

**University of Pune**  
**Three Year B. Sc. Degree Course in**  
**Zoology**

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Chairman,  
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University of Pune, Pune 411 007.

## **1) Title of the Course : B. Sc. Zoology**

### **F. Y. B. Sc. Zoology**

**(To be implemented from Academic Year 2013-14)**

## **2) Preamble:**

The well organized curricula including basic as well as advanced concepts in the Zoology from first year to the third year shall inspire the students for pursuing higher studies in Zoology and for becoming an entrepreneur and also enable students to get employed in the Biological research Institutes, Industries, Educational Institutes and in the various concerning departments of State and Central Government based on subject Zoology.

## **3) Introduction:**

At **first year of under-graduation** the topics related to the fundamentals of zoology, including exposure to diversity in animal groups and industries based on the zoological areas are covered. The practical course is aimed to equipped the students with skills required for animal identification, morphological, anatomical, technical description, classification and also applications of zoology in the various industries.

At **second year under-graduation:** The level of the theory and practical courses shall be one step ahead of the first year B.Sc. courses based on content of first year shall be introduced.

At **third year under-graduation:** Theory and practical courses in each semester shall deal with the further detailed studies of the various disciplines of the zoology subject and other branches of zoology such as Genetics, Animal Physiology, Molecular biology, Biochemistry, Microtechnique, Nonchordate and Chordate, Developmental Biology, Histology. Cell Biology, Biodiversity, Public health and hygiene, Pathology, Entomology, Biotechnology, etc. The students will also learn about use of various technical skills in the biological sciences to be helpful during research in the zoology subject.

## **Objectives:**

- To provide thorough knowledge about various animal sciences from primitive to highly evolved animal groups
- To make the students aware of applications of Zoology subject in various industries

- To highlight the potential of various branches to become an entrepreneur
- To equipped the students with skills related to laboratory as well as field based studies
- To make the students aware about conservation and sustainable use of biodiversity
- To inculcates interest and foundation for further studies in Zoology
- To address the socio-economical challenges related to animal sciences
- To facilitate students for taking up and shaping a successful career in Zoology

#### **4) Eligibility:**

- 1 **First Year B.Sc. :** A student who has passed the Higher Secondary School Certificate (10+2) Science stream with Biology or its equivalent examination as per the University of Pune eligibility norms.
- 2 **Second Year B.Sc. :** Keeping terms of First Year of B. Sc. with zoology as one of the subjects. Other students if they fulfill the conditions approved by the equivalence committee of Faculty of Science of the University of Pune are also eligible.
- 3 **Third Year B.Sc.:** Student shall pass all First Year B. Sc. courses and satisfactorily keeping terms of Second Year of B. Sc. with zoology as one of the subjects.

**Note:** Admissions will be given as per the selection procedure / policies adopted by the respective college, in accordance with conditions laid down by the University of Pune. Reservation and relaxation will be as per the Government rules.

#### **5 A) Examination Pattern:**

##### **First Year B. Sc. Zoology**

Pattern of Examination: Annual

Theory courses	Zoology Theory Paper I : Annual
	Zoology Theory Paper II : Annual
Practical Course	Annual

Paper/ Course No.	Title	Total Number of lectures/practicals per Term	Standard of passing		
			Internal marks out of <b>20</b>	External marks out of <b>80</b>	Total marks out of <b>100</b>
Theory Paper I ZY-101 (First term)	Animal Systematics and Diversity -I	Three lectures/Week (Total 36 lectures per term)	08	32	40 *
Theory Paper I ZY-101 (Second term)	Animal Systematics and Diversity -II	Three lectures/Week (Total 36 lectures per term)			
Theory Paper II ZY-102 (First term)	Fundamentals of Cell Biology	Three lectures/Week (Total 36 lectures per term)	08	32	40 *
Theory Paper II ZY-102 (Second term)	Genetics	Three lectures/Week (Total 36 lectures per term)			
Practical Paper III ZY-103 (First & Second Term)	Practical	9 Practicals of 4 lectures in each term (18 practicals / year)	08	32	40 *

\* Subject to compulsory passing in external examination and getting minimum 40 marks out of 100

Notes:

1. Total marks: Theory (100 + 100 ) = 200 marks
2. Total marks per year 200 (Theory) + 100 marks (practicals) = 300 marks
3. Internal marks for theory papers given on the basis of internal assessment tests

**Theory examination** will be of three hours duration for each theory course. There shall be 5 questions each carrying equal marks. The pattern of question papers shall be:

Question 1	8 sub-questions, each of 2 marks; answerable in 2 -3 lines and based on entire syllabus
Question 2 and 3	4 out of 6 - short answer type questions; answerable in 8 – 10 lines
Question 4	2 out of 4 – Descriptive answer type questions, answerable in 15 – 20 lines
Question 5	1 out of 2 – Descriptive answer type questions, answerable in 35 – 40 lines

**Internal examination:** Internal assessment of the student by respective teacher will be based on written test, 10 marks in each term. The written test shall comprise objective type questions – Multiple Type Questions, True / False, Definitions, Answer in one or two line questions. There shall be 20 questions.

Practical: Regular assessment of each practical for 20 marks each: Marks for journal: 10, Marks for attendance: 05, Marks experimental skills: 03, Practical Work Book: 02

**Practical Examination:** Practical examination shall be conducted by the respective college at the end of the academic year. Practical examination will be of more than 4 hours duration. Certified journal is compulsory to appear for practical examination. There shall be two expert and two examiners per batch for the practical examination.

### Second Year B. Sc. Zoology

Pattern of examination: Semester

Theory courses ZY- 211 and ZY- 212: Semester

ZY-211 and ZY-212: Semester

Practical Course: Annual

Paper/ Course No.	Title	Total Number of lectures/practicals Per Semester	Standard of passing		
			Internal marks out of 10 (theory) Out of 20 (practicals)	External marks out of 40 (theory) Out of 80 (practicals)	Total passing marks out of 50 (theory) and out of 100 (practicals)
ZY- 211	Animal Systematics and Diversity -III	Four lectures/Week (Total 48 per semester )	04	16	20 *
ZY- 212	Applied Zoology I	Four lectures/Week (Total 48 per Semester )	04	16	20 *
ZY-211	Animal Systematics and Diversity -IV	Four lectures/Week (Total 48 per Semester )	04	16	20 *
ZY-212	Applied Zoology II	Four lectures/Week (Total 48 per Semester )	04	16	20 *
ZY-223 (Semester- I and II)	Paper III Practical course	12 Practicals of 4 lectures in each Semester (24 practicals / year)	08	32	40**

\* Subject to compulsory passing in external examination and getting minimum 20 marks out of 50

\*\*Subject to compulsory passing in external examination and getting minimum 40 marks out of 100

Notes:

1. Total marks: Theory for each semester (50 + 50 ) = 100 marks
2. Total marks per year 200 (Theory) + 100 marks (practicals) = 300 marks
3. Internal marks for theory papers given on the basis of internal assessment tests.
4. Internal marks for Practical Course should be a regular assessment of each practical for 20 marks each: Marks for journal:10, Marks for attendance: 05, Marks experimental skills: 03, Practical Work Book: 02

**Theory examination** will be of two hours duration for each theory course. There shall be 4 questions each carrying equal marks as follows: The pattern of question papers shall be:

Question 1	10 sub-questions, each of 1 marks based on entire syllabus	10 marks
Question 2 and 3	2 out of 3 sub-questions, each of 5 marks; short answer type questions; answerable in 10-15 lines	5 marks each
Question 4	1 out of 2 sub-questions, each of 10 marks; long answer type questions (20-25lines)	10 marks

**Internal examination:** Internal assessment of the student by respective teacher will be based on written test, 10 marks each Semester. The written test shall comprise of objective type questions – Multiple Type Questions, True / False, Definitions, Answer in Two or three line question. There shall be 20 questions. Practicals: Regular assessment as described earlier (regular assessment of each practical for 20 marks each: Marks for journal:10, Marks for attendance: 05, Marks experimental skills: 03, Practical Work Book: 02)

**Practical Examination:** Practical examination shall be conducted at the respective college at the end of the academic year. Practical examination will be of more than 4 hours duration. Certified journal is compulsory to appear for practical examination. There shall be two expert and two examiners per batch for the practical examination. One of the examiners will be external.

## Third Year B. Sc. Zoology

Pattern of examination: Semester

Theory courses:

(Sem III: ZY-331 to ZY-336) : Semester

(Sem IV: ZY- 341 to ZY-346) : Semester

Practical Course:(ZY-347-349) : Annual

<b>Theory Papers</b>					
Paper/Course No.	Title	Total Number of lectures Per Semester	Standard of passing		
			Internal marks out of 10 (theory) Out of 20 (practicals)	External marks out of 40 (theory) Out of 80 (practicals)	Total passing marks out of 50 (theory) and out of 100 (practicals)
<b>SEM III</b>					
ZY-331	Animal Systematics and Diversity V	48	4	16	20*
ZY-332	Mammalian Histology	48	4	16	20*
ZY-333	Biological Chemistry	48	4	16	20*
ZY-334	Environmental Biology and Toxicology	48	4	16	20*
ZY-335	Parasitology	48	4	16	20*
ZY-336	General Pathology or Cell Biology	48	4	16	20*
<b>SEM IV</b>					
ZY-341	Biological Techniques	48	4	16	20*
ZY-342	Mammalian Physiology and Endocrinology	48	4	16	20*
ZY-343	Genetics and Molecular Biology	48	4	16	20*
ZY-344	Organic Evolution	48	4	16	20*
ZY- 345	General Embryology	48	4	16	20*
ZY-346	Public Health and Hygiene or Medical Entomology	48	4	16	20*

Practical Papers					
BO 347 (Semester III & IV)	Practical Paper I	12 Practicals of 4 lectures in each Semester (24 / year)	08	32	40 **
BO 348 (Semester III & IV)	Practical Paper II	12 Practicals of 4 lectures in each Semester (24 / year)	08	32	40 **
BO 349 (Semester III & IV)	Project Practical Paper III	12 Practicals of 4 lectures in each Semester (24 / year)	08	32	40 **

\* Subject to compulsory passing in external examination and getting minimum 20 marks out of 50

\*\*Subject to compulsory passing in external examination and getting minimum 40 marks out of 100

Notes:

1. Total marks: Theory for each semester ( $50 \times 6$ ) = 300 marks
2. Total marks per year 600 (Theory) + 300 marks (practicals) = 900 marks
3. Internal marks for theory papers be given on the basis of internal assessment tests.
4. Practicals: Regular assessment as described earlier (regular assessment of each practical for 20 marks each: Marks for journal:10, Marks for attendance: 05, Marks experimental skills: 03, Practical Work Book: 02)

**Theory examination** will be of two hours duration for each theory course. There shall be 4 questions each carrying marks as per the table. The pattern of question papers shall be:

Question 1	10 sub-questions, each of 1 marks based on entire syllabus	10 marks
Question 2 and 3	2 out of 3 sub-questions, each of 5 marks; short answer type questions; answerable in 10 – 15 lines	5 marks each
Question 4	2 out of 3 sub-questions, each of 10 marks; long answer type questions (20 – 25 lines)	10 marks

**Internal examination:** Internal assessment of the student by respective teacher will be based on written test, 10 marks each Semester. The written test shall comprise of objective type questions – Multiple Type Questions, True / False, Definitions, Answer in Two or three line question. There shall be 20 questions.



Practicals: Regular assessment as described earlier (regular assessment of each practical for 20 marks each: Marks for journal:10, Marks for attendance: 05, Marks experimental skills: 03, Practical Work Book: 02)

**Practical Examination:** Practical examination shall be conducted at the respective college at the end of the academic year. Practical examination will be of more than 4 hours duration. Certified journal is compulsory to appear for practical examination. There shall be two expert and two examiners per batch for the practical examination. One of the examiners will be external.

### **5 B) Standard of Passing:**

- i. In order to pass in the first year theory examination, the candidate has to obtain 40 marks out of 100 in each course. (Minimum 32 marks out of 80 must be obtained in the University Theory Examination.)
- ii. In order to pass in the Second Year and Third Year theory examination, the candidate has to obtain 20 marks out of 50 in each course of each semester. (Minimum 16 marks out of 40 must be obtained in the University Theory Examination.)
- iii. In order to pass in practical examination, the candidate has to obtain 40 marks out of 100 in each course. (Minimum 32 marks out of 80 must be obtained in the University Examination.)

### **5 C) ATKT Rules:**

While going from F.Y.B.Sc. to S.Y.B.Sc. at least 8 courses (out of total 12) should be passed; however all F.Y.B.Sc. courses should be passed while going to T.Y.B.Sc.

While going from S.Y.B.Sc. to T.Y.B.Sc., at least 12 courses (out of 20) should be passed (Practical Course at S.Y.B.Sc. will be equivalent to 2 courses).

### **5 D) Award of Class:**

The class will be awarded to the student on the aggregate marks obtained during the second and third year in the principal subject only. The award of the class shall be as follows:

1	Aggregate 70% and above	First Class with Distinction
2	Aggregate 60% and more but less than 70%	First Class
3	Aggregate 55% and more but less than 60%	Higher Second Class
4	Aggregate 50% and more but less than 55%	Second Class
5	Aggregate 40% and more but less than 50%	Pass Class
6	Below 40%	Fail

### **5 E) External Students:**

There shall be no external students.

### **5 F) Setting of question papers:**

**F. Y. B. Sc.:** For theory papers I and II annual question papers shall be set by the University of Pune and assessment done at the respective colleges. Questions should be designed to test the conceptual knowledge and understanding of the basic concepts of the subject. For Practical Paper III, papers shall be set by the University of Pune and assessment done at the respective colleges.

**S. Y. B. Sc. and T. Y. B. Sc.:** For theory papers for each semester and also for the annual practical examination, question papers shall be set by the University of Pune. Centralized assessment for theory papers done as per the University instructions. Questions should be designed to test the conceptual knowledge and understanding of the basic concepts of the subject. For Practical Papers, papers shall be set by the University of Pune and assessment done by the internal examiner and external examiner appointed by University of Pune.

### **5 G) Verification and Revaluation Rules:**

As per University Statues and Rules for verification and revaluation of marks in stipulated time after declaration of the semester examination result.

## **6) Course Structure:**

**Duration:** The duration of B.Sc. Zoology Degree Program shall be three years.

### **a) Compulsory Papers:**

F. Y. B. Sc.: 2 Theory + 1 Practical (Annual)

S. Y. B. Sc.: 2 Theory per semester + 1 Practical (Annual)

T. Y. B. Sc.: 6 Theory per semester + 3 Practical (Annual)

### **b) Question Papers :**

#### **F. Y. B. Sc. Theory paper:**

University Examination – 80 marks (at the end of 2<sup>nd</sup> term)

Internal Examination – 20 marks

#### **S. Y. / T. Y. - B. Sc. Theory paper:**

University Examination – 40 marks (at the end of each term)

Internal Examination – 10 marks

#### **F. Y. / S. Y. / T. Y. - B. Sc. Practical Paper:**

University Examination – 80 marks (at the end of 2<sup>nd</sup> term)

Internal Examination – 20 marks

c) **Medium of Instruction:** The medium of instruction for the course shall be **English**.

### 7) Equivalence of Previous Syllabus:

Old Course (2008 Pattern)	New Course (2013 Pattern)
Paper I: Nonchordates and Chordates	Animal Systematics and Diversity –I and II
Paper II: Genetics and Parasitology	Fundamentals of Cell Biology and Genetics
Paper III: Practical course	Paper III: Practical course

**8) University Terms:** Dates for commencement and conclusion for the first and second terms will be declared by the University authorities. Terms can be kept by only duly admitted students. The term shall be granted only on minimum 75 percent attendance at theory and practical course and satisfactory performance during the term.

**9) Qualification of Teachers:** M.Sc. Zoology or equivalent master degree in science with class/grades and NET/SET/Ph.D. as per prevailing University/Government /UGC rules.

**UNIVERSITY OF PUNE**  
**BOARD OF STUDIES IN ZOOLOGY**  
**Proposed Revised Syllabus for F. Y. B. Sc. (Zoology)**  
**To be implemented from June, 2013**  
**F. Y. B. Sc. (Zoology) New Syllabus**

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**1. Zoology: Paper- I**

**Term- I: Animal Systematics and Diversity –I**

**2. Zoology Theory Paper II**

**Term I: Fundamentals of Cell Biology**

**3. Zoology: Paper- I**

**Term- II: Animal Systematics and Diversity – II**

**4. Zoology: Paper- II**

**Term- II: Genetics**

**5. F. Y. B. Sc. Zoology Practical Paper - III based on Theory Paper I  
and Paper II**

UNIVERSITY OF PUNE  
BOARD OF STUDIES IN ZOOLOGY  
COURSE STRUCTURE OF UNDERGRADUATE CLASSES  
(To be implemented from June 2013)

**Class: F.Y. B. Sc.**

Paper	Course No.	Term I	Term II
I	ZY 101	Animal Systematics and Diversity -I	Animal Systematics and Diversity –II
II	ZY 102	Fundamentals of Cell Biology	Genetics
III	ZY 103	Practical course	

**Class: S.Y. B. Sc.**

Paper	Course No.	Semester I	Course No.	Semester II
I	ZY.211	Animal Systematics and Diversity -III	ZY. 221	Animal Systematics and Diversity –IV
II	ZY.212	Applied Zoology I	ZY.222	Applied Zoology II
III	ZY.223	Practical course		

**Class: T.Y. B. Sc.**

Paper	Course	Semester III	Course	Semester IV
I	ZY.331	Animal Systematics and Diversity V	ZY.341	Biological Techniques
II	ZY.332	Mammalian Histology	ZY.342	Mammalian Physiology and Endocrinology
III	ZY.333	Biological Chemistry	ZY.343	Genetics and Molecular Biology
IV	ZY.334	Environmental Biology and Toxicology	ZY.344	Organic Evolution
V	ZY.335	Parasitology	ZY.345	General Embryology
VI	ZY.336	General Pathology or Cell Biology	ZY.346	Public Health and Hygiene or Medical Entomology
VII	ZY.347	Practicals corresponding to ZY 331, ZY 332, ZY 341 & ZY 342		
VIII	ZY.348	Practicals corresponding to ZY 333, ZY 334, ZY 343 & ZY 344		
IX	ZY.349	Practicals corresponding to ZY 335, ZY 336, ZY 345 & ZY 346		

**Prin. (Dr) D. K. Mhaske**  
Chairman, B.O.S. in Zoology  
University of Pune

## **University of Pune**

Draft of Syllabus to be implemented from June 2013

### **F. Y. B. Sc. Zoology**

Paper 1- ZY-101:	First term:	Animal Systematics and Diversity - I
	Second term:	Animal Systematics and Diversity - II
Paper II- ZY-102:	First term:	Fundamentals of Cell Biology
	Second term:	Genetics
Paper III ZY-103:		Practical course

## PAPER I: FIRST TERM

### ZY-101: ANIMAL SYSTEMATICS AND DIVERSITY -I

- 1. Principles of classification:** **4**
  - 1.1 Systematics-Linnaean hierarchy (Phylum, Class, Order, Family, Genus and Species)
  - 1.2 Binomial nomenclature
  - 1.3 Five kingdom classification system
- 2. Salient features and classification upto classes of the following:** (any two examples from each class) **8**
  - 2.1 Protozoa
  - 2.2 Porifera
  - 2.3 Coelenterata
  - 2.4 Platyhelminthes
  - 2.5 Aschehelminthes
  - 2.6 Annelida
- 3. Study of *Paramoecium* :** **8**
  - 3.1 Systematic position, Habit and habitat
  - 3.2 Structure, nutrition, excretion and reproduction (binary fission and conjugation)
- 4. Study of Earthworm :** **16**
  - 4.1 Systematic position, Habit and habitat
  - 4.2 External characters
  - 4.3 Digestive system
  - 4.4 Circulatory system
  - 4.5 Excretory system
  - 4.6 Reproductive system
  - 4.7 Nervous system and sense organs
  - 4.8 Economic importance

**PAPER –I: SECOND TERM**

**ZY-101: ANIMAL SYSTEMATICS AND DIVERSITY – II**

**1. Salient features and classification upto order with one example of the following:**

**6**

1.1 Hemichordata

1.2 Urochordata

1.3 Cephalochordata

**2. Salient features of following classes with two examples of each**

**4**

2.1 Pisces- Cartilaginous and Bony fishes

2.2 Amphibia- Apoda, Urodela and Anura

**3. Study of Frog:**

**20**

3.1 Systematic position, Habit and habitat

3.2 External characters and sexual dimorphism

3.3 Digestive system, food, feeding and physiology of digestion

3.4 Circulatory system (lymphatic system not expected)

3.5 Central Nervous system

3.6 Sense organs

3.7 Reproductive systems (male & female)

**4. General topics:**

**6**

4.1 Migration in fishes

4.2 Neoteny in amphibia

4.3 Parental care in amphibia



**PAPER II-FIRST TERM**

**ZY 102: FUNDAMENTALS OF CELL BIOLOGY**

<b>1. Introduction to cell biology:</b>	<b>4</b>
1.1 Definition and scope	
1.2 Stains: Principle and composition of vital stains, cytoplasmic stains and nuclear stains with two examples of each	
<b>2. Structure of prokaryotic (<i>E.coli</i>) and eukaryotic (Plant and Animal) cell</b>	<b>3</b>
<b>3. Structure and function of cell membrane:</b>	<b>6</b>
3.1 Chemical composition	
3.2 Fluid mosaic model	
3.3 Functions of plasma membrane	
<b>4. Composition of Cytoplasm</b>	<b>1</b>
<b>5. Study of following cell organelles with respect to structure and functions in brief:</b>	<b>10</b>
5.1 Endoplasmic reticulum	
5.2 Golgi complex	
5.3 Lysosomes, peroxisomes and glyoxysomes	
5.4 Ribosomes	
5.5 Mitochondria	
<b>6. Nucleus:</b>	<b>5</b>
6.1 Shape, size, number and position	
6.2 Ultrastructure of nuclear envelope and pore complex	
6.3 Functions	
<b>7. Cell division and their significance:</b>	<b>7</b>
7.1 Cell cycle in brief	
7.2 Mitosis	
7.3 Meiosis	

## PAPER II-SECOND TERM

### ZY 102: GENETICS

<b>1. Introduction to genetics:</b>	<b>4</b>
1.1 Mendelian inheritance: laws of heredity and their practical application	
1.2 Test cross and Back cross	
<b>2. Gene Interaction:</b>	<b>5</b>
2.1 Concept of gene interaction, co-dominance and incomplete dominance	
2.2 Complementary factors (9:7)	
2.3 Supplementary Factors (9: 3:4)	
2.4 Inhibitory factors (13:3)	
2.5 Duplicate dominant factors (15:1)	
<b>3. Lethal genes in <i>Mus musculus</i></b>	<b>1</b>
<b>4. Multiple Alleles:</b>	<b>4</b>
4.1 Concept, characteristics and importance of multiples alleles, ABO & Rh-blood group system and it's medicolegal importance.	
4.2 Concept of polygenic inheritance with reference to skin color in man	
<b>5. Chromosomes:</b>	<b>5</b>
5.1 Introduction to morphology and composition	
5.2 Classification based on the centromeric position	
5.3 Types of chromosome (autosomes and sex chromosome)	
5.2 Chromosomal aberrations: structural changes	
<b>6. Sex-determination:</b>	<b>5</b>
6.1 Introduction	
6.2 Chromosomal theory of sex determination (XX-XY, ZZ-ZW, XX-XO and Haploid-Diploid method)	
6.3 Parthenogenesis and Gynandromorphism	
<b>7. Human genetics:</b>	<b>4</b>
7.1 Study of human karyotype	
7.2 Syndromes:	
a) Autosomal-Down's (Mongolism), Patau's, Edward's and Cri-du-chat	

b) Sex chromosomal abnormalities in man: Klinefelter's and Turner's syndrome	
7.3 Inborn errors of metabolism: albinism, phenylketonuria and alkaptonuria	
<b>8. Sex linked inheritance in human:</b>	<b>3</b>
8.1 Colorblindness, haemophilia and hypertrichosis	
<b>9. Cytoplasmic inheritance:</b>	<b>1</b>
9.1 Kappa particles in <i>Paramecium</i>	
<b>10. Application of genetics:</b>	<b>4</b>
10.1 Genetic counseling.	
10.2 Concept of genetic Engineering	
10.3 Eugenics	

### ZY-103 PRACTICAL COURSE

- Practical 1. To study the classification with reasons of the following (D)  
Phylum Protozoa- *Amoeba*, *Euglena* and *Volvox*  
Phylum Porifera- *Sycon*, *Hyalonema* and *Euspogia*
- Practical 2. To study the classification with reasons of the following (D)  
Phylum Coelenterata- *Hydra*, *Physalia* and any one coral  
Phylum Platyhelminthes- Tapeworm, Planeria and Liverfluke
- Practical 3. To study the classification with reasons of the following (D)  
Phylum Aschelminthes- *Ascaris*  
Phylum Annelida- *Tubifex*, Leech and *Neries*
- Practical 4. Culturing of *Paramoecium* (E)
- Practical 5. Study of live *Paramoecium* (E)
- Practical 6. Study of external characters, binary fission & conjugation (D)  
in *Paramoecium*
- Practical 7. Study of external characters and digestive system of Earthworm (E)
- Practical 8. Study of reproductive (male and female) system of Earthworm (E)
- Practical 9. Study of nervous system of Earthworm (E)
- Practical 10. Earthworm mounting- septal nephridia, setae and spermatheca (E)
- Practical 11. Study of prokaryotic and eukaryotic cell with the help of suitable (D)  
material
- Practical 12. Study of temporary preparation of different mitotic stages (E)  
from onion root tip cells
- Practical 13. To study the classification with reasons of the following (D)  
Hemichordata- *Balanoglossus*  
Urochordata- *Doliolum/ Salpa*  
Cephalochordata- *Amphioxus*
- Practical 14. To study the classification with reasons of the following (D)  
Cartilaginous fishes- any two  
Bony fishes- any two  
Amphibia- any three

- Practical 15. Study of external characters, sexual dimorphism and digestive system of Frog with the help of model/ charts (D)
- Practical 16. Study of brain of Frog with the help of model/ chart (D)
- Practical 17. Study of monohybrid ratio and dihybrid ratio by providing hypothetical data and deducing applicability of Mendelian laws (three examples of each ratio) (E)
- Practical 18. Preparation of culture media and maintenance of *Drosophila* culture (E)
- Practical 19. Study of *Drosophila*: External characters and sexual dimorphism (D)
- Practical 20. Study of *Drosophila* mutants (any two eye and any two wing mutant) (D)
- Practical 21. Study of genetic traits in human beings (tongue rolling, widow's peak, ear lobes, color blindness and PTC tasters/ nontasters) (E)
- Practical 22. Study of normal human karyotype from metaphase chromosomal spread picture (E)
- Practical 23. Study of blood groups in human (ABO and Rh) (E)
- Practical 24. Study of any 3- cell organelles from electron micrographs (D)
- Practical 25. Compulsory visit to vermiculture unit/biodiversity spot/ZSI/large water body (E)

Note: Minimum 18 practical are to be performed by the students.

