DEPARTMENT OF ZOOLOGY

UNIVERSITY OF PUNE

PUNE 411007

Syllabus

For
Credit/Semester Based

M. Sc. (Zoology)

w.e.f. June 2008

M.Sc. (Zoology) Part I Syllabus

SEMESTER I

Course Structure: Semester I (General)					
Theory Courses			**Practical Courses**		
Course No.	**Title**	**Credits**	**Course No.**	**Title**	**Credits**
ZY 101T	Biochemistry	2C	ZY 101P	Laboratory Exercises in Biochemistry	2C
ZY 102T	Cell biology	2C	ZY 102P	Laboratory Exercises in Cell biology	2C
ZY 103T	Fundamentals of Molecular Biology	2C	ZY 103P	Laboratory Exercises in Molecular biology	3C
ZY 104T	Developmental Biology	2C	ZY 104P	Laboratory Exercises in Developmental Biology	2C
ZY 105T	General Genetics	2C	ZY 105P	Laboratory Exercises in Genetics	2C
ZY 106T	Animal Physiology	2C	ZY 106P	Laboratory Exercises in Animal Physiology	2C
ZY 107T	Skills in Scientific communications	2C			
Total		**14 C**			**13 C**
Total Credits: 27. At least courses equivalent to 25 Credits should be taken by the student.					

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

		Topic	LH
A	**1.**	**Biomolecules, characteristic features.**	**1**
	2.	Water, structure of liquid water, water as ideal biological solvent.	**2**
	3.	Thermodynamics- free energy, entropy, high energy bonds	**2**
B	**1.**	**Mitochondria:** Electron transport, proton translocation, oxidation phosphorylation.	**3**
	2.	**Chloroplast:** Photosynthesis and other processes involving light.	**2**
C	**1.**	**Amino acids, peptides and polypeptides**	**2**
	2.	The three dimensional structures of proteins, the Ramchandran plot, α helix, β sheet.	**2**
	3.	Structure of collagen, domain - basic unit of tertiary structure, Quaternary structure. Functional diversity of proteins.	**2**
D	**1.**	**Carbohydrates:** Monosaccharides, Disaccharides and polysaccharides, structure and function.	**3**
	2.	**Lipids:** Chemistry of triglycerides sterols, quinones and prostaglandins.	**2**
E	**1.**	**Nucleic Acids:** structure and function, properties and types of nucleic acids.	**2**
	2.	The RNA world.	**2**
F	**1.**	**Enzymology:** Concepts of enzyme Units, Specific Activity, Coenzymes.	**1**
	2.	Kinetics of Enzyme catalyzed reactions, Effect of pH, Temp, Inhibitor, activator.	**2**
	3.	Regulation of enzyme activities.	**2**
	4.	Isoenzyme: structure and function.	**1**

Reference Books:

- *Biochemistry*, 3rd Ed. (2005), Voet Donald and Voet Judith G. John, Publisher: Wiley & sons, New York.
- *Biochemistry* 6th Ed, (2007) Berg Jeremy, Tymoczko John, Stryer Lubert, Publisher: W. H. Freeman, New York.
- *Lehninger's Principles of Biochemistry*, 4th edition, (2005) Nelson D. L. and Cox M. M. W. H. Freeman & Co. NY.
- *Biochemical Calculations,* 2nd Ed., (1997) Segel Irvin H., Publisher: John Wiley and Sons, New York.
- *Enzymes: Biochemistry, Biotechnology & Clinical chemistry*, (2001) Palmer Trevor , Publisher: Horwood Pub. Co., England.

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

	Topic	LH
01	**An overview of cell, cell shapes and types.**	**2**
02	**Plasma membrane and cell surface:** Structure, chemistry, receptors, transport, pinocytosis and phagocytosis, cell junctions, membrane potential and synaptic transmission, glycocalyx and cell wall.	**8**
03	**Mitochondria;** Structure, function, protein import, **Chloroplast** – PS I and PS II system, water-splitting complex.	**5**
04	**Subcellular organelles :** (a) The endoplasmic reticulum smooth and rough, (b) The Golgi complex, (c) Lysosomes, (d) Peroxysomes and glyoxysomes, (e) Nucleus	**10**
05	**Cell cycle:** Phases of cell cycle, checkpoints of cell cycle, regulation of cell cycle	**5**

Reference Books:

- *The World of the Cell*, 7th edition (2005), Wayne M. Becker, Lewis J. Kleinsmith, Jeff Hardin.Publisher-Benjamin Cummings.
- *Molecular Cell Biology*, 6th 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*, 5th edition, (2007), Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter. Publisher - Garland Science.

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

	Topic	LH
01	**Genome organization:** C value paradox and genome size, Cot curves, repetitive and non-repetitive DNA sequence, Cot ½ and Rot ½ 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	12
02	**DNA Replication:** 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	8
03	**DNA damage and repair:** 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	4
04	**Recombination:** Homologous and site specific recombination Models for homologous recombination: The Hollliday model, double strand break repair model Proteins involved in recombination: RecA, RuvA,B,C Gene conversion	3
05	**Mobile DNA elements:** 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	3

Reference books:

- *Genes IX*, 9th edition (2008), Benjamin Lewin, Publisher - Jones and Barlett Publishers Inc.
- *Molecular Biology of the Gene*, 5th 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*, 4th Edition (2007), Weaver R., Publisher-McGrew Hill Science.
- *Molecular Biology of the Cell*, 4th Edition (2004), Bruce Alberts, Dennis Bray, Julian Lewis, Martin Raff, Keith Roberts, and James D. Publisher: Garland Publishing.
- *Essential Cell Biology*, 2nd Edition (2003) Bruce Albert, 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)

	Topic	LH
01	**Basic concepts of Developmental Biology:**	**5**
	Model systems: Fish, Frog, Chick, Mouse and *Drosophila*.	
02	**Types of eggs and cleavage patterns:**	**5**
	Concepts in Pattern formation, animal vegetal axis, gradients, origin, and specification of germ layers.	
03	**Cell–cell interaction and cell signaling:**	**5**
	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	**Differentiation:**	**5**
	Cellular basis of differentiation, trans-differentiation, metaplasia and regeneration.	
	Stem cells and their role in development	
05	**Growth and post embryonic development**:	**5**
	Apoptosis, aging and senescence, abnormal development.	
06	**Evolution and development confirmative study.**	**5**

Reference Books:

- *Developmental Biology*, 8th edition (2006), S.F. Gilbert. Publisher - Sinauer Associates Inc.
- *Principles of Development*, 3rd edition (2007), Lewis Wolpert, Publisher- Oxford University Press.
- *An Introduction to Embryology*, 5th 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)

