttle, Mitochondrial and microsomal pathways of chain elongation, Fatty acid desaturation system long term dietary changes and enzyme level	6L 5L
04	<b>Metabolism of cholesterol :</b> Biosynthesis of cholesterol and its regulation at genetic and biochemical level, classes of lipoproteins, lipoprotein metabolism, chylomicrons, LDL, HDL, VLDL. Apolipoproteins Cholesterol Transport to Peripheral Tissues	4L
05	<b>Amino acid metabolism:</b> Transamination, deamination, Fate of amino acid carbon skeleton, glucose alanine cycle, urea cycle, Regulation of urea cycle, Pathways of amino acid degradation, diseases associated with amino acid metabolism	4L
06	<b>Purine and Pyrimidine metabolism:</b> Synthesis of inosinic acid and orotydic acid. Nucleotide synthesis and regulation.	3L

Purine, pyrimidine degradation, salvage pathways, Biosynthesis of nucleotide coenzymes.

07 **The tricarboxylic acid cycle:** 3L

Reactions and regulation of pyruvate dehydrogenase and  $\alpha$  ketoglutarate dehydrogenase complexes, stereochemical aspects of TCA cycle, amphibolic nature of the cycle.

**Reference Books:**

Lehninger, Principles of Biochemistry, 4<sup>th</sup> edition, (2005), David L. Nelson, Michael M. Cox  
Publisher - W.H. Freeman and Co.

Biochemistry, 3<sup>rd</sup> Edition, (2005), Donald J. Voet and Judith G. Voet, Publisher-Wiley,

Biochemistry, 6<sup>th</sup> edition (2007), Jeremy M. Berg, John L. Tymoczko, Lubert Stryer, Publisher-  
W.H. Freeman and Co.

Biochemical Calculations, 2<sup>nd</sup> edition (1968), I.H. Segel, Publisher-John Wiley and Sons.

Harper's biochemistry, 26<sup>th</sup> edition (2003) R.K. Murray, D.K. Granner, P.A. Mayes, V. W. Rodwell,  
Publisher-McGraw Hill.

**ZY – 202 T: Fundamentals of Immunology (2 Credits = 30 Lectures)**

01	Overview of Immune system, Cells and organs of Immune system, Innate and adaptive immunity, B & T cell response generation.	5L
02	Antibodies: structure, function, organization & expression of genes, Antigen-antibody interactions	5L
03	Major histocompatibility complex (MHC): structure, gene organization, Antigen processing & presentation, TCR	5L
04	T cell and B cell maturation & differentiation, Cell mediated immune responses, Cytokines & Complement system	5L
05	Hypersensitive reactions, Immune response to infectious diseases	5L
06	Autoimmunity, Vaccines, Tolerance	5L

**Reference Books:**

Kuby Immunology, 6<sup>th</sup> edition (2007), T. J. Kindt, R.A. Goldby, B.A. Osborne, Publisher - W.H. Freeman and Company.

Elgert: Understanding the Immune System, 1996, Wiley.

Kenneth et al: Janeway Immunobiology, 7<sup>th</sup>ed, 2009, Garland.

Abbas et al: Cellular and Molecular Immunology, 6<sup>th</sup>ed, 2000, Saunders.

Roitt: Essential Immunology, 10<sup>th</sup>ed, 2006, Mosby.

Immunobiology: The Immune System in Health and Diseases, 6<sup>th</sup> Edition (2005), Charles A. Janeway, Publisher-Garland Science.

### **ZY – 203T Genetic Information Flow and Processing (2 Credits: 30 Lectures)**

- |    |   |    |
|----|---|----|
| 01 | <b>Transcription-</b> Prokaryotic transcription- RNA Polymerase, Transcription unit, Initiation-promoter recognition, Elongation, Termination- rho dependent and rho independent.   | 7L |
| 02 | <b>Eukaryotic Transcription-</b> RNA Polymerases I, II and III, Transcription unit for each polymerase, Transcription factors, Processing of transcripts.   | 8L |
| 03 | <b>Regulation of transcription in prokaryotes</b> – Concept of Operon, Positive and Negative regulation, Regulation by attenuation, Phage strategies to regulate transcription, antitermination   | 5L |
| 04 | <b>Translation</b> - Prokaryotic translation – Genetic code, deciphering genetic code, codon usage, altered code in mitochondria<br>rRNA and ribosome structure, active center of ribosome<br>tRNA – structure of tRNA, modified bases of tRNA, Activation of tRNA<br>Initiation – role of initiation factors, Shine Dalgarno sequences, Elongation – Role of elongation factors, translocation of ribosomes, Termination – termination codons, role of release factors, GTP as an important source of energy for translation,<br>Fidelity of translation | 5L |
| 05 | <b>Eukaryotic translation</b> – Initiation, elongation and termination  | 3L |
| 06 | <b>Regulation of translation</b>  | 2L |

#### **Reference books:**

Genes IX, (2008), Benjamin Lewin, Publishers - Jones and Barlett Inc.

Molecular Biology of the Gene, 5<sup>th</sup> edition, (2004). James D. Watson, Tania Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Loswick, Publisher - Pearson Education Inc. and Dorling Kindersley Publishing Inc.

Molecular Biology, 4<sup>th</sup> edition (2007), Weaver R. Publisher - McGraw Hill Science.

Molecular Biology of the Cell, 4<sup>th</sup> edition, (2004). Bruce Alberts, Dennis Bray, Julian Lewis, Martin Raff, Keith Roberts, and James D. Watson. Publisher - Garland Publishing.

Essential Cell Biology, 2<sup>nd</sup> edition (2003). Bruce Alberts, Dennis Bray, Karen Hopkin, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter. Publisher - Garland Publishing

### **ZY-208 T: Applied Entomology (2 C = 30 Lectures)**

1. Applied Entomology (Insect, Man and Environment):
  - Apiculture and its management
  - Sericulture and silk chemistry
  - Threats to apiculture and sericulture
  - Insect pollinators and crop productivity
2. Principles of Integrate Pest Management (IPM)
  - Pest Surveillance-definition-importance in IPM and its advantages
  - Principles of IPM-economic threshold level (ETL), economic injury level (EIL), general equilibrium position (GEP)-components/tools of IPM-practices, scope and limitations of IPM.
  - Biological Control: Parasitoids, Entomopathogenic Nematodes,
  - Microbial Control: Pathogens, Entomopathogenic Fungi, Viruses, GMOs
3. Chemical control: History of Insecticides, importance and ideal properties of insecticides, classification of insecticides on the basis of origin, mode of entry, mode of action and toxicity-toxicity evaluation of insecticides, acute and chronic toxicities, oral and dermal toxicities, LC50 (lethal concentration), LD50 (lethal dose),
4. Chitin synthesis inhibitors-brief mode of action, formulations & use of diflubenzuron, flufenoxuron, chlorfluazuron, triflumuron, teflubenzuron, lufenuron, hexaflumuron, flucyclouron, novaluron & buprofezin.; juvenile hormone (JH) mimics- brief mode of action

Brief mode of action,

Formulations & use of IGRs/biopesticides/insecticides

#### **Juvenile hormone (JH) mimics- :**

Brief mode of action, formulations & use of jvabione, methoprene, hydroprene, kinoprene;

#### **JH agonists:**

Brief mode of action, formulations & use of pyriproxyfen, fenoxycarb; ecdysone agonists- brief mode of action, formulations & use of methoxyfenozide, halofenozide & tebufenozide

5. Insect-Host plants resistance – principles of host plant resistance –ecological resistance Insect Resistance development

6. Recent methods of pest control- repellants (physical and chemical repellents); antifeedants: importance of antifeedants and limitations of their use; sex pheromones-definition, insect moulting and juvenile hormones; gamma radiation-principles and limitations; genetic control- principles and its limitations (RNAi techniques); sterile male technique.

