

**DEPARTMENT OF ZOOLOGY**

**UNIVERSITY OF PUNE**

**PUNE 411007**



**Syllabus**

**For  
Credit/Semester Based**

**M. Sc. (Zoology)**

**w.e.f. 1<sup>st</sup> July 2013**

## M.Sc. (Zoology) Part I Syllabus

### SEMESTER I

Course No.	Course Title	Credit
ZY 101 T	Biochemistry	2C
ZY 102 T	Cell Biology	2C
ZY 103 T	Fundamentals of Molecular Biology	2C
ZY 104 T	Developmental Biology	2C
ZY 105 T	General Genetics	2C
ZY 106 T	Animal Physiology	2C
ZY 107 T	Basic Entomology	2C
ZY 101 P	Laboratory Exercises in Biochemistry	2C
ZY 102 P	Laboratory Exercises in Cell Biology	2C
ZY 103 P	Laboratory Exercises in Molecular Biology	2C
ZY 104 P	Laboratory Exercises in Developmental Biology	2C
ZY 105 P	Laboratory Exercises in Genetics	2C
ZY 106 P	Laboratory Exercises in Animal Physiology	2C
ZY 107 P	Laboratory Exercises in Entomology	2C
<b>Total</b>		<b>28C</b>

## M.Sc. (Zoology) Part I Syllabus

### SEMESTER II

<b>Course No.</b>	<b>Course Title</b>	<b>Credit</b>
ZY 201 T	Metabolic Pathways	2C
ZY 202 T	Fundamentals of Immunology	2C
ZY 203 T	Skills in Scientific communication	2C
ZY 204 T	Genetic Information Flow and Processing	2C
ZY 205 T + P	Tools and Techniques in Biology	6C
ZY 206 T + P	Histology and Histochemistry	4C
ZY 207 T + P	Quantitative Biology	4C
ZY 208 T	Applied Entomology	2C
ZY 202 P	Laboratory Exercises in Immunology	2C
ZY 208 P	Laboratory Exercises in Applied Entomology	2C
<b>Total</b>		<b>28C</b>

## M.Sc. (Zoology) Part II Syllabus

### SEMESTER III

Course No.	Course Title	Credit
ZY 301 T	Endocrinology	2C
ZY 302 T	Invertebrate and Vertebrate Embryology	2C
ZY 303 T	Biosystematics, Biodiversity and Evolution	4C
ZY 304 T	Introduction to Recombinant DNA Technology	2C
ZY 318T	Insect Biochemistry and Physiology	2C
ZY 301 P	Laboratory Exercises in Endocrinology	2C
ZY 302 P	Laboratory Exercises in Embryology	2C
ZY 303 P	Field and laboratory exercises in Biodiversity and Biosystematics	4C

#### Elective Courses

ZY 305 T	Regulation of Gene Expression (2C)	2C
ZY 313 P	Advanced Techniques in Molecular Biology (3C)	3C
ZY 314 T+P	Advanced Genetics (2C T + 3C P)	5C
ZY 317 T+P	Entomology I (2C T + 3C P)	5C
<b>Total</b>		<b>36 C</b>

## M.Sc. (Zoology) Part II Syllabus

### SEMESTER IV

Course No.	Course Title	Credit
ZY 401 T	Drosophila Genetics	1C
ZY 402 T	Physiology of Mammalian Reproduction	2C
ZY 403 T	Parasitology	2C
ZY 404 T	Developmental Genetics	1C
ZY 409 T	Seminars	2C
ZY 411 P	Project	10C

### Elective Courses

ZY 405 T + P	Bioinformatics	4C
ZY 407 T	Genomics and Proteomics	2C
ZY 408 T	Entomology II	2C
ZY 410 T	Review Writing	2C
<b>Total</b>		<b>28 C</b>

## GENERAL INSTRUCTIONS

- Among the 100 credits which candidate needs to complete and clear for M.Sc. in Zoology at least 75 credits must be taken from courses identified in the syllabus structure of the Department of Zoology, University of Pune, where he/she is registered for M.Sc. course. Remaining 25 credits can be taken from any other Department on the Campus. Candidate should inform about this in the beginning of the semester in writing to the Head of the Department.
- One credit of theory course is 15 clock hours of classroom teaching and one credit for practical course is 15 clock hours of laboratory exercises.
- Each course will be evaluated for 25 marks per credit of which 50 % will be based on continuous / internal evaluation.

No. of Credits	Continuous/Internal Assessment Marks	Semester End Assessment Marks	Total
1	12	13	25
2	25	25	50
3	37	38	75
4	50	50	100
5	62	63	125
6	75	75	150

- Theory courses are indicated by letter T followed by the number of the course while Practical courses are indicated by letter P. Theory and Practical courses together are indicated by T+P.
- Project is Voluntary.
- Allotment of the students for the project will be made based on the merit list and the option for the supervisor given by the candidate.
- In case project is not opted for, the candidate will have to take alternative course/s of equivalent credits offered by the Department or from any other Department on the University Campus.
- For the course “Review writing” candidate will have to make 30 minutes presentation at the end of the term which will be evaluated by the subject experts in the field.

- Results at the end of the semester will be declared using a grade point system.
- The formula for GPA will be based on weighted average. The final GPA will not be printed unless a student passed courses equivalent to minimum 100 credit hours. Total credit hours means sum of credit hours of the courses which a student has passed.
- A seven point grade system (guided by the Government of Maharashtra Resolution No. UGC-1298/[4619]/UNI. 4 dt December 11, 1999 and the University regulations) will be followed.

**Explanation of Grades and Grade Point Average (GPA)**

Marks Obtained	Grade	Grade Points
100-75	O Outstanding	06
74-65	A Very Good	05
64-55	B Good	04
54-50	C Average	03
49-45	D Satisfactory	02
44-40	E Pass	01
39 and less	F Fail	00

**Final Grade Points**

Grade Points	Final Grade
05.00-6.00	O
04.50-4.99	A
03.50-4.49	B
02.50-3.49	C
01.50-2.49	D
00.50-1.49	E
00.00-0.49	F

**Common formula for GPA:**

$$\text{GPA (Grade Point Average)} = \frac{\text{Total of (Grade Points Earned X Credit hours for each course)}}{\text{(Total Credit Hours)}}$$

- A seven point grade system (guided by the Government of Maharashtra Resolution No. UGC-1298/[4619]/UNI. 4 dt December 11, 1999 and the University regulations) will be followed. 'B' Grade is equivalent to at least 55% of the marks as per GR No. UGC1298/[4619]/UNI. 4 dt December 11, 1999. If the GPA is higher than the indicated upper limit in the third decimal digit, then the student be awarded higher final grade. E.g. a student getting GPA of 4.492 may be awarded 'A'.
- There will be only final compilation and moderation at CGPA (Final) level done at the Department. While declaring the result, the existing relevant ordinances are applicable.