	Topic	LH
01	**Review of Mendelian & Non-Mendelian Inheritance:**	**5**
	Mono / dihybrid inheritance, types of dominance, multiple allelism, Pleiotropy, epistasis, inheritance related to sex, probability and exercises for solving genetics problems.	
02	**Quantitative Genetics:**	**4**
	Polygenic traits and mode of inheritance, analysis of variation: genetic and environmental factors, Heritability, Inbreeding and consequences, Co-efficient of inbreeding and consanguinity.	
03	**Linkage and mapping in eukaryotes:**	**4**
	Detection of linkages, construction of linkage maps in diploids and their characteristics, Co-efficient of Coincidence, Outline of other mapping techniques	
04	**Cytogenetics:**	**2**
	Variation in chromosomal structure and number and genetic consequences	
05	**Cytoplasmic inheritance:**	**2**
06	**Microbial Genetics:**	**8**
	Recombination in bacteria and gene mapping, Transformation, Conjugation, Transduction (Generalized and Specialized),	
	Fine structure mapping of genes,	
	General principles and genetics of (a) bacteriophages (T-even and T-odd) (b) RNA phage c) Mu and transposons	

Reference Books:

- *Concepts of Genetics*, 9th edition (2008), William S. Klug, Michael R. Cummings, Charlotte Spencer, and Michael A. Palladino, Publisher-Benjamin Cummings
- *Genes IX*, 9th edition (2008), Benjamin Lewin, Publisher-Jones and Barlett Publishers Inc.
- *Principles of Genetics*, 4th edition, (2006), Snustad D. Peter and Simmons J. Micheal, Publisher -John Wiley and Sons. Inc.
- *Genetics*, (1999), Daniel J. Fairbanks, W. Ralph Andersen Publisher-Brooks/Cole Pub Co.
- *Principles of Genetics*, 8th edition (1991), Eldon J. Gardner, D.P. Snustad, M.J. Simmons, and D. Peter Snustad Publisher-John Wiley and Sons. Inc.
- *Microbial Genetics*, (1987), David Freifelder, Publisher-Jones & Bartlett
- *General Genetics*, (1985), Leon A. Snyder, David Freifelder, Daniel L. Hartl Publisher- Jones and Bartlett.
- *Genetics*, 3rd edition, Monroe W. Strickberger, (1968), Publisher - Macmillan Publishing Co.

ZY 106 T: Animal Physiology (2Credits: 30 L)

	Topic	LH
01	**Digestion:** Physiology of digestion and absorption.	**2**
02	**Blood pigments:** Role in oxygen transport, Oxygen dissociation curves and their physiological significances, Transport of CO_2.	**3**
03	**Circulation:** Cardiac cycle, Neurogenic and myogenic hearts, Blood volume, cardiac out-put.	**5**
04	**Muscle contraction:** Structure of the skeletal muscle, proteins of the myofilaments, actin-myosin interaction; sarcoplasmic reticulum and role of calcium in contraction.	**5**
05	**Osmotic regulation:** Osmolarity and toxicity, ionic regulation, hyper and hyposmotic regulators, ureosmotic animals.	**5**
06	**Excretion:** Basic processes in urine formation, Renal function in animals "mammalian kidney", Renal portal system.	
07	**Chemical communication:** Neuro-hemal and endocrine organs, chemistry of vertebrate hormones, Mechanism of hormone action.	**5**
08	**Sense organs:** Classification of sense organs and their principles. Detailed mechanism of photoreaction, Types of reflexes and their functions, Principles of neural integration.	**5**

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. Publisher-Cambridge 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.

ZY 101P: Laboratory exercises in Biochemistry (2Credits: 30H =10P x3H)

	Content	P
I	**Basic Standardization Methods:**	**2**
	1 Preparation of Acid & Alkali solutions and acid-base titration	
	2 pH, Buffers, Buffering capacity	
II	**Estimation of Micromolecules:**	**4**
	1 Estimation of Inorganic Phosphate	
	2 Estimation of Sugar (Glucose)	
	3 Estimation of Amino Acid (Tyrosine)	
	4 Estimation of Nitrogenous Base (Guanine)	
III	**Estimation of Macromolecules:**	**3**
	1 Estimation of Carbohydrates (Starch)	
	2 Estimation of Protein (BSA)	
	3 Estimation of Nucleic Acid (DNA)	
IV	**Paper Chromatography:**	**3**
	1 Separation of sugars	
	2 Separation of nitrogenous bases	
	3 Separation of amino acids	
V	**Enzyme Kinetics:**	**6**
	1 Units and specific activity of enzymes	
	2 Effect of substrate concentration on enzyme activity	
	3 Effect of pH and temperature on enzyme activity	

ZY 102P: Laboratory exercises in Cell Biology (2Credits: 30H =10P x3H)

	Content	P
01	Subcellular fractionation: nuclei, mitochondria Cytosol & assaying functional identification of mitochondria.	**2**
02	Mitosis: Effect of colchicine on mitosis and polyploidy. **(1P)**	**1**
03	Meiosis I and II. **(1P)**	**1**
04	Preparation of blood smears: Cell type identification and differential counts. **(1P)**	**1**
05	Study of Phagocytosis / pinocytosis.	**1**
06	EM – interpretation of cellular ultra structure.	**1**
07	To study lipid solubility of membrane.	**1**
08	Determination of Absorption spectrum of hemoglobin (Hb) in Fe^{2+} and Fe^{3+} state.	**1**
09	Determination of Percent Hemolysis and the Osmotic Fragility of Erythrocytes.	**1**

ZY 103P: Laboratory Exercises in Molecular Biology (3Credits: 45H = 9P X 5H)

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

ZY104P: Laboratory Exercises in Developmental Biology (3Credits: 9P X 5H)

	Content	P
01	Patterns of cleavages in starfish. Amphioxus, *Onepidula*, insects (slides)	**1**
02	Study of embryonic and post-embryonic development using frog egg as a model system.	**3**
03	Mounting of chick embryos and preparation of permanent mounts.	**2**
04	Gross anatomy and histology of chick embryos till 96 h.	**2**
05	Experiments in regeneration in Hydra or Planaria.	**1**
06	Study of cell death during limb morphogenesis in chick embryo.	**1**
07	Filter paper ring method for *in vitro* culturing of chick Embryo.	**1**

ZY 105P: Laboratory Exercises in Genetics (2 Credits: 30H = 10P x 3 hrs)

	Content	P
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.	**2**
02	Study of autosomal gene inheritance (monohybrid crosses and dihybrid crosses using vestigial and sepia mutants along with wild-type flies for F1 and F2 generations) and Chi-square analysis of data of progeny.	**3**
03	(a) Study of sex-linked gene inheritance (F1 and F2 generations) using white or yellow mutant flies.	**2**
	(b) Setting up reciprocal crosses	
04	Estimation of gene frequencies in human population and analysis of heterozygote frequencies.	**1**
05	Analysis of quantitative traits.	
06	Partitioning of variance in genetic and non-genetic components.	**1**
07	Preparation of analysis of human pedigree (including traits concerning penetrance, pleiotropy and cases of mutation and consanguinity).	**1**
08	Cytogenetic studies using Polytene chromosomes.	**1**
09	Cytogenetic studies and preparation of metaphase chromosome spreads using mouse bone marrow.	**1**
10	Study and characterization of normal and abnormal karyotypes from human subjects.	**1**