### **ZY208P-Lab Exercise in Applied Entomology.**

1. Mass rearing of Insects/natural enemies; testing side effects of pesticides on natural enemies; effect of, breeding of various biocontrol agents,
2. Project document preparation for establishing a viable mass-production unit /insectary
3. Study of DNA Barcoding in insects
4. Visit to bee nursery and commercial apiaries. Silkworm rearing and management.
5. Apiculture/sericulture/poultry units and assessing pest status in poultries.
6. Calculation of doses/ concentrations of different insecticidal formulations.
7. Compatibility of pesticides with other agro chemicals and phytotoxicity of insecticides.
8. Acquaintance of mass multiplication techniques of important predators- Cheilomenes,
9. Chrysoperla, and Cryptolaemus.
10. Acquaintance of mass multiplication techniques of important parasitoids-egg, larval and pupal parasitoids.
11. Acquaintance of mass multiplication techniques of important entomopathogenic fungi.
12. Study of haemocytes by using various staining techniques.
13. Effect of Biopesticides on insect immunity.
14. Effect of biopesticides on Hexamarine expression in insects.

### **Reference books:**

- Aruga H. 1994. *Principles of Sericulture*. Oxford & IBH, New Delhi.
- Atwal AS. 2006. *The World of the Honey Bee*. Kalyani Publ., New Delhi.
- Ganga G. 2003. *Comprehensive Sericulture*. Vol. II. *Silkworm Rearing and Silk Reeling*. Oxford & IBH, New Delhi.
- Partiban S & David BV. 2007. *Management of Household Pests and Public Health Pests*. Namratha Publ., Chennai.
- Singh S. 1975. *Beekeeping in India*. ICAR, New Delhi.
- Chapman RF. 1998. *Insects: Structure and Function*. ELBS Ed., London.
- Duntson PA. 2004. *The Insects: Structure, Function and Biodiversity*. Kalyani Publ., New Delhi.

Kerkut GA & Gilbert LI. 1985. *Comprehensive Insect Physiology, Biochemistry and Pharmacology*. Vols. I-XIII. Pergamon Press, New York.

Richards OW & Davies RG. 1977. *Imm's General Text Book of Entomology*. 10th Ed. Vol. 1. *Structure, Physiology and Development*. Chapman & Hall, New York.

Saxena RC & Srivastava RC. 2007. *Entomology at a Glance*. Agrotech Publ. Academy, Jodhpur.

Wigglesworth VB. 1984. *Insect Physiology*. 8th Ed. Chapman & Hall, New York.

**ZY – 202 P Laboratory exercises in Immunology (2C: 10P x 3H = 30 H)**

01	Demonstration of immunization in rabbits	(1P)
02	Generation of Antibodies, Immunization, titration	(2P)
02	Western blotting, Ouchterlony and antibody detection	(3P)
03	Enzyme linked immunosorbent assay (ELISA)	(2P)
06	Immunohistochemical detection and localization of specific antigens.	(2P)

**ZY – 205 T+P Tools and Techniques in Biology (4C: 2C + 2C) 60 H**

**Theory: (2 Credits: 30 Lectures) 30L**

01	<b>Fundamentals of optical microscopy:</b> Introduction to optics, magnification & limits of resolution, microscope designs and types, imaging components and image formation. Abbe's theory of microscopic resolution. Microscopic aberrations and remedial lens system	<b>4L</b>
02	<b>Contrast in microscopy:</b> Fundamentals of contrast modulation in bright-field and dark-field, Concept of phase differences, Phase contrast microscopy, Differential Interference contrast (Nomarsky) microscopy, Polarizing microscopy and Birefringence. Video enhanced contrast microscopy, Applications	<b>3L</b>
03	<b>Fluorescence microscopy &amp; Electron microscopy; &amp; New generation probe microscopy:</b> Principle of wide-field and confocal fluorescence microscopy, Fluorescent dyes, Application of conventional and confocal fluorescence Microscopy imaging, Principles and applications of transmission & scanning electron microscopes, Application of different EM techniques, New generation probe microscopy (e.g. Scanning Tunneling and Atomic Force Microscopy etc.)	<b>3L</b>
04	<b>Chromatography:</b> Principles, Adsorption chromatography Partition chromatography, Ion-exchange chromatography, affinity chromatography,	<b>4L</b>

Molecular exclusion chromatography, thin layer chromatography, HPLC, FPLC, selection of chromatographic system.

- |    |   |           |
|----|---|-----------|
| 05 | <b>Spectrophotometry:</b> Principles, UV-visible light spectroscopy , Spectrofluorometric, Nuclear magnetic resonance spectroscopy, Applications in biology           | <b>4L</b> |
| 06 | <b>Radioisotopes Technique:</b> Nature of radioactivity, detection and measurement of radioactivity, counting radioactivity, applications of radioisotopes in biology | <b>2L</b> |
| 07 | <b>Immunological Techniques:</b> Immunodiffusion, Immuno-electrophoresis, ELISA, Studying antigen antibody interactions, Immunofluorescence, Flow cytometry           | <b>4L</b> |
| 08 | <b>Electrophoretic Techniques:</b> General principles, Support media, electrophoresis of proteins and nucleic acids, Capillary electrophoresis.                       | <b>3L</b> |
| 09 | <b>Centrifugation:</b> Basic principles of sedimentation, Types of centrifuges, Analytical Centrifugation, Preparative centrifugation.                                | <b>3L</b> |

**Practical: (2 C)**

- |    |  |    |
|----|--|----|
| 01 | Microscopy lab exercise-1 : Components of optical systems in upright & inverted microscope, episcopic & diasopic illumination; Mechanical stage setting and scale reading. | 1P |
| 02 | Microscopy lab exercise-2: inter-pupillary distance adjustment, diopter ring adjustment, Köhler adjustment of microscope   | 1P |
| 03 | Microscopy lab exercise-3: Phase-contrast microscopy and phase ring adjustment and viewing, dark-field contrast adjustment and viewing                                     | 1P |
| 04 | Gel filtration   | 1P |
| 05 | Ion exchange chromatography  | 1P |
| 06 | Density gradient centrifugation  | 1P |
| 07 | Thin layer chromatography  | 1P |

Note: Each practical refers to 5 hours duration (6P x 5 hrs = 30 hrs ~2credit of laboratory contact hrs)

**Reference Books:**

Principles and Techniques of Biochemistry and Molecular Biology (Wilson & Walker's)—by Hofmann A & Samuel C (2018) Cambridge University Press.  
Essential Laboratory Skills for Biosciences – by Meah M. & Kebede-Westhead E. (2012) Wiley-Blackwell.

Fundamentals of Light Microscopy and Electronic imaging – by Murphy D.B. & Davidson M.W. (2012) Wiley-Blackwell.

Light Microscopy in Biology: A Practical Approach --- by Lacey A.J., (1999), 2<sup>nd</sup> edition Oxford University Press.

Electron Microscopy: Principles and Fundamentals—by Amelinckz S., Dyck D.V., Landuyt J.V., Tendeloo G.V. (2008) Wiley.

Electron Microscopy: Principles and Techniques for Biologists – by Russel L.D. (1992), (1992) Jones & Bartlett.