- There is also a provision for verification and revaluation. In case of verification the existing rules will be applicable. The revaluation result will be adopted if there is a change of at least 10% marks and in the grade of the course.
- For grade improvement minimum 30 credit courses should be taken by the student. These courses will be from the parent Department.



## M.Sc. (Zoology) Part I Syllabus

### SEMESTER I

Course No.	Course Title	Credit
ZY 101 T	Biochemistry	2C
ZY 102 T	Cell Biology	2C
ZY 103 T	Fundamentals of Molecular Biology	2C
ZY 104 T	Developmental Biology	2C
ZY 105 T	General Genetics	2C
ZY 106 T	Animal Physiology	2C
ZY 107 T	Basic Entomology	2C
ZY 101 P	Laboratory Exercises in Biochemistry	2C
ZY 102 P	Laboratory Exercises in Cell Biology	2C
ZY 103 P	Laboratory Exercises in Molecular Biology	2C
ZY 104 P	Laboratory Exercises in Developmental Biology	2C
ZY 105 P	Laboratory Exercises in Genetics	2C
ZY 106 P	Laboratory Exercises in Animal Physiology	2C
ZY 107 P	Laboratory Exercises in Entomology	2C
<b>Total</b>		<b>28C</b>

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

<b>01 Biomolecules: characteristic features:</b>	<b>7L</b>
Water, structure of liquid water, water as ideal biological solvent. Problems and concepts related to mole, molarity, normality, buffers etc. Thermodynamics – Laws of thermodynamics, free energy, entropy, high energy bonds.	
<b>02 Amino acids, peptides and polypeptides:</b>	<b>6L</b>
The three dimensional structures of proteins, the Ramchandran plot, $\alpha$ helix, $\beta$ sheet. Structure of collagen, domain – basic unit of tertiary structure, quaternary structure, Functional diversity of proteins.	
<b>03 Carbohydrates:</b>	<b>3L</b>
Monosaccharides, disaccharides and polysaccharides, structure and function.	
<b>04 Lipids:</b>	<b>3L</b>
Chemistry of triglycerides, sterols, quinones and prostaglandins.	
<b>05 Nucleotides:</b>	<b>4L</b>
Structure, function, properties and types of Nucleic acid. The RNA world.	
<b>06 Enzymology:</b>	<b>7L</b>
Classification, Units, Specific Activity, Coenzymes. Kinetics of enzyme catalyzed reactions, Effect of pH, Inhibitor, Activator. Regulation of enzyme activities. Isoenzyme: structure and function	

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### Reference Books:

- *Biochemistry*, 3<sup>rd</sup> Ed. (2005), Voet Donald and Voet Judith G. John, Publisher: Wiley & sons, New York.
- *Biochemistry* 6<sup>th</sup> Ed, (2007) Berg Jeremy, Tymoczko John, Stryer Lubert, Publisher: W. H. Freeman, New York.
- *Lehninger's Principles of Biochemistry*, 4<sup>th</sup> edition, (2005) Nelson D. L. and Cox M. M. W. H. Freeman & Co. NY.
- *Biochemical Calculations*, 2<sup>nd</sup> 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 102 T: Cell Biology (2 Credits: 30 Lectures)

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

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### 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.

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

<b>01</b>	<b>Genome organization:</b> 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	<b>12L</b>
<b>02</b>	<b>DNA Replication:</b> DNA replication in <i>E. coli</i> , Origin of replication, types of <i>E. coli</i> 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	<b>8L</b>
<b>03</b>	<b>DNA damage and repair:</b> 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	<b>4L</b>
<b>04</b>	<b>Recombination:</b> 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	<b>3L</b>
<b>05</b>	<b>Mobile DNA elements:</b> 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	<b>3L</b>

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### 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: Garland Publishing.
- *Essential Cell Biology*, 2<sup>nd</sup> 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 104 T: Introduction to Developmental Biology (2 Credits: 30 L)**

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

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

<b>01</b>	<b>Review of Mendelian &amp; Non-Mendelian Inheritance:</b> Mono / dihybrid inheritance, types of dominance, multiple allelism, Pleiotropy, epistasis, inheritance related to sex, probability and exercises for solving genetics problems.	<b>5L</b>
<b>02</b>	<b>Quantitative Genetics:</b> Polygenic traits and mode of inheritance, analysis of variation: genetic and environmental factors, Heritability, Inbreeding and consequences, Co-efficient of inbreeding and consanguinity.	<b>4L</b>
<b>03</b>	<b>Linkage and mapping in eukaryotes:</b> Detection of linkages, construction of linkage maps in diploids and their characteristics, Co-efficient of Coincidence, Outline of other mapping techniques	<b>4L</b>
<b>04</b>	<b>Cytogenetics:</b> Variation in chromosomal structure and number and genetic consequences	<b>2L</b>
<b>05</b>	<b>Cytoplasmic inheritance:</b>	<b>2L</b>
<b>06</b>	<b>Microbial Genetics:</b> 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	<b>8L</b>
<b>07</b>	<b>Population Genetics:</b> Basic concepts, terminologies, Hardy-Weinberg principles and applications, Changes in allelic frequencies, Exercises for solving population genetics problems.	<b>5L</b>

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### Reference Books:

- *Concepts of Genetics*, 9<sup>th</sup> edition (2008), William S. Klug, Michael R. Cummings, Charlotte Spencer, and Michael A. Palladino, Publisher-Benjamin Cummings
- *Genes IX*, 9<sup>th</sup> edition (2008), Benjamin Lewin, Publisher-Jones and Bartlett Publishers Inc.
- *Principles of Genetics*, 4<sup>th</sup> 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*, 8<sup>th</sup> 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*, 3<sup>rd</sup> edition, Monroe W. Strickberger, (1968), Publisher - Macmillan Publishing Co.

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

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

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### 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.