ZY 106 P: Laboratory exercises in Animal Physiology: 2 Credits: 30H= 10P x 3H

	Content	P
01	Body size and oxygen consumption in aquatic animals (crab/fish).	**1**
02	Study of nitrogenous waste products of animals from different habitats.	**1**
03	Study of cardiac cycle of frog and its response to temperature.	**1**
04	Effect of salinity on oxygen consumption of crab.	**1**
05	Effect of exercise on heart rate and lactic acid in human blood.	**1**
06	Estimation of Chloride content of the crab blood.	**1**
07	Determination of glomerular filtration rate by creatinine clearance.	**1**
08	Effect of starvation on liver and muscle glycogen of mouse.	**1**
09	Effect of adrenaline on liver and muscle glycogen of mouse.	**1**
10	Measurement of tidal volume and vital capacity.	**1**
11	RBCs in different vertebrates and in different physiological conditions.	**1**
12	Induction of diabetes in mouse.	**1**
13	Lipid profile in vertebrates.	**1**

M.Sc. (Zoology) Part I Syllabus

SEMESTER II

Course Structure: Semester II (General)					
Theory Courses			**Practical Courses**		
Course No.	**Title**	**Credits**	**Course No.**	**Title**	**Credits**
ZY 201T	Metabolic Pathways	2C	ZY 202P	Laboratory Exercises in Immunology	2C
ZY 202T	Fundamentals of Immunology	2C	ZY 203P	Laboratory Exercises in Entomology	2C
ZY 203T	Basic Entomology	2C			
ZY 204T	Genetic Information Flow and Processing	2C			
ZY 208T	Scientific Presentation	2C			
Theory + Practical Courses					
ZY 205T+P	Tools and Techniques in Biology	3C/6C	ZY 205T+P	Tools and Techniques in Biology	3C/6C
ZY 206T+P	Histology and Histochemistry	2C/4C	ZY 206T+P	Histology and Histochemistry	2C/4C
ZY 207T+P	Quantitative Biology	1C/3C	ZY 207T+P	Quantitative Biology	2C/3C
Total		**16 C**			**11 C**
Total Credits: 27. At least courses equivalent to 25 Credits should be taken by the student.					

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

		Topic	LH
A		**Basic concepts of Metabolism:**	
	1.	Concept of catabolism and anabolism: metabolic strategies, organization, clustering of enzymes. Experimental approaches to study metabolism.	**1**
	2.	Regulation of Metabolic Pathways: energy charge, phosphorylation potential etc.	**1**
B		**Carbohydrate metabolism :**	
	1.	Glycolysis, glycogenolysis, gluconeogenesis, pentose phosphate pathway, glucoronic acid pathway (emphasis on regulation)	**5**
	2.	Dark reactions of Photosynthesis: CO_2 fixation: C_3, C_4 and CAM pathways.	**2**
C	**1.**	**The Citric acid cycle:** Cyclic overview and reactions. Metabolic sources of acetyl CoA. Regulation and amphibolic nature of the cycle. Glyoxylate cycle.	**4**
D		**Lipid Metabolism :**	
	1.	β oxidation of unsaturated and saturated fatty acid and its regulation. Propoinyl CoA metabolism, significance of ketone bodies, Biosynthesis of palmitate and its regulation. Mitochondrial and microsomal pathways of chain elongation, long term dietary changes and enzyme level.	**6**
	2.	Metabolism of chloesterol: Biosynthesis of cholesterol and its regulation, lipoprotein metabolism, chylomicrons, LDL, HDL, VLDHL.	**4**
E		**Amino acid metabolism :**	
	1.	Transamination, deamination, Fate of amino acid skeleton, urea cycle, precursors for compounds other than proteins, Genetic diseases.	**5**
F		**Nucleotide Metabolism :**	
	1.	Salvage and *de novo* pathways of purine and pyrimidine nucleotide biosynthesis. Formation of deoxyribonucleotides, origin of thymine. Biosynthesis of Nucleotide coenzymes.	**3**
	2.	Nucleotide degradation: catabolism of purines and pyrimidines, fate of uric acid.	**1**

Reference Books:

- *Biochemistry*, 3rd Ed. (2005), Voet Donald and Voet Judith G. John, Publisher: Wiley & sons, New York.
- *Biochemistry* 6th Ed, (2007) Berg Jeremy, Tymoczko John, Stryer Lubert, Publisher: W. H. Freeman, New York.
- *Lehninger's Principles of Biochemistry*, 4th edition, (2005) Nelson D. L. and Cox M. M. W. H. Freeman & Co. NY.
- *Biochemistry: A problems approach* (1974) Wood W. B., Wilson J. H., Benbow R. M., Hood L. E. Publisher: W. A. Benjamin, Inc., Menlo Park, CAand London.
- *Harper's Biochemistry*, 26th edition (2003) R.K. Murray, D.K. Granner, P.A. Mayes, V. W. Rodwell, Publisher-McGraw Hill.

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

	Topic	LH
01	Overview of Immune system, Cells and organs of Immune system, B & T cell response generation	**5**
02	Antibodies structure, function, organization & expression of genes, Antigen-antibody interactions	**5**
03	MHC structure, gene organization, Antigen processing & presentation, TCR	**3**
04	T cell and B cell maturation & differentiation, Cell mediated immune responses, Cytokines & Complement system	**5**
05	Hypersensitive reactions, Immune response to infectious diseases	**5**
06	Autoimmunity, Vaccines, Transplantation, Tolerance	**5**

Reference Books:

- *Kuby Immunology*, 6th edition (2007), T. J. Kindt, R.A. Goldbye, B.A. Osborne, Publisher: W.H. Freeman and Company.
- *Immunobiology*: The Immune System in Health and Diseases, 6th Edition (2005), Charles A. Janeway, Publisher: Garland Science.
- *Roitt's Essential Immunology*, 11th Edition (2006) Peter Delves, Seamus Martin, Dennis Burton, Ivan Roitt, Publisher: Wiley-Blackwell.
- *Cellular and Molecular Immunology*, 6th Edition (2008) Abul K. Abbas, Andrew H. Lichtman, and Shiv Pillai, Publisher: Elsevier, USA.
- *Prescott, Harley, Klein's Microbiology* 7th edition (2009), Joanne M Willey, Christopher J Woolverton, Linda M Sherwood, Publisher: McGraw-Hill.