## ZY – 206 T+P:Histology and Histochemistry (4 Credits: 30L+ 30P)

01	<b>Fundamentals of histology:</b> Epithelial, connective, muscular, nervous and other specialized tissues.	5L
02	<b>Tools in histology:</b> Principles, design and functioning of microtomes, automated microtomes, ultramicrotome, cryostat, problems and trouble shooting	3L
03	<b>Techniques in histology:</b> Sample preparation, obtaining tissue samples, handling reagents, fixatives, processing of fixed samples, dehydration, embedding, block making, staining, dyes and dye-binding reactive groups, mordants and mordanting	7L
04	<b>Histochemical principles:</b> Principles of chemical reactions used in histochemistry and cytochemistry, detection techniques of carbohydrates, lipids and nucleic acids, proteins, hydrolytic and oxidative enzymes, use of inhibitors, detection, localization of calcium.	5L
05	<b>Cytochemistry and quantitation:</b> Cytochemical detection techniques, principles and technique of autoradiography, cytophotometry, microspectrophotometry, and other morphometric methods.	5L
06	<b>Histopathology:</b>  Principles, techniques and applications	5L
	<b>Practical (2C= 10 x 3H):</b>	
01	Fixation, dehydration, embedding, sectioning, staining, permanent mounting of tissues and histology	4 P
02	Microscopic measurements of histological samples using micrometers and planimeters	1P
03	PAS reaction, Alcian blue reaction, and detection <u>in situ</u>	2P
04	Alkaline phosphatase detection <u>in situ</u>	1P
05	Feulgen reaction	1P
06	Sudan black B staining for lipids	1P
07	Methyl green – Pyronin G method of detection of nucleic acids	1P
08	Millon's reagent and histochemical detection of basic proteins	1P

### Reference Books:

Histochemistry in focus: A source book of techniques and research needs. (2007), K. Shyamasundari and K. Hanumantha Rao. Publisher - M. J. Publishers Chennai, India

Histochemistry (Vol I –III). 4<sup>th</sup> Edition (1991), Stoward, P. J. & Pearse, A. G. E. Publisher – Churchill Livingstone Edinburgh, London

Histological and Histochemical methods: Theory and Practice. 4<sup>th</sup> edition (2008), J. A. Kiernan Publisher – Scion Publishing Ltd. Oxford shire.

Colour Atlas of Histology. 3<sup>rd</sup> edition (2000). L. P. Gartner and J. L. Hiat Publisher – Lippincott-Williams & Wilkins, Baltimore.

Histology: A text book and Atlas. 2<sup>nd</sup> edition (1989). M. H. Ross, E. J. Reith and L. J. Romrell Publisher - Williams & Wilkins, Baltimore.

Bailey's text book of Histology. 15<sup>th</sup> edition (1964). W. M. Copenhaver. Publisher – The Williams & Wilkins Company, Baltimore.

A text book of Histology. (1975), Bloom and Fawcett Publisher – W. B. Saunders Company Philadelphia.

Histology and Cell Biology: An introduction to pathology. (2002), A. L. Kierszenbaur Publisher – Mosby Inc. St. Louis USA.

### **ZY 207 T + P: Quantitative Biology (4 Credits: 60 H= 30 L+30 H practical)**

<b>Theory: 2 Credits = 30 Lectures</b>		<b>30L</b>
01	<b>Introduction:</b> Importance of statistics in biology, samples and populations, variables in biology, Accuracy and Precision. Significant digits and rounding off. Collection and Condensation of data, types of biological data and graphical/tabular representation (Histogram/Ogive curve/frequency curve).	5L
02	<b>Descriptive Statistics:</b> Measures of central tendency: Mean, Mode, Median. Concept of variation, Measures of variation such as variance, standard deviation, coefficient of variation.	5L
03	<b>Introduction to Probability Distribution:</b> Elements of probability, Definition, relative frequency approach. Binomial and Poisson distribution Normal Distribution: frequency distributions of continuous variables, properties of normal distribution, applications of normal distribution, fitting a normal distribution to observed data	5L
04	<b>Regression and correlation analysis, Curve fitting:</b> Pearson's and Spearman's correlation coefficient analysis, Coefficient of determination, Regression coefficient	5L
05	<b>Hypothesis testing:</b>	10L

Tests of simple hypothesis using normal and t-distribution, Types of errors  
 Tests of significance: Parametric and non-parametric tests  
 T-test (One sample t-test, Two sample t-test, Paired t-test)  
 Chi-square test for goodness of fit  
 F-test for comparing variance, One-way ANOVA  
 Mann-Whitney test, Kruskal- Wallis test

**Practical:**

**30 H**

- 01 Practical are to be conducted on the above topics giving examples from biological data. In the lectures and practical emphasis is to be given on biological situations wherein Statistics can be used.

**ZY 301–T: Endocrinology (2 C = 30 Lectures)**

- |     |  |    |
|-----|--|----|
| I   | Endocrine mechanisms in Crustaceans: X & Y organs, regulation of metabolism, heart, salt and water balance, reproduction, colour change and molting.                                     | 5H |
| II  | Hormones and reproduction in cephalopod molluscs and echinoderms.  | 5H |
| III | Types of chemical messengers, Hormone receptors and mechanisms of hormone action.<br>Hypothalamic hypophysiotropins  | 5H |
| IV  | Adenohypophysial hormones: ACTH, PRL, STH & TSH  | 5H |
| V   | Metabolic functions of thyroid hormones, Regulation of amphibian metamorphosis, Hormonal regulation of carbohydrate, protein and lipid metabolism, Pancreatic hormones, Glucocorticoids. | 5H |
| VI  | Osmoregulatory hormones: ADH, mineralocorticoids, renin – angiotensin system. Gastro-intestinal hormones, Phosphate metabolism.  | 5H |

**ZY – 302T Invertebrate and Vertebrate Embryology (2Credits: 30Lectures)**

- |   |  |    |
|---|--|----|
| 1 | Overview of invertebrate development<br>Basic patterns and model systems, <u>Deuterostome</u> and <u>Proterostome</u> developmental patterns, developmental origin of Coelom, body axis etc. | 5L |
|---|--|----|

2	Moulting and Post-embryonic metamorphosis in invertebrates. Insect development – Basic patterns	5L
3	Developments of gametes, spermiogenesis and capacitation, Oogenesis and vitellogenesis.	5L
4	Mechanisms of Fertilization, Acrosome reaction, egg activation.	5L
5	Metamorphosis; hormonal control during amphibian Development Limb regeneration, positional effect and polarity	5L
6	Molecular Mechanisms of competence and neural induction in frog and chick embryo.	5L

### Reference Books:

Developmental Biology (VIII edition) S. F. Gilbert. Sinauer Associates Inc. USA. 2006.

Principles of Development (III edition) Lewis Wolpert Oxford University Press UK. 2007.

An Introduction to Embryology (V edition). B. I. Balinsky. Thomas Asia PVT. LTD. Singapore.

Developmental Biology: R. M. Twyman. Bios Scientific Publishers LTD. New Delhi (2001)

### ZY 303–T: Biosystematics, Biodiversity and Evolution (4C = 60 Lectures)

01	Biosphere: Biodiversity: Characterization, generation and maintenance, Biosphere reserves, resources and management, Global diversity hotspots, Effect of manmade alteration of environment on Biospheres.	5H
02	Biotic community & interrelationships: Zoogeographical relations of species and population, interrelationships amongst organisms including parasitism, symbiosis & commensalism Diversity of adaptation in animals.	5H
03	Fundamental of Systematics: Biological classification, Hierarchy of categories and higher taxa, Taxonomic characters – procedures and keys, Species concepts: varieties, subspecies, sibling species, race etc. International code of Zoological nomenclature.	5H
04	Kingdoms of Life : General outline of kingdoms including Monera & Protista ; Broad outline & Diversity in kingdom Animalia	5H
05	Methodologies in systematics : Morphology based taxonomy, Numerical taxonomy, Cyto-taxonomy and chemotaxonomy, Molecular systematics, DNS fingerprinting & Molecular markers for detection/evaluation of	5H

	polymorphism, RFLP, RAPD etc.	
06	Conservation: Objective of Conservation, strategies of conservation, Global programmes and concept of endangered species, Modern tools and techniques to assess biodiversity.	5H
07	Introduction: Questions about behavior, Patterns of behavior, Development of behavior: genetic basis of behavior, Hormone- brain relationship, Bird song development, Neural basis of behavior: Stimulus filtering, Biological rhythms	6H
08	Exploitation of resources: decision making, prey-predator relationship, Communication and animal signals: communication, Evolution of animal signals,	4H
09	Reproductive strategies and Parental care: Sexual selection, Mating systems, Parental care	3H
	Social organization : Altruistic behavior and concept of inclusive fitness, Evolution of helpful behavior, Evolution of Eusocial behavior	2H
10	Darwinian & pre-Darwinian concepts of evolution: Birth of concept of organic evolution, Lamarckian theories, Darwin's theory of natural selection: merits and demerits, Neodarwinian concepts and sources of variation.	5H
11	Evidences of evolution: Evidences from fossils, geographic distribution, comparative anatomy & embryology, origin of life coacervatis, Oparin's concept of Miller's experiments, Evidences from homeotic genes, oncogenes and transposones.	5H
12	Post-Darwinian concepts of evolution: Gradualistic vs. non-gradualistic theories, Mayr's Founder Principle, Gould's punctuated equilibrium theory, Kimura's neutral theory, Endosymbiotic theory of Margulis contemporary views.	5H