## ZY 107 T: Basic Entomology (2 Credits: 30 Lectures)

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

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### Reference Books:

- *The insect structure and function*, 4<sup>th</sup> Edition (2008). Chapman, R.F. Publisher- Cambridge University Press London.
- *The Principles of Insect Physiology*, 2<sup>nd</sup> 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*. 2<sup>nd</sup> edition (2004). David, B. V. and Ananthkrishnan, 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 101 P: Laboratory Exercises in Biochemistry**  
**(2 Credits: 30H = 10P x3 hr)**

- 1 Basic and standardization Methods. (3P)**
  1. Preparation of Acid & Alkali solutions and acid-base titration.
  2. Concept of pH. Measuring pH of different solutions
  3. Preparation of buffers: Acetate, Phosphate and Tris buffers
  
- 2 Estimation of micromolecules. (4P)**
  4. Estimation of inorganic phosphate
  5. Estimation of sugar (glucose)
  6. Estimation of Amino acid (Tyrosine)
  7. Estimation of Base (Guanine)
  
- 3 Estimation of macromolecules. (3P)**
  8. Determination of Blue Value of Starch
  9. Estimation of Proteins
  10. Estimation of nucleic acids (DNA)
  
- 4 Separation of micromolecules by paper chromatography. (3P)**
  11. Sugars
  12. Amino acids
  13. Nitrogenous Bases
  
- 5 Enzyme kinetics. (3P)**
  14. Determination of Units and specific activity of an enzyme
  15. Determination of  $K_m$  and  $V_{max}$  of an enzyme

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**\* From above 15 practicals, any 10 practicals (equivalent to 30H) will be taken.**

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**ZY 102 P: Laboratory Exercises in Cell Biology**  
**(2Credits: 30H = 10P x 3H)**

- 1** Subcellular fractionation: nuclei, mitochondria Cytosol & assaying functional identification of mitochondria. **(2P)**
  - 2** Mitosis: Effect of colchicine on mitosis and polyploidy. **(1P)**
  - 3** Meiosis I and II. **(1P)**
  - 4** Preparation of blood smears: Cell type identification and differential counts. **(1P)**
  - 5** Study of Phagocytosis / pinocytosis. **(1P)**
  - 6** EM – interpretation of cellular ultra structure. **(1P)**
  - 7** To study lipid solubility of membrane. **(1P)**
  - 8** Determination of Absorption spectrum of hemoglobin (Hb) in  $\text{Fe}^{2+}$  and  $\text{Fe}^{3+}$  state. **(1P)**
  - 9** Determination of Percent Hemolysis and the Osmotic Fragility of Erythrocytes. **(1P)**
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**ZY 103 P: Laboratory Exercises in Molecular Biology  
(2 Credits: 30 H )**

- 01** Spectrophotometric analysis of nucleotides and amino acids. **(2P)**
- 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 x 5 H=10 H)**
  - a) SDS-Polyacrylamide gel electrophoresis.
  - b) Native Polyacrylamide gel electrophoresis.

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**\* From above 15 practicals, any 10 practicals (equivalent to 30H) will be taken.**

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**ZY 104 P: Laboratory Exercises in Developmental Biology**  
**(2 Credits : 30 H)**

- 01** Patterns of cleavages in starfish. *Amphioxus*, *Onepidula*, insects (slides) **(1P)**
  - 02** Study of embryonic and post-embryonic development using frog egg as a model system. **(3P)**
  - 03** Mounting of chick embryos and preparation of permanent mounts. **(2P)**
  - 04** Gross anatomy and histology of chick embryos till 96 h. **(2P)**
  - 05** Experiments in regeneration in Hydra or Planaria. **(1P)**
  - 06** Study of cell death during limb morphogenesis in chick embryo. **(1P)**
  - 07** Filter paper ring method for *in vitro* culturing of chick Embryo. **(1P)**
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## **ZY 105 P: Laboratory Exercises in Genetics (2 Credits: 10P x 3 H)**

- 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 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. **(3P)**
  - 03** (a) Study of sex-linked gene inheritance (F1 and F2 generations) using white or yellow mutant flies. **(2P)**  
(b) Setting up reciprocal crosses
  - 04** Estimation of gene frequencies in human population and analysis of heterozygote frequencies. **(1P)**
  - 05** Analysis of quantitative traits. **(1P)**
  - 06** Partitioning of variance in genetic and non-genetic components. **(1P)**
  - 07** Preparation of analysis of human pedigree (including traits concerning penetrance, pleiotropy and cases of mutation and consanguinity). **(1P)**
  - 08** Cytogenetic studies using Polytene chromosomes. **(1P)**
  - 09** Cytogenetic studies and preparation of metaphase chromosome spreads using mouse bone marrow. **(1P)**
  - 10** Study and characterization of normal and abnormal karyotypes from human subjects. **(1P)**
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**ZY 106 P: Laboratory exercises in Animal Physiology**  
**(2 Credits: 10P x 3H)**

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

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**\* From above 13 practicals, any 10 practicals (equivalent to 30H) will be taken.**

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## **M.Sc. (Zoology) Part I Syllabus**

### **SEMESTER II**

<b>Course No.</b>	<b>Course Title</b>	<b>Credit</b>
ZY 201 T	Metabolic Pathways	2C
ZY 202 T	Fundamentals of Immunology	2C
ZY 203 T	Skills in Scientific communication	2C
ZY 204 T	Genetic Information Flow and Processing	2C
ZY 205 T + P	Tools and Techniques in Biology	6C
ZY 206 T + P	Histology and Histochemistry	4C
ZY 207 T + P	Quantitative Biology	4C
ZY 208 T	Applied Entomology	2C
ZY 202 P	Laboratory Exercises in Immunology	2C
ZY 208 P	Laboratory Exercises in Applied Entomology	2C
<b>Total</b>		<b>28C</b>



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

<b>01</b>	<b>i. Basic concepts of Metabolism:</b>	<b>3L</b>
	Concept of catabolism and anabolism: metabolic strategies, organization, clustering of enzymes. Experimental approaches to study metabolism.	
	<b>ii. Regulation of Metabolic Pathways:</b> energy charge, phosphorylation potential etc.	
<b>02</b>	<b>i. Carbohydrate metabolism :</b>	<b>5L</b>
	Glycolysis, glycogenolysis, gluconeogenesis, pentose phosphate pathway, glucuronic acid pathway (emphasis on regulation)	
	<b>ii The Citric acid cycle:</b>	<b>3L</b>
	Cyclic overview and reactions. Metabolic sources of acetyl CoA. Regulation and amphibolic nature of the cycle. Glyoxylate cycle.	
	<b>iii Dark reactions of Photosynthesis:</b> CO <sub>2</sub> fixation: C <sub>3</sub> , C <sub>4</sub> and CAM pathways.	<b>2L</b>
<b>03</b>	<b>i. Lipid Metabolism :</b>	<b>6L</b>
	β oxidation of unsaturated and saturated fatty acid and its regulation. Propionyl 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.	
	<b>ii. Metabolism of cholesterol :</b> Biosynthesis of cholesterol and its regulation, lipoprotein metabolism, chylomicrons, LDL, HDL, VLDHL.	<b>4L</b>
<b>04</b>	<b>Amino acid metabolism :</b>	<b>5L</b>
	Transamination, deamination, Fate of amino acid skeleton, urea cycle, precursors for compounds other than proteins, Genetic diseases.	
<b>05</b>	<b>Nucleotide Metabolism :</b>	<b>5L</b>
	Salvage and <i>de novo</i> pathways of purine and pyrimidine nucleotide biosynthesis. Formation of deoxyribonucleotides, origin of thymine.	