ZY 203T: Basic Entomology (2 Credits: 30 Lectures)

	Topic	L
01	Scope and importance of entomology	**2**
02	Development of Insect (generalized insect), metamorphosis	**2**
03	Taxonomy of insects up to family level	**8**
04	Study of morphological features a. Head and its appendages b. Thorax and its appendages c. Abdomen and its genitalia	**6**
05	Collection, preservation and presentation of insects, rearing of insects	**2**
06	Internal organ systems : Digestive, nervous, circulatory, respiratory and reproductive systems	**6**
07	Sense organs and chemoreception	**4**

Reference Books:

- *The insect structure and function*, 4th Edition (2008).Chapman, R.F. Publisher- Cambridge University Press London.
- *The Principles of Insect Physiology*, 2nd edition (2007) Wigglesworth, V.B. Publisher- English Language Book Society and Methuen and Co. Ltd.
- *Physiological Systems in Insects*, (2008). Klowden, M. J. Publisher- Academic Press, New York.
- Principles of Insect Morphology, (1973). Snodgrass, R.E. Publisher- Tata McGraw Hill, Bombay.
- *The Insects: Structure, Function and Biodiversity*, (2004). Ambrose, D.P. Publisher- Kalyani Publishers, New Delhi.
- *The Science of Entomology*. 2nd edition (1982). Romoser, W. S. Publisher- MacMillan, New York.
- *General and Applied Entomology*. 2nd edition (2004). David, B. V. and Ananthakrishnan, T. N. Publisher- Tata McGraw Hill, New Delhi.
- *Arthropod Phylogeny with special reference to insects*, (1979). Boudreaux, H. B. Publisher- John Willey and Sons New York.

ZY 204T: Genetic Information Flow and Processing (2 Credits: 30 Lectures)

	Topic	LH
01	**Transcription**- Prokaryotic transcription- RNA Polymerase, Transcription unit, Initiation- promoter recognition, Elongation, Termination- rho dependent and rho independent.	**7**
02	**Eukaryotic Transcription**- RNA Polymerases I, II and III, Transcription unit for each polymerase, Transcription factors, Processing of transcripts.	**8**
03	**Regulation of transcription in prokaryotes** – Concept of Operon, Positive and Negative regulation, Regulation by attenuation, Phage strategies to regulate transcription, antitermination	**5**
04	**Translation - Prokaryotic translation** – Genetic code, deciphering genetic code, codon usage, altered code in mitochondria rRNA and ribosome structure, active center of ribosome tRNA – structure of tRNA, modified bases of tRNA, Activation of tRNA 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, Fidelity of translation	**5**
05	**Eukaryotic translation** – Initiation, elongation and termination	**3**
06	**Regulation of translation**	**2**

Reference books:

- *Genes IX*, (2008), Benjamin Lewin, Publishers - Jones and Barlett Inc.
- *Molecular Biology of the Gene*, 5th 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*, 4th edition (2007), Weaver R. Publisher - McGrew Hill Science.
- *Molecular Biology of the Cell*, 4th edition, (2004). Bruce Alberts, Dennis Bray, Julian Lewis, Martin Raff, Keith Roberts, and James D. Watson. Publisher - Garland Publishing.
- *Essential Cell Biology*, 2nd edition (2003). Bruce Alberts, Dennis Bray, Karen Hopkin, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter. Publisher - Garland Publishing

ZY 205 T+P: Tools and Techniques (6 Credits: 3 CT + 3CP:45 L+15 P)

	Theory: (3 C: 45 L) Topic	LH
01	**Fundamentals of optical microscopy**: Introduction to optics scales of 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	**4**
02	**Contrast in Microscopy** : 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	**4**
03	**Fluorescence Microscopy** : Principle of Fluorescence, Fluorescent dyes, Conventional Fluorescence Microscopy and imaging, Confocal imaging, Specialized Fluorescence imaging and applications	**2**
04	**Electron Microscopy and Scanning probe microscopic techniques** : Principles, Transmission Electron microscope, Scanning Electron Microscope, Specialized Electron microscopes (STEM, HVEM, Cryoelectron microscopy etc.), Scanning Tunneling Microscopes, Atomic Force Microscopes, New generation advanced probe microscopes	**3**
05	**Microscopic image documentation**: Photomicrography, Microscopic image acquisition, documentation and analysis techniques, Advanced imaging techniques of Biomedical applications.	**2**
06	**Chromatography**: Principles, Adsorption chromatography Partition chromatography, Ion-exchange chromatography, affinity chromatography, Molecular exclusion chromatography, thin layer chromatography, HPLC, FPLC, selection of chromatographic system.	**6**
07	**Spectrophotometry**: Principles, UV-visible light spectroscopy , Spectroflourimetry, Infrared and Raman spectroscopy, Nuclear magnetic resonance spectroscopy, Applications in biology	**5**
08	**Radioisotopes Technique**: Nature of radioactivity, detection and measurement of radioactivity, counting radioactivity, applications of radioisotopes in biology	**4**
09	**Immunological Techniques**: Immunodiffusion, Immunoelectrophoresis, ELISA, Studying antigen antibody interactions, Immunoflourescence, Flow cytometry	**5**
10	**Electrophoretic Techniques**: General principles, Support media, electrophoresis	**5**

	of proteins and nucleic acids, Capillary electrophoresis.	
11	**Centrifugation:** Basic principles of sedimentation, Types of centrifuges, Analytical Centrifugation, Preparative centrifugation.	**5**
	Practicals : (3 C:15 P X 3 H)	**P**
	Microscopy related Practical	**5**
01	Components of light microscopy, upright & inverted microscopes, episcopic & Diascopic microscopic alignment. Different types of lenses, Numerical apertures	
02	Handling and adjustment of microscopic components, Method of Köhler illumination, Interpupillary & diopter adjustment.	
03	Phase contrast and dark-field microscopy.	
04	Fluorescence microscopy.	
05	Electron microscopy and visit to other institutions.	
06	Microscopic image documentation techniques.	
	Other Techniques related practical	**10**
07	Gel filtration	
08	Ion exchange chromatography	
09	Density gradient centrifugation	
10	Thin layer chromatography	
11	Radioactivity based problems	

Reference books:

- *Principles and Techniques of Biochemistry and Molecular Biology*, 6th edition (2008), Keith Wilson and John Walker, Publisher–Cambridge University Press.
- *Light Microscopy in Biology*: A Practical Approach, 2nd edition (1999), Alan J. Lacey, Publisher–Oxford University Press.
- *Electron Microscopy: Principles and Techniques for Biologists*, (1992), Lonnie D. Russell, Publisher-Jones & Bartlett.