## REFERENCE BOOKS FOR F. Y. B. SC. ZOOLOGY

1. The Frog-its reproduction and development -By Robert Rugh,Tata McGraw Hill Edition,New Delhi
2. Biology of Animals By Ganguly,BB.,Sinha,A.K.,Adhikari,S.,New Central Book Agency,Kolkata
3. Arthropod Phylogeny By Gupta,A.P., Van Nostrand Co.,New York
4. Introduction to Amphibia By Bhamrah,MS.,Juneja,K.,Amol Publication,Delhi
5. Life of Vertebrates By Young,JZ., III Edition,Clarendon Press,London
6. General Zoology By Goodnight and others IBH Publishing Co.
7. Life of Invertebrates By Prasad,ASN,Vikas Publishing House,New Delhi
8. Textbook of Vertebrate Zoology By Prasad,SN.,Kashyap,V.,New Age India Publishers,New Delhi
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**UNIVERSITY OF PUNE**  
**BOARD OF STUDIES IN ZOOLOGY**  
**Revised Syllabus for S. Y. B. Sc. (Zoology) To be**  
**implemented from June, 2014**  
**S.Y. B. Sc. (Zoology) New Syllabus**

**Semester-I**

Paper I- ZY-211: Animal Systematics and Diversity – III

Paper II- ZY-212: Applied Zoology – I

**Semester-II**

Paper I- ZY-221: Animal Systematics and Diversity – IV

Paper II- ZY-222: Applied Zoology – II

**Semester-I and II (Annual Examination)**

Paper III- ZY-223: Practical course (Corresponding to Theory papers)



UNIVERSITY OF PUNE  
BOARD OF STUDIES IN ZOOLOGY  
COURSE STRUCTURE OF UNDERGRADUATE CLASSES

**Class: F.Y. B. Sc. (To be implemented from June 2013)**

Paper	Course No.	Term I	Term II
I	ZY 101	Animal Systematics and Diversity -I	Animal Systematics and Diversity -II
II	ZY 102	Fundamentals of Cell Biology	Genetics
III	ZY 103	Practical course	

**Class: S.Y. B. Sc. (To be implemented from June 2014)**

Paper	Course No.	Semester I	Course No.	Semester II
I	ZY.211	Animal Systematics and Diversity -III	ZY. 221	Animal Systematics and Diversity -IV
II	ZY.212	Applied Zoology I	ZY.222	Applied Zoology II
III	ZY.223	Practical course		

**Class: T.Y. B. Sc. (To be implemented from June 2015)**

Paper	Course	Semester III	Course	Semester IV
I	ZY.331	Animal Systematics and Diversity V	ZY.341	Biological Techniques
II	ZY.332	Mammalian Histology	ZY.342	Mammalian Physiology and Endocrinology
III	ZY.333	Biological Chemistry	ZY.343	Genetics and Molecular Biology
IV	ZY.334	Environmental Biology and Toxicology	ZY.344	Organic Evolution
V	ZY.335	Parasitology	ZY.345	General Embryology
VI	ZY.336	General Pathology or Cell Biology	ZY.346	Public Health and Hygiene or Medical Entomology
VII	ZY.347	Practicals corresponding to ZY 331, ZY 332, ZY 341 & ZY 342		
VIII	ZY.348	Practicals corresponding to ZY 333, ZY 334, ZY 343 & ZY 344		
IX	ZY.349	Practicals corresponding to ZY 335, ZY 336, ZY 345 & ZY 346		

**Prin. (Dr) D. K. Mhaske**  
Chairman, B.O.S. in Zoology  
University of Pune

## University of Pune

Draft of Syllabus to be implemented from June 2014

### S. Y. B. Sc. Zoology

#### Semester-I

Paper I- ZY-211: Animal Systematics and Diversity – III

Paper II- ZY-212: Applied Zoology – I

#### Semester-II

Paper I- ZY-221: Animal Systematics and Diversity – IV

Paper II- ZY-222: Applied Zoology – II

#### Semester-I and II (Annual Examination)

Paper III- ZY-223: Practical course (Corresponding to Theory papers)

#### Equivalence of Previous Syllabus:

Semester	Old Course (2009 Pattern)	New Course (2014 Pattern)
Semester-I	Paper I: General Zoology and Biological Techniques-I	Paper I: Animal Systematics and Diversity –III
Semester-I	Paper II: Applied Zoology-I	Paper II: Applied Zoology-I
Semester-II	Paper I: General Zoology and Biological Techniques-II	Paper I: Animal Systematics and Diversity –IV
Semester-II	Paper II: Applied Zoology-II	Paper II: Applied Zoology-II
Annual Examination	Paper III: Practical course	Paper III: Practical course

## **PAPER I: FIRST SEMESTER**

### **ZY-211: ANIMAL SYSTEMATICS AND DIVERSITY -III**

- 1. Salient features and classification upto classes of the following: (any two examples from each class) : 15**
  - 1.1** Arthropoda :- Crustacea, Arachnida, Insecta, Myriapoda, Onychophora.
  - 1.2** Mollusca:- Aplacophora, Gastropoda, Pelecypoda, Scaphopoda, Cephalopoda.
  - 1.3** Echinodermata:- Asteroidea, Ophuroidea, Holothuria, Echinoidea, Crinoidea.
- 2. Study of following with reference to: 15**
  - 2.1** Arthropoda:- Mouthparts in Insects, Metamorphosis in Insects, Mimicry in Insects,  
Economic importance of Insects, Larval forms in Crustacea
  - 2.2** Mollusca:- Economic importance of mollusc, Shell and foot modification in mollusc,  
Torsion and Detorsion in mollusc, Larval forms in molluscs
  - 2.3** Echinodermata:- Origin of Echinodermata, Types of Pedicellariae, Larval forms in Echinodermata,
- 3. Study of Starfish : 18**
  - 4.1** Systematic position, Habit and habitat
  - 4.2** External characters
  - 4.3** Digestive system
  - 4.4** Water vascular system
  - 4.5** Reproductive system
  - 4.6** Autotomy and regeneration

## PAPER –I: SECOND SEMESTER

### ZY-221: ANIMAL SYSTEMATICS AND DIVERSITY – IV

- 1. Salient features of following classes and its subclasses with two examples of each:** **12**
  - 1.1 Reptilia
  - 1.2 Aves
  - 1.3 Mammalia
- 2. General topics:** **16**
  - 2.1 Poisonous and non-poisonous snakes (Two examples each)
  - 2.2 Desert adaptations in reptiles in brief.
  - 2.3 Beak and feet modifications in birds
  - 2.4 Migration in birds
  - 2.5 Aerial adaptations in birds
  - 2.6 Egg laying mammals
  - 2.7 Aquatic mammals
- 3. Study of *Scoliodon* :** **20**
  - 3.1 Systematic position, Habit and habitat
  - 3.2 External characters
  - 3.3 Digestive system, food, feeding and physiology of digestion
  - 3.4 Respiratory system
  - 3.5 Blood vascular system
  - 3.6 Nervous system and sense organs
  - 3.7 Male urinogenital system and female reproductive system

**PAPER II: FIRST SEMESTER**  
**ZY-212: APPLIED ZOOLOGY – I**

- 1. Fisheries :**
- 1.1** An introduction to fisheries and its types (in brief) : Freshwater fisheries, Marine fisheries, Brackish water fisheries. **2**
- 1.2** Different types of ponds used in fishery : Nursery pond, Rearing pond  
Stock pond **2**
- 1.3** Habit, habitat and culture methods of following freshwater forms : **10**
- a) Rohu (*Labeo rohita*)
  - b) Catla (*Catla catla*)
  - c) Mrigal (*Cirrhinus mrigala*)
  - d) Giant prawn (*Macrobrachium rosenbergi*)
- 1.4** Harvesting methods of following marine forms : **4**
- a) Harpadon
  - b) Mackerel
  - c) Lobster
  - d) Pearl oyster
- 1.5** Crafts and gears in Indian Fishery : **2**
- a) Crafts – Catamaran, Machwa, Dinghy, Dug out canoe, Built –up boat  
Gears – Gill net, Dol net, Purse net, Rampani net, Cast net
- 1.6** Fishery byproducts : **2**
- a) Fish meal
  - b) Fish flour
  - c) Liver oil
  - d) Ising glass
  - e) Fish glue
  - f) Fish manure
  - g) Fish fin soup
- 1.7** Fish preservation technique : **2**
- a) Chilling
  - b) Freezing
  - c) Salting
  - d) Drying
  - e) Canning

## **2. Agricultural Pests and their control :**

- 2.1** An introduction to Pest, types of pests (agricultural, household, stored grain, structural, veterinary, forestry and nursery) **2**
- 2.2** Major insect pests of agricultural importance ( Marks of identification, life cycle, nature of damage and control measures) **9**
- a) Jowar stem borer
  - b) Red cotton bug
  - c) Brinjal fruit borer
  - d) Mango stem borer
  - e) Pulse beetle
  - f) Rice weevil
- 2.3** Non insect pest : Rats and Bandicoots, Crabs, Snails, Slugs, Birds and Squirrels **2**
- 2.4** Pest control practices in brief : Cultural control, Physical control, Mechanical control, Chemical control, Biological control, Pheromonal control and Concept of IPM in brief **6**
- 2.5** Plant protection appliances : Rotary duster, Knapsack sprayer, Cynogas Pump. **3**
- 2.6** Hazards of pesticides on human and antidotes. **2**

## PAPER II: SECOND SEMESTER

### ZY-222: APPLIED ZOOLOGY – II

#### 1. Apiculture :

- 1.1 An introduction to Apiculture, Study of habit, habitat and nesting behavior of *Apis dorsata*, *Apis indica*, *Apis florea* and *Apis mellifera*. 3
- 1.2 Life cycle, Colony organization and division of labour, Polymorphism 3
- 1.3 Bee behaviour and bee communication. 3
- 1.4 Bee keeping equipments : a) Bee box (Langstroth type) b) Honey extractor c) Smoker d) Bee-veil e) Gloves f) Hive tool g) Bee Brush h) Queen excluder 3
- 1.5 Bee keeping and seasonal management. 2
- 1.6 Bee products (collection methods, composition and uses: a) Honey b) Wax c) Bee Venom d) Propolis e) Royal jelly f) Pollen grains 4
- 1.7 Diseases and enemies of Bees:
- a) Bee diseases – Protozoan, Bacterial, Viral, Fungal – with two examples.
- b) Bee pests – Wax moth (Greater and Lesser), Wax beetle.
- c) Bee Enemies – Bee eater, King crow, Wasp, Lizard, Bear, Man. 5
- 1.8 Bee pollination 1

#### 2. Sericulture :

- 2.1 An introduction to sericulture, Study of different types of silk moths, their distribution and varieties of silk produced by Mulberry, Tassar, Eri and Muga silk worms in India. 4
- 2.2 External morphology and life cycle of *Bombyx mori*. 3
- 2.3 Cultivation of mulberry (moriculture): a) Varieties for cultivation, b) Rainfed and irrigated mulberry cultivation – Fertilize schedule, Pruning methods and leaf yield. 4
- 2.4 Harvesting of mulberry: a) Leaf plucking b) Branch cutting c) Whole shoot cutting. 2
- 2.5 Silk worm rearing: a) Types of rearing b) Rearing house c) Rearing techniques d) Important diseases and pests. 7
- 2.6 Post harvest processing of cocoons:
- a) Harvesting and Preparation of cocoons for marketing

- b) Stiffling, Sorting, Storage, Deflossing and Riddling**
- c) Cocoon cooking, Reeling Equipment and Rereeling,  
Washing and Polishing.**



### PAPER III: FIRST AND SECOND SEMESTER

#### ZY-223: PRACTICAL COURSE

- Practical 1. Study and classification with reasons of the following animals  
Phylum Arthropoda:- Scorpion, Crab, Cockroach, Head louse, Centipede,  
Peripatus (D)
- Practical 2. Study and classification with reasons of the following animals  
Phylum Mollusca:- Chiton, Snail, Bivalve, Dentalium, Octopus, (D)
- Practical 3. Study and classification with reasons of the following animals  
Phylum Echinodermata:- Star fish, Brittle star, Holothuria, Sea Urchin,  
Echinus (D)
- Practical 4. Study of permanent slides of mouthparts of the following insects : (D)  
Cockroach, Mosquito, Plant bug/Bed bug, Butterfly, Honey Bee and Housefly
- Practical 5. A) Study of Shell:- Chiton, Pila, Sepia, Pecten, Dentalium,  
B) Study of Foot:- Chiton, Patella, Aplysia, Sepia, Octopus, Dentalium (D)
- Practical 6. To Study the external characters and digestive system of *starfish*. (E)
- Practical 7. A) Study of water vascular system of *starfish*. (E)  
B) Temporary preparation of gonads from *starfish*. (E)
- Practical 8. A) Study of permanent slides of T. S. of arm and types of pedicellariae  
of *starfish*. (D)  
B) Larval forms in Echinodermata. (D)
- Practical 9. Identification, Classification and study of habit, habitat and economic  
importance of the following:  
a) Rohu, Catla, Mrigal, Pomphret. (D)  
b) Prawn, Crab, Oyster. (D)
- Practical 10. Study and maintenance of Aquarium. (E)
- Practical 11. Study of any three types of crafts and gears in fishing. (D)
- Practical 12. Study of insect pests with respect to marks of identification, nature of  
damage and economic importance (Examples related to theory course) (D)
- Practical 13. Study of pest control appliances (Sprayer/Duster) (D)
- Practical 14. Study and classification with reasons of the following animals (D)  
Class Reptilia – Cobra, Garden lizard, Turtle, Rat snake, Draco

- Practical 15. Study and classification with reasons of the following animals (D)  
 Class Aves – Sparrow, Crow, Parrot, Woodpecker  
 Class Mammals – Rabbit, Mongoose, Kangaroo
- Practical 16. Identification of Poisonous and non- poisonous snakes with the help of identification key with two examples of each (D)
- Practical 17. Study of modifications of beaks and feet in birds (Museum specimen) (D)  
 a) Beaks: tearing and piercing, fruit eating, mud probing, fish catching, wood chiseling and flower probing.  
 b) Feet: perching, raptorial, climbing, swimming, running.
- Practical 18. Study of external characters and digestive system of *Scoliodon*. (E)
- Practical 19. Study of brain of *Scoliodon* (E)
- Practical 20. a) Temporary preparation of placoid scales from *Scoliodon* (E)  
 b) Study of cranial nerves, eye ball muscles of *Scoliodon* (D)  
 c) Study of Membranous labyrinth of *Scoliodon* (D)
- Practical 21. a) Study of life cycle of Honey bee (D)  
 b) Study of mouth parts, thoracic appendages (legs and wings) and sting apparatus of Honey bee (E)
- Practical 22. Study of various bee keeping equipments (D)
- Practical 23. Study of: a) bee products, b) bee pests, d) bee enemies (D)
- Practical 24. a) Study of life cycle of *Bombyx mori*. (D)  
 b) Study of any five equipments in Sericulture. (D)
- Practical 25. Compulsory submission of field visit report along with at least five Photographs/ sketches of insect pest/fishes/any animal corresponding to theory courses
- Practical 26. Compulsory study tour/visit to sea coast/fishery institute/sericulture farm/apiculture institute / agricultural farm.

## Practical Skeleton Paper

**Class – S.Y.B.Sc.**

**Subject – Zoology**

**Time – 10.00 am onwards**

**Max. Marks – 80**

- Q.1 – Dissect Starfish/*Scoliodon* so as to expose its.....system. (16)
- Q.2 – Make a stained temporary preparation of .....  
from Honey bee/Starfish/*Scoliodon* (10)
- Q.3 – Identification (Non-chordates and Chordates) (21)
- a) Identify and classify giving reasons (Arthropoda)
  - b) Identify and classify giving reasons (Mollusca/Echinodermata)
  - c) Identify and classify giving reasons (Cyclostomata/Reptiles)
  - d) Identify and classify giving reasons (Aves/Mammals)
  - e) Identify and describe the types of mouthparts of insect
  - f) Identify and describe (Shell/Foot of mollusca/Poisonous/Non poisonous snake)
  - g) Identify and comment on its modifications (Beak/feet modifications in birds)
- Q.4 – Identification (Applied Zoology) (18)
- a) Identify and give its economic importance (Any fish)
  - b) Identify and describe (Any gear/craft)
  - c) Identify and give its application (Plant protection appliance)
  - d) Identify and describe (One stage of life cycle of honeybee/silkworm)
  - e) Identify and describe (Sericulture equipment)
  - f) Identify and describe (Bee keeping equipment/Bee product)
- Q.5 – a) Tour report and Certified Journal (05)
- b) Viva- voce (05)
- Q.6- Submission of field visit report along with five photographs/sketches  
of insect pest/fishes/any animal (05)

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4. Invertebrate Zoology, 1982, R. D. Barnes, Saunders College, Philadelphia.
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10. Diversity of Organisms. Edited by Caroline M., Pond Biology- Form and Function. Published by Hodder and Stoughton, The Open University, London.
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### ZY- 212 Applied Zoology Part- I

#### Fisheries & Agricultural pests and their Control

1. Fishes . Mary Chandy. N.B.T. India, 2005.
2. Economic Zoology, Shukla Upadhyay, Rastogi Publication, Meerut, India, 1998.
3. Fisheries Developments, K.K. Trivedi, Oxford and IBH Pub. Co.
4. Marine Fishes in India, 1990, D.V.Bal & K. Virabhdra, tata McGraw Hill Publication.
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13. Applied Entomology. Vol. I & II. K.P. Srivastava. Kalyani Publication, Ludhiyana, New Dehli.
14. Principles of Insect Pest Management. G.S. Dhaliwal and Ramesh Arora, Kalyani Publications, Ludhiyana.
15. Pest Management and Pesticides: Indian Scenario. Editor- B. Vasantaraj David, Namrutha Publications, Madras (Chennai).
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### **ZY- 221 Animal Systematics and Diversity - IV**

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## **ZY-222 Applied Zoology Part-II**

### **Apiculture and Sericulture**

1. Destructive and useful Insects, their habit and Control, 1973. C.L. Metcalf and W. p. Flint, Tata McGraw Hill Publications, New Dehli.
2. A Text Book Of Entomology, 1974. V.K. Mathur and K.D. Upadhayay, Goel Printing Press, Barani.
3. Imm's Text Book of Entomology, Vol I & II, Richard and Owen.
4. Biology of Insects, 1992. S.C. Saxena. Oxford and IBH Publishing Co., New Dehli. Bombay, Calcutta.
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7. Principal of Sericulture, 1994. Hisao Arguo, Oxford & Co.
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**SAVITRIBAI PHULE PUNE UNIVERSITY, PUNE**

**Three Year B. Sc. Degree Course in**

***Zoology***

**Principal Dr. D. K. Mhaske**

***Chairman,***

***Board of Studies in Zoology,***

***Savitribai Phule Pune University, Pune. 411 007***



**1) Title of the Course: B. Sc. Zoology**

**F. Y. B. Sc. Zoology**

**(To be implemented from Academic Year 2013-14)**

**2) Preamble:**

The well organized curricula including basic as well as advanced concepts in Zoology from first year to third year shall inspire the students for pursuing higher studies in Zoology and for becoming an entrepreneur and also enable students to get employed in the Biological research Institutes, Industries, Educational Institutes and in the various concerning departments of State and Central Government based on subject Zoology.

**3) Introduction:**

At **first year of under-graduation** the topics related to the fundamentals of zoology, including exposure to diversity in animal groups and industries based on the zoological areas are covered. The practical course is aimed at to equip the students with skills required for animal identification, morphological, anatomical, technical description, classification and also applications of zoology in the various industries.

At **second year under-graduation**: The level of the theory and practical courses shall be one step ahead of the first year B.Sc. courses based on the content of first year shall be introduced.

At **third year under-graduation**: Theory and practical courses in each semester shall deal with the further detailed studies of the various disciplines of the Zoology subject and other branches of Zoology such as Genetics, Animal Physiology, Molecular Biology, Biochemistry, Microtechnique, Non-chordate and Chordate, Developmental Biology, Histology, Cell Biology, Biodiversity, Public health and hygiene, Pathology, Entomology, Biotechnology, etc. The students will also learn about use of various technical skills in the biological sciences to be helpful during research in the Zoology subject.

**Objectives:**

- To provide thorough knowledge about various animal sciences from primitive to highly evolved animal groups.
- To make the students aware of applications of Zoology subject in various industries.
- To highlight the potential of various branches of Zoology to become an entrepreneur.

- To equip the students with skills related to laboratory as well as field based studies.
- To make the students aware about conservation and sustainable use of biodiversity.
- To inculcate interest and foundation for further studies in Zoology.
- To address the socio-economical challenges related to animal sciences.
- To facilitate students for taking up and shaping a successful career in Zoology.

#### 4) Eligibility:

1. **First Year B.Sc.:** A student who has passed the Higher Secondary School Certificate (10+2) Science stream with Biology or its equivalent examination as per the Savitribai Phule Pune University, Pune eligibility norms.
2. **Second Year B.Sc.:** Keeping terms of First Year of B. Sc. with zoology as one of the subjects. Other students if they fulfill the conditions approved by the equivalence committee by Faculty of Science of the Savitribai Phule Pune University, Pune are also eligible.
3. **Third Year B.Sc.:** Student shall pass all First Year B. Sc. courses and satisfactorily keeping terms of Second Year of B. Sc. with zoology as one of the subjects.

**Note:** Admissions will be given as per the selection procedure / policies adopted by the respective college, in accordance with terms and conditions laid down by the Savitribai Phule University of Pune. Reservation and relaxation will be as per the Government rules.

#### 5 A) Examination Pattern:

##### First Year B. Sc. Zoology

Pattern of Examination : Annual

Theory courses	Zoology Theory Paper I : Annual
	Zoology Theory Paper II : Annual
Practical Course	Annual

Paper/ Course No.	Title	Total Number of lectures/practicals per Term	Standard of passing		
			Internal marks out of <b>20</b>	External marks out of <b>80</b>	Total marks out of <b>100</b>
Theory Paper I ZY-101 (First term)	Animal Systematics and Diversity -I	Three lectures/Week (Total 36 lectures per term)	8	32	40*
Theory Paper I ZY-101 (Second term)	Animal Systematics and Diversity -II	Three lectures/Week (Total 36 lectures per term)			
Theory Paper II ZY-102 (First term)	Fundamentals of Cell Biology	Three lectures/Week (Total 36 lectures per term)	8	32	40*
Theory Paper II ZY-102 (Second term)	Genetics	Three lectures/Week (Total 36 lectures per term)			
Practical Paper III ZY-103 (First & Second Term)	Practical	9 Practicals of 4 lectures in each term (18 practicals / year)	8	32	40*

\* Subject to compulsory passing in external examination and getting minimum 40 marks out of 100

**Notes:**

1. Total marks: Theory (100 + 100 ) = 200 marks
2. Total marks per year 200 (Theory) + 100 marks (practicals) = 300 marks
3. Internal marks for theory papers be given on the basis of internal assessment, tests etc.

**Theory examination** will be of three hours duration for each theory course. There shall be 5 questions each carrying equal marks. The pattern of question papers shall be:

Question 1	8 sub-questions, each of 2 marks; answerable in 2 -3 lines and based On entire syllabus
Question 2 and 3	4 out of 6 - short answer type questions; answerable in 8 – 10 lines
Question 4	2 out of 4 – Descriptive answer type questions, answerable in 15 – 20 lines
Question 5	1 out of 2 – Descriptive answer type questions, answerable in 35 – 40 lines

**Internal examination:** Internal assessment of the student by respective teacher will be based on written test, 10 marks in each term. The written test shall comprise objective type questions – Multiple choice questions, True / False, Definitions, Answer in one or two line questions. There shall be 20 questions.