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### Reference Books:

- *Biochemistry*, 3<sup>rd</sup> Ed. (2005), Voet Donald and Voet Judith G. John, Publisher: Wiley & sons, New York.
- *Biochemistry* 6<sup>th</sup> Ed, (2007) Berg Jeremy, Tymoczko John, Stryer Lubert, Publisher: W. H. Freeman, New York.
- *Lehninger's Principles of Biochemistry*, 4<sup>th</sup> 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, CA and London.
- *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)**

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

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**Reference Books:**

- *Kuby Immunology*, 6<sup>th</sup> 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*, 6<sup>th</sup> 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*, 6<sup>th</sup> Edition (2008) Abul K. Abbas, Andrew H. Lichtman, and Shiv Pillai, Publisher: Elsevier, USA.
- *Prescott, Harley, Klein's Microbiology* 7<sup>th</sup> edition (2009), Joanne M Willey, Christopher J Woolverton, Linda M Sherwood, Publisher: McGraw-Hill.

## **ZY 203 T: Skills in Scientific Communication (2 Credits = 30 Lectures)**

*Note: This is a 30 Lectures, 2 Credits Course, Topic nos. 1-6 are to be taught by a teacher of English and Topic nos. 7-16 by a Biology teacher.*

<b>01</b>	Making oral presentations: Pronunciation, accent, intonation, clarity, speed, fluency, eye contact; Planning and organization.	<b>4L</b>
<b>02</b>	Enrichment of vocabulary: Word forms and derivations, prefixes and suffixes, other processes of word formation. Scientific and technical vocabulary, spellings; Frequently confused words.	<b>3L</b>
<b>03</b>	Basic grammar: Tenses; Voices; Propositions and conjunctions; Conditional sentences; Count and non-count nouns; Concord; Punctuations.	<b>4L</b>
<b>04</b>	Effective written presentation: Order of sentences in a paragraph; Sentence connection, cohesion and coherence; Contradiction, tautology, semantic anomaly, circumlocution	<b>2L</b>
<b>05</b>	Using the dictionary and the thesaurus.	<b>1L</b>
<b>06</b>	The curriculum vitae.	<b>1L</b>
<b>07</b>	Scientific method: Concept, hypothesis, theory, law; Design of experiment; Inductive and deductive reasoning.	<b>2L</b>
<b>08</b>	Types of presentation: Oral, poster, written, audio-visual. Aids for presentation	<b>1L</b>
<b>09</b>	Preparing the manuscript. Guidelines for authors. The IMRAD format.	<b>1L</b>
<b>10</b>	Title, byline; Abstract and Summary; Keywords.	<b>1L</b>
<b>11</b>	Introduction: Defining the problem; Literature survey; Justification of study.	<b>1L</b>
<b>12</b>	Materials and Methods: Contents, sources, procedures, techniques, reproducibility, Units of measurements, metric system and SI units. Basic statistical techniques, confidence limits, tests, probability, significance.	<b>2L</b>
<b>13</b>	Results: Text; How to present data; Tables and illustrations. Writing captions, labels and legends.	<b>2L</b>
<b>14</b>	Discussion: Components and sequence. Analysis, comparison and integration of data. Likely sources of errors in Results; Conclusions and significance.	<b>2L</b>

Implications for further study.

- 15** Acknowledgements. Literature citation systems. Sources of references: Journals, books, bibliographies, abstracting journals; Databases. **2L**
- 16** Preparing and submitting the manuscript. Revising, editing, proofreading. **2L**
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**Reference Books:**

- Day D.A., Sakaduski N, Day N. (2011) *Scientific English: A guide for scientists and other professionals*. ABC-CLIO Publ.
- Day R.A. & Gastel B 6<sup>th</sup> Edition (2006) *How to write & publish a scientific paper*, Cambridge University Press.
- Alley M (1996) *The craft of scientific writing*. Springer Publ.
- Day R.A. (1988) ) *How to write & publish a scientific paper*, Cambridge University Press.

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

<b>01</b>	<b>Transcription-</b> Prokaryotic transcription- RNA Polymerase, Transcription unit, Initiation- promoter recognition, Elongation, Termination- rho dependent and rho independent.	<b>7L</b>
<b>02</b>	<b>Eukaryotic Transcription-</b> RNA Polymerases I, II and III, Transcription unit for each polymerase, Transcription factors, Processing of transcripts.	<b>8L</b>
<b>03</b>	<b>Regulation of transcription in prokaryotes</b> – Concept of Operon, Positive and Negative regulation, Regulation by attenuation, Phage strategies to regulate transcription, antitermination	<b>5L</b>
<b>04</b>	<b>Translation</b> - 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	<b>5L</b>
<b>05</b>	<b>Eukaryotic translation</b> – Initiation, elongation and termination	<b>3L</b>
<b>06</b>	<b>Regulation of translation</b>	<b>2L</b>

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**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 205 T+P: Tools and Techniques in Biology (6C: 3CT + 3CP)