## Reference Books

- This is Biology: The Science of Living world, Mayr, M. (1997), Universities Press Ltd.
- Evolution, 3<sup>rd</sup> edition, Strickberger, M. W. (2000), Jones and Bartlett Publishers London.
- J.R.B. Alfred and Ramakrishna (2004) Collection, Preservation and Identification of animals. Zoological Survey of India Publications.
- N.A. Campbell and J.B. Reece (2004) Biology, 7<sup>th</sup> edition, Benjamin Cummings Publ. [ 8<sup>th</sup> edition (2009)]
- P.D. Sharma (2005) Ecology and Environment, Rastogi Publications
- N.H. Barton et al. (2007) Evolution. Cold Spring Harbor Lab. Press

### **ZY 304T: Introduction to Recombinant DNA Technology (2 Credits = 30 L)**

1	Introduction to Recombinant DNA Technology	1L
2	General strategy of recombinant DNA technology and gene cloning : genomic libraries, cDNA libraries, single gene cloning	1L
3	Isolation, identification and characterization of DNA fragments to be cloned, preparation of cDNA	2L
4	Vectors in gene cloning: types of vectors and choice of vectors: plasmids, cosmids, lambda phage vectors, shuttle vectors, YACs, BACs, Other advanced vectors,	5L
5	Methods of transferring recombinant DNA to different host cells	2L
6	DNA modifying and degrading enzymes used in recombinant DNA technology	5L
7	Screening for transformants, Characterisation of transformants: different hybridization techniques, probe preparation using radioactive and nonradioactive ligands detection of hybrids, DNA sequencing, site directed mutagenesis	8L
8	Genetic manipulation of animals	2L
9	Gene transfer to plants	2L
10	Various expression vectors in bacteria and eukaryotes, choice of appropriate hosts, induce expression, Expression of industrially important	2L

#### **Reference Books:**

Primrose S., Twyman R., Old D., Sixth Edition (2001) Principles of Gene Manipulation, Blackwell Science Ltd.

Primrose S., Twyman R., Third Edition (2003) Principles of genome analysis and genomics., Blackwell Science Ltd.

Alcamo I. Second Edition (2001) DNA Technology, the awesome skill, Harcourt Academic Press

Brown T.A., Third Edition (2007) Genomes 3, Garland Science, Taylor and Francis Group.

### **ZY- 318 T: Insect Biochemistry & Physiology (1C = 15 Lectures)**

01	Integument – structure, chemistry, sclerotization, regulation, Function.	3L
	Insecticide detoxification – Microsomal and extra-microsomal enzymes, Role in insecticide degradation.	2L
02	Fat body – structure and function	3L
	Hemolymph – chemical composition and function Household and stored grain pests and their control.	2L

03	Digestion and absorption, adaptation to special diet.	3L
	Bioluminescence	2L
04	Muscle – structure and physiology, biochemistry of flight muscle.	5L
05	Endocrine systems – Neurosecretion, chemistry function and Mechanism of hormone action.	5L
06	Excretion and water balance – structure and function of MTs, Water balance and nitrogen excretion.	3L
	Ventilatory mechanisms and their control.	2L

### References:

The Insects: Structure and Function. Forth ed., Chapman R. F. (1998), Cambridge University Press, UK.

Comprehensive Insect Physiology, Biochemistry & Pharmacology. Vol. 3, 4, 5, 10 and 12 Gilbert L. I. and G. A. Kerkut (1985), Pergamon Press, Oxford.

Insect Physiology. Prakash, M. (2008), iscovery Publishing House Pvt. Ltd., New Delhi.

Physiological Systems In Insects. Second ed., Klowden, Marc (2007), Elsevier, USA.

The Principles of Insect Physiology, Seventh ed. Wigglesworth, V.B. (1972), Chapman and Hall, London.

### ZY 208 T: Scientific presentation (1 Credit: 15 Lectures)

01	Making oral presentations: Pronunciation, accent, intonation, clarity, speed, fluency, eye contact; Planning and organization.	4L
02	Enrichment of vocabulary: Word forms and derivations, prefixes and suffixes, other processes of word formation. Scientific and technical vocabulary, spellings; Frequently confused words.	3L
03	Basic grammar: Tenses; Voices; Propositions and conjunctions; Conditional sentences; Count and non-count nouns; Concord; Punctuations.	4L
04	Effective written presentation: Order of sentences in a paragraph; Sentence connection, cohesion and coherence; Contradiction, tautology, semantic anomaly, circumlocution	2L
05	Using the dictionary and the thesaurus.	1L
08	Types of presentation: Oral, poster, written, audio-visual. Aids for presentation	1L

### ZY – 314T : Advanced Genetics (2 Credits : 30 Lectures)

01	Non-mammalian model system in genetic studies: <i>Drosophila melanogaster</i> , <i>Caenorhabditis elegans</i> , <i>Danio rerio</i> (Suitability of salient features, scope, genetic methodologies and applications of each model system)	6L
02	Advanced Cytogenetics:	5L

Chromosome studies in advanced genetic analysis; Human chromosomes – banding, clinical nomenclatures, practices and applications; Polytene chromosome system and applications

03	Developmental Genetics: Genetic regulation of early embryonic development, Cascade of gene action control of differentiation and cell-cell interactions during development ( <i>Drosophila</i> as model)	5L
04	Behavioural and Neurogenetics: General methodologies for studying genes influencing / regulating innate behavioural traits. Mutants of cognitive functions, Genetic regulation of biological rhythms, Ion channel mutants affecting neural circuitry.	5L
05	Evolutionary genetics: Genetic polymorphism and effect on gene pool after balanced, directional and disruptive selection pressures, Genetics of speciation and 'molecular clock' in evolutionary genetics studies.	5L
06	Extrinsic & Intrinsic factors and genetic consequences : Epigenetics, genetics of cancer, genetics of ageing	4L

#### Reference Books:

- Genetics: Analysis & Principles – by Brijjer R S (2018) McGraw Hill
- Principles of Genetics. -- by Gardner E.J., Simmon M. J., Snustad D.P. (2006) 8<sup>th</sup> ed. Wiley
- Lewin's GENES XII --- by Krebs J.E., Goldstein E.S., Kilpatrick S.T. (2018) Jones & Bartlett
- Concepts of Genetics – by Klug W.S., Cummings M.R., Spencer C.A., Palladins M.A. (2015) 11<sup>th</sup> edition, Pearson Publ.
- Genetics – by Strickberger M.W. (2015) (3<sup>rd</sup> Indian edition) Pearson Education
- iGenetics: A molecular approach – by Russel P.J. (2016) Pearson Education
- Evolution – by Futuyama D & Kirkpatric M. (2017) 4<sup>th</sup> edition, Sinauar Publ.
- Introduction to Quantitative Genetics – by Falconer D.S. (2009) Pearson Education
- Chromosomes: Analyzing The Basics. –by Czepulkowski B. (2000) Taylor & Francis.
- Genetics – by Fairbanks D.J. and Andersen W.R. (1999), Brooks-Cole Publ Co.
- Drosophila – by Dahmann C. edited (2008) Humana Press.
- Drosophila Genetics – by Graf U, Schaviv N.V., Wurgler F.E. (1992) Springer-Verlag.
- Genetics & Biology of Drosophila – by Ashburner A & Carson J.L. (1986) Academic Press.
- Principles of Genetics – by Gardner E.J. 8<sup>th</sup> edition (2006) John Wiley & Sons.
- Drosophila: A practical approach – by Roberts D.B. (1998) Oxford University Press.