Practical: Regular assessment of each practical for 20 marks each: Marks for journal: 10, Marks for attendance: 05, Marks for experimental skills: 05.

**Practical Examination:** Practical examination shall be conducted by the respective college at the end of the academic year. Practical examination will be of more than 4 hours duration. Certified journal is compulsory for appearing in practical examination. There shall be two expert and two examiners per batch for the practical examination.

### Second Year B. Sc. Zoology

(To be implemented from academic year 2014-2015)

Pattern of examination: Semester

Theory courses: Sem I: ZY- 211 and ZY- 212: Semester

Sem II: ZY-221 and ZY-222: Semester

Practical Course: Annual

Paper/ Course No.	Title	Total Number of lectures/practicals per Term	Standard of passing		
			Internal marks out of <b>10</b> (Theory) out of <b>20</b> (Practical)	External marks out of <b>40</b> (Theory) out of <b>80</b> (Practical)	Total passing marks out of <b>50</b> (Theory) out of <b>100</b> (Practical)
ZY- 211	Animal Systematics and Diversity -III	Four lectures/Week (Total 48 per semester )	4	16	20*
ZY- 212	Applied Zoology I	Four lectures/Week (Total 48 per Semester )	4	16	20*
ZY-211	Animal Systematics and Diversity -IV	Four lectures/Week (Total 48 per Semester )	4	16	20*
ZY- 212	Applied Zoology II	Four lectures/Week (Total 48 per Semester )	4	16	20*
ZY-223 (Semester- I and II)	Paper III Practical course	12 Practicals of 4 lectures in each Semester (24 practicals / year)	8	32	40**

- \* Subject to compulsory passing in external examination and getting minimum 20 marks out of 50
- \*\* Subject to compulsory passing in external examination and getting minimum 40 marks out of 100

**Notes:**

1. Total marks: Theory for each semester (50 + 50 ) = 100 marks
2. Total marks per year 200 (Theory) + 100 marks (practicals) = 300 marks
3. Internal marks for theory papers be given on the basis of internal assessment tests.
4. Internal marks for Practical Course should be a regular assessment of each practical for 20 marks each : Marks for journal : 10, Marks for attendance : 05, Marks for experimental skills : 05.

**Theory examination** will be of two hours duration for each theory course. There shall be 4 questions each carrying equal marks as follows: The pattern of question papers shall be:

Question 1	10 sub-questions, each of 1 marks based on entire syllabus	10 marks
Question 2 and 3	2 out of 3 sub-questions, each of 5 marks; short answer type questions; answerable in 10-15 lines	10 marks each
Question 4	1 out of 2 sub-questions, each of 10 marks; long answer type questions (20-25lines)	10 marks

**Internal examination:** Internal assessment of the student by respective teacher will be based on written test, 10 marks each Semester. The written test shall comprise of objective type questions – Multiple choice Questions, True / False, Definitions and Answer in Two or three lines. There shall be 20 questions.

Practicals: Regular assessment of each practical for 20 marks each: Marks for journal:10, Marks for attendance: 05, Marks for experimental skills: 05

**Practical Examination:** Practical examination shall be conducted at the respective college at the end of the academic year. Practical examination will be of more than 4 hours duration. Certified journal is compulsory for appearing in practical examination. There shall be two expert and two examiners per batch for the practical examination. One of the examiners will be external.

**Third Year B. Sc. Zoology**  
**(To be implemented from academic year 2015-2016)**

Pattern of examination: Semester

Theory courses: (Sem III: ZY-331 to ZY-336) : Semester

(Sem IV: ZY- 341 to ZY-346) : Semester

Practical Course:(ZY-347-349) : Annual

<b>Theory Papers</b>					
Paper/Course No.	Title	Total Number of lectures Per Semester	Standard of passing		
			Internal marks out of <b>10</b> (Theory) out of <b>20</b> (Practical)	External marks out of <b>40</b> (Theory) out of <b>80</b> (Practical)	Total passing marks out of <b>50</b> (Theory) out of <b>100</b> (Practical)
<b>SEM III</b>					
ZY-331	Animal Systematics and Diversity V	48	4	16	20*
ZY-332	Mammalian Histology	48	4	16	20*
ZY-333	Biological Chemistry	48	4	16	20*
ZY-334	Environmental Biology and Toxicology	48	4	16	20*
ZY-335	Parasitology	48	4	16	20*
ZY-336	General Pathology or Cell Biology	48	4	16	20*
<b>SEM IV</b>					
ZY-341	Biological Techniques	48	4	16	20*
ZY-342	Mammalian Physiology and Endocrinology	48	4	16	20*
ZY-343	Genetics and Molecular Biology	48	4	16	20*
ZY-344	Organic Evolution	48	4	16	20*
ZY-345	General Embryology	48	4	16	20*
ZY-346	Public Health and Hygiene or Medical Entomology	48	4	16	20*

Practical Papers					
ZY- 347 (Semester III & IV)	Practical Paper I	Practicals related to ZY-331, ZY-332, ZY-341, ZY-342. 12 Practical of 4 lectures in each Semester (24 Practical / year)	8	32	40**
ZY- 348 (Semester III & IV)	Practical Paper II	Practicals related to ZY-333, ZY-334, ZY-343, ZY-344. 12 Practical of 4 lectures in each Semester (24 Practical / year)	8	32	40**
ZY- 349 (Semester III & IV)	Practical Paper III	Practicals related to ZY-335, ZY-336, ZY-345, ZY-346. 12 Practical of 4 lectures in each Semester (24 Practical / year)	8	32	40**

\* Subject to compulsory passing in external examination and getting minimum 20 marks out of 50

\*\* Subject to compulsory passing in external examination and getting minimum 40 marks out of 100

**Notes:**

1. Total marks: Theory for each semester ( $50 \times 6$ ) = 300 marks
2. Total marks per year 600 (Theory) + 300 marks (practicals) = 900 marks
3. Internal marks for theory papers be given on the basis of internal assessment tests.
4. Practicals: Regular assessment of each practical for 20 marks each: Marks for journal: 10, Marks for attendance: 05, Marks for experimental skills: 05.

**Theory examination** will be of two hours duration for each theory course. There shall be 4 questions each carrying 10 marks. The pattern of question papers shall be:

Question 1	10 sub-questions, each of 1 marks based on entire syllabus	10 marks
Question 2 and 3	2 out of 3 sub-questions, each of 5 marks; short answer type questions; answerable in 10 – 15 lines	10 marks each
Question 4	1 out of 2 sub-questions, each of 10 marks; long answer type questions (20 – 25 lines)	10 marks

**Internal examination:** Internal assessment of the student by respective teacher will be based on written test, 10 marks each Semester. The written test shall comprise of objective type questions – Multiple choice questions, True / False, Definitions, Answer in Two or three line questions. There shall be 20 questions.

Practicals: Regular assessment of each practical for 20 marks each: Marks for journal: 10, Marks for attendance: 05, Marks for experimental skills: 05.

**Practical Examination:** Practical examination shall be conducted at the respective college at the end of the academic year. Practical examination will be of more than 4 hours duration. Certified journal is compulsory to appear for practical examination. There shall be two expert and two examiners per batch for the practical examination. One of the examiners will be external.

#### 5 B) Standard of Passing:

- i) In order to pass in the first year theory examination, the candidate has to obtain 40 marks out of 100 in each course. (Minimum 32 marks out of 80 must be obtained in the University Theory Examination.)
- ii) In order to pass in the Second Year and Third Year theory examination, the candidate has to obtain 20 marks out of 50 in each course of each semester. (Minimum 16 marks out of 40 must be obtained in the University Theory Examination.)
- iii) In order to pass in practical examination, the candidate has to obtain 40 marks out of 100 in each course. (Minimum 32 marks out of 80 must be obtained in the University Examination.)

#### 5 C) ATKT Rules:

While going from F.Y.B.Sc. to S.Y.B.Sc. at least 8 courses (out of total 12) should be passed; however all F.Y.B.Sc. courses should be passed while going to T.Y.B.Sc.

While going from S.Y.B.Sc. to T.Y.B.Sc., at least 12 courses (out of 20) should be passed (Practical Course at S.Y.B.Sc. is equivalent to 2 courses).

#### 5 D) Award of Class:

The class will be awarded to the student on the aggregate marks obtained during the second and third year in the principal subject only. The award of the class shall be as follows:

1	Aggregate 70% and above	First Class with Distinction
2	Aggregate 60% and more but less than 69%	First Class
3	Aggregate 55% and more but less than 59%	Higher Second Class
4	Aggregate 50% and more but less than 54%	Second Class
5	Aggregate 40% and more but less than 49%	Pass Class
6	Below 40%	Fail



**5 E) External Students:**

There shall be no external students.

**5 F) Setting of question papers:**

**F. Y. B. Sc.:** For theory papers I and II annual question papers shall be set by the University of Pune and assessment shall be done at the respective colleges. Questions should be designed to test the conceptual knowledge and understanding of the basic concepts of the subject. For Practical Paper III, papers shall be set by the University of Pune and assessment done at the respective colleges.

**S. Y. B. Sc. and T. Y. B. Sc.:** For theory papers for each semester and also for the annual practical examination, question papers shall be set by the University of Pune. Centralized assessment for theory papers shall be done as per the University instructions. Questions should be designed to test the conceptual knowledge and understanding of the basic concepts of the subject. For Practical Papers, papers shall be set by the University of Pune and assessment shall be done by the internal examiner and external examiner appointed by University of Pune.

**5 G) Verification and Revaluation Rules:**

As per University Statues and Rules for verification and revaluation of marks in stipulated time after declaration of the semester examination result.

**6 Course Structure:**

**Duration:** The duration of B.Sc. Zoology Degree Program shall be three years.

**a) Compulsory Papers:**

F. Y. B. Sc.: 2 Theory + 1 Practical (Annual)

S. Y. B. Sc.: 2 Theory per semester + 1 Practical (Annual)

T. Y. B. Sc.: 6 Theory per semester + 3 Practical (Annual)

**b) Question Papers :**

**F. Y. B. Sc. Theory paper:**

University Examination – 80 marks (at the end of 2<sup>nd</sup> term)

Internal Examination – 20 marks

**S. Y. / T. Y. - B. Sc. Theory paper:**

University Examination – 40 marks (at the end of each term)

Internal Examination – 10 marks

**F. Y. / S. Y. / T. Y. - B. Sc. Practical Paper:**

University Examination – 80 marks (at the end of 2<sup>nd</sup> term)

Internal Examination – 20 marks

**Medium of Instruction:** The medium of instruction for the course shall be **English**.

**7 Equivalence of Previous Syllabus:**

**F.Y.B.Sc. :-**

Old Course (2008 Pattern)	New Course (2013 Pattern)
Paper I: Nonchordates and Chordates	Animal Systematics and Diversity –I and II
Paper II: Genetics and Parasitology	Fundamentals of Cell Biology and Genetics
Paper III: Practical course	Paper III: Practical course

**S.Y.B.Sc. :-**

Semester	Old Course (2009 Pattern)	New Course (2014 Pattern)
Semester-I	Paper I: General Zoology and Biological Techniques-I	Paper I: Animal Systematics and Diversity –III
Semester-I	Paper II: Applied Zoology-I	Paper II: Applied Zoology-I
Semester-II	Paper I: General Zoology and Biological Techniques-II	Paper I: Animal Systematics and Diversity –IV
Semester-II	Paper II: Applied Zoology-II	Paper II: Applied Zoology-II
Annual Examination	Paper III: Practical course	Paper III: Practical course

**T.Y.B.Sc. :-**

**Semester- III**

	Papers in Old Course (2010 Pattern)		Equivalent papers in new Course (2015 Pattern)
ZY-331	General Zoology	ZY-331	Animal Systematics and Diversity V
ZY-332	Mammalian Histology	ZY-332	Mammalian Histology
ZY-333	Biological Chemistry	ZY-333	Biological Chemistry
ZY-334	Environmental Biology and Toxicology	ZY-334	Environmental Biology and Toxicology
ZY-335	Any one of the following a. Basic Entomology b. General Pathology	ZY-335	Parasitology
ZY-336	Cell Biology	ZY-336	Any one of the following a. General Pathology b. Cell Biology

#### Semester-IV

	<b>Papers in Old Course (2010 Pattern)</b>		<b>Equivalent papers in new Course (2015 Pattern)</b>
ZY-341	Biotechnology	ZY-341	Biological Techniques
ZY-342	Mammalian Physiology and Endocrinology	ZY-342	Mammalian Physiology and Endocrinology
ZY-343	Molecular Biology	ZY-343	Genetics and Molecular Biology
ZY-344	Organic Evolution	ZY-344	Organic Evolution
ZY-345	Any one of the following a. Biodiversity b. Public Health and Hygiene	ZY-345	General Pathology
ZY-346	Genetics and Developmental Biology	ZY-346	Any one of the following a. Public Health and Hygiene b. Medical Entomology
ZY-347	Practical I ZY-331, ZY-332, ZY-341, ZY-342	ZY-347	Practical I ZY-331, ZY-332, ZY-341, ZY-342
ZY-348	Practical II ZY-333, ZY-334, ZY-343, ZY-344	ZY-348	Practical II ZY-333, ZY-334, ZY-343, ZY-344
ZY-349	Practical III ZY-335, ZY-336, ZY-345, ZY-346	ZY-349	Practical III ZY-335, ZY-336, ZY-345, ZY-346

**8 University Terms:** Dates for commencement and conclusion for the first and second terms will be declared by the University authorities. Terms can be kept by only duly admitted students. The term shall be granted only on minimum 75 percent attendance at theory and practical course and satisfactory performance during the term.

**9 Qualification of Teachers:** M.Sc. Zoology or equivalent master degree in science with class/grades and NET/SET/Ph.D. as per prevailing rules and regulations laid down by University/Government /UGC.

**SAVITRIBAI PHULE PUNE UNIVERSITY**

**BOARD OF STUDIES IN ZOOLOGY**

**Revised Syllabus for T. Y. B. Sc. (Zoology) to be implemented from June, 2015**

**Semester-III:-**

- ZY-331: Animal Systematics and Diversity V
- ZY-332: Mammalian Histology
- ZY-333: Biological Chemistry
- ZY-334: Environmental Biology and Toxicology
- ZY-335: Parasitology
- ZY-336: General Pathology or Cell Biology

**Semester-IV:-**

- ZY-341: Biological Techniques
- ZY-342: Mammalian Physiology and Endocrinology
- ZY-343: Genetics and Molecular Biology
- ZY-344: Organic Evolution
- ZY-345: General Embryology
- ZY-346: Public Health and Hygiene or Medical Entomology
- ZY-347: Practical I- ZY-331, ZY-332, ZY-341, ZY-342
- ZY-348: Practical II- ZY-333, ZY-334, ZY-343, ZY-344
- ZY-349: Practical III- ZY-335, ZY-336, ZY-345, ZY-346

**SAVITRIBAI PHULE PUNE UNIVERSITY**  
**BOARD OF STUDIES IN ZOOLOGY**  
**COURSE STRUCTURE OF UNDERGRADUATE CLASSES**  
**(To be implemented from June 2015)**

**Class: F.Y. B. Sc.**

Paper	Course No.	Term I	Term II
I	ZY 101	Animal Systematics and Diversity -I	Animal Systematics and Diversity –II
II	ZY 102	Fundamentals of Cell Biology	Genetics
III	ZY 103	Practical course	

**Class: S.Y. B. Sc.**

Paper	Course No.	Semester I	Course No.	Semester II
I	ZY.211	Animal Systematics and Diversity -III	ZY. 221	Animal Systematics and Diversity –IV
II	ZY.212	Applied Zoology I	ZY.222	Applied Zoology II
III	ZY.223	Practical course		

**Class: T.Y. B. Sc.**

Paper	Course	Semester III	Course	Semester IV
I	ZY.331	Animal Systematics and Diversity V	ZY.341	Biological Techniques
II	ZY.332	Mammalian Histology	ZY.342	Mammalian Physiology and Endocrinology
III	ZY.333	Biological Chemistry	ZY.343	Genetics and Molecular Biology
IV	ZY.334	Environmental Biology and Toxicology	ZY.344	Organic Evolution
V	ZY.335	Parasitology	ZY.345	General Embryology
VI	ZY.336	General Pathology or Cell Biology	ZY.346	Public Health and Hygiene or Medical Entomology
VII	ZY.347	Practicals corresponding to ZY 331, ZY 332, ZY 341 & ZY 342		
VIII	ZY.348	Practicals corresponding to ZY 333, ZY 334, ZY 343 & ZY 344		
IX	ZY.349	Practicals corresponding to ZY 335, ZY 336, ZY 345 & ZY 346		

**Prin. (Dr) D. K. Mhaske**  
Chairman, B.O.S. in Zoology  
Savitribai Phule Pune University, Pune

**T. Y. B. Sc. Zoology**  
**ZY- 331 (Paper I)**  
**Animal Systematics and Diversity- V**

**Total lectures: 48**

- |          |  |           |
|----------|--|-----------|
| <b>1</b> | <b>Study of <i>Pila globosa</i> with reference to the following:</b>   | <b>12</b> |
|          | 1.1 Systematic position, habit, habitat and external characters  |           |
|          | 1.2 Body wall & pallial complex  |           |
|          | 1.3 Functional anatomy: digestive, respiratory, circulatory, excretory, reproductive, nervous system & sense organs                                |           |
| <b>2</b> | <b>Study of the following groups with reference to:</b>  | <b>08</b> |
|          | 2.1 Protozoa : locomotion & nutrition  |           |
|          | 2.2 Porifera : skeleton and canal system   |           |
|          | 2.3 Coelenterata : polymorphism and corals   |           |
|          | 2.4 Hemichordata : affinities  |           |
| <b>3</b> | <b>Study of <i>Calotes versicolor</i> with reference to the following :</b>  | <b>14</b> |
|          | 3.1 Systematic position, habit, habitat and External characters  |           |
|          | 3.2 Functional Anatomy - Digestive, Circulatory, Excretory, Reproductive, Nervous system and Sense organs  |           |
| <b>4</b> | <b>Comparative study of following topics in vertebrates</b>  | <b>08</b> |
|          | 4.1 <b>Integument:</b> Skin of <i>Scoliodon</i> , Frog, <i>Calotes</i> , Pigeon & Rat  |           |
|          | 4.2 <b>Heart:</b> Structure of heart of <i>Scoliodon</i> , Frog, <i>Calotes</i> , Pigeon & Rat   |           |
|          | 4.3 <b>Kidney:</b> Evolution of Archinephros, Pronephros, Mesonephros, Metanephros   |           |
|          | 4.4 <b>Brain:</b> Morphological variation in the different regions of the brain of <i>Scoliodon</i> , Frog, <i>Calotes</i> , Pigeon and Rat/Rabbit |           |
| <b>5</b> | <b>Study of following groups with reference to</b>   | <b>06</b> |
|          | 5.1 Pisces : Dipnoi, Accessory respiratory organs , Electric organs  |           |
|          | 5.2 Reptilia : Temporal vacuities, General characters of Rhyncocephalia  |           |
|          | 5.3 Mammalia : Dentition in mammals  |           |

### Reference Books

1. Living Invertebrates, 1987: Pearse, Buchsbaum, Blackwell Scientific Publication, California.
2. A Text book of Zoology Invertebrates, Vol. I 1992, 7<sup>th</sup> Edn. Parker and Haswell edited by Marshall William, C B S publishers and distributors, New Delhi.
3. Invertebrate Zoology, 1992; S. N. Prasad, Vikas Publishing House, New Delhi.
4. Life of Invertebrates, 1992; S.N. Prasad, Vikas Publishing House, New Delhi.
5. Invertebrate Zoology, 1992 4<sup>th</sup> Edn., reprint, P.S. Dhami and J. K. Dhami, R. Chand and Co., New Delhi.
6. Modern text book of Zoology, Invertebrates 10<sup>th</sup> Edn., 2009, R.L. Kotpal, Rastogi publ., Meerut.
7. Invertebrates Structure and Function, 2<sup>nd</sup> Edn.1979, EJW Barrington, John Wiley and Sons Inc.
8. Invertebrates Zoology, 1994, 6<sup>th</sup> Edition, Ruppert, E. Edward, R. D. Barnes; Saunders college Publishing, USA.
9. Invertebrate Zoology, 1991, P.A. Meglitsch and F. R. Schram, Oxford University Press; New York.
10. Invertebrate: A New synthesis, 1988, R.S.K. Barnes, P. Calow and P.J.W., Olive Blackwell Scientific, U.K.
11. An Introduction to Protochordata, 1990, H. S. Bhamrah and KavitaJuneja, Anmol publication, New Delhi.
12. The invertebrates: Protozoa through Ctenophora Vol.I, 1959, Hyman, Libbie Henrietta, McGraw-Hill Book Co., Inc. New York.
13. A text book of Zoology, Vol.II, 1990, T. J. Parker and W. A. Haswell, Low price Publication, Delhi.
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15. Chordate Zoology, 1982, P. S. Dhami and J. K. Dhami, R. Chand and Co., New Delhi.
16. The life of Vertebrates, 3<sup>rd</sup> edn.1993, J. Z. Young, Oxford University Press, USA.
17. The Phylum Chordata: Biology of Vertebrates and their Kin, 1987, H. H. Newman, Distributor Satish book enterprise, Agra.
18. A text book of Zoology, 1984, R. D. Vidyarthi, S. Chand and Co., New Delhi.
19. Comparative Anatomy of the Vertebrates, G. C. Kent, R. K Carr, 9<sup>th</sup>Edn., 2001, McGraw Hill, Boston, USA

20. Practical Zoology Invertebrates, 11<sup>th</sup> revised Edn., 2014, S. S. Lal, Rastogi publ., Meerut.
21. Vertebrate Practical Zoology, 11<sup>th</sup> revised Edition, 2014, S. S. Lal, Rastogi publ., Meerut.
22. Practical Zoology, 2004, Vijay Laxmi Sharma, Paragon International Publishers.
23. The anatomy of Garden Lizard, 1974, S.Y. Paranjape, Pune University Publication, Pune.
24. Chordate Zoology, 2009 reprint, E. L. Jorden, S. Chand and Co., New Delhi.
25. Text book of Zoology, Vertebrates, Vol. II, T.J. Parker and W.A. Haswell, edited by Marshall and Williams, CBS Publications, New Delhi.



**ZY- 332 (Paper II)**  
**Mammalian Histology**

**Total lectures: 48**

<b>1</b>	<b>Introduction</b>	<b>1</b>
	1.1 Definition and scope	
<b>2</b>	<b>Tissues:</b>	<b>6</b>
	2.1 Definitions and review of tissues (location, structure and functions): epithelial, connective, nervous and muscular	
<b>3</b>	<b>Histological study of following organs</b>	
	3.1 Skin (V.S.)	3
	3.2 Tooth (V.S.)	2
	3.3 Tongue (C.S.) with reference to mucosa papillae and taste buds	2
	3.4 Alimentary canal: Basic histological organization with reference to: Oesophagus (T.S.), stomach (T.S.), duodenum (T.S.) Ileum (T.S.) and rectum (T.S.)	8
	3.5 Glands associated with digestive system:	6
	Salivary glands – parotid (C.S.), submandibular (C.S.) sublingual (C.S.), liver (C.S.) and pancreas (C.S.) including both exocrine and endocrine components	
	3.6 Respiratory organs: Trachea (T.S.) and lung (C.S.)	2
	3.7 Blood vessels: Artery (T.S.), vein (T.S.) and capillaries (T.S.)	2
	3.8 Kidney (L.S.), Structure of nephron and juxtaglomerular complex	4
	3.9 Reproductive organs:	6
	a) Testis (T.S.) with reference to Seminiferous Tubules and cells of Leydig	
	b) Ovary (C.S.) - primary, secondary and matured (Graffian) follicle, corpus luteum and corpus albicans	
<b>4</b>	<b>Histology of endocrine glands :</b>	<b>6</b>
	4.1 Pituitary gland	
	4.2 Thyroid gland	
	4.3 Adrenal gland	

### Reference Books

1. Inderbir Singh's Textbook of Human Histology (With Colour Atlas and Practical Guide), 2014, 7<sup>th</sup> Edn., Neelam Vasudeva and Sabita Mishra, Jaypee Brothers Medical Publishers, New Delhi, India.
2. Bailey's Text book of Histology, 1971, 16th edn. Wilfred M. Copenhaver, Richard P. Bung & Mary Bartell Bunge, The William & Wilkins Company, Baltimore.
3. Histology, 1987, 9th Edn., Arthur W. Ham, David H. Cormack, J. B. Lippincott Co. Philadelphia.
4. Essential Histology, 2001, 2<sup>nd</sup> Edition, David H. Cormack, Lippincott Williams & Wilkins, Philadelphia.
5. A text book of Histology, 2014, 5<sup>th</sup> edn. Krishna Garg, Indira Bahl & Mohini Kaul CBS publication & Distributors, Delhi.
6. Histology, 1977, 4<sup>th</sup> Edn., R. O. Greep and L. Weiss, McGraw Hill Int. Book Co., New York.
7. Histology of Mammals, 1983, M. V. Athawale and A. N. Latey, Narendra Prakashan, Pune.
8. Hand book of Basic Microtechnique, 1964, 3rd Edn., Peter Gray, McGrawHill Book Co. New York.
9. Hand Book of Histopathological & Histochemical Techniques, 1983, 3<sup>rd</sup> Edition reprint, Butterworth & Co. (Publishers) Ltd, UK.
10. Hand Book of Histological and Histochemical Techniques, 1991, 1st Edn. S. K. David, CBS publisher & Distributors, Delhi.