**Theory: (3 C: 45 Lectures)**

- 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 **4L**
- 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 **4L**
- 03 Fluorescence Microscopy :** Principle of Fluorescence, Fluorescent dyes, Conventional Fluorescence Microscopy and imaging, Confocal imaging, Specialized Fluorescence imaging and applications **2L**
- 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 **3L**
- 05 Microscopic image documentation:** Photomicrography, Microscopic image acquisition, documentation and analysis techniques, Advanced imaging techniques of Biomedical applications. **2L**
- 06 Chromatography:** Principles, Adsorption chromatography Partition chromatography, Ion-exchange chromatography, affinity chromatography, Molecular exclusion chromatography, thin layer chromatography, HPLC, FPLC, selection of chromatographic system. **6L**
- 07 Spectrophotometry:** Principles, UV-visible light spectroscopy , Spectrofluorimetry, Infrared and Raman spectroscopy, Nuclear magnetic resonance spectroscopy, Applications in biology **5L**
- 08 Radioisotopes Technique:** Nature of radioactivity, detection and measurement of radioactivity, counting radioactivity, applications of radioisotopes in biology **4L**
- 09 Immunological Techniques:** Immunodiffusion, Immunoelectrophoresis, ELISA, Studying antigen antibody interactions, Immunofluorescence, Flow cytometry **5L**
- 10 Electrophoretic Techniques:** General principles, Support media, electrophoresis of proteins and nucleic acids, Capillary electrophoresis. **5L**

- 11 Centrifugation:** Basic principles of sedimentation, Types of centrifuges, Analytical Centrifugation, Preparative centrifugation. **5L**
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**ZY 205 T+P: Practicals of Tools and Techniques in Biology : (3 C )**

**Microscopy related Practical (1C)** (any 5 practical of the following)

- 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 (2C=30 H)**

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

**ZY- 206 T+P: Histology and Histochemistry**  
**(4 Credits: 30L+ 30 H)**

<b>01</b>	<b>Fundamentals of histology:</b> Epithelial, connective, muscular, nervous and other specialized tissues.	<b>5L</b>
<b>02</b>	<b>Tools in histology:</b> Principles, design and functioning of microtomes, automated microtomes, ultramicrotome, cryostat, problems and trouble shooting	<b>3L</b>
<b>03</b>	<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	<b>7L</b>
<b>04</b>	<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.	<b>5L</b>
<b>05</b>	<b>Cytochemistry and quantitation:</b> Cytochemical detection techniques, principles and technique of autoradiography, cytophotometry, microspectrophotometry, and other morphometric methods.	<b>5L</b>
<b>06</b>	<b>Histopathology:</b> Principles, techniques and applications	<b>5L</b>

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**ZY- 206 T+P: Practicals of Histology and Histochemistry (2C=30 H)**

<b>01</b>	Fixation, dehydration, embedding, sectioning, staining, permanent mounting of tissues and histology	<b>4P</b>
<b>02</b>	Microscopic measurements of histological samples using micrometers and planimeters	<b>1P</b>
<b>03</b>	PAS reaction, Alcian blue reaction, and detection <u>in situ</u>	<b>2P</b>
<b>04</b>	Alkaline phosphatase detection <u>in situ</u>	<b>1P</b>
<b>05</b>	Feulgen reaction	<b>1P</b>
<b>06</b>	Sudan black B staining for lipids	<b>1P</b>
<b>07</b>	Methyl green – Pyronin G method of detection of nucleic acids	<b>1P</b>
<b>08</b>	Millon's reagent and histochemical detection of basic proteins	<b>1P</b>

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**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= Theory 30 L+30 H practical)**

<b>01 Introduction:</b>	
Importance of Statistics in biology, samples and populations, variables in biology, Accuracy and Precision.	<b>5L</b>
Collection and Condensation of data, types of biological data and graphical representation of the data (graphs like Histogram/Ogive curve/frequency curve).	
<b>02 Descriptive Statistics:</b>	<b>5L</b>
Measures of central tendency: Mean, Mode, Median.	
Concept of variation, Measures of variation such as variance, standard deviation, coefficient of variation.	
<b>03 Introduction to Probability Distribution:</b>	<b>5L</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	
<b>04 Regression and correlation analysis, Curve fitting.</b>	<b>5L</b>
<b>05 Hypothesis testing:</b>	<b>10L</b>
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	

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**ZY 207 T+P: Practicals of Quantitative Biology (2C=30 H)**

Practicals are to be conducted using computers 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.

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**Reference Books:**

- *Biometry*. 3<sup>rd</sup> edition (2001). R. R. Sokal and F. J. Rohlf. W. H. Publisher-Freeman and Company.
- *Biostatistical analysis*. 5<sup>th</sup> edition (2008). J. H. Zar. Publisher-Pearson Education Inc. and Dorling Kindersley Publishing Inc.
- *Statistical methods*. 6<sup>th</sup> edition (1967). G. W. Snedecor and W. G. Cochran. Publisher-Oxford and

IBH Publishing Co.

- *Introductory Statistics for Biology*. 3<sup>rd</sup> 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*, 4<sup>th</sup> ed.(2006) P.S.S. Sundar Rao and J. Richard, Publisher-Prentice Hall of India, New Delhi.

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

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

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### 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 202 P: Laboratory Exercises in Immunology**  
**( 2 Credits:10 P x 3H = 30 H)**

<b>01</b>	Generation of Antibodies, Immunization, titration	<b>2P</b>
<b>02</b>	Antibody detection, Immuno-electrophoresis, Ouchterlony technique	<b>2P</b>
<b>03</b>	Purification of Immunoglobulin G with DEAE Column Chromatography	<b>1P</b>
<b>04</b>	Western blotting and detection	<b>2P</b>
<b>05</b>	ELISA	<b>1P</b>
<b>06</b>	Immunohistochemical detection and localization of specific antigens.	<b>2P</b>

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## M.Sc. (Zoology) Part II Syllabus

### SEMESTER III

Course No.	Course Title	Credit
ZY 301 T	Endocrinology	2C
ZY 302 T	Invertebrate and Vertebrate Embryology	2C
ZY 303 T	Biosystematics, Biodiversity and Evolution	4C
ZY 304 T	Introduction to Recombinant DNA Technology	2C
ZY 318T	Insect Biochemistry and Physiology	2C
ZY 301 P	Laboratory Exercises in Endocrinology	2C
ZY 302 P	Laboratory Exercises in Embryology	2C
ZY 303 P	Field and laboratory exercises in Biodiversity and Biosystematics	4C

#### Elective Courses

ZY 305 T	Regulation of Gene Expression (2C)	2C
ZY 313 P	Advanced Techniques in Molecular Biology (3C)	3C
ZY 314 T+P	Advanced Genetics (2C T + 3C P)	5C
ZY 317 T+P	Entomology I (2C T + 3C P)	5C
<b>Total</b>		<b>36 C</b>

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

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

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#### **Reference Books:**

- Endocrinology 5<sup>th</sup> 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).