#### ZY-305 T: Regulation of Gene Expression (2 Credits: 30 Lectures)

I	Activating transcription: Transcription activating factors, Different domains in transcription factors, Mechanism of transcription activation, response elements recognized by activators.	5L
II	RNA processing Splicing: Nuclear pre-mRNA splicing - spliceosomes, alternative splicing, trans splicing	10L

	tRNA splicing, rRNA splicing - autosplicing in group I and group II introns.	
	Editing: types of editing gRNA mediated editing, enzyme mediated editing	
	3'processing: Polyadenylation, PARP, Poly (A) signal, mRNA stability	
	5'Processing: Capping, importance of capping, mechanism of capping	
III	Chromatin remodeling: alternative states of chromatin, mechanisms of modification	2L
V	Epigenetic effect: heterochromatin and euchromatin, inactive and active chromatin, mechanisms of x chromosome inactivation, genome imprinting, importance of imprinting	5L
VI	Translational regulation	8L
	mRNA stability, half life- polyadenylation, polysome formation	
	mRNA structure-3' and 5' UTRs CAP independent, CAP dependent translation, IRE sites, multiple ORFs, 5' and 3' structures formed, role of initiation and elongation factors	
	Mechanism of global and mRNA specific regulation of translation: Initiation by eIF2, cap binding protein assembly, IRE mediated regulation, mRNPs –as trans regulating proteins, miRNA mediated regulation	
	mRNA localization and regulation of translation, protein degradation and regulation of translation.	

#### Reference Books:

Benjamin Lewin. (2008) *Genes IX*, Jones and Barlett Publishers Inc.

James D. Watson, Tania Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Loswick (2004) *Molecular Biology of the Gene*, Fifth Edition, Pearson Education, Inc. and Dorling Kindersley Publishing, Inc.

Weaver R., (2007) *Molecular Biology*, fourth Edition, McGraw Hill Science.

Krebs J.E., Goldstein E.S., Kilpatrick S.T., Second Edition (2010) *Lewin's essential Genes*, Jones and Barlett Publishers Inc.

## **ZY 317 T ENTOMOLOGY –I (2C) 30L**

1. Sensory system and Behaviour, Mechanical Stimuli, Thermal Stimuli, Chemical Stimuli: Sensory Systems and Behavior -Sensory organs of insects: Primary and Secondary, Main groups of Receptors: Mechanical receptors: Modifications and functions in various insects ,Cuticular (Trichoid and campaniform sensilli), Subcuticular (Cordotonal organs), and stretch receptors, Sound reception in insects: directional sensitivity, Thermoreception and thermoregulation in insects: Thermo-hygro receptors: modifications and functions in various insects Chemoreceptors: Gustatory and Olfactory -Modifications and functions in various insects:
- 2 Polymorphism and polyphenism, Age- grading, Environmental effect on development,
- 3 Insect Behaviour: Defining behaviour, complex behaviour, induced behaviour, motivation etc
- 4 Reproductive behaviour- Mate finding, courtship, territoriality, parental care, parental investment, sexual selection and evolution of sex ratios; Social behaviour- kin selection, parental manipulation and mutualism; Self organization and insect behaviour.
- 5 Foraging- Role of different signals in host searching (plant and insects) and host acceptance, ovipositional behaviour, pollination behaviour, coevolution of plants and insect pollinators. Use of semio-chemicals, auditory stimuli and visual signals in pest management.
- 6 Immune system in insects and its importance
- 7 Insect Ecology: Insect relationship with living and non-living environment. Modern Techniques in Assessment of Biodiversity, various methods, Diapause.
- 8 Insect Biogeography and Evolution: Insect biogeography, The antiquity of insect. Where the first insects aquatic or terrestrial? Evolution of wings Evolution, of metamorphosis, Insect Diversification.
- 9 Insect host plants and insect herbivore relationships.

## **ZY 317 P Experiments in Entomology.**

1. Effect of IGR/pesticides on midgut histology of insect.
2. Determination of gut pH from different insects.
3. Study of gut enzymes in insects by using various techniques.
4. Detection of lipids, carbohydrates, proteins from insect body by using appropriate staining methods.
5. Determination of chitin in insect cuticle.
6. Chromatographic separation of amino acids from insect hemolymph.
7. Study of behaviour and orientation of insects- repellence, deterrence and stimulation.
8. Field visits to understand different ecosystems and to study insect occurrence in these systems.
9. Isolation and identification of useful gut microbiota from insects.

**Reference Books:**

- Chapman JL & Reiss MJ. 2006. *Ecology: Principles & Applications*. 2<sup>nd</sup> Ed. Cambridge Univ. Press, Cambridge.
- Gotelli NJ & Ellison AM. 2004. *A Primer of Ecological Statistics*. Sinauer Associates, Inc., Sunderland, MA.
- Gotelli NJ. 2001. *A Primer of Ecology*. 3rd Ed. Sinauer Associates, Inc., Sunderland, MA
- Gupta RK. 2004. *Advances in Insect Biodiversity*. Agrobios, Jodhpur.
- Krebs CJ. 1998. *Ecological Methodology*. 2nd Ed. Benjamin-Cummings Publ. Co., New York.
- Krebs CJ. 2001. *Ecology: The Experimental Analysis of Distribution and Abundance*. 5th Ed. Benjamin-Cummings Publ. Co., New York.
- Magurran AE. 1988. *Ecological Diversity and its Measurement*. Princeton Univ. Press, Princeton.
- Price PW. 1997. *Insect Ecology*. 3rd Ed. John Wiley, New York.
- Real LA & Brown JH. (Eds). 1991. *Foundations of Ecology: Classic Papers with Commentaries*. University of Chicago Press, Chicago. Southwood TRE & Henderson PA. 2000. *Ecological Methods*. 3rd Ed. Methuen & Co. Ltd., London.
- Speight MR, Hunta MD & Watt AD. 2006. *Ecology of Insects: Concepts and Application*. Elsevier Science Publ., The Netherlands.
- Wilson EO & William H Bossert WH. 1971. *A Primer of Population Biology*. Harvard University, USA.
- Wratten SD & Fry GLA. 1980. *Field and Laboratory Exercises in Ecology*. Arnold, London

**ZY – 301P Practical in Endocrinology (2C = 30H) 10P x 3H = 30H**

1	Internal anatomy and histology of mammalian endocrine organs	3
2	Histochemical localization of 3 $\beta$ -HSD in the adrenal and gonads.	1
3	Induction of diabetes and the role of insulin in glucose metabolism.	2
4	Dissection and display of Retrocerebral complex and immunohistochemical localization of neurosecretory cells in cockroach	2
5	Quantification of steroid hormones using non-invasive enzyme immunoassay	2
5	Staging of fish chromatophores and effect of epinephrine (in-vivo and in-vitro) and acetyl choline (in-vitro) esterase	1
6	Effect of Thyroxin in amphibian metamorphosis	1

**ZY – 302 P Practical in Vertebrate Embryology (2C = 30H) 6 x 5 = 30**

I	Autoclaving, sterilization and preparation of media Study of apoptosis during embryonic development using vital dye	1
II	Chick embryo culturing technique - Gallera (double ring) method	5h
III	Preparation of shell-less chick embryo culture.	1
IV	Study of Exo-gastrulation in <i>Lymnaea</i> embryos by various treatments	1
V	Study of effect of hypertonic salt solutions on hatching of <i>Lymnaea</i> embryos.	5h
VI	Study of neural induction by transplanted Hensen's node using chick embryo	5h
VII	Chick embryo culturing technique - New's method (single ring technique)	5h
VIII	Study of the effect of anti-pacap antibody on early development of chick embryo	1