ZY 206 T+P: Histology and Histochemistry (4 Credits: 2 CT + 2CP:30 L+10 P)

	Theory: (2 C: 30 L) Topic	LH
01	**Fundamentals of histology:** Epithelial, connective, muscular, nervous and other specialized tissues.	**10**
02	**Tools in histology:** Principles, design and functioning of microtomes, automated microtomes, ultramicrotome, cryostat, problems and trouble shooting	**4**
03	**Techniques in histology:** 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	**10**
04	**Histochemical principles:** 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.	**10**
05	**Cytochemistry and quantitation:** Cytochemical detection techniques, principles and technique of autoradiography, cytophotometry, microspectrophotometry, and other morphometric methods.	**10**
06	**Histopathology:** Principles, techniques and applications	**6**
	Practicals : (2 C:10 P X 3 H)	**P**
01	Fixation, dehydration, embedding, sectioning, staining, permanent mounting of tissues and histology	**4**
	Microscopic measurements of histological samples using micrometers and planimeters	**1**
02	PAS reaction, Alcian blue reaction, and detection in situ	**2**
03	Alkaline phosphatase detection *in situ*	**1**
04	Feulgen reaction	**1**
05	Sudan black B staining for lipids	**1**
06	Fixation, dehydration, embedding, sectioning, staining, permanent mounting of tissues and histology	**1**
07	Methyl green – Pyronin G method of detection of nucleic acids	**1**
08	Millon's reagent and histochemical detection of basic proteins	**1**

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).* 4th Edition (1991), Stoward, P. J. & Pearse, A. G. E. Publisher – Churchill Livingstone Edinburgh, London.

- *Histological and Histochemical methods: Theory and Practice*. 4th edition (2008), J. A. Kiernan Publisher – Scion Publishing Ltd. Oxford shire.
- *Colour Atlas of Histology*. 3rd edition (2000). L. P. Gartner and J. L. Hiat Publisher – Lippincott- Williams & Wilkins, Baltimore.
- *Histology: A text book and Atlas*. 2nd edition (1989). M. H. Ross, E. J. Reith and L. J. Romrell Publisher - Williams & Wilkins, Baltimore.
- *Bailey's text book of Histology*. 15th 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 (3 Credits: 2 CT + 1CP:30 L+5 P)

	Theory: (2 C: 30 L) Topic	LH
01	**Introduction:**	
	Importance of Statistics in biology, samples and populations, variables in biology, Accuracy and Precision.	**5**
	Collection and Condensation of data, types of biological data and graphical representation of the data (graphs like Histogram/Ogive curve/frequency curve).	
02	**Descriptive Statistics:**	**5**
	Measures of central tendency: Mean, Mode, Median.	
	Concept of variation, Measures of variation such as variance, standard deviation, coefficient of variation.	
03	**Introduction to Probability Distribution:**	**5**
	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	
04	**Regression and correlation analysis, Curve fitting.**	**5**
05	**Hypothesis testing:**	**10**
	Tests of simple hypothesis using normal and t-distribution, Types of errors	
	Tests of significance: Parametric and non-parametric tests	
	T-tests (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	
	Practicals : (1 C:5 P X 3 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.	**15**

Reference Books:

- *Biometry*. 3rd edition (2001). R. R. Sokal and F. J. Rohlf. W. H. Publisher-Freeman and Company.
- *Biostatistical analysis*. 5th edition (2008). J. H. Zar. Publisher-Pearson Education Inc. and Dorling Kindersley Publishing Inc.

- *Statistical methods*. 6th edition (1967). G. W. Snedecor and W. G. Cochran. Publisher-Oxford and IBH Publishing Co.
- *Introductory Statistics for Biology*. 3rd edition (1979) R. E. Parker, Publisher-Edward Arnold Ltd.
- *Statistics and Experimental Design* 2nd edition (1980). G. M. Clarke. Publisher-Edward Arnold Ltd.
- *Elementary Bayesian Biostatistics*. (2008) L. E. Moye. Publisher - Chapman and Hall/CRC, Boca Raton,
- *Statistical Methods in Biology* 3rd edition (1994). N.T. J. Bailey. Publisher-Cambridge University Press
- *Understanding Medical Statistics*. (1983) L. A. Goldstone and William Heinemann. Publisher-Medical Books LTD.
- *Introduction to Biostatistics*. (1973) R. R. Sokal and F. J. Rohlf. Publisher-W. H. Freeman & Company.
- *Statistics: Concepts and Applications.* (1995), H. Frank and S. C. Althoen. Publisher-Cambridge University Press.
- *Biostatistics: A foundation for analysis in Health Sciences.* 5th edition (1991). W. W. Daniel. Publisher-John Wiley & Sons.
- *Introduction to Biostatistics and Research Methods*, 4th ed.(2006) P.S.S. Sundar Rao and J. Richard, Publisher-Prentice Hall of India, New Delhi.

ZY- 202P: Laboratory exercises in Immunology (2Credits: 30H =10P x3H)

	Content	P
01	Generation of Antibodies, Immunization, titration	**2**
02	Antibody detection, Immunoelectrophoresis, Ochterlony technique	**2**
03	Purification of Immunoglobulin G with DEAE Column Chromatography	**1**
04	Western blotting and detection	**2**
05	ELISA	**1**
06	Immunohistochemical detection and localization of specific antigens.	**2**

ZY- 203P: Laboratory exercises in Entomology (2Credits: 30H =10P x3H)

	Content	P
01		
02		
03		
04		
05		
06		

M.Sc. (Zoology) Part II Syllabus

During M. Sc. II (Semesters III and IV), specializations, viz., Molecular Biology, Genetics, Developmental Biology, Animal Physiology and Entomology are offered depending upon the availability of faculty and interest of students.

SEMESTER III

Course Structure: Semester III (General)					
Theory Courses			**Practical Courses**		
Course No.	**Title**	**Credits**	**Course No.**	**Title**	**Credits**
ZY 301T	Endocrinology	2C	ZY 301P	Laboratory Exercises in Endocrinology	2C
ZY 302T	Invertebrate and Vertebrate Embryology	2C	ZY 302P	Laboratory Exercises in Embryology	2C
ZY 303T	Biosystematics, Biodiversity and Evolution	2C	ZY 303P	Field and Laboratory Exercises in Biodiversity and Biosystematics	2C
ZY 304T	Introduction to Recombinant DNA Technology	2C			
		8 C			
ZY 305T*	Regulation of gene expression	2C	ZY 312P	Project	5C
ZY 306T*	Genetic Toxicology	2C	OR		
ZY 307T*	Drosophila Genetics	2C	ZY 310P	Review Writing	2C
ZY 308T*	Economic Zoology	2C	ZY 311P	Exercises in Biodiversity Assessment I	3C
ZY 309T*	Scientific communications	2C			
Total		**4 C**			**11 C**

* Any course/s from the above list equivalent to **4 C** can be offered.

Total Credits: 29. At least courses equivalent to 25 Credits should be taken by the student.