## ZY-333 (Paper III)

### Biological chemistry

**Total lectures: 48**

- 1. Basic Biochemistry:** 10
  - 1.1 Bonds –Types: Ionic, covalent, noncovalent bonds (hydrogen, hydrophobic, electrostatic, Van der Waal forces) and their functions in bio molecules
  - 1.2 Structure of water molecule (liquid, ice and colloid)
  - 1.3 Physico-chemical properties of water
  - 1.4 Concept of acid and base, pH, Sorenson's scale, derivation of Henderson Hasselbalch equation and its applications
  - 1.5 Concept of Buffer-types of buffer, buffering capacity and buffers in biological system (Phosphate, bicarbonate)
- 2. Carbohydrates:** 10
  - 2.1 Definition and classification of carbohydrates
  - 2.2 Isomerism in carbohydrates- Structural and stereoisomerism
  - 2.3 Stereo chemical properties-enantiomers, anomers, epimerism, mutarotation, racemisation, biological significance and clinical significance-hypoglycemia and hyperglycemia
- 3. Proteins:** 08
  - 3.1 Essential and non essential amino acids
  - 3.2 Structure and classification of amino acids, Peptide bond, types of proteins, protein structures (primary, secondary, tertiary and quaternary structures with suitable example), bonds responsible for protein structures and Biological significance of proteins
- 4. Enzymes:** 12
  - 4.1. Classification and properties of enzymes
  - 4.2 Regulatory and non regulatory enzymes
  - 4.3 Enzyme kinetics, MM equation and its importance and LB plot
  - 4.4 Reversible and irreversible enzyme inhibition
  - 4.5 Factors influencing enzyme activity (pH, temperature, substrate concentration, enzyme concentration)
  - 4.6. Introduction of isoenzymes, allosteric enzymes, immobilized enzymes and ribozymes
  - 4.7. Clinical significance of enzymes- PKU and AKU

## 5. Lipids:

08

- 5.1 Introduction, classification and chemistry
- 5.2 Clinical significance (obesity, atherosclerosis, myocardial infarction)
- 5.3 Biological significance of lipids

### Reference books

1. Principles of Biochemistry, 1993, 2<sup>nd</sup> Edn, Lehninger A. L. Nelson D.L. & Cox M.M. CBH Publisher and distributors, Delhi.
2. Biochemistry, 1995 5<sup>th</sup> Edn. Zubay G. Wm, C.Brown Communications USA
3. Harpers Biochemistry ,1996 , 26<sup>th</sup> Edn., Murray R.k.,Granner D.K. ,Mayes P.A. &Rodwell V.W. Prentice Hall international USA.
4. Outline of biochemistry, 1995 5<sup>th</sup> Edn, Conn E.E., Stumph P.K. Bruening G &Doi R.H.John Wiley & Sons, USA
5. Principals of Biochemistry, 1993, 1<sup>st</sup> Edn., Pattabhiraman T.N.,Gajanan Book publisher s and distributors Bangalore.
6. Clinical Biochemistry, 1994, B. P. Godkar, Bhalini Publishing house, Mumbai.
7. Biochemistry, 1995 5<sup>th</sup> Edn, Stryer Sanfrancisco, W. H. Freeman & Co.
8. Biochemistry, 1990, 8<sup>th</sup> Edn., D.Voet & J. Voet, JohnWilley, New York

## ZY-334 (Paper IV)

### Environmental Biology and Toxicology

Total lectures: 48

- |   |           |
|---|-----------|
| <b>1 Environmental Biology</b>  | <b>2</b>  |
| Introduction- Definition, basic concepts and scope  |           |
| <b>2 The Ecosystem</b>  | <b>8</b>  |
| 2.1 Definition, abiotic and biotic components and their interrelationship   |           |
| 2.2 Energy flow in ecosystem and flow models  |           |
| 2.3 Major Ecosystems: (a) natural ecosystem: e.g. fresh water, forest (b) artificial ecosystem: e.g. cropland                               |           |
| 2.4 Food chain in ecosystem and food web  |           |
| 2.5 Ecological pyramids   |           |
| <b>3 Environmental Pollution:</b>   | <b>12</b> |
| 3.1 Definition and types of pollution   |           |
| 3.2 Pollutants, types of pollutants (metallic, gaseous, acids, alkalis, biocides)   |           |
| 3.3 Air pollution: Definition, sources of air pollution and their effects   |           |
| 3.4 Air pollution and its relevance with the following  |           |
| 3.4.1 Acid rain   |           |
| 3.4.2 Greenhouse effect   |           |
| 3.4.3 Ozone layer depletion   |           |
| 3.5 Water pollution: definition, sources of water pollution and their effects on ecosystem.<br>Community waste with reference to following: |           |
| I. Sewage   |           |
| II. Industrial wastes   |           |
| III. Agricultural wastes  |           |
| 3.6 Land / Soil pollution: definition, sources of land / soil pollution and their effects   |           |
| 3.7 Noise pollution: definition, sources of noise pollution and their effects and control measures  |           |
| <b>4 Environment and Development</b>  | <b>5</b>  |
| 4.1 Bioindicators and environmental monitoring  |           |
| 4.2 Environmental challenges in India: land degradation, population explosion, urbanization and industrialization                           |           |

<b>5</b>	<b>Natural Resources and Conservation:</b>	<b>5</b>
5.1	Renewable and non-renewable resources	
5.2	Soil conservation	
5.3	Forest conservation	
5.4	Energy sources: conventional and non-conventional	
<b>6</b>	<b>Wildlife Management:</b>	<b>5</b>
6.1	Definition, causes of wildlife depletion	
6.2	Importance of wildlife management in India	
6.3	Endangered species, vulnerable species, rare species and threatened species	
6.4	Wild life conservation	
<b>7</b>	<b>Toxicants and Toxicity:</b>	<b>7</b>
7.1	Definition of toxicology, scope and branches	
7.2	Types of toxicants	
7.3	Factors influencing toxicity (pH, temperature, reproductive status, age, physiological state)	
7.4	Dose, LD <sub>50</sub> , LC <sub>50</sub>	
<b>8</b>	<b>Toxicants of Public Health and Hazards:</b>	<b>4</b>
	Pesticides, heavy metals, fertilizers, food additives and radioactive substances	

### Reference Books

1. Ecology and environment, 2014, 12th revised Edition, P. D. Sharma, Rastogi Publ. Meerat.
2. Environmental Biology, 1996, P. S. Verma and V. K. Agrawal, S. Chand and Co. New Delhi.
3. Ecology, 2007, 1<sup>st</sup> Edn. Mohan P. Arora, Himalaya Publ. House, Delhi.
4. Fundamentals of ecology, 2009, 3<sup>rd</sup> Edn., M. C. Dash, Tata Mcgraw Hill, New Delhi.
5. Elements of ecology, 1967, George L. Clarke, John Wiley and Sons, New York.
6. Ecology of Natural resources, 1985, Francois Ramade, W. J. Duffin, John Wiley and Sons, New York.
7. Concepts of Ecology, 1996, E.J. Kormondy, Prentice Hall of India. New Delhi
8. Modern concept of Ecology, 1995, 8<sup>th</sup> Edn. H. D. Kumar, Vikas Publishing House, New Delhi

9. Fundamentals of Ecology, 2006, 5<sup>th</sup> Edn., E. P. Odum, Oxford & IBM Publi.Co. New Delhi.
10. Environmental problems and Solution, 1998, 2<sup>nd</sup>Edn. D. K. Asthana, Meera Asthana, S. Chand Publi., New Delhi.
11. Toxicology, 2011, 3<sup>rd</sup> revised Edn., P.D. Sharma, Rastogi Publi. Meerut.
12. Pollution and Health hazards in India, 1987, R. Kumar,. Ashish Publi. House, New Delhi.
13. Toxicology – Principles and Methods, 2010, 2<sup>nd</sup> Edn., M. A. Subramanian,, M J P Publishers, Chennai.
14. Selective Toxicity, 1973, A. Albert, Chapman and Hall, London.
15. Environmental Toxicology, 2003, M. Satake, Y. Mido, Discovery Publi. House, New Delhi.
16. Introduction to General Toxicology, 1976, E. J. Ariens; A. M. Simonis; J. Offermeier, Academic Press, London.

## ZY-335 (Paper V)

### Parasitology

**Total lectures: 48**

- |          |   |    |
|----------|---|----|
| <b>1</b> | <b>Introduction:</b> Scope and branches of Parasitology   | 3  |
|          | Definition: host, parasite, vector, commensalisms, mutualism and parasitism   |    |
| <b>2</b> | <b>Types of parasites:</b> ectoparasites, endoparasites and their subtypes  | 3  |
| <b>3</b> | <b>Types of hosts:</b> intermediate and definitive, paratenic, reservoir  | 3  |
| <b>4</b> | <b>Host-Parasite relationship:</b> Host specificity- definition, structural specificity, physiological specificity and ecological specificity   | 3  |
| <b>5</b> | <b>Study of the following parasites</b> with reference to habit, habitat, Life cycle, Mode of Infection, pathogenicity and control measures - <i>Plasmodium vivax</i> , <i>Entamoeba histolytica</i> , <i>Ascaris lumbricoides</i> and <i>Taenia solium</i> | 16 |
| <b>6</b> | <b>Study of the following parasites</b> with reference to morphology, life cycle, pathogenicity and control measures: Head louse, Tick, Mite ( <i>Sarcoptes scabiei</i> )   | 6  |
| <b>7</b> | <b>Parasitological significance of Zoonosis:</b> Bird flu, Rabies and Toxoplasmosis   | 4  |
| <b>8</b> | <b>Control measures of arthropod vectors of human diseases:</b> Malaria ( <i>Anopheles stephensi</i> , <i>A. culicifacies</i> ), Dengue, Haemorrhagic fever ( <i>Aedes aegypti</i> , <i>A. albopictus</i> ), Filariasis ( <i>Culex pipiens fatigans</i> )   | 6  |
| <b>9</b> | <b>Epidemic diseases:</b> Typhoid, Cholera, Small pox; their occurrence and eradication programmes  | 4  |

### Reference Books

1. Comparative Protozoology: Ecology, Parasitology, Life history, 1988, Anderson, O.R. Springer Verlag, Berlin.
2. Parasites and parasitism, Cameron, 1958, T. W. M. Methuen, London
3. An Introduction to Parasitology, 1961, Chandler, A.C. & C. P. Read, Wiley, New York
4. Parasitology and Helminthology in relation to Clinical Medicine, 1980, Edn.12 Chatterjee, K.D., Chatterjee Medical publishers, Calcutta.
5. The biology of animal parasites, 1964, Cheng T.C., Saunders, Philadelphia.
6. Symbiosis, 1970, Cheng T.C., Pegasus, New York.
7. Parasitology -The biology of animal parasites, 1971, Noble E.R. & G. A. Noble, Lea and Febiger, Philadelphia U.S.A.



8. Fundamentals of Ecology, 1971, Edn.3, Odum E.P., Saunders, Philadelphia U.S.A.
9. Entomology.Edn.10 Vols.1&2 McGraw Hill, New York.
10. Animal Parasitism, 1972, C.P. Read, Prentice Hall, Englewood Cliffs, N.J., U.S.A.
11. Parasites: Lice, Ticks& Fleas (Free Kindle), 2014, C.D. Shelton

**ZY-336 (Paper VI)**

**a) General Pathology**

**Total lectures: 48**

<b>1 Introduction:</b>	<b>4</b>
1.1 Definition, scope and basic branches	
1.2 Applied pathology- biopsy and surgery	
1.3 Autopsy- post mortem changes	
<b>2 Clinical pathology</b>	<b>4</b>
2.1 Definition and scope	
2.2 Gastric analysis	
2.3 Urine examination	
2.4 Importance of CSF examination	
2.5 Liver function test	
2.6 Renal function test	
<b>3 Diseases:</b>	<b>4</b>
3.1 Definition and causes	
3.2 Infectious diseases: aetiology and infectious agents	
<b>4 Retrogressive changes:</b>	<b>4</b>
Definition, cloudy (changes) swelling, degeneration, fatty degeneration, mucoid degeneration and amyloid degeneration	
<b>5 Necrosis:</b>	<b>3</b>
5.1 Definition and causes	
5.2 Nuclear and cytoplasmic changes	
5.3 Types of necrosis	
<b>6 Gangrene:</b>	<b>3</b>
6.1 Definition and causes	
6.2 Types: dry, moist and gas gangrene	
<b>7 Circulatory disturbances:</b>	<b>8</b>
7.1 Hyperemia: active and passive (causes and effects)	
7.2 Ischaemia: causes and effects	
7.3 Hemorrhage: causes, effects and hemorrhagic effects	

7.4	Thrombosis: thrombus formation, its causes and effects	
7.5	Embolism: Definition, sources, types and effects	
<b>8</b>	<b>Inflammation:</b>	<b>5</b>
8.1	Definition and causes, cardinals of inflammation (signs), vascular phenomenon and cellular response	
8.2	Acute and chronic inflammation	
<b>9</b>	<b>Repair:</b>	<b>4</b>
9.1	Process of Repair	
9.2	Types: by regeneration, by connective tissue proliferation	
9.3	Healing: primary and secondary	
<b>10</b>	<b>Neoplasia:</b>	<b>4</b>
10.1	Definition, causes and types of tumours-benign and malignant	
10.2	Leukemia: acute and chronic.	
<b>11</b>	<b>Disorders of pigmentations:</b>	<b>2</b>
	Brief idea about normal process of pigmentation, melanosis and jaundice	
<b>12</b>	<b>Disorders of mineral metabolism:</b>	<b>3</b>
	Mechanism of calcification, pathological calcification (dystrophic and metastatic) causes and its effects. Gout aetiology and pathogenesis	

### **Reference Books**

1. A text book of Pathology, 2009, 15<sup>th</sup> Rev Edn., Dey N. C. and Dey T. K. Sinha Debashish, New central book agency, Kolkota
2. General pathology and pathology of systems, 2008, 6<sup>th</sup> Edn., Bhende Y. M. and Deodhar S.G.; Popular Prakashan Ltd, India.
3. Robins Basic Pathology, 2012, 9<sup>th</sup> Edn., Vinay Kumar, Abul K. Abbas, Jon C. Aster, Saunders, Philadelphia.
4. Textbook of Pathology, 2014, 7th Edition, Harsh Mohan, Jaypee Brothers Medical Publishers (P) Ltd
5. Essentials in Hematology & Clinical Pathology, 2012, 1st Edition, Ramadas Nayak, Sharada Rai, Astha Gupta,
6. Concise Book On Medical Laboratory Technology, 2005 reprint, 1<sup>st</sup> Edn., C. R. Maiti, New Central Book Agency (p) Ltd, Kolkata, India

## ZY- 336 (Paper VI)

### b) Cell Biology

**Total lectures: 48**

- |          |  |          |
|----------|--|----------|
| <b>1</b> | <b>Introduction to Cell biology:</b>                                     | <b>3</b> |
| 1.1      | Definition and scope   |          |
| 1.2      | Prokaryotic and eukaryotic cell: size, shape and structure               |          |
| <b>2</b> | <b>Plasma membrane:</b>  | <b>6</b> |
| 2.1      | Unit membrane concept  |          |
| 2.2      | Models: Lipid membrane, Protein-Lipid (Danielli-Davson) and Fluid Mosaic |          |
| 2.3      | Membrane receptors   |          |
| 2.4      | Membrane transport: Passive and Active                                   |          |
| 2.5      | Exocytosis and Endocytosis (Phagocytosis and Pinocytosis)                |          |
| <b>3</b> | <b>Endoplasmic reticulum:</b>  | <b>5</b> |
| 3.1      | Occurrence and ultrastructure  |          |
| 3.2      | Type: smooth and rough   |          |
| 3.3      | Functions  |          |
| <b>4</b> | <b>Golgi complex:</b>  | <b>3</b> |
| 4.1      | Origin, occurrence and morphology  |          |
| 4.2      | Ultrastructure and functions   |          |
| <b>5</b> | <b>Lysosomes:</b>  | <b>3</b> |
| 5.1      | Origin, occurrence and morphology  |          |
| 5.2      | Ultrastructure, polymorphism and functions                               |          |
| <b>6</b> | <b>Mitochondria:</b>   | <b>4</b> |
| 6.1      | Origin, occurrence and morphology  |          |
| 6.2      | Ultrastructure and functions (explanation of the cycles not expected)    |          |
| <b>7</b> | <b>Nucleus:</b>  | <b>6</b> |
| 7.1      | Shape, Size, number and position   |          |
| 7.2      | Ultrastructure of nuclear membrane and pore complex                      |          |
| 7.3      | Nucleolus: general organization, chemical composition and functions      |          |
| 7.4      | Nuclear sap/ nuclear matrix  |          |
| 7.5      | Nucleocytoplasmic interactions   |          |

<b>8</b>	<b>Cytoskeleton:</b>	<b>3</b>
8.1	Microfilaments: location, ultrastructure, biochemical composition and functions	
8.2	Intermediate Filament: location, ultrastructure, biochemical composition and functions	
8.3	Microtubules: location, ultrastructure, biochemical composition and functions	
<b>9</b>	<b>Cell cycle and cell division:</b>	<b>6</b>
	Various phases of cell cycle, mitosis, meiosis & role of centriole in the cell division	
<b>10</b>	<b>Cellular ageing and cell death:</b>	<b>4</b>
10.1	Concept of ageing theories:	
10.1.1	Intracellular changes: free radicals	
10.1.2	Extra cellular changes	
10.2	Cell death:	
10.2.1	Apoptosis: definition and significance	
10.2.2	Necrosis: definition and examples	
<b>11</b>	<b>Cancer cell:</b>	<b>5</b>
11.1	Characteristics	
11.2	Theories/ hypothesis regarding causes of cancer	
11.2.1	Extrinsic causes: physical, chemical and biological agents (viruses).	
11.2.2	Intrinsic causes: somatic mutations, oncogenes and ageing related phenomenon	

### **Reference Books**

1. Cell and molecular biology, 2010, 8<sup>th</sup> Edn., De Robertis EDP and De Robertis EMF Jr., Lippincott Williams & Wilkins, Philadelphia
2. Molecular Cell biology, 2013, 1<sup>st</sup> Edn., C. B. Powar, Himalaya Publi. House.
3. Cell and molecular biology, 1968, Dupraw E. J., Academic Press, New York.
4. Molecular Cell biology, 1986, Avers C.J. Addison Wesley Pub. Co., New York & London.
5. Cell and Molecular biology, 2013, 7<sup>th</sup> Edn., Gerald Karp, John Wiley and Sons, USA.
6. Cell biology, 1993, David E. Sadava, Johnes and Bartlett Publi., London.
7. Cell Structure and Function, 1991, 3<sup>rd</sup> Edn, A.G. Loewy & Siekevitz, Saunder college Publi., Philadelphia
8. Becker's World of the Cell, 2012, 8th Edition, Jeff Hardin, Gregory Paul Bertoni, Lewis J. Kleinsmith, Benjamin Cummings, UK
9. The Cell: A molecular approach, 2013, 6<sup>th</sup> Edn., Geoffrey M. Cooper, Robert E. Hausman, Sinauer Associates, USA
10. Molecular Biology of the Cell, 2007, 5<sup>th</sup> Edn., Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Taylor & Francis, UK

**ZY- 341(Paper I)**  
**Biological Techniques**

**Total lectures: 48**

- 1 Introduction to biological techniques** 10
  - 1.1 **Solution/strengths of chemicals:** percentage, normality, molarity, molality, osmolarity, osmolality, ppm, ppb
  - 1.2 Separation techniques: principle and applications, techniques related to isolation, purification and characterization of bio molecules
    - 1.2.1 Chromatography (paper, ion-exchange), gel filtration
    - 1.2.2 Electrophoresis-(agarose, polyacrylamide)
    - 1.2.3 Ultracentrifugation
    - 1.2.4 Colorimetry and spectroscopy
- 2 Haematological Techniques:** 08
  - 2.1 Blood cell count –Total count of RBCs, WBCs and Differential count of WBCs and their significance. Examination of bone marrow. Hb%, bleeding time, clotting time and their significance
  - 2.2 Microscopy: simple, compound, phase contrast, electron - their principle & working
  - 2.3 Micrometry
  - 2.4 Camera Lucida
- 3 Micro technique:** 10
  - 3.1 Procurement of tissues and precautions to be taken to avoid tissue damage during procurement
  - 3.2 Fixatives: Classification of fixatives and importance of fixation of tissues
  - 3.3 Methods of fixation
  - 3.4 Dehydration, clearing, impregnation and block making:
    - 3.4.1. Clearing and alcoholising agents
    - 3.4.2. Clearing and dealcoholisation
    - 3.4.3. **Impregnation and Embedding:** Types of embedding media, methods of embedding and block making. Comments on hardening of paraffin
- 4 Microtomes and Knives:** 08
  - 4.1 Types of microtomes
  - 4.2 Types of microtome knives



4.3	Section cutting: Microtomy- steps and precautions, common faults in section cutting- reasons & remedies. Mounting and spreading of ribbons	
<b>5</b>	<b>Stains and Staining</b>	<b>06</b>
5.1	Classification of stains	
5.2	Methods and types of staining	
5.3	General procedure for staining of sections	
5.4	Vital Stains	
5.5	Mounting and labeling of sections: Classification of mounting media, refractive indices of mounting media	
<b>6</b>	<b>Histochemical staining:</b>	<b>06</b>
6.1	Demonstration of Carbohydrates (PAS technique)	
6.2	Demonstration of Nucleic acid (Feulgen Reaction)	

## References

1. Introduction of Medical Laboratory Technique, 1998, 7<sup>th</sup> Edn., Baker F. J., Silverton R. E., Pallister C. J., Butterworth-Heinemann, UK
2. Hematology: Basic Principles and Practice, 2008, 5<sup>th</sup> Edn., Ronald Hoffman , Bruce Furie, Philip McGlave, Churchill Livingstone Elsevier, USA
3. Histological and Histochemical Methods, Theory and Practice, 2008, 4<sup>th</sup> Edn., John A. Kiernan, Scion Publishing Ltd, UK
4. Basic Separation Techniques in Biochemistry, 1998, Okotore R. O., New Age International, New Delhi.
5. Cytological techniques: The Principles Underlying Routine Methods, 1963, Baker J.R, Methuen & Co, London
6. Davenport H. A.: Histological and Histochemical techniques.
7. Handbook of basic Microtechnique, 1958, 2<sup>nd</sup> Edn., Gray P., McGraw-Hill, USA
8. The microscope and how to use it, 1970, George Stehli, Dover Publications Inc., New York.
9. Histopathological technique and Practical Histochemistry, 1976, 4<sup>th</sup> Edn, Lillie R.D McGraw-Hill, USA
10. Staining methods (Histological and Histochemical), 1960, Mc Manus J. F. A. And Mowry R.W., Paul B. Hoeber, Inc.; Harper & Brothers, NY
11. Notes on Microscopical Techniques for Zoologist, 1964, Pantin C. F.A.: Cambridge University Press
12. Elementary Microtechnique, 1973, 4<sup>th</sup> Edn., Peacock H.A., Edward Arnold Publ. Ltd., UK
13. Histochemistry, 1968, Pearse A.G.E., Vol. I & II., W.B. Saunders Company (WBS) of Philadelphia
14. Microscope and microscopic life, 1979, 2<sup>nd</sup> Edn., Peter Healey, Hamlyn, UK
15. Biological Instrumentation and methodology, 2008, 2<sup>nd</sup> Revised Edition, P.K. Bajpai, S. Chand and Co. Ltd., New Delhi.