**ZY 303 - P Biosystematics, Biodiversity and Evolution (2C = 30 H)**

01	Study of Freshwater planktons, collection, sorting, identification of samples of zooplanktons: protozoans, rotifers, crustaceans. (including study of permanent specimens)	2
02	Study of biodiversity sampling using quadrat method: study of community in an ecosystem by determination of frequency density and abundance of different taxonomic groups (fauna only) present in the community.	2
03	Study of biotic component of a pond ecosystem and grouping on the basis of their trophic position.	1
04	Study of water quality and dissolved oxygen content in water samples of an ecosystem.	1
05	Museum preservation techniques of selected vertebrates and invertebrates.	1
06	Laboratory and field exercises of animal behaviors; Learning, Recognition, Feeding	2
07	Visit to ZSI Pune and other places.	1

**ZY – 313P: Advanced techniques in Molecular Biology (4C – 60 H: 12P x 5H)**

1	Isolation and purification of nuclei, mitochondria from mouse liver.	2P
2	Analysis of chromatin	4P
	a) Micrococcal nuclease digestion and DNA gel electrophoresis	
	b) Determination of mononucleosomal size	
	c) Chromatin gel electrophoresis	
	d) Two dimensional electrophoresis	
3	Extraction and estimation of nuclear DNA	1P
4	Extraction and estimation of mitochondrial DNA and mapping by restriction endonuclease digestion	2P
5	Isolation, purification and electrophoresis of RNA	2P
6	Isolation of mRNA by oligodT cellulose column chromatography	1P
7	DNA amplification by PCR	1P
8	Checking for gene expression by RT-PCR	1P
9	Western hybridization	2P
10	In situ hybridization	2P
11	Use of nucleic acid database	1P

### **ZY-401 T : Analytical & Applied Genetics (2 Credits : 30 Lectures)**

01	Advanced Quantitative Genetics: Concept of phenotypic variance and partitioning. Measurement of heritability & application (Broad sense and narrow sense heritability), Quantitative inheritance in human, Coefficient of relationship and Coefficient of inbreeding, Twin studies in human for heritability estimation, mapping strategy of quantitative trait loci (QTL)	6L
02	Advanced Population Genetics: Implications of Hardy-Weinberg principle on gene pool, effect of genetic drift, application of HW law for multiple alleles and X-linked traits, Inbreeding depression, artificial selection and application in animal breeding, numerical problem solving of HW principles for multiple alleles & other non-Mendelian traits.	6L
03	Inherited disorders and clinical genetics: Single gene, multifactorial and chromosomal disorders, loss of function and other mutations, somatic cell genetic analysis, organelle based genetic disorders, Inherited disorders of metabolism of nucleic acids, proteins, carbohydrate and lipids, detection techniques of genetic disorders, family screening and counselling, risk assessment, conventional and contemporary prenatal diagnosis and pre-implantation diagnostic methods, Genetic basis of psychiatric disorders	8L
04	Genetic Toxicology: Mutagenic agents in environment & application of genetic toxicology to human & environmental monitoring, screening of chemicals for genotoxic potential and common assays for testing mutagenicity using microbes and animals; Mutagenicity screening methods using <i>Drosophila</i> as model: Sex-linked recessive lethal (SLRL) test, Muller's CIB test, Somatic mutation and recombination tests (SMART); P-element mediated mutagenesis & transformation, UAS-GAL4 system in <i>Drosophila</i>	10

### Reference Books:

- Genetics: Analysis & Principles – by Brijjer R S (2018) McGraw Hill
- Inborn Errors of Metabolism -- by Lee B & Scaglia F (2014) OUP Publ.
- *i*-Genetics: A molecular approach – by Russel P.J. (2016) Pearson Education
- Introduction to Quantitative Genetics – by Falconer D.S. (2009) Pearson Education
- Principles of Genetics-- by Gardner E.J., Simmon M. J, Snustad D.P(2006) 8<sup>th</sup> ed. Wiley
- Chromosomes: Analyzing The Basics. –by Czepulkowski B. (2000) Taylor & Francis.
- Emery's Elements of Medical Genetics-- by Turnpenny P.D. & Ellard S. (2017) Elsevier
- Medical Genetics --- by Jorde L.B., Carey J.C., Bamshad M.J. (2015) 5<sup>th</sup> edition, Elsevier
- Genetic Toxicology – by Li A.P. & Heflich R.H. (1991) CRC Press.
- Drosophila – by Dahmann C. edited (2008) Humana Press.
- Drosophila Genetics – by Graf U, Schavah N.V., Wurgler F.E. (1992) Springer-Verlag.
- Principles of Genetic Toxicology – by Brusck D. 2<sup>nd</sup> edition (1987,) Plenum Press

### **ZY – 403T Parasitology (2 Credits – 30Lectures)**

1. **Basic concept and overview:** Parasites and parasitism, Host: Parasite relationship, Parasitic adaptations, interrelationships between host and parasite. **5L**
2. **Type study: Unicellular parasites.** Protozoans (*Entamoeba histolytica*, *Plasmodium* spp., *Trypanosoma* spp. *Leishmania* spp., *Giardia* spp etc.). **5L**
3. **Type study: Multicellular parasites.** Platyhelminths (tape worms, liver flukes), nemathelminths (round worms, hook worms), Arthropods and Vector biology. **5L**
4. **Genomes & genes of some important parasites:** Antigenic variation in Trypanosomes, Specialized & unique molecular features of *Plasmodium* spp., *Leishmania* spp., *Entamoeba* spp. Etc. **5L**
5. **Physiology and structure and cell biology** of parasites. **5L**
6. **Diagnosis and control** of parasites. **5L**

### **Reference Books:**

Burton J Bogitsh: Human Parasitology 3rd edition Elsevier.

Roberts, L. S. and J. Janovy, Jr: 2004. *Foundations of Parasitology*. 7<sup>th</sup> Edition. McGraw Hill, Boston.

Smith: Animal Parasitology 1996. Cambridge University Press.

Chandler and Reid: Introduction to Parasitology 1970, Wiley.

Marr et al: Molecular Medical Parasitology 2003, Elsevier.

Lawrence R: Ash and Thomas C. Orihel. Atlas of Human Parasitology. American Society for clinical pathology press 5<sup>th</sup> edition, 2007.

Alan Gunn: Parasitology: An Integrated Approach Wiley-Blackwell. 2012.

Janet Amundson Romich: Understanding Zoonotic Diseases. 2007

Paul Schmid-Hempel: The Integrated Study of Infections, Immunology, Ecology, and Genetics (Oxford Biology), 2011

Anderson RM, May RM. (1985) Helminth infections of humans: mathematical models, population dynamics, and control. *Adv Parasitol.*:1-101.

Cox F. E. G. (1993) *Modern Parasitology: A Textbook of Parasitology*

Chatterjee (1967) K. D. *Parasitology: Protozoology & Helminthology*

Gardner MJ et al (2002) Genome sequence of the human malaria parasite *Plasmodium falciparum*. *Nature* 419:498-511.

Ivens AC et al. (2005) The genome of the kinetoplastid parasite, *Leishmania major*. *Science*.309:436-42.

LS Garcia, DA Bruckner (1997) *Diagnostic medical Parasitology*.

## **ZY 418 T ENTOMOLOGY-II (2C) -30L**

### **1. Insect Reproduction**

Mate finding, Courtship, Sexual Selection, Copulation, Diversity in genitalic morphology, Sperm storage, fertilization, and sex determination, Sperm competition, Oviposition. A typical mode of reproduction, Physiological control and reproduction.

### **2. Insect development**

Spermatogenesis and oogenesis, Seminal transfer and fertilization, Sex determination, Pre eclosion morphogenesis, blastoderm formation, germ cells, gastrulation and blastokinesis, Differentiation of germinal layer, fate maps, Segmentation, Appendages formation, organogenesis, Fate of germinal layers, Hatching, Post embryonic development, Imaginal disc: Hadorn's experiment. Aging and life span.