SEMESTER III

Molecular biology Specialization

Course Structure: Semester III (Molecular biology specialization)					
Theory Courses			**Practical Courses**		
Core Courses					
Course No.	**Title**	**Credits**	**Course No.**	**Title**	**Credits**
ZY 304T	Introduction to Recombinant DNA Technology	2C	ZY 313P	Advanced Techniques in Molecular Biology	4C
ZY 303T	Biosystematics, Biodiversity and Evolution	4C	ZY 303P	Field and Laboratory Exercises in Biodiversity and Biosystematics	2C
ZY 305T	Regulation of gene expression	2C	ZY 312P	Project	5C
ZY 306T	Genetic Toxicology	2C			
		10 C			**11 C**
Additional Courses			OR		
ZY 301T*	Endocrinology	2C	ZY 301P*	Laboratory Exercises in Endocrinology	2C
ZY 307T*	Drosophila Genetics	2C			
ZY 309T*	Scientific communications	2C			
Total		**6 C**			**2 C**
* Any course/s from the above list equivalent to **4 C** can be offered.					
Total Credits: 29: At least courses equivalent to 25 Credits should be taken by the student.					

SEMESTER III

Genetics Specialization

Course Structure: Semester III (Genetics specialization)					
Theory Courses			**Practical Courses**		
Core Courses					
Course No.	**Title**	**Credits**	**Course No.**	**Title**	**Credits**
ZY 314T	Advanced Genetics I	2C	ZY 314P	Laboratory Exercises in Advanced Genetics	2C
ZY 307T	Drosophila Genetics	2C	ZY 307P	Laboratory Exercises in Drosophila Genetics	2C
ZY 303T	Biosystematics, Biodiversity and Evolution	2C	ZY 303P	Field and Laboratory Exercises in Biodiversity and Biosystematics	2C
ZY 304T	Introduction to Recombinant DNA Technology	2C	ZY 312P	Project	5C
		10 C			**11 C**
Additional Courses			OR		
ZY 301T*	Endocrinology	2C	ZY 301P*	Laboratory Exercises in Endocrinology	2C
ZY 315T*	Medical Genetics	2C			
ZY 306T*	Genetic Toxicology	2C			
ZY 309T*	Scientific communications	2C			
Total		**8 C**			**2 C**

* Any course/s from the above list equivalent to **4 C** can be offered.

Total Credits: 31: At least courses equivalent to 25 Credits should be taken by the student.

SEMESTER III

Developmental Biology Specialization

Course Structure: Semester III (Developmental Biology specialization)					
Theory Courses			**Practical Courses**		
Core Courses					
Course No.	**Title**	**Credits**	**Course No.**	**Title**	**Credits**
ZY 316T	Developmental Biology I	4C	ZY 316P	Practicals in Developmental Biology	4C
ZY 303T	Biosystematics, Biodiversity and Evolution	4C	ZY 303P	Field and Laboratory Exercises in Biodiversity and Biosystematics	2C
ZY 304T	Introduction to Recombinant DNA Technology	2C	ZY 312P	Project	5C
		10 C			**11 C**
Additional Courses OR					
ZY 301T*	Endocrinology	2C	ZY 301P*	Laboratory Exercises in Endocrinology	2C
ZY 305T*	Regulation of Gene Expression	4C			
ZY 306T*	Genetic Toxicology	2C			
ZY 309T*	Scientific communications	2C			
Total		**8 C**			**2 C**

* Any course/s from the above list equivalent to **2 C** can be offered.

Total Credits: 31: At least courses equivalent to 25 Credits should be taken by the student.

SEMESTER III

Animal Physiology Specialization

Course Structure: Semester III (Developmental Biology specialization)					
Theory Courses			**Practical Courses**		
Core Courses					
Course No.	**Title**	**Credits**	**Course No.**	**Title**	**Credits**
ZY 317T	Animal Physiology I	4C	ZY 317P	Practicals in Animal Physiology	4C
ZY 301T	Endocrinology	2C	ZY 301P	Laboratory Exercises in Endocrinology	2C
ZY 304T	Introduction to Recombinant DNA Technology	2C	ZY 312P	Project	5C
		8 C			**11 C**
Additional Courses OR					
ZY 303T*	Biosystematics, Biodiversity and Evolution	4C	ZY 303P*	Field and Laboratory Exercises in Biodiversity and Biosystematics	2C
ZY 306T*	Genetic Toxicology	2C			
ZY 309T*	Scientific communications	2C			
Total		**8 C**			**2 C**

* Any course/s from the above list equivalent to **6 C** can be offered.

Total Credits: 29: At least courses equivalent to 25 Credits should be taken by the student.

SEMESTER III

Entomology Specialization

Course Structure: Semester III (Developmental Biology specialization)					
Theory Courses			**Practical Courses**		
Core Courses					
Course No.	**Title**	**Credits**	**Course No.**	**Title**	**Credits**
ZY 319T	Entomology I	4C	ZY 319P	Experiments in Entomology	4C
ZY 303T	Biosystematics, Biodiversity and Evolution	4C	ZY 303P	Field and Laboratory Exercises in Biodiversity and Biosystematics	2C
ZY 320T	Applied Entomology	2C	ZY 312P	Project	5C
		10 C			**11 C**
Additional Courses			OR		
ZY 301T*	Endocrinology	2C	ZY 301P*	Laboratory Exercises in Endocrinology	2C
ZY 304T*	Introduction to Recombinant DNA Technology	2C			
ZY 318T*	Insect Biochemistry and Physiology	2C			
ZY 306T*	Genetic Toxicology	2C			
ZY 309T*	Scientific communications	2C			
Total		**10 C**			**2 C**
* Any course/s from the above list equivalent to **4 C** can be offered.					
Total Credits: 33: At least courses equivalent to 25 Credits should be taken by the student.					

ZY 301T: Endocrinology (2 Credits: 30 Lectures)

	Topic	LH
01	Endocrine mechanisms in Crustaceans: X & Y organs, regulation of metabolism, heart, salt and water balance, reproduction, colour change and molting.	**5**
02	Hormones and reproduction in cephalopod molluscs and echinoderms.	**5**
03	Types of chemical messengers, Hormone receptors and mechanisms of hormone action. Hypothalamic hypophysiotropins	**5**
04	Adenohypophysial hormones : ACTH, PRL, STH & TSH	**5**
05	Metabolic functions of thyroid hormones, Regulation of amphibian metamorphosis, Hormonal regulation of carbohydrate, protein and lipid metabolism, Pancreatic hormones, Glucocorticoids.	**5**
06	Osmoregulatory hormones: ADH, mineralocorticoids, renin – angiotensin system. Gastro-intestinal hormones, Phosphate metabolism.	**5**

Reference Books:

- Endocrinology 5th edition (2008) Mac. E. Hadley. Publisher - Pearson Education Inc. and Dorling Kindersley Publishing Inc.
- Comparative Vertebrate Endocrinology. (III edition) P. J. Bentley. Publisher - Cambridge University Press, Cambridge UK. (1998).
- Vertebrate Endocrinology. (III edition) D. O. Norris. Publisher- Academic Press: An imprint of Elsevier, California, USA. (1997).
- Vertebrate Endocrinology: Fundamentals and Biomedical implications (Volume I to III). P. K. T. Pang and M. P. Schreibman Publisher - Academic Press Inc. Orlando Florida (1986).
- An Introduction to General and Comparative endocrinology. E.J.W. Barrington. Publisher - Clarendon Press Oxford (1975) .
- Hand book of Endocrinology (II edition) Volume I & II. G. H. grass and H. M. Kaplan. Publisher - CRC Press, New York. (1996).
- William's text book of Endocrinology. (XI edition) H. M. Kronenberg, S. Melmed, K. S. Polonsky and P. R. Larsen. Publisher - Saunders, Elsevier Inc. (2009).