## ZY- 342 (Paper II)

### Mammalian Physiology & Endocrinology

**Total lectures: 48**

- |          |   |          |
|----------|---|----------|
| <b>1</b> | <b>Introduction: Definition and scope</b>   | <b>1</b> |
| <b>2</b> | <b>Nutrition:</b>   | <b>6</b> |
| 2.1      | Concept of nutrition and energy requirements  |          |
| 2.2      | Physiology of digestion: digestive enzymes and their actions- salivary, gastric and intestinal digestion. Role of liver and pancreas in digestion |          |
| <b>3</b> | <b>Circulation :</b>  | <b>6</b> |
| 3.1      | Cardiac Cycle- systole, diastole and pacemakers   |          |
| 3.2      | Cardiac output and blood pressure   |          |
| 3.3      | Definitions and significance of electrocardiogram, colour doppler, angioplasty, angiography, angina pectoris, and coronary bypass                 |          |
| <b>4</b> | <b>Respiration:</b>   | <b>5</b> |
| 4.1      | Definition and types- Pulmonary and tissue respiration  |          |
| 4.2      | Mechanism of transport of gases   |          |
|          | (a) Transport of Oxygen- Oxyhaemoglobin formation   |          |
|          | (b) Transport of Carbon-dioxide   |          |
|          | (c) Respiratory Quotient and BMR  |          |
| <b>5</b> | <b>Excretion:</b>   | <b>5</b> |
| 5.1      | Physiology of Urine formation- ultrafiltration, reabsorption, tubular secretion   |          |
| 5.2      | Counter-Current Multiplier theory for urine concentration   |          |
| 5.3      | Role of ADH, and Renin angiotensin system   |          |
| 5.4      | Definitions and clinical significance of- renal failure, renal calculi, dialysis  |          |
| <b>6</b> | <b>Muscles:</b>   | <b>5</b> |
| 6.1      | Ultrastructure of striated muscle   |          |
| 6.2      | Sliding filament theory of muscle contraction – physical and chemical changes   |          |
| 6.3      | Response of muscles to stimulation- simple muscle twitch, muscle fatigue and rigor mortis   |          |
| <b>7</b> | <b>Nervous Excitation:</b>  | <b>5</b> |
| 7.1      | Origin and conduction of nerve impulse, saltatory conduction  |          |

7.2 Synapse- ultrastructure and transmission of nerve impulse

7.3 Definitions/concepts: impulse, stimulation, conduction, response, EEG, epilepsy

**8 Reproduction:** 8

8.1 Reproductive cycles with hormonal control- estrous and menstrual

8.2 Hormonal control of pregnancy

8.3 Hormonal control of parturition and lactation

8.4 Hormonal control of male reproduction

**9 Endocrinology:** 7

9.1 Introduction

9.2 Mechanism of hormone action

9.3 Endocrine disorders: gigantism, acromegaly, dwarfism, diabetes insipidus, goiter, cretinism, myxedema, rickets, Addison Disease, Cushing's syndrome

**Reference Books**

1. Textbook of Medical Physiology, Guyton A.C. & Hall J.E., 2006, 11<sup>th</sup> Edition, Herculat Asia Pvt. Ltd. / W.B. Saunders Company
2. Principles of Anatomy & Physiology, 2006, 11<sup>th</sup> Edition, Tortora G.J. & Grabowski S., John Wiley & sons, Inc.
3. Human physiology, Vol. I & II, 1980, 12th Edn. Dr. C. C. Chatterjee, Medical applied agency, Kolkata
4. Text book of Animal Physiology, 2008, 2<sup>nd</sup> Edn. Nagabhushanam, S. V. S. Rana, S. Kalavathy, Oxford University Press, India.
5. Animal Physiology: Adaptation and Environment, 1997, Schmidt-Nielsen, Knut, Cambridge University Press,
6. General and Comparative Physiology, 1983, 3<sup>rd</sup> Edn., Hoar W. S., Prentice Hall, UK.
7. Medical Physiology, 2006, Asis Das, Books and Allied Pvt. Ltd., Kolkata
8. Endocrinology, 2005, Lohar P. S., M J P Publishers, Chennai
9. Vander, Sherman, Luciano's Human Physiology: The Mechanisms of Body Function, 2003, 9<sup>th</sup> Edn., Eric P. Widmaier, Hershel Raff , Kevin T. Strang , Mc Graw Hill

## ZY -343 (Paper III)

### Genetics and Molecular Biology

Total lectures: 48

1. Linkage, crossing over and molecular basis of recombination 5
2. **Gene Mutation** 6
  - 2.1 Definition
  - 2.2 Types of mutations: spontaneous, induced, somatic, gametic, forward, reverse. Types of point mutation- deletion, insertion, substitution, transversion, transition
  - 2.3 Mutagenic agents.
    - a) UV radiation and ionising radiation
    - b) Base analogs, alkylating and intercalating agents
3. **Population Genetics** 5
  - 3.1 Basic Concepts in population genetics: Mendelian population, gene pool, gene frequency, chance mating (Panmictic mating)
  - 3.2 Hardy Weinberg law and its equilibrium
4. **Molecular Biology**
  - 4.1. DNA as genetic material- evidences (Griffith's, Avery et al and Hershey and Chase experiment), RNA as genetic material-TMV 4
  - 4.2. Chromatin-Heterochromatin, Euchromatin, histones, nucleosome arrangement, packaging of DNA 3
5. **Central Dogma of Molecular Biology**
  - 5.1. **DNA Replication**-Semiconservative (Messelson and Stahl experiment) Mechanism in prokaryotes and eukaryotes 5
  - 5.2. **Transcription**- Transcriptional unit, RNA polymerase, transcription in prokaryotes and eukaryotes, post transcriptional modification (splicing- mRNA, modifications at 3' and 5' end) 5
  - 5.3. **Translation**-Genetic code, properties of genetic code, ribosome structure [prokaryotes and eukaryotes], protein synthesis-initiation, elongation, termination and concept of post translational modification (glycosylation) 5
6. **Concept of operon** - regulation of gene action, Lac operon, Trp operon 5
7. **Recombinant DNA Technology**- 5

Introduction, restriction enzymes, cloning vector, PCR (polymerase chain reaction), DNA finger printing

### Reference Books

1. Principles of Genetics, 1997, P. D. Snustad, M. L. Simmons J. B. Jenkins, John Wiley & Sons, USA
2. Genetics, 2014, 9<sup>th</sup> Edn., Verma P. S. and Agarwal V. K., S. Chand and Co., New Delhi
3. Genetics, 2014, 4<sup>th</sup> rev Edn., 3<sup>rd</sup> reprint, Gupta P. K., Rastogi Publications, Meerut
4. Genetics, 2004, 1<sup>st</sup> Edn. Sarin, C., Tata McGraw Hill, New Delhi.
5. Principles of Genetics, 2006, 8<sup>th</sup> Edn., Gardner E. J., Simmons M. J. and Snustad D. P., Wiley India Pvt Ltd
6. Genetics, 1997, 3<sup>rd</sup> Edn., D. L. Hartl, Jones and Bartlett Publishers, USA
7. Genetics, 1985, 3<sup>rd</sup> revised Edn., Strickberger M. W., Macmillan USA
8. Molecular Biology of the Cell, 2007, 5<sup>th</sup> Edn., Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Taylor & Francis, UK
9. Gene V & VI, 1994, Lewin Boxford University Press ,Oxford
10. Molecular Biology of the gene, 1993, Watson J. Hopkins, Roberts, Steitz and Weiner, Benjamin Cummings.
11. Text book of Molecular biology, 1994, K. ShivramaSastry, G. Padmanabhan & C. Subramanyan, Mc. Millan India.
12. Cell and molecular biology, 2010, 8<sup>th</sup> Edn., De Robertis EDP and De Robertis EMF Jr., Lippincott Williams & Wilkins, Philadelphia

## ZY-344 (Paper IV)

### Organic Evolution

Total lectures: 48

- |   |   |
|---|---|
| <b>1 Introduction.</b>  | 4 |
| 1.1 Origin of life  |   |
| 1.2 Origin of eukaryotic cell (Origin of mitochondria , plastids & symbionts)   |   |
| <b>2 Evidences in favour of organic evolution:</b>  | 8 |
| Evidences from: anatomy, embryology, geographical distribution, palaeontology, physiology, biochemistry, genetics and molecular biology |   |
| <b>3 Theories of organic evolution</b>  | 8 |
| 3.1 Lamarckism  |   |
| 3.2 Darwinism and Neo Darwinism   |   |
| 3.3 Mutation Theory   |   |
| 3.4 Modern Synthetic theory   |   |
| <b>4 Isolation:</b>   | 6 |
| 4.1 Isolating mechanism   |   |
| 4.2 Classification of isolating mechanism: Pre-zygotic and post-zygotic   |   |
| <b>5 Speciation:</b>  | 4 |
| 5.1 Types of speciation(Allopatric & Sympatric )  |   |
| 5.2 Mechanism of speciation   |   |
| 5.3 Patterns of speciation  |   |
| 5.4 Factors influencing speciation  |   |
| <b>6 Geological Time Scale</b>  | 4 |
| <b>7 Animal Distribution:</b>   | 2 |
| 7.1 Methods of distribution   |   |
| 7.2 Classification of animal distribution   |   |
| 7.3 Patterns of animal distribution   |   |
| 7.4 Factors affecting distribution  |   |
| <b>8 Antiquity of Man:</b>  | 7 |
| Evolution of anthropoids including man (Kenya-pithecus to <i>Homo sapiens</i> )   |   |
| <b>9 Zoogeographical Realms: With reference to fauna</b>  | 5 |

### **Reference Books**

1. Organic Evolution, Richard Swann Lull, Light & Life Publishers.
2. Introductions to Evolution, Paul Amos Moody, Kalyani Publishers, New Delhi.
3. Organic Evolution, 1991 T.S. Gopalkrishanan, Itta Sambashivarab Publ. House
4. Evolution, 1996 P. K. Gupta, Rastogi Publ., Meerut
5. Evolutionary Biology, 1990, Mohan P. Arora, Himalaya Publi. House, Delhi.
6. Evolution, 1968, E. O. Dodson, Reinhold Publ. Crop., New York.
7. The major features of evolution, 1953, Simpson G. G. Columbia, New York.
8. The origin of species, 1959, Charles Darwin, New American Library, New York.



**ZY-345 (Paper V)**  
**General Embryology**

**Total lectures: 48**

- |          |   |          |
|----------|---|----------|
| <b>1</b> | <b>Introduction:</b>  | <b>4</b> |
| 1.1      | Definition and scope  |          |
| 1.2      | Theories of preformation, pangenesis, epigenesis, axial gradient and germ plasm   |          |
| <b>2</b> | <b>Concepts in Developmental Biology:</b>   | <b>2</b> |
|          | Growth, differentiation, dedifferentiation, cell determination, cell communication, morphogenesis, induction and regeneration   |          |
| <b>3</b> | <b>Gametogenesis:</b>   | <b>8</b> |
| 3.1      | General aspects and origin of germ cells  |          |
| 3.2      | Sperm: general structure, mention variations with reference to Insect, Amphioxus, Frog, Bird and Human  |          |
| 3.3      | Ultra structure of typical sperm. (entire, T.S. through head, middle piece and tail)  |          |
| 3.4      | Spermatogenesis: phases & spermiogenesis (nuclear and cytoplasmic changes)  |          |
| 3.5      | Oogenesis phases: growth phase- pre-vitellogenesis, vitellogenesis and post-vitellogenesis  |          |
| 3.6      | Oocyte maturation: role of MPF ( maturation promotion factor )  |          |
| 3.7      | Ovum: general structure   |          |
| 3.8      | Egg membranes: primary, secondary and tertiary  |          |
| 3.9      | Types of eggs   |          |
| <b>4</b> | <b>Fertilization:</b>   | <b>7</b> |
| 4.1      | Concept and types   |          |
| 4.2      | Attraction of gametes: sperm activation, chemotaxis (fertilizin and antifertilizin as enzymes and gamones as hormones)  |          |
| 4.3      | Sperm penetration: acrosome reaction, capacitation & decapacitation   |          |
| 4.4      | Activation of ovum: fertilization cone, polyspermy prevention: fast block (fertilization potential) & slow block (cortical reaction) & perivitelline space fertilization membrane |          |
| 4.5      | Amphimixis  |          |
| 4.6      | Significance of fertilization   |          |

<b>5</b>	<b>Cleavage</b>	<b>5</b>
5.1	Mechanism	
5.2	Planes and symmetry	
5.3	Patterns / Types	
5.4	Significance	
<b>6</b>	<b>Blastula: Definition and types</b>	<b>3</b>
<b>7</b>	<b>Gastrulation:</b>	<b>6</b>
7.1	Concept	
7.2	Basic cell movements in gastrulation: epiboly, emboly, convergence, invagination, ingression & involution (with reference to frog )	
7.3	Organizer: primary, secondary, tertiary	
7.4	Organogenesis: cell differentiation, tissue differentiation & organ formation up to rudimentary stage	
<b>8</b>	<b>Chick Embryology:</b>	<b>11</b>
8.1	Structure of Hen's egg	
8.2	Fertilization and cleavage	
8.3	Gastrulation:	
8.3.1	Formation of primitive endoderm	
8.3.2	Primitive streak development	
8.3.3	Head process and regression of Primitive streak	
8.4	Development of nervous system up to 48 hours	
8.5	Development of heart and blood vessels up to 48 hours	
8.6	Development of digestive system up to 48 hours	
<b>9</b>	<b>Extra embryonic membranes</b>	<b>2</b>

### Reference Books

1. An Introduction to Embryology 2012, 5<sup>th</sup>Edn., Balinsky B. L., Fabian B. C. Brooks Cole Pub. Co., USA.
2. Developmental Biology: Patterns, principle and problems, 1982, Saunders J. W., Prentice Hall Coll Div.
3. Developmental Biology 1992 3<sup>rd</sup> den Browder L. W., Erickson C.A. & Jeffery W. R., Saunders college pub., London.
4. Developmental Biology, 2013, 10<sup>th</sup>Edn. Gilbert S. F., Sinauer Associates Inc.

## ZY- 346 (Paper VI)

### a) Public Health and Hygiene

**Total lectures: 48**

<b>1</b>	<b>Introduction and scope of public health</b>	<b>1</b>
<b>2</b>	<b>Health:</b>	<b>4</b>
	2.1 Definition, factors affecting health (inborn, environmental)	
	2.2 Personal and community health.	
	2.3 Effects of alcohol, tobacco and drugs	
	2.4 WHO and its programmes	
<b>3</b>	<b>Food:</b>	<b>6</b>
	3.1 Sources: Plants and Animals	
	3.2 Necessity: deficiency diseases	
	3.3 Beverages and condiments	
	3.4 Food preservation methods	
<b>4</b>	<b>Air and ventilation:</b>	<b>3</b>
	4.1 Composition of air	
	4.2 Purification of air	
	4.3 Ventilation system: natural and artificial	
<b>5</b>	<b>Water and water supplies:</b>	<b>5</b>
	5.1 Sources and properties of water, quality of water for human consumption	
	5.2 Process of purification of water- small scale and large scale	
	5.3 Slow sand or biological filtration of water and rapid sand or mechanical filtration of water	
<b>6</b>	<b>Soil:</b>	<b>3</b>
	Composition, properties and diseases spread by soil	
<b>7</b>	<b>Sanitation:</b>	<b>5</b>
	7.1 Definition and concept	
	7.2 Disposal of human and animal waste, refuse, sewage	
<b>8</b>	<b>Diseases:</b>	<b>10</b>
	8.1 Communicable diseases: causative organisms, signs and symptoms, modes of transmission, prevention and control measures of: influenza, chicken pox, measles, tuberculosis, leprosy, swine flu and encephalitis	

8.2	Non Communicable diseases: rheumatic heart disease, coronary heart disease and diabetes	
<b>9</b>	<b>Demographic Biostatistics:</b>	<b>4</b>
9.1	Introduction	
9.2	Purpose of data sampling	
9.3	Methods of sampling	
<b>10</b>	<b>Epidemiology</b>	<b>3</b>
10.1	Introduction	
10.2	Epidemiologic methods	
10.3	Causes of epidemiology	
<b>11</b>	<b>Social and Industrial hygiene:</b>	<b>2</b>
11.1	Accident, emergencies in home and industries	
11.2	Occupational disease (details of diseases not expected)	
11.3	Provisions for disabled and mental hygiene	
11.4	Bio-safety for disabled and mental hygiene	
<b>12</b>	<b>Radiation risk</b>	<b>2</b>

### Reference Books

1. A text book of preventive and social medicine 2011, 21<sup>st</sup> Edn., Park. K., Banarsidas Bhanot Publishers, Jabalpur, India
2. Preventive and social medicine in India, 2013, 4<sup>th</sup> Edn., B. K. Mahajan, M. C. Gupta, Jaypee Brothers Medical Publishers, New Delhi, India
3. Medical Zoology and Medical Technology. R.C. Sobti, Shobanlal and Co., Jalandhar
4. Review in community medicine, 2006, 2<sup>nd</sup> Edn., V. V. R. Seshu Babu, Paras Medical Books Pvt. Ltd., Hyderabad.

**ZY-346 (Paper VI)**

**b) Medical Entomology**

**Total lectures: 48**

<b>1</b>	<b>Fundamentals of Agricultural, Forest, Medical and Veterinary Entomology</b>	<b>02</b>
<b>2</b>	<b>Introduction to medical entomology</b>	<b>06</b>
	2.1 Morphology and anatomy of insects	
<b>3</b>	<b>Veterinary entomology- Insects as disease spreading agents in general</b>	<b>06</b>
<b>4</b>	<b>Insects as social groups-</b>	<b>06</b>
	4.1 Definition, intraspecific and interspecific relationships among insects	
	4.2 Social organization in wasps and termites	
	4.3 Significance of social organizations	
<b>5</b>	<b>House hold insects in relation to human-</b>	<b>12</b>
	5.1 Cockroach	
	5.2 House cricket	
	5.3 Silver fish	
	5.4 Carpet beetles	
	5.5 Furniture beetles	
	5.6 Ants	
<b>6</b>	<b>Study of following insects as causing agents of human diseases- their classification up to family, appearance, habit, brief life history, distribution, diseases caused and control measures-</b>	<b>16</b>
	6.1 Mosquito	
	6.2 Flea	
	6.3 House fly	
	6.4 Bed bug	
	6.5 Louse	
	6.6 Tick	
	6.7 Mite	
	6.8 Blister beetle	

### **Reference Books**

1. Social Insects: Their Origin and Evolution, 2006, W. M. Wheeler, Discovery Publishing House, Delhi
2. Lives of Social Insects, 1968, P. P. Larson, M. W. Larson, World Pub. Co.
3. Handbook of medical entomology, Riley W. A., Johannsen O. A., Comstock Pub., New York.
4. Medical and Veterinary Entomology, 1995, 2<sup>nd</sup>Edn., Kettle D. S., CABI, UK
5. Medical Entomology for Students, 2012, 5<sup>th</sup>Edn., Mike Service, Cambridge University Press, UK
6. Essentials of Parasitology, 2008, 8<sup>th</sup> Edn., Schmidt G. D., McGraw Hill.
7. Parasitology: Biology of animal parasites, 1982, 3<sup>rd</sup> Edition, Noble E. A. and Noble G. A., Lippincott Williams and Wilkins
8. A text book of preventive and social medicine 2011, 21<sup>st</sup> Edn., Park. K. Banarsidas Bhanot Publishers, Jabalpur, India.

### ZY-347 (Practical I)

#### ZY -331 Paper I Animal Systematics and Diversity V

##### Practicals:

- 1 Study of external characters and digestive system of *Pila* E
- 2 A. Study of Nervous system of *Pila* E  
B. Temporary mounting of radula, osphradium and statocyst of *Pila* E
- 3 Study of external characters and digestive system of *Calotes* D
- 4 Study of arterial and venous system of *Calotes* D
- 5 Study of nervous system of *Calotes* D
- 6 A. study of male and female urinogenital systems of *Calotes* D  
B. Temporary mounting of scales, pecten and hyoid apparatus of *Calotes* D
- 7 Study of Spicules in sponges D
- 8 Study of *Balanoglossus*-external characters, T. S. through proboscis, collar and trunk D
- 9 Comparative study of D  
A. Scales in fishes: Placoid, Cycloid, and Ctenoid  
B. Heart: *Scoliodon*, Frog, *Calotes*, Pigeon and Rat  
C. Brain: *Scoliodon*, Frog, *Calotes*, Pigeon and Rat
- 10 Study of accessory respiratory organs in fishes: *Anabas*, *Labeo*, *Clarias* D
- 11 Compulsory study tour to visit costal locality / Bio-diversity area / Hilly area / ponds/ lakes / tanks / zoo / museum / science center- prepare tour report and submit at the time of examination

#### ZY-332 Mammalian Histology

##### Practicals:

- 1 Study of the different types of tissues with the help of permanent slides D
- 2 Temporary mounting of tissues: E  
a) medullated nerve fiber b) striated muscle fiber
- 3 Study of permanent histological slides of skin, tooth, tongue, stomach, duodenum, ileum, liver, pancreas and any one salivary gland D
- 4 Study of permanent histological slides of trachea, lung, kidney, testis, ovary, thyroid and adrenal D
- 5 Study of human blood smear to observe different cells E

## ZY- 341 Biological Techniques

### Practicals:

- |   |   |   |
|---|---|---|
| 1 | a) Principle & use of camera lucida   | E |
|   | b) Study of micrometer  | E |
| 2 | Tissue collection & fixation. Block making  | E |
| 3 | Sectioning, staining & mounting. Submission of any three permanent slides from three different organs | E |
| 4 | Total count of W.B.Cs.  |   |
| 5 | Principle and applications of colorimeter and spectrophotometer.                                      | E |
| 6 | Separation of amino acid mixture by ascending paper chromatography.                                   | E |

## ZY-342 Mammalian Physiology & Endocrinology

### Practicals:

- |   |   |   |
|---|---|---|
| 1 | a) Estimation of haemoglobin  | E |
|   | b) Preparation of haemin crystals   | E |
| 2 | To study the effects of various osmolarities on erythrocytes                        | E |
| 3 | To estimate the blood glucose level   | E |
| 4 | Estimation of bleeding and clotting time  | E |
| 5 | Study of any five disorders caused by endocrine glands with the help of photographs | E |

**Minimum 24 practicals be performed during the year**



## ZY-348 (Practical Course II)

### ZY- 333 - Biological Chemistry

#### Practicals

- |   |   |   |
|---|---|---|
| 1 | Study of principle and working of pH meter and measuring pH of three samples                                    | D |
| 2 | To study the effect of pH, temperature and inhibition on salivary amylase                                       | E |
| 3 | Detection of carbohydrates (monosaccharides, disaccharides and polysaccharides) with the help of suitable tests | E |
| 4 | Isolation of casein by adjusting isoelectric point  | E |
| 5 | Study of preparation of standard acid and alkali and its standardisation  | E |

### ZY- 334- Environmental Biology and Toxicology

#### Practicals:

- |   |  |   |
|---|--|---|
| 1 | Study of fresh water plankton (field collection, preservation and gross identification)  | E |
| 2 | A visit to water body to study physiochemical properties of water. (Temperature, pH, turbidity, hardness, acidity and alkalinity) using analysis kit | E |
| 3 | Study of physiochemical properties of soil sample (using analysis kit)   | E |
| 4 | Estimation of dissolved oxygen in water by winkler's method  | E |
| 5 | Estimation of dissolved CO <sub>2</sub> in water   | E |
| 6 | Hypothetical problem to determine LC <sub>50</sub> and LD <sub>50</sub>  | E |

### ZY-343- Genetics and Molecular Biology

- |   |  |   |
|---|--|---|
| 1 | Study of Hardy- Weinberg law with suitable recording of genetic traits | E |
| 2 | Temporary preparation of polytene chromosome from suitable material    | E |
| 3 | Estimation of DNA by Diphenylamine method                              | E |
| 4 | Detection of DNA and RNA by Methylgreen Pyronin                        | E |
| 5 | Preparation of DNA paper model   | E |

## ZY 344-Organic Evolution

### Practicals:

1. Study of morphological similarities and differences between man and ape D
2. Study of types of fossils with the help of specimens/ charts/ photos D
3. Study of animal adaptations in: Turtle, Draco, Exocoetus, Bat and Parrot D
4. Study of evidences of evolution- embryological, palaeontological, connecting links, morphology and comparative anatomy D
5. Study of successive stages of evolution of man: a) Australopithecus b) *Homo erectus* c) *Homo neanderthalis* d) Cro-magnon man e) *Homo sapiens* D
6. To record Zoogeographical distribution of animals to respective zoogeographical realms on the world map (Lung fishes, marsupials, flightless birds, Camel, Elephant, Ostrich etc.) E

## ZY- 349 (Practical Course III)

### ZY-335: Parasitology

#### Practicals:

- 1 Study of Life cycle of *Plasmodium vivax* and *Entamoeba histolytica* (whole mounts of life stages) D
- 2 Study of Life Cycle –*Ascaris lumbricoides* and *Taenia solium* (whole mounts of life stages) D
- 3 Study of morphology and pathogenicity of Head louse, Tick, Mite and blister beetle D
- 4 Study of vectors—mosquito, rat flea, house fly and bed bug D
- 5 To study rectal parasites of cockroach E

### ZY-336 a) General Pathology

#### Practicals:

- 1 Study of pathogenic agents and pathological conditions with the help of suitable microscopic slides D
  - a) *Mycobacterium tuberculae*
  - b) *Mycobacterium leprae*
  - c) *Vibrio cholerae*
  - d) *Anthrax bacilli*
  - e) *Pneumococci* sp.
  - f) *Trypanosoma* sp.
- 2 Study of pathological conditions with the help of suitable microscopic slides D
  - a) Normal and diseased cell (Lung)
  - b) Fatty degeneration (Liver)
  - c) Cloudy degeneration/Swelling (Kidney)
  - d) Dying cell –necrosis (Liver)
  - e) Lung lobar pneumonia
  - f) Ovarian cyst
  - g) Thyroid goitre
- 3 Study of following pathological slides or specimens D
  - a) Carcinoma in situ eg. Human cervix

- b) Malignant cell
  - c) Organized thrombus
  - d) Ovary fibroid tumour/carcinoma
  - e) Carcinoma of colon-cauliflower growth
  - f) Carcinoma of stomach
  - g) Liver cirrhosis
  - h) Breast fibrocystic disease
4. To detect the normal and abnormal constituents of urine E
  5. Study of Gastric juice analysis by Toffler's reagent (alcoholic solution of dimethylamino-azobenzol methyl orange indicator). E
  6. Visit to medical college/hospital/pathological laboratory

**OR**

**ZY-336: b) Paper VI- Cell biology**

**Practicals:**

- 1 Study of detection of mitochondria by Janus Green B E
- 2 Study of permanent slides of mitosis & meiosis D
- 3 Study of temporary preparation of different mitotic stages from onion root tip cells E
- 4 To study the effect of Colchicine on mitosis E
- 5 Study of temporary preparation of different meiotic stages from grasshopper testis / Tradescantia/ Onion floral bud E

**ZY-345 General Embryology**

**Practicals:**

- 1 Study of sperm smear (any one animal), types of eggs (insect, amphioxus, frog and hen) D
- 2 To study the types of blastulae and gastrulae (amphioxus, frog and hen) D
- 3 Study of whole mount slides of chick embryology – 24h, 33hr and 48 hr D
- 4 To study the sections of chick embryo--24hr, 33hr and 48 hr D
- 5 Ex-ovo culture of chick embryo E
- 6 Temporary preparation of chick embryo E

### **ZY-346 – a) Public Health and Hygiene**

#### **Practicals:**

- 1 To detect adulterants in the food samples by appropriate tests E
- 2 To study the food preservation methods E
- 3 Study of housefly, cockroach, ants and rats with reference to public health and hygiene D
- 4 A compulsory visit to water purification / sewage treatment /effluent treatment plant D
- 5 Testing potability of water for human consumption by MPN method E
- 6 Any suitable example of measurement of dispersion E  
(Mean deviation or Standard deviation)

**OR**

### **ZY-346 -b) Medical Entomology**

#### **Practicals:**

- 1 Study of interrelationships of insects and man (Any three) D
- 2 Study of household insects in relation to human health D
- 3 Study of social insects- honey bee and termites D
- 4 Temporary preparation of mouth parts of harmful insects—mosquito, bed bug and house fly E
- 5 To study control methods of harmful insects with suitable examples (biological control measures, repellants, fumigation, dusting, netting) D

# **University of Pune**

## **Two Year M.Sc. Degree Course in Zoology**

### **M.Sc. Zoology**

**(Credit and Semester based Syllabus to be implemented from Academic Year 2013-14)**

**1) Title of the Course:**

M.Sc. Zoology

**2) Preamble of the Syllabus:**

Master of Science (M.Sc.) in Zoology is a post graduation course of University of Pune. The credit system to be implemented through this curriculum, would allow students to develop a strong footing in the fundamentals and specialize in the disciplines of his/her liking and abilities.