### **3. Plant and Insect herbivore relationship: (3L)**

Co-evolution, interaction between insect and plants, Insect plant reproductive biology, Insect that live mutualistically in specialized plant structure.

Insect immunity and its Importance. Plant and Insect herbivore relationship: (3L)

Co-evolution, interaction between insect and plants, Insect plant reproductive biology, Insect that live mutualistically in specialized plant structure.

### **4. Insect immunity against interference**

### **5. Molecular Approaches in Entomological Research**

- i. Transgenic plants for insect pest resistance and diseases, RNAi technique. (2L)
- ii. DNA recombinant technology, identification of genes/nucleotide sequences for characters of interest. Genetic improvement of natural enemies. Cell lines, genetic engineering in baculoviruses, *Bt* and entomopathogenic fungi. Genes of interest in entomological research-marker genes for sex identification, neuropeptides, JH esterase, St toxins and venoms, chitinase.
- iii. Insect gene transformation; biotechnology in relation to silkworms and honey bees; introduction of lectin genes for pest suppression; Genetic improvement of inebriate tolerance of natural enemies. Molecular basis of

- metamorphosis; Sf transgenic technology and implications; molecular biology of baculoviruses; insecticide resistance.
6. Barcoding of Insect. (2L)
  7. Arthropod vector biology with special reference to: (5L)  
Vector-borne diseases including Dengue fever, Lyme disease, Plague, West Nile virus, Kala azar etc. Mosquito, Tse-Tse fly, Sand fly, ticks, Flies and Fleas, -Management and control strategies.
  8. Ecology and Population ecology: Dominance, abundance, species richness, Insect population, density, dispersion, growth and regulations. Population dynamics, Insect sampling tools, life table study. (5L)

**Referece Books:**

- Bhattacharya TK, Kumar P & Sharma A. 2007. *Animal Biotehnology*. 1<sup>st</sup> Ed., Kalyani Publ., New Delhi.
- Hagedon HH, Hilderbrand JG, Kidwell MG & Law JH. 1990. *Molecular Insect Science*. Plenum Press, New York.
- Oakeshott J & Whitten MA.. 1994. *Molecular Approaches to Fundamental and Applied Entomology*. Springer Verlag.
- Rechcigl JE & Rechcigl NA. 1998. *Biological and Biotechnological Control of Insect Pests*. Lewis Publ., North Carolina.
- Roy U & Saxena V. 2007. *A Hand Book of Genetic Engineering*. 1st Ed., Kalyani Publ., New Delhi.
- Singh BD. 2008. *Biotechnology (Expanding Horizons)*. Kalyani Publ., New Delhi.
- Singh P. 2007. *Introductory to Biotechnology*. 2nd Ed. Kalyani Publ., New Delhi.

- 9.
10. Molecular Approaches in Entomological Research
  - iv. Transgenic plants for insect pest resistance and diseases, RNAi technique. (2L)
  - v. DNA recombinant technology, identification of genes/nucleotide sequences for characters of interest. Genetic improvement of natural enemies. Cell lines, genetic engineering in baculoviruses, *Bt* and entomopathogenic fungi. Genes of interest in entomological research-marker genes for sex identification, neuropeptides, JH esterase, St toxins and venoms, chitinase.
  - vi. Insect gene transformation; biotechnology in relation to silkworms and honey bees; introduction of lectin genes for pest suppression; Genetic improvement of inebriate tolerance of natural enemies. Molecular basis of metamorphosis; Sf transgenic technology and implications; molecular biology of baculoviruses; insecticide resistance.
11. Barcoding of Insect. (2L)
12. Arthropod vector biology with special reference to: (5L)  
Vector-borne diseases including Dengue fever, Lyme disease, Plague, West Nile virus, Kala azar etc. Mosquito, Tse-Tse fly, Sand fly, ticks, Flies and Fleas, -Management and control strategies.

13. Ecology and Population ecology: Dominance, abundance, species richness, Insect population, density, dispersion, growth and regulations. Population dynamics, Insect sampling tools, life table study. (5L)

**Referece Books:**

Bhattacharya TK, Kumar P & Sharma A. 2007. *Animal Biotehnology*. 1<sup>st</sup> Ed., Kalyani Publ., New Delhi.

Hagedon HH, Hilderbrand JG, Kidwell MG & Law JH. 1990. *Molecular Insect Science*. Plenum Press, New York.

Oakeshott J & Whitten MA.. 1994. *Molecular Approaches to Fundamental and Applied Entomology*. Springer Verlag.

Rechcigl JE & Rechcigl NA. 1998. *Biological and Biotechnological Control of Insect Pests*. Lewis Publ., North Carolina.

Roy U & Saxena V. 2007. *A Hand Book of Genetic Engineering*. 1st Ed., Kalyani Publ., New Delhi.

Singh BD. 2008. *Biotechnology (Expanding Horizons)*. Kalyani Publ., New Delhi.

Singh P. 2007. *Introductory to Biotechnology*. 2nd Ed. Kalyani Publ., New Delhi.

**ZY 402-T Biology of Reproduction (2C – 30 Lectures)**

- |   |  |    |
|---|--|----|
| 1 | <p>Reproductive organs: Male and female gonads, duct systems and sex accessories.</p> <p>Reproductive Patterns: Environmental factors and breeding; continuous and seasonal breeders, Environmental and hormonal control of reproductive cycles in vertebrates.</p> <p>Reproductive Cycles : Puberty; Oestrous and menstrual cycles. Ovulation (spontaneous and reflex), luteal phase, Cycling of non-pregnant uterus and vagina</p> | 7L |
| 2 | <p>Hormonal regulation: Hypothalamohypophysial–gonadal axis; Pituitary gonadotropins and behavioural effects. Testicular hormones, Inhibin.</p> <p>Ovarian hormones.</p>   | 3L |
| 3 | <p>Pregnancy : Conception and blastocyst formation, Implantation and delayed implantation Placenta : formation, types and functions. Hormones in pregnancy.</p>  | 5L |
| 4 | <p>Parturition : Birth process and its neuro – endocrine control. Puerperium.</p> <p>Lactation : Milk glands, milk synthesis ad secretion, Hormonal regulation : sucking reflex.</p>   | 5L |
| 5 | <p>Reproductive dysfunctions: Ageing and reproduction, Climacteric.</p> <p>Anatomical, endocrine and genetic disorders. Immunological aspects.</p> <p>Environmental effects.</p>   | 5L |
| 6 | <p>Artificial control of reproduction: Increasing reproductive potential : artificial</p>  |    |

insemination, *in vitro* fertilization and embryo transfer induced breeding, 5L  
 synchronization of Estrus and ovulation : Chemical and hormonal aspects.  
 Limiting reproductive potential: Physical, physiological, surgical and  
 chemical methods of contraception in male and female infertility: Causes  
 and treatment, hormonal aspects, Monitoring fetal development: Methods  
 and implications.