## **ZY- 302 T: Invertebrate and Vertebrate Embryology (2C = 30 L)**

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

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### **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**  
**(Theory 4C = 60 Lectures)**

- |           |  |                        |
|-----------|--|------------------------|
| <b>01</b> | Biosphere: Biodiversity: Characterization, generation and maintenance, Biosphere reserves, resources and management, Global diversity hotspots, Effect of manmade alteration of environment on Biospheres.   | <b>5L</b>              |
| <b>02</b> | Biotic community & interrelationships: Zoogeographical relations of species and population, interrelationships amongst organisms including parasitism, symbiosis & commensalism Diversity of adaptation in animals.  | <b>5L</b>              |
| <b>03</b> | 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. | <b>5L</b>              |
| <b>04</b> | Kingdoms of Life : General outline of kingdoms including Monera & Protista ; Broad outline & Diversity in kingdom Animalia   | <b>4L</b>              |
| <b>05</b> | 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.                         | <b>5L</b>              |
| <b>06</b> | Conservation: Objective of Conservation, strategies of conservation, Global programmes and concept of endangered species, Modern tools and techniques to assess biodiversity.  | <b>5L</b>              |
| <b>07</b> | 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                         | <b>5L</b>              |
| <b>08</b> | Exploitation of resources: decision making, prey-predator relationship, Communication and animal signals: communication, Evolution of animal signals,  | <b>4L</b>              |
| <b>09</b> | Reproductive strategies and Parental care: Sexual selection, Mating systems, Parental care<br>Social organization : Altruistic behavior and concept of inclusive fitness, Evolution of helpful behavior, Evolution of Eusocial behavior                        | <b>3L</b><br><b>2L</b> |
| <b>10</b> | 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.  | <b>5L</b>              |

- 11** Origin of Universe (Big Bang Theory); Origin of life: coacervates, Origin of basic biological molecules; abiotic synthesis of organic monomers and polymers; concept of Oparin and Haldane; experiment of Miller (1953); the first cell; evolution of prokaryotes; origin of eukaryotic cells; evolution of unicellular eukaryotes; anaerobic metabolism, evolution of metabolic pathways. **7L**  
Evidences of Evolution: Evidences from fossils, geographic distribution, comparative anatomy & embryology. Radioactive dating for fossil age determination.
- 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. **5L**
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**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 304 T: Introduction to Recombinant DNA Technology (2C:30 L)**

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

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### **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.

## ZY 318 T: Insect Biochemistry and Physiology (2 Credits = 30 L)

01	Integument – structure, chemistry, sclerotization, regulation, Function.	3L
	Insecticide detoxification, Type I and Type II reactions. Role of 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 and function Mechanism of hormone action.	5L
06	Excretion and water balance – structure and function of Microtubules, Water balance and nitrogen excretion.	3L
	Ventilatory mechanisms and their control.	2L

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### 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 301 P: Laboratory Exercises in Endocrinology (2C = 30H)**

<b>1</b>	Internal anatomy and histology of mammalian endocrine organs	<b>3P</b>
<b>2</b>	Immunohistochemical localization of neurosecretory cells in the rat/mouse/chick/frog.	<b>2P</b>
<b>3</b>	Histochemical localization of 3 $\beta$ -HSD in the adrenal and gonads.	<b>1P</b>
<b>4</b>	Effect of gonadectomy on the sex accessory structures and HPG axis	<b>2P</b>
<b>5</b>	Effect of exogenous testosterone on sex accessory structure and Hypothalamo-Hypophysial-Gonadal axis.	<b>2P</b>
<b>6</b>	Induction of diabetes and the role of insulin in glucose metabolism.	<b>2P</b>
<b>7</b>	Dissection and display of Retrocerebral complex and immunohistochemical localization of neurosecretory cells in cockroach	<b>2P</b>
<b>8</b>	Staging of fish chromatophores and effect of epinephrine (in-vivo and in-vitro) and acetyl choline (in-vitro) esterase	<b>1P</b>
<b>9</b>	Effect of Thyroxin in amphibian metamorphosis	<b>1P</b>

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**\* From above practicals, any 10 practicals (equivalent to 30H) will be taken.**

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**ZY 302 P: Laboratory Exercises in Embryology (2C = 30H)**

<b>1</b>	Preparation of culture media autoclaving, sterilization	<b>1</b>
<b>2</b>	Chick embryo culture <i>in vitro</i> by New's technique	<b>2</b>
<b>3</b>	Chick embryo culture <i>in vitro</i> by Gallera's technique	<b>1</b>
<b>4</b>	Transplantation of Hensen's node for neural induction.	<b>2</b>
<b>5</b>	Chick embryo culture <i>in vitro</i> and estimation of cell population growth.	<b>1</b>
<b>6</b>	Chick embryo culture <i>in vitro</i> and effect of a teratogen on blastoderm area expansion.	<b>1</b>
<b>7</b>	Isolation of mouse embryos and their study	<b>2</b>
<b>8</b>	Study of apoptosis during embryonic development using vital dye	<b>1</b>
<b>9</b>	Terratogenic effect of ethanol on development of chick embryo by shell less culture method.	<b>1</b>
<b>10</b>	Terratogenic effects of Lithium Chloride on the development of <i>Lymnea acuminata</i> .	<b>2</b>

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**ZY 303 P: Field and Laboratory Exercises in Biodiversity and  
Biosystematics (4C = 60 H)**

<b>01</b>	Study of soil fauna: sampling, extraction / collection, preservation and analysis.	<b>4</b>
<b>02</b>	Collection, identification and preservation of various insect orders and arthropod groups (including study of permanent specimens).	<b>10</b>
<b>03</b>	Study of Freshwater planktons, collection, sorting, identification of samples of zooplanktons: protozoans, rotifers, crustaceans. (including study of permanent specimens)	<b>8</b>
<b>04</b>	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.	<b>6</b>
<b>05</b>	Study of biotic component of a pond ecosystem and grouping on the basis of their trophic position.	<b>4</b>
<b>06</b>	Study of water quality and dissolved oxygen content in water samples of an ecosystem.	<b>4</b>
<b>07</b>	Museum preservation techniques of selected vertebrates and invertebrates.	<b>6</b>
<b>08</b>	Laboratory and field exercises of animal behaviors; Learning, Recognition, Feeding	<b>12</b>
<b>09</b>	Visit to ZSI Pune and other places.	<b>6</b>