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

	Topic	LH
01	Developments of gametes, spermiogenesis and capacitation. Ovogenesis and vitellogenesis.	**5**
02	Mechanisms of Fertilization, Acrosome reaction, egg activation.	**5**
03	Patterns of cleavages and blastulation in Drosophila, Sea urchin, frog, chick and mouse Cell adhesion, cell migration and molecular mechanisms.	**5**
04	Fate maps and gastrulation in vertebrate & invertebrate models	**5**
05	Molecular Mechanisms of competence and neural induction in frog and chick embryo.	**5**
06	Metamorphosis; hormonal control during amphibian development. Limb regeneration, positional effect and polarity. Insect metamorphosis; hormonal control	**5**

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 303T: Biosystematics, Biodiversity and Evolution (4 Credits: 60 Lectures)

	Topic	LH
01	Biosphere: Biodiversity: Characterization, generation and maintenance, Biosphere reserves, resources and management, Global diversity hotspots, Effect of manmade alteration of environment on Biospheres.	**5**
02	Biotic community & interrelationships: Zoogeographical relations of species and population, interrelationships amongst organisms including parasitism, symbiosis & commensalism Diversity of adaptation in animals.	**5**
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.	**5**
04	Kingdoms of Life : General outline of kingdoms including Monera & Protista ; Broad outline & Diversity in kingdom Animalia	**5**
05	Methodologies in systematics : Morphology based taxonomy, Numerical taxonomy, Cyto-taxonomy and chemotaxonomy, Molecular systematics, DNS fingerprinting & Molecular markers for detection/evaluation of polymorphism, RFLP, RAPD etc.	**5**
06	Conservation: Objective of Conservation, strategies of conservation, Global programmes and concept of endangered species, Modern tools and techniques to assess biodiversity.	**5**
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	**6**
08	Exploitation of resources: decision making, prey-predator relationship, Communication and animal signals: communication, Evolution of animal signals,	**4**
09	Reproductive strategies and Parental care: Sexual selection, Mating systems, Parental care	**3**
	Social organization : Altruistic behavior and concept of inclusive fitness, Evolution of helpful behavior, Evolution of Eusocial behavior	**2**

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.	**5**
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.	**5**
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.	**5**

Reference Books:

- This is Biology: The Science of Living world, Mayr, M. (1997), Universities Press Ltd.
- Evolution, 3rd 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, 7th edition, Benjamin Cummings Publ. [8th 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)

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

Reference Books:

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

ZY305T: Regulation of Gene Expression (2 Credits: 30 Lectures)

	Topic	LH
01	Activating transcription: Transcription activating factors, Different domains in transcription factors, Mechanism of transcription activation, response elements recognized by activators.	**5**
02	RNA processing Splicing: Nuclear pre-mRNA splicing - spliceosomes, alternative splicing, trans splicing 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	**10**
03	Chromatin remodeling: alternative states of chromatin, mechanisms of modification	**2**
04	Epigenetic effect: hetrocromatin and euchromatin, inactive and active chromatin, mechanisms of x chromosome inactivation, genome imprinting, importance of imprinting	**5**
05	Translational regulation 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.	**8**

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

ZY 306T: Genetic Toxicology (2 Credits: 30 Lectures)

	Topic	LH
01	Definition scope and significance	**2**
02	Mutations at molecular, functional and chromosomal levels. Mechanisms of mutagenesis, biological significance.	**5**
03	DNA damage and DNA repair, different repair systems in prokaryotes and eukaryotes, Methods for assaying repair efficiency of the cell.	**5**
04	Mutagenic agents in human environment. Applications of genetic toxicology to human and environmental monitoring.	**5**
05	Screening chemicals for genotoxic properties: Screening tests, hazard assessment, Risk analysis anlysis tests. Common assays used t for testing mutagenic activity using bacteria, yeasts, insects, plants, animals.	**8**
06	Genetic toxicology and its role in the study of congenital malformations.	**2**
07	Mutagenesis and carcinogenesis, antimutagenesis.	**3**

Reference Books:

- Principles of Genetic toxicology, 2nd edition (1987), David Brusick, Publisher-Plenum press.

ZY 314T: Advanced Genetics-I (2 Credits: 30 Lectures)

	Topic	LH
01	Advanced Population Genetics : Recapitulation of basic concepts and H-W law, estimation of gene frequencies in population through mutation, migration and selection, Selection – Mutation equilibrium and quantitation	**5**
02	Advanced quantitative genetics : A. Concept of continuous variation, phenotypic variance and its partitioning into subcomponents, co-variance, correlation and regression, degree of genetic determination, measurement of heritability, quantitative inheritance in humans. B. Mapping of quantitative trait loci, LOD score analysis	**10**
03	Advanced evolutionary genetics : A. Genetic polymorphism and selection strategies and effects, genetic drift, genetics of speciation: classical and modern concepts, neutral mutations, use of molecular information in evolutionary genetics. B. Artificial selection and its role in animal breeding, assortative mating, phenotypic variances in inbred lines, co-efficient of relationship and coefficient of inbreeding.	**10**
04	Molecular approach in genetic analysis: Recapitulation of Genome organizations, application of molecular methologies in genetic analysis, gene-based therapeutic approaches.	**5**

Reference Books:

ZY 318T: Insect Biochemistry and Physiology (2 Credits: 30 Lectures)

	Topic	LH
01	Integument – structure, chemistry, sclerotization, regulation, Function.	**3**
	Insecticide detoxification – Microsomal and extra-microsomal enzymes, Role in insecticide degradation.	**2**
02	Fat body – structure and function	**3**
	Hemolymph – chemical composition and function	**2**
03	Digestion and absorption, adaptation to special diet.	**3**
	Bioluminescence	**2**
04	Muscle – structure and physiology, biochemistry of flight muscle.	**5**
05	Endocrine systems – Neurosecretion, chemistry function and Mechanism of hormone action.	**5**
06	Excretion and water balance – structure and function of Microtubules, Water balance and nitrogen excretion.	**3**
	Ventilatory mechanisms and their control.	**2**