The students pursuing this course would have to develop in depth understanding various aspects of the subject. The working principles, design guidelines and experimental skills associated with different fields of Zoology such as Genetics and Cell Biology, Biochemistry, Molecular Biology, Biostatistics, Bacterial and Phage technology, Biodiversity, Entomology, Physiology, Developmental Biology, Endocrinology, Biochemical Techniques, Animal tissue culture, etc.

**3) Introduction:****Salient Features of the Credit System:**

1. Master's degree course in Zoology would be of 100 credits, where one credit course of theory will be of one clock hour per week running for 15 weeks and one credit for practical course will consist of 15 hrs. of laboratory exercise including the revision and setting up the practical. Thus, each credit will be equivalent to 15 hours.
2. Student will have to take admission in Zoology and complete 75 credits incorporated in the syllabus structure of Zoology. The remaining 25 credits shall be chosen from the courses offered by the Zoology Department or other Departments of the University/College with credit system structure.
3. Besides Credits related to practical Courses, students may be allowed to take courses with less weightage per semester on the condition they complete the degree in maximum of four years. This provision can be availed which is subject to the availability of concerned courses in a given semester and with a maximum variation of 25 credits (in case of fresh credits) per semester in the concerned department/college.
4. Every student shall complete 100 credits in a minimum of four semesters. All Semesters will have 25 credits each.
5. The student will be declared as failed if he/she does not pass in all credits within a total period of four years. After that such students will have to seek fresh admission as per admission rules prevailing at that time.
6. Academic calendar showing dates of commencement and end of teaching, internal assessment tests and term end examination will be prepared and duly notified before commencement of each semester every year.
7. Project course should not be greater than 10% of the total credits of the degree course. Project course is equivalent to 10 credits.

### **Instructions for the Students:**

The students seeking admission to M.Sc. Zoology course is hereby informed that they are supposed to adhere to the following rules:

1. A minimum of 75 % attendance for lectures / practical is the pre-requisite for grant of term.
2. There shall be tutorial / practical / surprise test / home assignment / referencing of research papers / seminar / industrial visits/Field Visit / training course/viva-voce as a part of internal assessment in each semester. The students are supposed to attend all the tests. The students should note that re-test will not be permitted to the student absent for the test/s unless the case is considered by competent authority.
3. The students opting for dissertation course shall follow the rules framed for the same.
4. The students are supposed to attend all the Industrial Workshops / Laboratory Workshops / Training Programme/ symposia/ seminar/ field visit / study tour organized by the department/ college. The students shall attend these programmes at their own cost.

### **4) Eligibility:**

The candidate should have a B.Sc. degree with Zoology as principal subject or B.Sc. (General) degree with Zoology as one of the subsidiary subjects. Graduates in any life science related subjects such as Biotechnology, Bioinformatics, Life science, Biochemistry, Microbiology, Agriculture, Veterinary sciences, Biology, Botany etc.

Admission: Admissions will be given as per the selection procedure / policies adopted by the respective college, in accordance with conditions laid down by the University of Pune.

Reservation and relaxation will be as per the government rules.

### **5) Examination**

#### **[A] Pattern of Examination**

Evaluation of Students:

- 1) The In-semester and End-Semester examinations will be of 50 marks each.
- 2) Student has to obtain 40% marks in the combined examination of In-Semester and End-Semester assessment with minimum passing of 30% marks in both assessments separately.
- 3) A student cannot register for third semester if he/she fails to complete the 50% credits of the total expected within two semesters.
- 4) Internal marks remain unchanged and internal assessment cannot be repeated. If student remain absent during internal assessment examination, he/she will have second chance with the permission of the competent authority. But it will not be right of the student. It will be under the discretion of the competent authority and internal departmental assessment committee. In case he/she wants to repeat Internal, he/she can do so only by registering for the said courses.
- 5) There shall be revaluation of answer script of end semester examination, but not of internal assessment papers.



**i. In-semester Examination:** Internal assessment for each course would be continuous and dates for each tutorials/practical tests etc. will be pre-notified in the time table for teaching or placed separately as a part of time table. Department / College Internal Assessment Committee will coordinate this activity.

**a) Theory Courses:** Students should be encouraged to participate in various academic activities. A teacher must select a variety of the procedures for conducting internal assessment suggested as follows.

- a) Multiple choice questions
- b) Combination of objective and subjective questions.
- c) Open book test (concerned teacher will decide the allowed books)
- d) Tutorial
- e) Surprise test specified topics in a given notified period
- f) Oral
- g) Assignments
- h) Review of research paper
- i) Seminar presentation
- j) Journal/Lecture/Library notes

Student has to preserve the documentation of the internal assessment except midterm test answer script. It is the responsibility of the student to preserve the documents.

**b) Practical Courses:** It is a continuous evaluation process. Practical courses will be evaluated on the basis of the following:

1. Performance assessment of each experiment on the basis of attendance, punctuality, journal completion, practical skills, results, oral and analysis.
2. Assessment on practical course be conducted before the end-semester examination.
3. Assessment of each experiment shall be done for each practical weekly.
4. Assessment of the Activity will be based on any one of the following (per practical course).
  - i. Special training programs in recognized research institutes such as NCL, NIO, NIV, ZSI, BNHS, etc.
  - ii. Project on Research Methodology
  - iii. Industrial/Institution Visit report
  - iv. Field visit report/ study tour report

The student strength of practical batch should be 12.

**Project Course:** Project will be evaluated by the examiner/s in consent with the project guide if required.

**ii. End-Semester Examination:** The End-semester examination programme will be scheduled as per the notifications and guidelines issued by the Examination section of University of Pune.

**[B] Standard of Passing**

Student has to obtain 40% marks in the combined examination of In-Semester and End-Semester assessment with minimum passing of 30% passing in both assessments separately.

**[C] ATKT Rules**

A student cannot register for third semester if he/she fails to complete the 50% credits of the total credits expected to be ordinarily completed within two semesters.

**[D] Award of Class**

Grades will be awarded from grade point average (GPA) of the credits.

**GPA Rules:**

1. The formula for GPA will be based on Weighted Average. The final GPA will not be printed unless a student passes courses equivalent to minimum 100 credit hours (Science). Total credit hours indicate the sum of credit hours of the courses which a student has passed.
2. A seven point grade system [guided by the Government of Maharashtra Resolution No. NGO – 1298 / [4619] / UNI 4 dt. December 11, 1999 and University regulations] will be followed. The corresponding grade table is attached herewith.
3. 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')
4. For Semester I, II, III examinations, only the grade points will be awarded for each subject. Final GPA along with final grade will be awarded only at the end of IV semester. 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.
5. After the declaration of result, for the improvement of Grade, the student can reappear for the examination of 30 credits worth theory courses.
6. Grade improvement programme will be implemented at the end of the academic year. A student can opt for grade improvement programme only after the declaration of final semester examination i.e. at the end of next academic year after passing M.Sc. (Zoology) examination and within two years of completion of M.Sc. (Zoology). A student can appear for grade improvement programme only once.

Grade and Grade Point Average		
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
5.00 – 6.00	<b>O</b>
4.50 – 4.99	<b>A</b>
3.50 – 4.49	<b>B</b>
2.50 – 3.49	<b>C</b>
1.50 – 2.49	<b>D</b>
0.50 – 1.49	<b>E</b>
0.00 – 0.49	<b>F</b>

Common Formula for Grade Point Average (GPA):

$$\text{GPA} = \frac{\text{Total of Grade Points earned} \times \text{Credit hours for each course}}{\text{Total Credit hours}}$$

B Grade is equivalent to at least 55% of the marks

**[E]External Students:** There shall be no external students.

**[F]Setting of Question Paper / Pattern of Question Paper**

For core (compulsory) theory courses end semester question papers set by the University of Pune and centralized assessment for theory papers done as per the University instructions. Questions should be designed to test the conceptual knowledge and understanding of the basic concepts of the subject.

Theory examination will be of 3 hours duration for each theory course of 4 credits. There shall be 3 questions each carrying marks as shown below. The pattern of question papers shall be:

Question 1 (20 Marks)	10 compulsory sub-questions, each of 2 marks; answerable in 2 -3 lines
Question 2 (20 Marks)	5 out of 7– short answer type questions.
Question 3 (10 Marks)	2 out of 3 – Long answer type questions.

### [G]Verification / Revaluation

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. There shall be revaluation of answer script of end semester examination, but not of internal assessment papers.

### 6) Structure of Course

Basic structure/pattern (Framework) of the proposed postgraduate syllabus for the two year integrated course leading to M.Sc. (Zoology) in the colleges affiliated to Pune University.

#### M.Sc. Zoology - Course structure & Credits Distribution

##### M.Sc. Zoology –Part –I Semester-I

Course No	Title	Credits	Course No	Title	credits
ZY 101T	Biochemistry-I	3C	ZY 101 P	Practicals in Biochemistry-I	3C
ZY 102T	Cell Biology	3C	ZY 102 P	Practicals in Cell Biology	2C
ZY 103T	Genetics	2C	ZY 103 P	Practicals in Genetics	2C
ZY104T	Biostatistics	2C	ZY104 P	Practicals in Biostatistics	2C
ZY105T	Skills in Scientific communication and writing	2C	ZY105 P	Practicals in Skills in Scientific communication	2C
ZY106T	Fresh Water Zoology	2C	ZY106 P	Practicals in Fresh Water Zoology	2C
		<b>14C</b>			<b>13C</b>

(T = Theory ; P = Practicals)

**Total credits =27**

**Note:- Courses equivalent to atleast 25 credits should be taken by the students.**

##### Semester-II

Course No	Title	credits	Course No	Title	credits
ZY 201T	Biochemistry-II	3C	ZY 201 P	Practical Biochemistry-II	2C
ZY 202 T	Molecular Biology	3C	ZY 202 P	Practical Molecular Biology	3C
ZY 203T	Developmental Biology	2C	ZY 203 P	Practical Developmental Biology	2C
ZY204T	Endocrinology	2C	ZY204 P	Practical Endocrinology	2C
ZY205T	Comp.Animal Physiology	2C	ZY205 P	Practical Comp.Animal Physiology	2C
ZY206T	Biochemical techniques/ Ichthyology	2C	ZY206 P	Practicals in Biochemical techniques/ Ichthyology	2C
		<b>14C</b>			<b>13C</b>

(T = Theory ; P = Practicals)

**Total credits =27**

**Note: - Courses equivalent to atleast 25 credits should be taken by the students.**

**M.Sc. Zoology –Part –II**  
**Semester-III**

Course No	Title	Credit	Course No	Title	credits
ZY 301T	Animal Physiology I (special) or Entomology I (special) or Genetics I (special)	4C	ZY 301 P	Practicals in Animal Physiology I/Entomology I/Genetics I	3C
ZY 302T	Immunology / Environmental biology	2C	ZY 302 P	Practicals in Immunology / Environmental biology	2C
ZY 303T	Genetic toxicology / Aquaculture	2C	ZY 303 P	Practicals in Genetic toxicology / Aquaculture	2C
ZY304T	Insect physiology and biochemistry	2C	ZY304 P	Practicals in Insect physiology and biochemistry	2C
ZY305T	Research methodology	2C	ZY305 P	Practicals in Research methodology	2C
ZY306T	Parasitology	2C	ZY306 P	Practicals in Parasitology	2C
ZY307T	Fundamentals of Systematics	2C	ZY307 P	Practicals in Fundamentals of Systematics	2C
ZY 308T	Insect Ecology	2C	ZY308 P	Research Project	2C
ZY 309 T	Toxicology I	2C	ZY 309 P	Practicals in Toxicology I	2C
		20C			19C

(T = Theory ; P = Practicals)

**Total credits =39**

**Note:- courses equivalent to atleast 25 credits should be taken by the students.**

**Semester-IV**

Course No	Title	Credit	Course No	Title	Credits
ZY 401T	Animal Physiology II (special) or Entomology II (special) or Genetics II (special)	4C	ZY 401 P	Practical Animal Physiology II/ Entomology II/ Genetics II	3C
ZY 402 T	Economic Zoology / Bacteria and phage Genetics	2C	ZY 402 P	Practical Economic Zoology / Bacteria and phage Genetics	2C
ZY 403T	Mammalian reproductive physiology / Biodiversity assessment	2C	ZY 403 P	Practical Mammalian reproductive physiology / Biodiversity assessment	2C
ZY404T	Histology and histochemistry	2C	ZY404 P	Practical Histology and histochemistry	2C
ZY405T	Pollution biology	2C	ZY405 P	Practical Pollution biology	2C
ZY406T	Apiculture	2C	ZY406 P	Practical Apiculture	2C
ZY 407T	Pest control	2C	ZY308 P	Research Project	2C
ZY 408 T	Toxicology II	2C	ZY 408 P	Practicals in Toxicology II	2C
		18C			17C

(T = Theory ; P = Practicals)

**Total credits = 35**

**Note:- courses equivalent to Atleast 25 credits should be taken by the students.**

**a) Question Papers and papers etc.:**

Theory

In-Semester Examination : 50 Marks

End-Semester Examination : 50 Marks

Practical

In-Semester Examination : 50 Marks

End-Semester Examination : 50 Marks

**b) Medium of Instructions:** English.

**7) Equivalence of Previous Syllabus:**

<b>Old Course (2008 Pattern)</b>	<b>New Course (2013 Pattern)</b>
ZY 101 Biochemistry	ZY101T: Biochemistry
ZY 202 b Cell Biology	ZY102T: Cell Biology
ZY 102 a Genetics	ZY103T: Genetics
ZY 103 b Statistical Methods	ZY104T: Biostatistics
ZY 102 b English for Scientists	ZY105T: Skills in scientific communication and writing
ZY 103 a Fresh Water Zoology	ZY106T: Fresh water zoology
ZY 104 a Biochemistry	ZY101P: Practicals in Biochemistry
ZY 205 b Cell biology	ZY102P: Practicals in Cell Biology
ZY 105 b Genetics	ZY103P: Practicals in Genetics
ZY 105 a Statistical Methods	ZY104P: Practicals in Biostatistics
ZY 105 c English for Scientists	ZY105P: Practicals in Skills in scientific communication and writing
ZY 104 b Fresh water Zoology	ZY106P: Practicals in Fresh water zoology

<b>Old Course (2008 Pattern)</b>	<b>New Course (2013 Pattern)</b>
ZY 101 Biochemistry	ZY 201 T Biochemistry-II
ZY 202 a Molecular Biology	ZY 202 T Molecular Biology
ZY 201 a Developmental Biology	ZY 203 T Developmental Biology
ZY 203 b Endocrinology	ZY 204 T Endocrinology
ZY 201 b Comparative Animal Physiology	ZY 205 T Comparative Animal Physiology
ZY 203 a Biochemical Techniques/ Ichthyology	ZY 206 T Biochemical techniques/ Ichthyology
ZY 104 a Biochemistry	ZY 201P Practical Biochemistry-II
ZY 204 b Molecular biology	ZY 202P Practical Molecular Biology
ZY 205 a Developmental Biology	ZY 203P Practical Developmental Biology
ZY 205 c Endocrinology	ZY 204P Practical Endocrinology
ZY 204 a Comparative Animal Physiology	ZY 205P Practical Comparative Animal Physiology
ZY 204 c Biochemical techniques/ Ichthyology	ZY 206P Practicals in Biochemical techniques/ Ichthyology

### 8) University Terms:

Dates for commencement and conclusion for the first and second terms will be declared by the University authorities. Terms can be kept by only for duly admitted students. The term shall be granted only on minimum 75 percent attendance at theory and practical course and satisfactory performance during the term.

### 9) Qualification of Teacher:

- i. M.Sc. (Zoology) degree with NET/SET/ Ph.D qualification.
- ii. Recognition of Pune University as a post graduate teacher, by papers.
- iii. Other criteria as per the guidelines of UGC and University of Pune.

### 10) Detail Syllabus with Recommended Books



**ZY 101 T: BIOCHEMISTRY – I ( 3 Credits = 45 lectures)**

1. Water :Structure and Function, pH and Buffers, Biological Buffer System (3L)
2. Carbohydrates: Classification, basic Chemical Structures, General Reactions and properties, Biological Significance. (6L)
3. Lipids: Classification, structure and function of major lipid subclasses. Formation of micelles, monolayers, bilayer (5L)
4. Vitamins and Coenzymes: Classification, water-soluble and fat-soluble vitamins, coenzyme forms and their significance (6L)
5. Amino acids: Classification, properties and reactions (N / C terminal reactions, ninhydrin reaction) (4L)
6. Proteins: (4L)
  - a. Peptide bond, formation, End group analysis and sequencing, Ramachandran plot
  - b. Protein structure :
    - i. Levels, primary structure and its importance
    - ii. Secondary structure- X ray diffraction, alpha-helix, beta-helix
    - iii. Tertiary structure: Forces stabilizing, unfolding and refolding.
    - iv. Quaternary structure- hemoglobin.
  - c. Biological Roles of Proteins
7. Enzymes: (10L)
  - a. Classification, nomenclature and properties
  - b. Enzyme kinetics -one substrate reaction (Michaelis-Menten Equation)
  - c. Factors affecting enzyme activity
  - d. Enzyme inhibition
  - e. Allosteric Enzymes.
  - f. Isozymes.(LDH)

**REFERENCE BOOKS**

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

**ZY 101 P: PRACTICALS IN BIOCHEMISTRY I (3 Credits: 45hours)**

1. Preparation of Acid & Alkali solutions and acid-base titration (4H)
2. To prepare Buffers of known pH and molarity and measurement of pH of various samples, Buffering capacity (4H)
3. Estimation of alpha amino nitrogen by formal titration. (4H)
4. To find saponification value of a given fat. (4H)
5. Estimation of Inorganic Phosphate (4H)
6. Estimation of Sugar (Glucose) by Folin Wu method. (4H)
7. Estimation of Amino Acid (Tyrosine) (4H)
8. Isolate proteins by salting out / by adjusting isoelectric point. (4H)
9. Estimation of vitamin. (4H)
10. Isolation of amylase/ invertase, to find specific activity and progress curve (5H)
11. Estimation of protein by Lowry et.al method. (4H)

**REFERENCE BOOK:**

1. An introduction to Practical Biochemistry by David Plummer; Eds. 3, Tata McGraw Hill Publishing Company.
2. Practical Biochemistry by Jayraman.
3. Biochemical Methods by S. Sadasivam and A. Manickam; New Age International Publishers.

**ZY 102 T: CELL BIOLOGY (3 Credits= 45 Lectures)**

1. Introduction to the cell types and shapes (2L)
2. Overview of chemical nature of the cell (2L)  
Carbon as backbone of biologically important molecules  
Macromolecules and their role in form and function of living systems.
3. Plasma membrane : (9L)  
Structure, Location of Intrinsic and extrinsic proteins and channels; Receptors-  
Structure and role in signal transduction; membrane potential and synaptic  
transmission; glycocalyx; cell junction, cell adhesion molecules
4. Endomembrane system: (Endoplasmic reticulum, Golgi complex, Lysosomes;  
Glyoxysomes, peroxisomes: Structure and function), protein trafficking (10L)
5. Mitochondria and chloroplast- Structure, Genetic system, Functions; protein import. (6L)
6. Nucleus: Ultrastructure, Nuclear pore complex, nuclear cytoplasmic interactions,  
Nucleolus, Nuclear lamina and its role in cell division. (Lamin Dissociation) (4L)
7. Cell Cycle: Phases, Check points of cell cycle mechanism of regulation (Cyclin and  
cyclindependent kinases) Regulation of CDK cyclin activity. (7L)
8. Cytoskeleton:types,Chemistry,Organisations,associated proteins and their role (5L)

**REFERENCE BOOKS**

1. Alberts, B., D. Bray, J. Lewis, M. Raff, K. Roberts and J. D. Watson. (1995). Molecular  
Biology of the Cell. Eds. 3, Garland Publi. New York and London.
2. Lodish, H., D. Baltimore, A. Berk, L. Zipursky, M. Matsudaira and J. Darnell. (1995).  
Molecular Cell Biology, Eds. 3, Scientific American & W. H. Freeman. New York.
3. Cell and Molecular Biology By De Robertis, EDP. And De Robertis EME,Molt Saunders Inc

**ZY 102 P: PRACTICALS IN CELL BIOLOGY (2 Credits: 30hr) (1P= 4hr)**

1. Measurements of cell size using light microscope. (1P)
2. Temporary preparation of human epithelial cheek cells (1P)
3. Study of different stages of mitosis in suitable material and mitotic index (1P)
4. Study of meiosis in Grasshopper testes / Onion flower buds / Aloe vera with emphasis on  
all stages of prophase. (1P)
5. Limits of cleanliness (To check for microbial flora) (2P)
6. Cell fractionation- Nuclei, mitochondria observation, nuclear count. (2P)
7. Study of Cyclosis in *Paramecium* (1P)
8. Ultra structure of cell organelles. (1P)
9. Study of different types of Cells. (1P)
10. Study of disaggregation and reaggregation in sponge cells and effect of toxicant or  
cytochalasin / pesticide endosulfan / CuSO<sub>4</sub> or toxicant (1P)
11. Study of metaphase spreads from bone marrow of rat / mouse (1P)

**ZY 103 T: GENETICS (2 Credits= 30 lectures)**

1. Recapitulation of Mendelian principles; Practical applications of genetics in brief. **(3L)**
2. Classical concept of a gene: multiple alleles (blood groups), gene interactions (dominant and recessive epistasis) **(3L)**
3. Linkage and crossing over: Linkage, linkage groups, types of crossing over, recombination maps in diploids for 3 point test cross, (determination of gene order with suitable examples) **(5L)**
4. Inheritance of qualitative and quantitative traits: genetic basis and influence of environment on quantitative inheritance. **(3L)**
5. Principles of Population Genetics: Hardy-Weinberg law and its application for autosomal genes. Calculations of gene frequencies with suitable examples. **(5L)**
6. Organization and regulation of lac and arabinose operons. **(4L)**
7. Somatic cell genetics and its applications. **(3L)**
8. Human genetics: dominant and recessive disorders, physical and physiological traits. **(4L)**

**REFERENCE BOOKS:**

1. Strickberger, M.W., Genetics, Edn.III, MacMillan, 1976.
2. Gardner, E.J., Peter & Simmons, M.J. and Snustad, D.P. Principles of Genetics, John Wiley AND Sons, New York, 2006.
3. William S Klug and Michael R Cummings. Concepts of Genetics. Edn. IX. Prentice Hall Internatl, Inc., New York, 2008.
4. Trends in Genetics. Elsevier Publications, Amsterdam.
5. Lewin, Benjamin. Genes IX. John Wiley and Sons, New York, 2008.
6. Genetics By Verma,PS. And Agrawal, VK., S.Chand and Co.,New Delhi
7. Genetics By Gupta, PK., Rastogi Publication, Meerut
8. Genetics By Sarin,C., Tata McGraw Hill,New Delhi
9. Genetics: Daniel J Fairbanks, W. Ralph Andersen; Brooks / Cole Publ. co. (1999).
10. Genetics-A Molecular Approach: Peter J. Russell;Pearson Inc. publishing as Benjamin Cummings; 2006

**ZY 103 P: PRACTICALS IN GENETICS : (2 credits) (1P: 3 hrs) (10PX3= 30 hrs)**

1. Study of sex linked inheritance in *Drosophila sp.* (1P)
2. Study of monohybrid ratio in *Drosophila sp.* (1P)
3. Study of dihybrid ratio in *Drosophila sp.* (1P)
4. Non-allelic gene interaction in *Drosophila sp.* (1P)
5. Linkage study in *Drosophila sp.* (1P)
6. Determination of gene distances and gene order for a given three point test cross (1P)
7. Polytene chromosomes of *Drosophila or Chironomous*-examination of puff and bands (1P)
8. Estimation of allelic frequencies, heterozygote frequencies in human populations (1P)
9. Human Mendelian traits (blood groups, attached ear lobe, tongue rolling, etc.) family studies. Estimation of gene frequencies & percentage of heterozygotes for the given data. (1P)
10. Pedigree Analysis: Sex-Linked, Autosomal dominant and recessive. (1P)
11. Analysis of quantitative trait in a plant/ animal.: frequency distribution (1P)
12. Analysis of quantitative trait in a plant/ animal.: standard deviation variance (1P)
13. Microbial Genetics: Basic methodology; colony counts, growth curve (2P)
14. Bacterial transformation- antibiotic resistance marker (2P)

**ZY 104 (T) BIostatistics****2 Credits= 30 lecturers**

1. Introduction: (2)
  - 1.1 Applications and Uses of Statistics
  - 1.2 Population & sample, Different types of Sample
  - 1.3 Exercise & Problems.
2. Data Classification: (3)
  - 2.1 Some important terms (Class frequency, class- limits, Class-width, class –mark)
  - 2.2 Frequency distribution, Cumulative frequency, Graphical representation of data (Histogram, Pie-Diagram, Ogive-Curve.)
  - 2.3 Exercise & Problems.
3. Measures of central tendency: (3)
  - 3.1 Concept of central tendency, Types of central tendency (Arithmetic mean, Median and mode) combined mean.
  - 3.2 Partition values (Quartiles, Deciles, and Percentiles)
  - 3.3 Exercise & Problems.
4. Measures of dispersion: (4)
  - 4.1 Concept of dispersion, absolute and relative measure of dispersion.
  - 4.2 Different measures of dispersion (Range, Quartile-Deviation, Variance and standard-deviation, Coefficient of Variation) combined variance
  - 4.3 Exercise & Problems.
5. Correlation and Regression: (5)
  - 5.1 Bivariate data, concept of correlation, Types of Correlation, Scatter diagram, Karl Pearson’s coefficient of correlation and its properties.
  - 5.2 Concept of regression, Linear regression, regression Coefficients and its properties.
  - 5.3 Exercise & Problems.
6. Probability and probability distribution: (5)
  - 6.1 Some important terms (types of experiment, sample Space and types of sample space, events and types of events.)
  - 6.2 Definition of probability (mathematical and classical) Conditional probability. Concept of random variable Univariate probability Distribution and its mathematical expectation.
  - 6.3 Some standard probability distributions (binomial, Poisson and normal)their probability distribution, mean, variance,and properties of these distribution .
  - 6.4 Exercise & Problems.