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

<b>01</b>	Activating transcription: Transcription activating factors, Different domains in transcription factors, Mechanism of transcription activation, response elements recognized by activators.	<b>5L</b>
<b>02</b>	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	<b>10L</b>
<b>03</b>	Chromatin remodeling: alternative states of chromatin, mechanisms of modification	<b>2L</b>
<b>04</b>	Epigenetic effect: heterochromatin and euchromatin, inactive and active chromatin, mechanisms of X chromosome inactivation, genome imprinting, importance of imprinting	<b>5L</b>
<b>05</b>	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.	<b>8L</b>

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### 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 313 P: Advanced Techniques in Molecular Biology (3C:45H)**

- 1** To study the transformation of *E.coli.* cells with plasmid DNA.
  - 2** To study small scale extraction and purification of plasmid DNA.
  - 3** To set Restriction digestion reaction of pBR322 DNA
  - 4** Extraction and estimation of mitochondrial DNA and mapping by restriction endonuclease digestion
  - 5** Isolation, purification and electrophoresis of RNA
  - 6** To Prepare a passenger DNA by PCR using *Taq* DNA Polymerase
  - 7** Linearization of T – vector
  - 8** Ligation of PCR product into T-vector
  - 9** Transformation of Ligated T vector.
  - 10** Quantitative analysis of gene expression using RT – PCR
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**ZY 314 T+P: Advanced Genetics (2+3=5 C)**  
**(5 Credits: Theory 2C: 30L + Practicals 3 C:45 H)**

- 01 Advanced Quantitative Genetics:**  
Concept of phenotypic variance and its partitioning into subcomponents, measurement of heritability and its application. Quantitative inheritance in humans, co-efficient of relationship and coefficient of inbreeding, twin studies and measurement of concordance. **6L**
- 02 Advanced Population and Evolutionary Genetics :**  
Genetic polymorphism and selection strategies. Quantitative aspect of selection pressure, selection-mutation equilibrium and quantitation, genetic drift, genetics of speciation : classical and modern concepts, use of molecular information in evolutionary genetics, artificial selection and applications. **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 of genetic disorders, family screening and counseling, risk assessment, conventional and prenatal diagnosis, pre-implantation diagnosis. Genetic basis of psychiatric disorders **6L**
- 04 Environment and Genome :**  
(a) Imprinting and Epigenetics  
(b) Genetics of Cancer (Oncogenes and tumour suppressor genes) **6L**  
(c) Genetics of Ageing
- 05 Advanced Molecular genetic approaches and techniques :**  
Molecular approaches in genetic analysis, Recapitulation of genome organizations, Application of molecular methodologies in genetic analysis, Gene-based therapeutic approaches, Mapping human genome, Genetic analysis using genomic data, Polymorphism and population analysis – SNPs and genotyping using sequence analysis and microarray. **6L**
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**ZY 314 P: Laboratory Exercises in Advanced Genetics (3 C)**

- 1 Estimation of heritability of quantitative traits
- 2 Chromosome preparation from bone marrow cells / peripheral blood samples, banding techniques (Light microscopic and Fluorescent microscopy based)
- 3 Allozyme variation in a population to study genetic polymorphism
- 4 Study of natural and artificial selection using *Drosophila* population

- 5 Identification of Polytene chromosome arms of *Drosophila melanogaster*, method of referring a map and localization of chromosomal site, puffing
- 6 Study of non-allelic gene interaction in *Drosophila*
- 7 Study of molecular marker analysis in population
- 8 PCR-based diagnosis of inherited disorders.
- 9 SNP detection in human genome
- 10 SSCP / ARMS in genetic studies
- 11 Genotyping and fingerprinting
- 12 Mutations in genes – frequency analysis
- 13 Exercises in genome mapping strategies
- 14 RT PCR and cloning

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**\* From above practicals, any 9 practicals (equivalent to 45H) will be taken.**

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**References:**

- Gardner E.J. 8<sup>th</sup> edition (2006) Principle of Genetics, John Wiley & Sons Publ.
- Hartl D.L. & Jones E.W. (2005) Genetics: Analysis of Genes & Genomes. Jones & Bartlett Publ.
- Klug W.S. & Cummings M.R. 8<sup>th</sup> edition (2005) Concepts of Genetics. Benjamin Cummings Publ.
- Stachan T. & Read A.P. 4<sup>th</sup> edition (2010) Human Molecular Genetics. Garland Publishers.
- Smith J.M. (1989) Evolutionary Genetics Oxford University Press.
- Lewin B. GENES XI Jones & Bartlett Publ.
- Strickberger M.W. (1995) Genetics. Macmillan Publ.

**ZY 317 T: Entomology I (2+3=5 C)**  
**(5 Credits: Theory 2C: 30L + Practicals 3 C:45 H)**

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|-----------|--|-----------|
| <b>01</b> | 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 into families. | <b>8L</b> |
| <b>02</b> | Integumentary system: Integument, its structure & derivatives. Comparative morphology of head, thorax & abdomen, their appendages & modifications. Exocrine glands.  | <b>7L</b> |
| <b>03</b> | Maintenance Systems: Comparative anatomy of alimentary, circulatory, respiratory, excretory & reproductive system. Fat body.   | <b>8L</b> |
| <b>04</b> | Control System: Comparative study of muscular, nervous & endocrine system, Sense organs, photogenic organs. Sonification.  | <b>7L</b> |
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**ZY 317 P: Practicals of Entomology I (3 C)**

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**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.
- Evans. E. H.(1984) : " Insects: Textbook of Entomology " Addison- Wesley. London.
- Fox, R.M. & J.W. Fox (1964): "Introduction to Comparative Entomology "Reinhold, New York.

- Henning, W. (1981): "Insect Physiology". Wiley – Interscience 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.