Reference Books:

- *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 319T: Entomology I (4 Credits: 60 Lectures)

	Topic	LH
01	Short history of Entomology. Origin, adaptive radiation & evolution of insects; evolution of modern orders; continuing evolution & diversification. Evolutionary interrelationships of insects. Principles & history of insect classification. Classification of orders unto families.	**15**
02	Integumentary system: Integument, its structure & derivatives. Comparative morphology of head, thorax & abdomen, their appendages & modifications. Exocrine glands.	**15**
03	Maintenance Systems: Comparative anatomy of alimentary, circulatory, respiratory, excretory & reproductive system. Fat body.	**15**
04	Control System: Comparative study of muscular, nervous & endocrine system, Sense organs, photogenic organs. Sonification.	**15**

Reference Books:

- Boudreau, (1979): "Arthropod Phylogeny with Special Reference to Insects". John Wiley & Sons, New York.
- Chapman, R.F. (1982): "The Insects: Structure & Function". Edn. 3. ELBS & English Universities Press. London.
- Daly, H.V., J. T. Doyen & P. R. Ehrlich (1981): "Introduction to Insect Biology & Diversity". International Student Edn. McGraw-Hill, Kogakusha, Japan.
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- Henning, W. (1981): "Insect Physiology". Wiley – Inrerscience Publ., John Wiley & Sons, Chichester, England.
- Kapoor, V.C. (1981): "Origine & Evolution of Insects". Kalyani Publication. Ludhiana.
- Kerkut, G.A. & L.I. Gilbert (Eds) (1984): "Comparative Insect Physiology, Biochemistry & Pharmacology". Vols. I- XIII. Pergamon, New York.
- Nayar, K..K., T.N. Ananthakrishnan & B.V. David (1976): General & Applied Entomology". Tata McGraw-Hill, New Delhi.
- Richards, O.W. & R.G. Davies (1977): "Imms" Text book of Entomology". Vols. I & II. Menthuen. London.
- Romoser, W.S. (1982): "The Science of Entomology". Edn. 2. Macmillan, New York.
- Snodgrass, R.E. (1973): "Principles of Insect Morphology". Tata McGraw-Hill, Bombay.

ZY 320T: Applied Entomology (2 Credits: 30 Lectures)

	Topic	LH
01	Fundamentals of Agricultural, Forest, Medical and Veterinary Entomology.	**2**
	General biology of important pests cultivated in Maharashtra and in India	**3**
02	Measures to control the vectors of medical, veterinary importance	**2**
	Household and stored grain pests and their control.	**3**
03	Principles of Mechanical, Biological and chemical control.	**4**
	Useful insects of economic importance.	**1**
04	Uses of sex attractants, Pheromones and hormones in insect control.	**5**
05	**Introduction of Lac culture**.	
	Life cycle of the lac insects; Lac cultivation, Composition & uses of Lac.	**4**
06	**Introduction to sericulture**.	
	Life cycle of the silk moth, cultivation, composition and uses of silk.	**3**
07	**Introduction to Apiculture**.	
	Types of honey bees, social organization, Life history of honey-bee, Bee keeping, economic importance of honey bee.	**3**

Reference Books:

- Boudreau, (1979): "Arthropod Phylogeny with Special Reference to Insects". John Wiley & Sons, New York.
- Applied Entomology, 2nd edition, P G Fenemore, Alka Prakash, Publisher: New Age International.
- General and Applied Entomology, 2nd edition, B. V. David and T. N. Ananthkrishnan (2006), Publisher: Tata McGraw Hill
- Text Book of Applied Entomology, K. P. Shrivastava (1996), Publisher: Kalyani Publishers Introduction to General and Applied Entomology, 2nd edition, V. B. Awasthi
- (2007), Publisher: Scietific Publishers India Jodhapur.
- Insect pests of crops, S. Pradhan (1969), Publisher: National Book Trust of India, New Delhi The Insects: Structure and Function, R. F. Chapman, Publsiher: Cambridge University Press.
- Biological control by natural enemies, Bebach P. and David R. (1991), Publisher: Cambridge University Press.

ZY 301P: Practicals in Endocrinology (2Credits: 30H =10P x3H)

	Content	P
01	Internal anatomy and histology of mammalian endocrine organs	**1**
02	Immunohistochemical localization of neurosecretory cells in the rat/mouse/chick/frog.	**1**
03	Histochemical localization of 3ß-HSD in the adrenal and gonads.	**1**
04	Effect of gonadectomy on the sex accessory structures and HPG axis	**2**
05	Effect of exogenous testosterone on sex accessory structure and Hypothalamo-Hypophysial-Gonadal axis.	**2**
06	Induction of diabetes and the role of insulin in glucose metabolism.	**2**
07	Dissection and display of Retrocerebral complex and immunohistochemical localization of neurosecretory cells in cockroach	**2**
08	Staging of fish chromatophores and effect of epinephrine (in-vivo and in-vitro) and acetyl choline (in-vitro) esterase	**1**
09	Effect of Thyroxin in amphibian metamorphosis	**1**

ZY 303P: Biosystematics, Biodiversity and Evolution (2Credits: 30H)

	Content	H
01	Study of soil fauna: sampling, extraction / collection, preservation and analysis.	**2**
02	Collection, identification and preservation of various insect orders and arthropod groups (including study of permanent specimens).	**5**
03	Study of Freshwater planktons, collection, sorting, identification of samples of zooplanktons: protozoans, rotifers, crustaceans. (including study of permanent specimens)	**4**
04	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.	**3**
05	Study of biotic component of a pond ecosystem and grouping on the basis of their trophic position.	**2**
06	Study of water quality and dissolved oxygen content in water samples of an ecosystem.	**2**
07	Museum preservation techniques of selected vertebrates and invertebrates.	**3**
08	Laboratory and field exercises of animal behaviors; Learning, Recognition, Feeding	**6**
09	Visit to ZSI Pune and other places.	**3**

ZY 313 P: Advanced techniques in Molecular Biology (4Credits: 60H=12P x 5H)

	Content	P
01	Isolation and purification of nuclei, mitochondria from mouse liver.	**2**
02	Analysis of chromatin a) Microccocal nuclease digestion and DNA gel electrophoresis b) Determination of mononucleosomal size c) Chromatin gel electrophoresis d) Two dimensional electrophoresis	**4**
03	Extraction and estimation of nuclear DNA	**1**
04	Extraction and estimation of mitochondrial DNA and mapping by restriction endonuclease digestion	**2**
05	Isolation, purification and electrophoresis of RNA	**2**
06	Isolation of mRNA by oligodT cellulose column chromatography	**1**
07	DNA amplification by PCR	**1**
08	Checking for gene expression by RT-PCR	**1**
09	Western hybridization	**2**
10	In situ hybridization	**2**
11	Use of nucleic acid database	**1**