## 7. Test of hypothesis: (8)

- 7.1 Some important terms (hypothesis, types of hypothesis, Test, Critical region, acceptance region, type I error, type II error, level of significance, p- value)
- 7.2 Test for mean and equality of two population means, Test for proportion and equality of two population proportions.
- 7.3 chi-square test for goodness of fit, Unpaired and paired t test.  
F test for equality of two population variances.
- 7.4 Exercise & Problems.

### REFERENCES:

1. Principles And Practice of Biostatistics : Dr J.V. Dixit
2. Statistical Methods: Snedecor G.W. & Cochran W.G.
3. Statistical Methods : Dixon W.S. and Massey

### **ZY 104 (P) - BIOSTATISTICS: (2 credits) (1P: 3 hrs) (10PX3= 30 hrs)**

1. Construction of frequency distribution and its graphical representation.
2. Measures of Central Tendency.
3. Measures of Dispersion.
4. Correlation and Regression.
5. Computation and application of binomial & Poisson probabilities.
6. Computation and application of normal probabilities.
7. Test for means and proportions.
8. Chi-square test of goodness of fit.
9. Paired and unpaired t- test, F-test.
10. Statistical analysis with Computer software packages.

**ZY 105 T: SKILLS IN SCIENTIFIC COMMUNICATION AND WRITING**

**(2 Credits = 30 lectures)**

1. Language as a communication tool, relationship among reading, writing, hearing and speaking, synonyms and antonyms (2L)
2. Organization of English language: sentence structure, basic grammar, Syntax, paragraphs, paraphrases and précis- recognizing important statements, key words (3L)
3. Common error in written and spoken presentation: tautology, double negative, doubles positive, superfluous words, sequence and tenses. (2L)
4. Oral presentation: How to prepare presentation, power point slides, use of communication and IT, Voice, speed of delivery, obstacles in effective communication (2L)
5. Hypothesis, theory and concept (1L)
6. The Genetic code as a simple language (2L)
7. Outline of a science paper and project preparation, funding (2L)
8. Introduction: Survey of literature, defining the problem and justification (2L)
9. Materials and Methods: contents, importance of measurements, reproducibility etc. (2L)
10. Observations and Results: text and data presentation, tables, graphs, histograms, diagrams, photographic plates, legends & captions (3L)
11. Discussion: What to discuss? Logical sequence and critical analysis of ideas and evidence or data conclusion (2L)
12. Citation: How to find references from journals, books and data bases, styles of citations (2L)
13. Summary , Abstract, acknowledgements and Title designing (3L)
14. Editing & correcting: proof- reading symbols, Jargons and abbreviations (2L)

**REFERENCE BOOKS:**

1. O'Conner, M and Woodford, F.P.(1975). Writing scientific papers in English. Elsevier- Excerpta Medica-North Holland pul., Amsterdam.
2. Trelease, S.F. (1958). How to write Scientific and Technical papers. Williams and Wilkins Co. Baltimore, USA



3. Robert Day (1996). How to write and publish a Scientific Paper. Cambridge University Press
4. McMillan, V (1997). Writing Papers in the Biological Sciences. Edn. 2, W.H. Freeman. New York
5. G. Vijayalakshmi and C. Sivapragasam. (2008) Research Methods –Tip & Techniques, MJP Publishers, Chennai. WWW.mjppublishers.com

**ZY 105 P: PRACTICALS IN SSCW: (2 credits) (1P: 3 hrs) (10PX3= 30 hrs)**

1. English vocabulary, word formation, basic grammar-verb, adverb, adjective, noun, pronoun (1P)
2. Syntax, paraphrasing and précis writing, synonyms, antonyms, abbreviations (1P)
3. Spoken English: pronunciation, diphthong, accent, clarity, speed, punctuation, simplicity and syntax (1P)
4. Common errors in written and spoken presentation- Tautology, double negatives and double positives, sequence and tenses, ambiguity, spellings, jargons. (1P)
5. Outline of a scientific paper; preparation of a project and writing Introduction. (1P)
6. Writing abstracts, conclusion/ summary and acknowledgements, key words (1P)
7. To suggest a title to the given abstract/paper (1P)
8. Assigning legends to given graphs, figures and captions to given tables, Deciphering the given pictorals (1P)
9. Study of proof correction symbols; proof- reading the given text & correcting the proofs (1P)
10. Designing of tables and graphs from the given data, (1P)
11. How to write materials and methods ,observation section of a research paper (1P)
12. Write discussion section for the given discussionless research paper (1P)
13. Citations/ Bibliography: how to find and cite references from journals, books and databases` (1P)
14. Oral presentation: Rhythm, style, control, mock presentation for 10 minutes (1P)
15. Use of animation in scientific communication (1P)

**ZY 106 T: FRESHWATER ZOOLOGY (2 Credits: 30 Lectures)**

1. Types of Aquatic environment. (4L)  
 Lotic Habitat : Major river systems in India / rapid and slow moving rivers.  
 Lentic Habitat: Lakes, Ponds and Swamps, Bogs lakes and succession of lakes.  
 Ephemeral water bodies (Temporary habitat).
2. Physical conditions of water: movement of water, Depth, Viscosity, Density, Buoyancy, (surface film and surface film animals), Temperature and light, Transparency and turbidity. (4L)
3. Chemical conditions of water: Dissolved oxygen and Carbon di-oxide, phosphates, Nitrates. Acidity and alkalinity, Mg-hardness, Ca-hardness, dissolved solids, organic Matter, Importance of chemical conditions to aquatic life. (4L)
4. Physiological and protective adaptations of the following. (2L)  
 Protozoa, Rotifera, Crustaceans, Fishes.
5. Diagnostic features and life cycle of temporary rainwater pool animals: Fairy shrimps and Tadpole shrimps. (3L)
6. Respiratory and Locomotory adaptations in freshwater insects and their larvae. (3L)
7. Amphibia and water: General life cycle of frog. Tadpole as important herbivore of freshwater habitat. (2L)
8. Adaptations in freshwater reptiles: Turtles and Crocodiles. economic importance of reptiles. (3L)
9. Economic importance of freshwater molluscs (snails and bivalves)- as a food & medicine. (2L)
10. Biological changes in freshwater due to sewage pollution (with reference to rivers) and its effect on freshwater animals. (3L)

**REFERENCE BOOKS**

1. Mellanby, H (1975).Animal life in freshwater, 6<sup>th</sup> Edn., Chapman-Hall.
2. Limnology: Welch P.S.(1957), Mc Grall, and Hill Co. New York.
3. Treatise on limnology: Hutchinson, G.E.(1967). John. Willy.Pub.New York.
4. Aquatic pollution: Edward A.(2000) Laws. 3<sup>rd</sup> edition.John wiley and Sons. New York.
5. Life in Lakes and Rivers: T.T.Macan and Worthington E.B.(1951) COLLIN, London.

6. Limnology: by Alexander Home, Charles Goldman.
7. Limnology: Lake and River Ecosystem, Robert G. Wetzel 3<sup>rd</sup> edition.
8. Fundamentals of Limnology: franz Ruttner. 3<sup>rd</sup> Edition. University of Toronto Press, 1963.
9. The Ecology of Running water: Hugh Bernard Noel Hynes.
10. Limnological methods: Paul Smith Welch.
11. Fresh water animals of India (An Ecological Approach) : G.T.Tonapi

**ZY 106 P: PRACTICALS IN FRESH WATER ZOOLOGY: (2 credits) (1P: 3 hrs)**

**(10PX3= 30 hrs)**

1. A qualitative and quantitative analysis of zooplankton from a given sample of water using Sedgwick rafter counting cell. **(1P)**
2. To prepare and maintain a culture of paramecium, Daphnia and Hydra. **(1P)**
3. Study of aquatic and semiaquatic adaptations in amphibians and reptiles. **(1P)**
4. Study of locomotory and respiratory adaptations in aquatic insects and their larvae.(Ranatra, Notonecta, Gerris, Bellostoma, Dytiscus). **(1P)**
5. Estimation of Chlorides in given sample of water. **(1P)**
6. Identification of commercially important freshwater fishes and crustaceans. **(1P)**
7. Study if Bioindicators of pollution by insects, rotifers, algae, diatoms. **(1P)**
8. Determinations of LC50 using fish/insect larvae for known pollutant like Heavy metal/any Pesticide/industrial effluent. **(1P)**
9. Water analysis with regadrns to hardness (Total and Calcium). **(1P)**
10. Visit to freshwater body for the study of aquatic ecosystem. **(1P)**
11. Collection and identification of Benthos. **(1P)**
12. Compulsory Visit to ZSI, Pune and water purification plant and submission of tour report. **(1P)**

**ZY 201 T: BIOCHEMISTRY-II (3 Credits = 45 lectures)**

**A. Bioenergetics I**

1. Basic law of thermodynamics, internal energy, enthalpy, entropy, concept of free energy, redox potentials, high energy compounds, structure and function of ATP. (4L)
2. Concepts of metabolism, Metabolic pathways-Catabolic and anabolic, regulation of metabolic pathways (2L)
3. Glycolysis; Detailed study, energetic and its regulation; PFK, gluconeogenesis (5L)
4. Carbohydrate metabolisms: Glycogen biosynthesis and its regulation. Role of enzymes in synthesis and degradation of glycogen, role of cAMP (4L)
5. Citric acid cycle: Detailed study, energetics, regulation and significance, Role of PDH. (7L)
6. Electron transport chain and oxidative phosphorylation (4L)

**B. Bioenergetics II**

1. Oxidative degradation of amino acids: transamination, oxidative deamination, ureacycle, Ammonia excretion (6L)
2. Purine and pyrimidine degradation, biosynthesis of purine and pyrimidine nucleotides (6L)
3. Lipid metabolism: Introduction, oxidation of even chain saturated fatty acids, oxidation of unsaturated fatty acids, oxidation of odd chain fatty acids, omega ( $\omega$ )-oxidation of fatty acids, Ketogenesis. Transport of Fatty Acids. (7L)

**REFERENCE BOOKS**

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

**ZY 201 P: PRACTICALS IN BIOCHEMISTRY II (3Credits: 45hours)**

1. Units and specific activity of enzymes. (4H)
2. Effect of substrate concentration on enzyme activity (4H)
3. Effect of pH and temperature on enzyme activity. (4H)
4. Effect of inhibitor and activator on enzyme activity. (5H)
5. Colorimetry and spectrophotometry (2H)
6. Estimation of cholesterol (4H)
7. Separation sugars by paper chromatography (5H)
8. Estimation of uric acid in Lizard excreta/ Human blood etc. (4H)
9. To find absorption spectrum of haemoglobin, BSA, Tyrosine (4H)
10. Estimation of Nitrogenous Base (Guanine) (4H)
11. Estimation of free aminoacids by Ninhydrin method. (5H)
12. Estimation of Starch (3H)
13. Separation of amino acids by TLC (4H)

**REFERENCE BOOK:**

1. An introduction to Practical Biochemistry by David Plummer; Eds. 3, Tata McGraw Hill Publishing Company.
2. Practical Biochemistry by Jayraman.
3. Biochemical Methods by S. Sadasivam and A. Manickam; New Age International Publisheres.

## ZY 202T: MOLECULAR BIOLOGY (3 Credits = 45 lectures)

1. DNA structure and topology :-Structure of chromatin, nucleosome, chromatin organization and remodeling, higher order organization - chromosome, centromere, telomere, Histones and its effect on structure and function of chromatin, type of DNA (**A, B,Z**) **(5L)**
2. Physical properties of DNA : T<sub>m</sub>, hypo and hyper chromicity, solubility, mutarotation and buoyancy. **(2L)**
3. **Genome organization:** C value paradox and genome size, Cot curves, repetitive and non-repetitive DNA sequence, Cot ½ and, kinetic and sequence complicity,satellite DNA. **Types of RNA and their significance** **(2L)**
4. **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. **(10L)**
5. **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, Nick Translation and SOS Repair **(5L)**
6. Transcriptional Unit in prokaryotes and eukaryotes, role and significance of promoter,enhancer, intron, exon, silencer, Transcriptional factors, mechanism of prokaryotic gene transcription, structure of RNA polymerase,post transcriptional processing: Capping,polyadenylation and splicing in eukaryots. Ribonucleoproteins (SnRNPs &ScRNPs) **(10L)**
7. Protein synthesis:Genetic Code ribosome structure, activation of aminoacids,peptide bond formation and translocation of peptides, post-translational modifications, inhibitors of protein synthesis **(7L)**
8. **Mobile DNA elements:** Transposable elements in bacteria, IS elements, composite transposons, replicative, non-replicative transposons, Mu transpositionControlling elements in Tn A and Tn 10 transposition, SINES and LINES. Retroviruses and retrotransposon **(4L)**

### REFERENCE BOOKS:

1. *Genes IX*, 9th edition (2008), Benjamin Lewin, Publisher - Jones and Barlett Publishers Inc.
2. *Molecular Biology of the Gene*, 5th Edition (2004), James D. Watson, Tania Baker,
3. Stephen P. Bell, Alexander Gann, Michael Levine, Richard Lodwick. Publisher -
4. Pearson Education, Inc. and Dorling Kindersley Publishing, Inc.

5. *Molecular Biology*, 4th Edition (2007), Weaver R., Publisher-McGraw Hill Science.
6. *Molecular Biology of the Cell*, 4th Edition (2004), Bruce Alberts, Dennis Bray, Julian
7. Lewis, Martin Raff, Keith Roberts, and James D. Publisher: Garland Publishing.
8. *Essential Cell Biology*, 2nd Edition (2003) Bruce Albert, Dennis Bray, Karen Hopkin,
9. Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter, Publisher: Garland Publishing.
10. *Fundamentals of Molecular Biology*, (2009), Pal J.K. and Saroj Ghaskadbi, Publisher: Oxford University Press.

**ZY 202 P: PRACTICALS IN MOLECULAR BIOLOGY (2 credits) (9 PX5hrs= 45)**

1. Isolation of bacterial DNA and estimation by UV spectrophotometry (2P)
2. Absorption studies of isolated DNA (1P)
3. Isolation of Liver DNA and quantification by Agarose gel electrophoresis (2P)
4. Isolation of RNA and agarose gel electrophoresis. (1P)
5. Demonstration of plasmid DNA in *E. coli*. and its characterization by UV-spectrophotometry (1P)
6. Concept of biological database, gene and protein search by BLASTA and FASTA (1P)
7. Lab Safety Techniques and sterilization. (1P)
8. To analyse protein on native PAGE and SDS-polyacrylamide gel electrophoresis (2P)

**ZY 203 T: DEVELOPMENTAL BIOLOGY (2 Credits = 30 lectures)**

1. Basic concepts of Developmental Biology: Model systems: Fish, Frog, Chick, Mouse and *Drosophila*. (2L)
2. Introduction of gametogenesis, regulation of sperm motility (tail fiber complex and role of dyenin ATPase), role of pH and divalent cation. (2L)
3. Oogenesis: synthesis and storage of maternal transcripts, proteins and cell organelles, rDNA amplification, transcription lampbrush chromosomes, vitellogenesis (3L)
4. Fertilization : Species specific sperm attraction, recognition of egg & sperm, acrosome reaction, signal transduction, molecular strategy to ensure monospermy and species-specificity in fertilization (4L)
5. Types of eggs and cleavage patterns: Concepts in Pattern formation, animal vegetal axis, gradients, origin, and specification of germ layers (2L)
6. Egg activation: regulation of cell cycle and utilization of maternal macromolecules and organelles during early development. (2L)
7. Organizers: Role of Spemann's organizers in frog and Hensen's node in birds (2L)
8. Mesoderm induction in *Xenopus*: Role of signals in dorsal, intermediate and ventral mesoderm induction. (3L)
9. Pattern formation in *Drosophila*.: Bicoid , Nanos and Torso Morphogen gradients and regulation of Hunchback (3L)
10. Neural competence and molecular signaling during neural induction (3L)
11. Concept of growth, differential cell proliferation, shaping of organ primordia and programmed morphogenetic cell death. (2L)
12. Growth and post embryonic development: Apoptosis, aging and senescence Hayflicks experiment (2L)

**REFERENCE BOOKS:**

1. *Developmental Biology*, 8th edition (2006), S.F. Gilbert. Publisher - Sinauer Associates Inc.
2. *Principles of Development*, 3rd edition (2007), Lewis Wolpert, Publisher- Oxford University Press.
3. *An Introduction to Embryology*, 5th edition (2004), B. I. Balinsky. Publisher - Thomas Asia Pvt. Ltd.
4. *Developmental Biology*, (2001), R. M. Twyman, Publisher - Bios Scientific Publishers LTD.



**ZY 203 P: PRACTICALS IN DEVELOPMENTAL BIOLOGY: (2 CREDITS)****(1P: 3 HRS) (10PX3= 30 HRS)**

1. Mounting of chick embryos and preparation of permanent mounts (1P)
2. Filter paper ring method for *in vitro* culturing of chick Embryo & observations. (1P)
3. Gross anatomy and histology of chick embryo upto 72 hrs. Brain, heart, lens, ear development. (1P)
4. Drosophila development on live material: egg structure, egg laying and early development in culture by phase contrast (1P)
5. Study of embryonic and post-embryonic development using frog egg as a model system. (1P)
6. Study of effect of ligature in Drosophila / House fly larva (1P)
7. Study the imaginal disc in Drosophila larva (1P)
8. Chick limb bud staining with neutral red for morphogenetic cell death (2P)
9. Study of grafting of Hensen's node (2P)
10. Regeneration of Hydra/Planaria (1P)

**ZY 204 T: ENDOCRINOLOGY (2Credits=30 Lectures)**

1. Hormones as chemical messenger, structure of hormones (2L)
2. Hormone receptors; on the plasma membrane, cytoplasm & nucleus (2L)
3. Mechanism of hormone action- signal transduction cascade (2L)
4. Hypothalamic hypophysiotropins (2L)
5. Adenohypophysial hormones: ACTH, PRL, STH and TSH (2L)
6. Control of chromatophores: Pituitary, pineal (2L)
7. Hormonal regulation of carbohydrates, protein & lipid metabolism: pancreatic hormones- glucocorticoids (3L)
8. Osmoregulatory hormones: ADH, mineralcorticoids, renin-angiotensin (2L)
9. Gastrointestinal hormones (2L)
10. Control of calcium and phosphate metabolism (2L)
11. Endocrine mechanism in crustacean: X & Y organs, regulation of metabolism, heart, salt and water balance, reproduction, colour change, moulting (3L)
12. Hormonal regulation of yolk synthesis, secretion & uptake in oogenesis w.r.t amphibian. (2L)
13. Hormones and reproduction in cephalopod mollusks and echinoderms (2L)
14. Hormones regulation in insect larval development and metamorphosis (2L)

**REFERENCE BOOKS**

1. Bentley, P.J. (1998). Comparative vertebrate endocrinology, edn.3, Cambridge University Press, London.
2. Bollander, F. (1994). Molecular endocrinology, edn.2, Acad. Press, San Diego.
3. Hadely, M.E. (1996). Endocrinology. Edn.4, Prentice Hall, Upper Saddle Park.
4. Thomdyke, M.C. and Goldsworthy, G.J. (1988). Neurohormones in Invertebrates. Cambridge University Press.
5. Hoar, W.S. and Hickman, C.P., Jr. (1983). A laboratory companion for general and comparative physiology. Edn.3, Prentice-Hall, Englewood Cliffs, N.J., USA.
6. Kobayashi, H. Malsumolo, A. and Ishii, S. (Eds.) (1992). Atlas of endocrine organs: vertebrates and invertebrates. Springer Verlag, Berlin.
7. Zarrow, M.X., Yachim, J.M. and McCarthy, J.L. (1964). Experimental endocrinology: a sourcebook of basic techniques. Academic Press, New York

**ZY 204 P: PRACTICALS IN ENDOCRINOLOGY: (2 credits) (1P: 3 hrs)****(10PX3= 30 hrs)**

1. Histology of invertebrate and vertebrate neurosecretory and endocrine structures. (1P)
2. Staging of fish chromatophores and effect of adrenaline *in vivo* and *in vivo*, and Acetylcholine *in vivo*. (1P)
3. Blood sugar regulation in the crab- role of eye stalk. (1P)
4. Study of retrocerebral complex of the cockroach. (1P)
5. Introduction of alloxan diabetes in the mouse/ rat / human. (1P)
6. Gonadectomy in the mouse/ rat. (1P)
7. Pancreatectomy in the mouse/ rat. (1P)
8. Effect of insulin on blood sugar, hepatic and muscle glycogen of the rat/human. (1P)
9. Adrenalectomy and self- selection of fluid by the rat. (1P)
10. Thyroidectomy in the rat. (1P)
11. Estimation of thyroxine from human blood. (1P)
12. Determination of Acetylcholine esterase. (1P)

**ZY 205 T: COMPARATIVE ANIMAL PHYSIOLOGY (2 Credits = 30 lectures)**

1. Digestion: Physiology of digestion. (3L)
2. Respiration: Respiratory Surfaces: comparison of ventilation associated with gills and pulmonary respiration. Blood pigment, role in Oxygen transport. O<sub>2</sub> dissociation curves- physiological and ecological significance, CO<sub>2</sub> (4L)
3. Muscle contraction : Structure (light & electron microscopic) of the skeletal muscle, proteins of the myofilaments, nature of actin-myosin interaction, sarcoplasmic reticulum and role of Ca<sup>++</sup> in contraction (4L)
4. Osmotic regulation: Concepts of osmole, osmolarity and tonicity, ionic regulation, Hyper-and hypo-osmotic regulators, ureosmotic animals (4L)
5. Excretion: Basic processes in urine formation, renal function in animals specially the mammalian kidney, Renal pressure system, Comparative biochemistry of nitrogen excretion. (4L)
6. Temperature: Biokinetic Zones, tolerance and resistance. Thermobiological terminology. Compensatory patterns in poikilotherms. Critical temp, and zone of thermal neutrality. Mechanism of thermoregulation in homeotherms. (4L)
7. Chemical Communication: Neurosecretion, neurohemal & endocrine organs. chemistry of vertebrate hormones, Mechanism of hormone action (4L)
8. Sense organ: classification & functions (details of photoreception as a model). Reflexes, Principles of neural integration. (3L)