## M.Sc. (Zoology) Part II Syllabus

### SEMESTER IV

Course No.	Course Title	Credit
ZY 401 T	Drosophila Genetics	1C
ZY 402 T	Physiology of Mammalian Reproduction	2C
ZY 403 T	Parasitology	2C
ZY 404 T	Developmental Genetics	1C
ZY 409 T	Seminars	2C
ZY 411 P	Project	10C

#### Elective Courses

ZY 405 T + P	Bioinformatics	4C
ZY 407 T	Genomics and Proteomics	2C
ZY 408 T	Entomology II	2C
ZY 410 T	Review Writing	2C
<b>Total</b>		<b>28 C</b>

## ZY 401 T: *Drosophila* Genetics (1 Credit: 15 L)

1	Introduction to <i>Drosophila</i> Genetics, advantages, methodologies, Balanced lethal systems	2L
2	Polytene chromosome: Polytenisation process, significance, features-, puffs, regulation of puffing, evidences of transcriptional activity, induction by stress	3L
3	Sex Determination: Sex Determination and dosage compensation, Chromosomal genetic and molecular aspects	5L
4	Behavioural and Neuro-Genetics Behavioural traits, mutants, tools & Methodologies for genetic analysis, genetic and molecular basis of behavioural traits in <i>Drosophila</i> .	3L
5	<i>Drosophila</i> Transposons & Phenocopies	2L

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### References:

- Ashburner A & Carson H.L. (1986) *The Genetics & Biology of Drosophila*. Academic Press.
- Roberts D.B. (1998) *Drosophila : A practical approach*. Oxford University Press.
- Gardner E.J. 8<sup>th</sup> edition (2006) *Principle of Genetics*, John Wiley & Sons Publ.
- Hartl D.L. & Jones E.W. (2005) *Genetics: Analysis of Genes & Genomes*. Jones & Bartlett Publ.
- Klug W.S. & Cummings M.R. 8<sup>th</sup> edition (2005) *Concepts of Genetics*. Benjamin Cummings Publ.
- Lewin B. (2013) *GENES XI* Jones & Bartlett Publ.

## ZY 402 T: Physiology of Mammalian Reproduction (2C – 30L)

- 1 Reproductive organs: Male and female gonad : duct systems and sex accessories. **5L**  
Reproductive Patterns : Environmental factors and breeding continuous and seasonal breeders.  
Reproductive organs: Cycles : Puberty : Oestrous and menstrual cycles. Ovulation (spontaneous and reflex), luteal phase, Cycling of non-pregnant uterus and vagina
- 2 Hormonal regulation: Hypothalamohypophysial–gonadal axis; Hypothalamic GnRH, **5L**  
Pituitary gonadotropins, behavioural effects. Testicular hormones, Inhibin. Ovarian hormones.
- 3 Pregnancy: Conception and blastocyst formation, Implantation and delayed **5L**  
implantation Placenta : formation, types and functions. Hormones in pregnancy.
- 4 Parturition: Birth process and its neuro – endocrine control. Puerperium. Lactation : **5L**  
Milk glands, milk synthesis ad secretion, Hormonal regulation : sucking reflex.
- 5 Reproductive dysfunctions: Ageing and reproduction, Climacteric. Anatomical, **5L**  
endocrine and genetic disorders. Immunological aspects. Environmental effects.
- 6 Artificial control of reproduction: Increasing reproductive potential : artificial **5L**  
insemination, *in vitro* fertilization and embryo transfer induced breeding,  
synchronization of Estrus and ovulation : Chemical and hormonal aspects.  
Limiting re4productive 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.

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### References:

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



## ZY 403 T: Parasitology (2C – 30Lectures)

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

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### References:

- 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 404 T: Developmental Genetics (1C – 15 Lectures)

1	Introduction, Historical perspectives, Methodologies & approaches in Developmental Genetics, gene transfer techniques	2L
2	Slime moulds: Principles – gene targetting Caenorhabditis elegans : Genetics of Development & Differentiation	4L
3	Developmental Genetics of Drosophila	3L
4	Mammalian sex determination, Transgenesis, identification of genes, knock-outs.	4L
5	Arabidopsis Post-Genomic era- developmental genetic approach	2L

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### References:

- Wolpert L. (2011) *Principles of Development* : Oxford University Press.
- Gilbert S.F. (2013) *Developmental Biology* 10<sup>th</sup> edition. Sinauer Associates Inc. Publ.
- Gardner E.J. 8<sup>th</sup> edition (2006) *Principle of Genetics*, John Wiley & Sons Publ.
- Hartl D.L. & Jones E.W. (2005) *Genetics: Analysis of Genes & Genomes*. Jones & Bartlett Publ.
- Lewin B. (2013) *GENES XI* Jones & Bartlett Publ.

## **ZY 406 T+P: Bioinformatics (4C=2C Theory+ 2C Practical)**

### **Theory 2C=30L**

- 1 Introduction to Bio-informatics
- 2 DNA Sequence Databases – Genbank and EMBL
- 3 Protein sequence Database – UniProtKB / Swiss – Prot
- 4 Literature Database:
  - a) Introduction to sequence alignment, Needleman and Wunsch algorithm.
  - b) Local alignment of sequences, Smith and Waterman algorithm.
- 5 Basic Local alignment Search Tool
- 6 Multiple Sequence alignment and Molecular Phylogenetics
- 7 Genome Database, Gene prediction and Genome comparison
- 8 ProSite – derived database  
Protein Structure database and structure visualization

### **Practicals (2C=30H)**

- 1 Introduction to Bio-informatics
- 2 DNA Sequence Databases – Genbank and EMBL
- 3 Protein sequence Database – UniprotKB / Swiss – Prot
- 4 Literature Database:
  - a) Introduction to sequence alignment, Needleman and Wunsch algorithm.
  - b) Local alignment of sequences, Smith and Waterman algorithm.
  - c) ExPasy tools
- 5 Basic Local alignment Search Tool

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### **References:**

- *Introduction to Bioinformatics*. Arthur M. Lesk (3rd ed.). Oxford University Press.
- *Bioinformatics: Sequence and Genome Analysis*. David Mount (2nd ed.). Cold Spring Harbor Laboratory Press.
- *Bioinformatics for Geneticists: A Bioinformatics Primer for the Analysis of Genetic Data*. Michael R. Barnes (2nd ed.). John Wiley & Sons Inc.

## ZY 407 T: Genomics and Proteomics (2 Credits: 30 Lectures)

1	Introduction to Genomics and Proteomics: structural genomics, Functional Genomics	1L
2	Genome mapping- Genetic mapping, Physical mapping, Resolution of mapping	5L
3	Strategies for Sequencing whole genome and sequence data analysis	5L
4	Comparative Genomics	2L
5	Global expression profiling : whole genome analysis of mRNA and protein expression, microarray analysis and their applications	4L
6	Toxicogenomics, Pharmacogenomics, Metagenomics, metabolic engineering	2L
7	Importance of proteomics	1L
8	Strategies in proteomics: 2D PAGE and Mass spectrometry	3L
9	Database and search engines in proteomics	1L
10	Mapping of protein interactions: two hybrid, phage display	2L
11	Applications of proteomics: Understanding mechanism of pathogenesis, Drug discovery, Disease diagnosis, identification and characterization of novel proteins	4L

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### Reference Books:

- 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 408 T: Entomology II (2 Credits: 30 Lectures)

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

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### 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.