### References:

1. Knobil, Ernst and Neill, Jimmy D. (2005). Physiology of Reproduction Vol 1 – 3. Academic Press.
2. Knobil, Ernst and Neill, Jimmy D. (1998). Encyclopedia of Reproduction. Vol 1-3. Academic Press.
3. Nalbandov, A.V. (1964). Reproductive Physiology
4. Clarke, J. R. (1988). Oxford Review of Reproductive biology. Oxford Science Publications.
5. James, E. W. Jr. (1988). Vertebrate Reproduction. Wiley Interscience.
6. Metz, C.B. and Monroy, A. (1985). Biology of Fertilization. Academic Press.
7. Devaraj Sarkar, H. B. (1985). Principles of Vertebrate Reproductive Biology. Ganapathy Graphics.
8. Guyton, A. C. and Hall, J. E. (2001). Text book of Medical Physiology. 10<sup>th</sup> edition. W. B. Saunders Company, Philadelphia.
9. Tortora, G. J. and Derrickson, B. (2006). Principles of Anatomy and Physiology, 11<sup>th</sup> edition, John Wiley and Sons Inc

### ZY 407T+P: Genomics and Proteomics (4 Credits : 60 Lectures)

- |   |   |    |
|---|---|----|
| 1 | Introduction to Genomics and Proteomics: structural genomics, Functional Genomics   | 5  |
| 2 | Genome mapping-<br>Genetic mapping: I) Cross breeding and pedigree analysis, II) DNA markers - RFLPs, SSLPs, SNPs<br>Physical mapping: Restriction mapping, Fluorescent in situ hybridization, Radiation hybrid mapping and Sequence tagged site mapping.   |    |
| 3 | Genome projects: The Human genome project, HapMap Project, The 1000 genome project, and The ENCODE Project.<br>Structural genomics: Genome sequencing, Sanger sequencing, NGS<br>Assembly of a contiguous DNA sequence- shotgun method, clone contig method, and whole –genome shotgun sequencing<br>Understanding a genome sequence: locating the genes in a genome sequence, determining the functions of individual genes and by studying the activity of a protein coded of an unknown gene | 10 |

4	Introduction to Bioinformatics, Concepts and applications Biological Databases- Concept, types, specialization, limitations, DBMS Data retrieval from various databases, homology searching and their applications Sequence Alignments- Algorithms, Scoring Matrices, Multiple Sequence Alignment (MSA) Gene Annotation- Introduction	10
5	Molecular Modeling, Phylogenetic analysis Acquisition and visualization of molecular structures, Energy optimization methods Sequence and Structure based predictions- Simulation of Molecular interactions Phylogenetic analysis and tree construction methods Comparative Genomics	10
6	Global expression profiling: Whole genome analysis of mRNA and protein expression, microarray analysis and their applications. RNA Seq	5
7	Toxicogenomics, Pharmacogenomics, Metagenomics, Metabolic engineering	2
8	Importance of proteomics Strategies in proteomics: 2D PAGE and Mass spectrometry Database and search engines in proteomics Structural bioinformatics Protein structure basics, Ramachandran plot, Protein structure- function relationship, SCOP and CATH Introduction to: Protein motifs and domain prediction, Protein profiles and Hidden Markov Model (HMM), Drug target finding.	8
9	Mapping of protein interactions: two hybrid, phage display	1
10	Applications of proteomics: Understanding mechanism of pathogenesis, Drug discovery, Disease diagnosis, identification and characterization of novel proteins	4

### **ZY – 320T Animal Physiology -II ( 1C: 15 L)**

**Unit-I** : Receptor Physiology & Pathways: hearing and tactile response , Mechano receptors , Photo receptors , Thermo receptors , Chemo receptors , Electro receptors , Magneto receptors , Equilibrium receptors **4L**

Reflexes and reflex arcs: the stretch reflex, the tendon reflex, the flexor and crossed extensor reflex **2L**

**Unit- II** : Physiology of High altitude : Effects of acute exposure to high altitude , Acclimatization to high altitude , Respiratory changes , Exercise at high altitude Physiology of Exercise , Cardiovascular response to exercise , Skeletal muscle blood flow , Local factors, neural factors, humoral factors , Blood pressure during exercise , Respiratory response during exercise , Endocrine response to exercise , Metabolic adjustments in exercise , Fatigue-biochemical and Physiological changes **5L**

**Unit- III:** Stress and adaptation: Physiology underlying fear and anxiety **2L**

**UNIT IV:** Thermoregulation - Comfort zone, body temperature – physical, chemical, neural regulation, acclimatization. **2L**

### **ZY – 320P Laboratory exercises in Animal Physiology: 1Credits: 15H= 5P x 3H**

**(Any 5 laboratory exercises from the list below)**

	Exercise	
1	Assay of Tropinin in vivo/in vitro	1
2	Analysis of Creatine phosphate in vivo/in vitro	1
3	Determination of the efficiency of contraction in skeletal muscle fibers by rate of release of inorganic phosphate	1
4	Investigating the effects of drugs/pesticides on serum parameters	2
6	Examination of sections of mammalian oesophagus, stomach, duodenum, ileum, rectum liver, trachea, lung, kidney	1
7	Study of permanent slides of Mammalian skin, Cartilage, Bone, Spinal cord, Nerve cell, Pituitary, Pancreas, Testis, Ovary, Adrenal, Thyroid and Parathyroid	2
8	Detection of blood by hemin crystals test	1
9	3-D viewing of Acetylcholine, ion channel proteins using RasMol/ Deep-view soft-wares/	1
10	Determination of pack cell volume (P.C.V).	1
11	Determination of mean corpuscular volume (M.V.C.)	1

#### Reference Books:

- Principles of Animal Physiology (2006), C. D. Moyes and P. M. Schulte. Publisher - Pearson Education Inc. and Dorling Kindersley Publishing Inc.
- Text book of Medical Physiology 10th edition (2001),. A. C. Guyton and J. E. Hall. Publisher - W. B. Saunders Company, Philadelphia. -
- Principles of Anatomy and Physiology, 11th edition (2006), G. J. Tortora and B. Derrickson. Publisher-John Wiley and Sons Inc.
- Endocrinology, 5th edition (2008), Mac. E. Hadley. Publisher-Pearson Education Inc. and Dorling Kindersley Publishing Inc.
- Comparative Vertebrate Endocrinology 3rd edition (1998), P. J. Bentley. PublisherCambridge University Press.
- Vertebrate Endocrinology 3rd edition (1997), D. O. Norris. Publisher- Academic Press: An imprint of Elsevier.
- The World of the Cell, 7th edition, (2005), Wayne M. Becker, Lewis J. Kleinsmith, Jeff Hardin., Publisher - Benjamin Cummings.
- Animal Physiology: Adaptation and Environment (1997) [Knut Schmidt-Nielsen](#) Publisher: Cambridge University Press
- Principles of Animal Physiology (2nd Edition) ( 2007) Christopher D. Moyes , Patricia M. Schulte
- Animal Physiology, Third Edition ( 2012) Richard W. Hill, Gordon A. Wyse, Margaret Anderson
- 
- Functional Anatomy and Physiology of Domestic Animals 4<sup>th</sup> Edition ( 2009) William O. Reece

- Animal Physiology 2<sup>nd</sup> Edition Richard W. Hill Publisher: Sinauer Associates, Incorporated
- Eckert's Animal Physiology ( 2004) Roger Eckert, D.J. Randall, Warren Burggren, Kathleen French Publisher: W.H.Freeman & Co Ltd
- Animal Physiology: Adaptation and Environment (1997) [Knut Schmidt-Nielsen](#) Publisher: CAMBRIDGE UNIVERSITY PRESS
- Principles of Animal Physiology ( 2013) [Christopher D. Moyes](#), [Patricia M. Schulte](#) Publisher: Pearson Education Limited
- Environmental Physiology of Animals(2004) [Pat Willmer](#), [Graham Stone](#), [Ian Johnston](#) Publisher: Blackwell Publishing Ltd
- The Eye: A Very Short Introduction (2014) [Michael F. Land](#) Publisher: Oxford University Press
- Introduction to Animal Physiology(1998) [Ian Kay](#) Publisher: Bios Scientific Publishers Ltd

### **ZY-314P : Laboratory Exercises in Advanced Genetics**

01	Estimation of heritability of quantitative traits	1P
02	Study of genetic polymorphism in a natural population using allozyme variants and traits.	1P
03	Study of natural and artificial selection using appropriate wild type and mutant alleles in <i>Drosophila</i> population under laboratory simulated conditions.	2P
04	Analysis of cryo-frozen chromosome spreads using cytogenetic techniques	1P
05	Identification of polytene chromosome arms of <i>Drosophila melanogaster</i> , method of referring to chromosome map and localization of chromosome sites, puffing.	1P
06	Study of non-allelic gene interaction in <i>Drosophila</i>	2P