**ZY 205 P: PRACTICALS (2 credits) (10PX3= 30) (Any 10)**

1. Study of nitrogenous waste products of animals from different habitats. (1P)
2. RBCs in different vertebrates and in different physiological conditions. (1P)
3. Body size and oxygen consumption in aquatic animals (crab/fish). (1P)
4. Estimation of sugar in rat/crab/human blood. (1P)
5. Effect of insulin on the blood sugar of rat. (1P)
6. Estimation of lactate content of rat/crab/human blood. (1P)
7. Determination of bleeding time & clotting time of human blood. (1P)
8. Estimation of chloride content of rat/crab/human blood. (1P)
9. Capillary circulation in the foot-web of frog/tail-fin of fish. (1P)
10. Effect of load on muscle contraction in the frog/rat/fowl. (1P)
11. Determination of the heart beat in the crab-effect of temperature & ions. (1P)
12. Effect of eye stalk ablation on chloride & glucose in the haemolymph of the crab. (1P)

**References:**

1. Comparative animal physiology, Clifford Ladd Prosser, John Wiley & Sons
2. Animal physiology, Richard W. Hill, Gordon A. Wyse. Harper and Row
3. Comparative animal physiology, Philip Carew Withers, Saunders College Pub., 1992

**ZY 206 T: BIOCHEMICAL TECHNIQUES (2 Credits = 30 lectures)**

1. **Chromatography:** Principles and applications of: Adsorption chromatography Partition chromatography, Ion-exchange chromatography, affinity chromatography, Molecular exclusion chromatography, thin layer chromatography, HPLC, RPLC, selection of chromatographic system. (9L)
2. **Electrophoresis:** Moving boundary electrophoresis, zone electrophoresis, different supports used for electrophoresis, electrophoresis under native, dissociating and denaturing conditions, occurrence of artefacts, isoelectric focussing, activation analysis (5L)
3. **Absorption spectroscopy:** Concepts of light & electromagnetic spectrum, IR: identification of functional groups, atomic absorption spectrometry and applications (5L)
4. **Radioactivity:** Properties of radioisotopes, commonly used isotopes, structure & working of G.M, counter, isotopic dilution analysis, use of isotopes in biology, radiation hazards. (3L)
5. **Manometry:** Respiratory quotient determination, Principle of Warbug's apparatus, working and applications. (2L)
6. Methods for protein and DNA sequencing. (3L)
7. **Centrifugation:** Principle, basic theory of ultracentrifuge, molecular weight determination and its applications (3L)

**REFERENCE BOOKS:**

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

**ZY 206 P: PRACTICALS (2 credits) (10 PX3= 30) (Any 10P)**

1. Estimation of proteins by colorimetric and spectrophotometric methods (1P)
2. To find out the capacity and nature of a given ion-exchanger. Investigate the % retention and %elution of aminoacids on a given ion exchanger (1P)
3. To analyse protein on native PAGE and SDS-polyacrylamide gel electrophoresis (2P)
4. To separate protein by gel filtration G-50 (1P)
5. To locate enzymes on electrophoreogram by active staining (1P)
6. Enzyme purification by salting out and organic solvent precipitation (2P)
7. To study the effect of different solvents for a given dye using thin layer chromatography (1P)
8. Characterization of DNA by density gradient centrifugation (1P)
9. In situ detection of different enzymes (1P)
10. Estimation of respiratory quotient by Warburg's Respirometer (1P)
11. Enzyme isolation and purification by fractionation methods (2P)
12. Immobilization of enzymes (1P)
13. Analysis of sequences by BLAST and FASTA. (1P)

**ZY 206 T: ICHTHYOLOGY (2 Credits= 30 lectures)**

1. Classification and diagnostic characters (up to orders) of extant Cyclostomata, Chondrichthyes and Osteichthyes (9 major orders of fishes) (4L)
2. Phylogeny of fishes (1L)
3. External morphology, body form, appendages, pigmentation, skin and scales. Principles of morphometry, Locomotion (2L)
4. Endoskeleton: Skull, axial and appendicular skeleton (2L)
5. Food and feeding habits, Digestive system and its anatomical modifications (3L)
6. Respiration: Structure and functions of gills; adaptations for air breathing; role of air bladder. Respiratory functions of food (2L)
7. Buoyancy mechanisms: Role of fat and swim bladder (2L)
8. Excretion and Osmoregulation; Glomerular and aglomerular kidneys; Nitrogen(ammonia,urea, TMAO) excretions; water and salt and balance in steno-and euryhayline fishes. Role of skin and gills (3L)
9. Catadromous and anadromous fishes (1L)
10. Reproduction: Structure of gonads, gametogenic cycles; spawning, Parental care (4L)
11. Nervous system and Sense organs: Organization of the central and peripheral nervous systems. Eye, lateral line organs and chemoreceptors (3L)
12. Endocrine organs: Functions of the pituitary, thyroid, inter-renal and chromaffin tissues, ultimaobranchial and corpuscles of Stannius (3L)

**REFERENCE BOOKS:**

1. Bal, D. V. & K.V.Rao (1984). Marine Fisheries. Tata McGraw-Hill, New Delhi.
2. Bone, Q., N.B. Marshall & J.H.S. Blaxter (1995). Biology of Fishes, Edn.2, Blackie, Academic % Professional (Chapman & Hall), London.
3. Hoar, W.S. & D.J. Randall, (1969). Fish Physiology. Vols.I onwards, Academic Press, New York.
4. Jayaram, K.C. (1981). The freshwater fishes of India. Pakistan, Bangladesh, Burma and Sri Lanka- A Handbook. Zool. Survey of India, Academic Press, New York.
5. Khanna, S.S. (1984). An Introduction to Fishes. Central Book Depot., Allahabad.



6. Lagler, K.E., J.E. Bardach, R.R. Miller & D.R.M. Passino (1977). Ichthyology, Edn.2, Wiley, New York.
7. Talwar, P.K. & A.G. Jhingran (1991). Fish and Fisheries of India and Adjacent Countries, Vols. I & II. Oxford & I.B.H., New York.
8. Wake, M.H. (Ed.) (1979). Hyman's Comparative Vertebrate Anatomy. Edn.3, University of Chicago Press, Chicago

**ZY 206 P: PRACTICALS IN ICHTHYOLOGY: (2 credits) (1P: 3 hrs) (10PX3= 30 hrs)**

1. General external characters, fins and scales (permanent slides & temporary preparations); morphometric measurements (1P)
2. Classification of fishes (12-18 representatives of different orders); use of diagnostic keys (1P)
3. Pharyngeal basket and skull of lamprey; endoskeleton (9 articulated and disarticulated) of carp (1P)
4. Length-weight relationship, condition factors, gonosomatic and hepatosomatic indices of any one species (1P)
5. Adaptations of fishes (adhesive organs, accessory respiratory organs, stomachless fishes, spiral valve, electric organs etc) (1P)
6. Digestive, and reproductive systems of carp/catfish/Tilapia (1P)
7. Cranial nerves (V, VII, IX & X) and eye ball musculature and innervations in Scoliodon and carp/catfish (1P)
8. Histology of digestive, respiratory, excretory, reproductive and endocrine organs (1P)
9. Chromatophores and their responses to external agent (1P)
10. Satiation index (e.g. Gambusia-mosquito larvae system) (1P)
11. Setting up of an aquarium and study of breeding behaviour of gourami Siamese fighter, swordtail/tilapia (1P)
12. Visit to fish farm/fish market. (1P)

# **University of Pune**

## **Two Year M.Sc. Degree Course in Zoology**

### **M.Sc. Zoology**

**(Credit and Semester based Syllabus to be implemented from Academic Year 2013-14)**

**1) Title of the Course:**

M.Sc. Zoology

**2) Preamble of the Syllabus:**

Master of Science (M.Sc.) in Zoology is a post graduation course of University of Pune. The credit system to be implemented through this curriculum, would allow students to develop a strong footing in the fundamentals and specialize in the disciplines of his/her liking and abilities.

The students pursuing this course would have to develop in depth understanding various aspects of the subject. The working principles, design guidelines and experimental skills associated with different fields of Zoology such as Genetics and Cell Biology, Biochemistry, Molecular Biology, Biostatistics, Bacterial and Phage technology, Biodiversity, Entomology, Physiology, Developmental Biology, Endocrinology, Biochemical Techniques, Animal tissue culture, etc.

**3) Introduction:****Salient Features of the Credit System:**

1. Master's degree course in Zoology would be of 100 credits, where one credit course of theory will be of one clock hour per week running for 15 weeks and one credit for practical course will consist of 15 hrs. of laboratory exercise including the revision and setting up the practical. Thus, each credit will be equivalent to 15 hours.
2. Student will have to take admission in Zoology and complete 75 credits incorporated in the syllabus structure of Zoology. The remaining 25 credits shall be chosen from the courses offered by the Zoology Department or other Departments of the University/College with credit system structure.
3. Besides Credits related to practical Courses, students may be allowed to take courses with less weightage per semester on the condition they complete the degree in maximum of four years. This provision can be availed which is subject to the availability of concerned courses in a given semester and with a maximum variation of 25 credits (in case of fresh credits) per semester in the concerned department/college.
4. Every student shall complete 100 credits in a minimum of four semesters. All Semesters will have 25 credits each.
5. The student will be declared as failed if he/she does not pass in all credits within a total period of four years. After that such students will have to seek fresh admission as per admission rules prevailing at that time.
6. Academic calendar showing dates of commencement and end of teaching, internal assessment tests and term end examination will be prepared and duly notified before commencement of each semester every year.
7. Project course should not be greater than 10% of the total credits of the degree course. Project course is equivalent to 10 credits.

### **Instructions for the Students:**

The students seeking admission to M.Sc. Zoology course is hereby informed that they are supposed to adhere to the following rules:

1. A minimum of 75 % attendance for lectures / practical is the pre-requisite for grant of term.
2. There shall be tutorial / practical / surprise test / home assignment / referencing of research papers / seminar / industrial visits/Field Visit / training course/viva-voce as a part of internal assessment in each semester. The students are supposed to attend all the tests. The students should note that re-test will not be permitted to the student absent for the test/s unless the case is considered by competent authority.
3. The students opting for dissertation course shall follow the rules framed for the same.
4. The students are supposed to attend all the Industrial Workshops / Laboratory Workshops / Training Programme/ symposia/ seminar/ field visit / study tour organized by the department/ college. The students shall attend these programmes at their own cost.

### **4) Eligibility:**

The candidate should have a B.Sc. degree with Zoology as principal subject or B.Sc. (General) degree with Zoology as one of the subsidiary subjects. Graduates in any life science related subjects such as Biotechnology, Bioinformatics, Life science, Biochemistry, Microbiology, Agriculture, Veterinary sciences, Biology, Botany etc.

Admission: Admissions will be given as per the selection procedure / policies adopted by the respective college, in accordance with conditions laid down by the University of Pune.

Reservation and relaxation will be as per the government rules.

### **5) Examination**

#### **[A] Pattern of Examination**

Evaluation of Students:

- 1) The In-semester and End-Semester examinations will be of 50 marks each.
- 2) Student has to obtain 40% marks in the combined examination of In-Semester and End-Semester assessment with minimum passing of 30% marks in both assessments separately.
- 3) A student cannot register for third semester if he/she fails to complete the 50% credits of the total expected within two semesters.
- 4) Internal marks remain unchanged and internal assessment cannot be repeated. If student remain absent during internal assessment examination, he/she will have second chance with the permission of the competent authority. But it will not be right of the student. It will be under the discretion of the competent authority and internal departmental assessment committee. In case he/she wants to repeat Internal, he/she can do so only by registering for the said courses.
- 5) There shall be revaluation of answer script of end semester examination, but not of internal assessment papers.

i. **In-semester Examination:** Internal assessment for each course would be continuous and dates for each tutorials/practical tests etc. will be pre-notified in the time table for teaching or placed separately as a part of time table. Department / College Internal Assessment Committee will coordinate this activity.

a) **Theory Courses:** Students should be encouraged to participate in various academic activities. A teacher must select a variety of the procedures for conducting internal assessment suggested as follows.

- a) Multiple choice questions
- b) Combination of objective and subjective questions.
- c) Open book test (concerned teacher will decide the allowed books)
- d) Tutorial
- e) Surprise test specified topics in a given notified period
- f) Oral
- g) Assignments
- h) Review of research paper
- i) Seminar presentation
- j) Journal/Lecture/Library notes

Student has to preserve the documentation of the internal assessment except midterm test answer script. It is the responsibility of the student to preserve the documents.

b) **Practical Courses:** It is a continuous evaluation process. Practical courses will be evaluated on the basis of the following:

1. Performance assessment of each experiment on the basis of attendance, punctuality, journal completion, practical skills, results, oral and analysis.
2. Assessment on practical course be conducted before the end-semester examination.
3. Assessment of each experiment shall be done for each practical weekly.
4. Assessment of the Activity will be based on any one of the following (per practical course).
  - i. Special training programs in recognized research institutes such as NCL, NIO, NIV, ZSI, BNHS, etc.
  - ii. Project on Research Methodology
  - iii. Industrial/Institution Visit report
  - iv. Field visit report/ study tour report

The student strength of practical batch should be 12.

**Project Course:** Project will be evaluated by the examiner/s in consent with the project guide if required.

ii. **End-Semester Examination:** The End-semester examination programme will be scheduled as per the notifications and guidelines issued by the Examination section of University of Pune.

**[B] Standard of Passing**

Student has to obtain 40% marks in the combined examination of In-Semester and End-Semester assessment with minimum passing of 30% passing in both assessments separately.

**[C] ATKT Rules**

A student cannot register for third semester if he/she fails to complete the 50% credits of the total credits expected to be ordinarily completed within two semesters.

**[D] Award of Class**

Grades will be awarded from grade point average (GPA) of the credits.

**GPA Rules:**

1. The formula for GPA will be based on Weighted Average. The final GPA will not be printed unless a student passes courses equivalent to minimum 100 credit hours (Science). Total credit hours indicate the sum of credit hours of the courses which a student has passed.
2. A seven point grade system [guided by the Government of Maharashtra Resolution No. NGO – 1298 / [4619] / UNI 4 dt. December 11, 1999 and University regulations] will be followed. The corresponding grade table is attached herewith.
3. 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')
4. For Semester I, II, III examinations, only the grade points will be awarded for each subject. Final GPA along with final grade will be awarded only at the end of IV semester. 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.
5. After the declaration of result, for the improvement of Grade, the student can reappear for the examination of 30 credits worth theory courses.
6. Grade improvement programme will be implemented at the end of the academic year. A student can opt for grade improvement programme only after the declaration of final semester examination i.e. at the end of next academic year after passing M.Sc. (Zoology) examination and within two years of completion of M.Sc. (Zoology). A student can appear for grade improvement programme only once.

Grade and Grade Point Average		
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
5.00 – 6.00	<b>O</b>
4.50 – 4.99	<b>A</b>
3.50 – 4.49	<b>B</b>
2.50 – 3.49	<b>C</b>
1.50 – 2.49	<b>D</b>
0.50 – 1.49	<b>E</b>
0.00 – 0.49	<b>F</b>

Common Formula for Grade Point Average (GPA):

$$\text{GPA} = \frac{\text{Total of Grade Points earned} \times \text{Credit hours for each course}}{\text{Total Credit hours}}$$

B Grade is equivalent to at least 55% of the marks

**[E]External Students:** There shall be no external students.

**[F]Setting of Question Paper / Pattern of Question Paper**

For core (compulsory) theory courses end semester question papers set by the University of Pune and centralized assessment for theory papers done as per the University instructions. Questions should be designed to test the conceptual knowledge and understanding of the basic concepts of the subject.

Theory examination will be of 3 hours duration for each theory course of 4 credits. There shall be 3 questions each carrying marks as shown below. The pattern of question papers shall be:

Question 1 (20 Marks)	10 compulsory sub-questions, each of 2 marks; answerable in 2 -3 lines
Question 2 (20 Marks)	5 out of 7– short answer type questions.
Question 3 (10 Marks)	2 out of 3 – Long answer type questions.

### [G]Verification / Revaluation

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. There shall be revaluation of answer script of end semester examination, but not of internal assessment papers.

### 6) Structure of Course

Basic structure/pattern (Framework) of the proposed postgraduate syllabus for the two year integrated course leading to M.Sc. (Zoology) in the colleges affiliated to Pune University.

#### M.Sc. Zoology - Course structure & Credits Distribution

#### M.Sc. Zoology –Part –I Semester-I

Course No	Title	Credits	Course No	Title	credits
ZY 101T	Biochemistry-I	3C	ZY 101 P	Practicals in Biochemistry-I	3C
ZY 102T	Cell Biology	3C	ZY 102 P	Practicals in Cell Biology	2C
ZY 103T	Genetics	2C	ZY 103 P	Practicals in Genetics	2C
ZY104T	Biostatistics	2C	ZY104 P	Practicals in Biostatistics	2C
ZY105T	Skills in Scientific communication and writing	2C	ZY105 P	Practicals in Skills in Scientific communication	2C
ZY106T	Fresh Water Zoology	2C	ZY106 P	Practicals in Fresh Water Zoology	2C
		<b>14C</b>			<b>13C</b>

(T = Theory ; P = Practicals)

**Total credits =27**

**Note:- Courses equivalent to atleast 25 credits should be taken by the students.**

#### Semester-II

Course No	Title	credits	Course No	Title	credits
ZY 201T	Biochemistry-II	3C	ZY 201 P	Practical Biochemistry-II	3C
ZY 202 T	Molecular Biology	3C	ZY 202 P	Practical Molecular Biology	3C
ZY 203T	Developmental Biology	2C	ZY 203 P	Practical Developmental Biology	2C
ZY204T	Endocrinology	2C	ZY204 P	Practical Endocrinology	2C
ZY205T	Comp.Animal Physiology	2C	ZY205 P	Practical Comp.Animal Physiology	2C
ZY206T	Biochemical techniques/ Ichthyology	2C	ZY206 P	Practicals in Biochemical techniques/ Ichthyology	2C
		<b>14C</b>			<b>14C</b>

(T = Theory ; P = Practicals)

**Total credits =28**

**Note: - Courses equivalent to atleast 25 credits should be taken by the students.**



**M.Sc. Zoology –Part –II**  
**Semester-III**

Course No	Title	Credit	Course No	Title	credits
ZY 301T	Animal Physiology I (special) or Entomology I (special) or Genetics I (special)	4C	ZY 301 P	Practicals in Animal Physiology I/Entomology I/Genetics I	3C
ZY 302T	Immunology / Environmental biology	2C	ZY 302 P	Practicals in Immunology / Environmental biology	2C
ZY 303T	Genetic toxicology / Aquaculture	2C	ZY 303 P	Practicals in Genetic toxicology / Aquaculture	2C
ZY304T	Insect physiology and biochemistry	2C	ZY304 P	Practicals in Insect physiology and biochemistry	2C
ZY305T	Research methodology	2C	ZY305 P	Practicals in Research methodology	2C
ZY306T	Parasitology	2C	ZY306 P	Practicals in Parasitology	2C
ZY307T	Fundamentals of Systematics	2C	ZY307 P	Practicals in Fundamentals of Systematics	2C
ZY 308T	Insect Ecology	2C	ZY308 P	Research Project	2C
ZY 309 T	Toxicology I	2C	ZY 309 P	Practicals in Toxicology I	2C
		20C			19C

(T = Theory ; P = Practicals)

**Total credits =39**

**Note:- courses equivalent to atleast 25 credits should be taken by the students.**

**Semester-IV**

Course No	Title	Credit	Course No	Title	Credits
ZY 401T	Animal Physiology II (special) or Entomology II (special) or Genetics II (special)	4C	ZY 401 P	Practical Animal Physiology II/ Entomology II/ Genetics II	3C
ZY 402 T	Economic Zoology / Bacteria and phage Genetics	2C	ZY 402 P	Practical Economic Zoology / Bacteria and phage Genetics	2C
ZY 403T	Mammalian reproductive physiology / Biodiversity assessment	2C	ZY 403 P	Practical Mammalian reproductive physiology / Biodiversity assessment	2C
ZY404T	Histology and histochemistry	2C	ZY404 P	Practical Histology and histochemistry	2C
ZY405T	Pollution biology	2C	ZY405 P	Practical Pollution biology	2C
ZY406T	Apiculture	2C	ZY406 P	Practical Apiculture	2C
ZY 407T	Pest control	2C	ZY308 P	Research Project	2C
ZY 408 T	Toxicology II	2C	ZY 408 P	Practicals in Toxicology II	2C
		18C			17C

(T = Theory ; P = Practicals)

**Total credits = 35**

**Note:- courses equivalent to Atleast 25 credits should be taken by the students.**

**a) Question Papers and papers etc.:**

Theory

In-Semester Examination : 50 Marks

End-Semester Examination : 50 Marks

Practical

In-Semester Examination : 50 Marks

End-Semester Examination : 50 Marks

**b) Medium of Instructions:** English.

**7) Equivalence of Previous Syllabus:**

<b>Old Course (2008 Pattern)</b>	<b>New Course (2013 Pattern)</b>
ZY 101 Biochemistry	ZY101T: Biochemistry
ZY 202 b Cell Biology	ZY102T: Cell Biology
ZY 102 a Genetics	ZY103T: Genetics
ZY 103 b Statistical Methods	ZY104T: Biostatistics
ZY 102 b English for Scientists	ZY105T: Skills in scientific communication and writing
ZY 103 a Fresh Water Zoology	ZY106T: Fresh water zoology
ZY 104 a Biochemistry	ZY101P: Practicals in Biochemistry
ZY 205 b Cell biology	ZY102P: Practicals in Cell Biology
ZY 105 b Genetics	ZY103P: Practicals in Genetics
ZY 105 a Statistical Methods	ZY104P: Practicals in Biostatistics
ZY 105 c English for Scientists	ZY105P: Practicals in Skills in scientific communication and writing
ZY 104 b Fresh water Zoology	ZY106P: Practicals in Fresh water zoology

<b>Old Course (2008 Pattern)</b>	<b>New Course (2013 Pattern)</b>
ZY 101 Biochemistry	ZY 201 T Biochemistry-II
ZY 202 a Molecular Biology	ZY 202 T Molecular Biology
ZY 201 a Developmental Biology	ZY 203 T Developmental Biology
ZY 203 b Endocrinology	ZY 204 T Endocrinology
ZY 201 b Comparative Animal Physiology	ZY 205 T Comparative Animal Physiology
ZY 203 a Biochemical Techniques/ Ichthyology	ZY 206 T Biochemical techniques/ Ichthyology
ZY 104 a Biochemistry	ZY 201P Practical Biochemistry-II
ZY 204 b Molecular biology	ZY 202P Practical Molecular Biology
ZY 205 a Developmental Biology	ZY 203P Practical Developmental Biology
ZY 205 c Endocrinology	ZY 204P Practical Endocrinology
ZY 204 a Comparative Animal Physiology	ZY 205P Practical Comparative Animal Physiology
ZY 204 c Biochemical techniques/ Ichthyology	ZY 206P Practicals in Biochemical techniques/ Ichthyology

### 8) University Terms:

Dates for commencement and conclusion for the first and second terms will be declared by the University authorities. Terms can be kept by only for duly admitted students. The term shall be granted only on minimum 75 percent attendance at theory and practical course and satisfactory performance during the term.

### 9) Qualification of Teacher:

- i. M.Sc. (Zoology) degree with NET/SET/ Ph.D qualification.
- ii. Recognition of Pune University as a post graduate teacher, by papers.
- iii. Other criteria as per the guidelines of UGC and University of Pune.

### 10) Detail Syllabus with Recommended Books

**M.Sc. Zoology –Part –II**  
**Semester-III**

Course No	Title	Credit	Course No	Title	credits
ZY 301T	Animal Physiology I (special) or Entomology I (special) or Genetics I (special)	4C	ZY 301 P	Practicals in Animal Physiology I/Entomology I/Genetics I	3C
ZY 302T	Immunology / Environmental biology	2C	ZY 302 P	Practicals in Immunology / Environmental biology	2C
ZY 303T	Genetic toxicology / Aquaculture	2C	ZY 303 P	Practicals in Genetic toxicology / Aquaculture	2C
ZY304T	Insect physiology and biochemistry	2C	ZY304 P	Practicals in Insect physiology and biochemistry	2C
ZY305T	Research methodology	2C	ZY305 P	Practicals in Research methodology	2C
ZY306T	Parasitology	2C	ZY306 P	Practicals in Parasitology	2C
ZY307T	Fundamentals of Systematics	2C	ZY307 P	Practicals in Fundamentals of Systematics	2C
ZY 308T	Insect Ecology	2C	ZY308 P	Research Project	2C
ZY 309 T	Toxicology I	2C	ZY 309 P	Practicals in Toxicology I	2C
		20C			19C

(T = Theory ; P = Practicals)

**Total credits =39**

**Note:- courses equivalent to atleast 25 credits should be taken by the students.**

**Semester-IV**

Course No	Title	Credit	Course No	Title	Credits
ZY 401T	Animal Physiology II (special) or Entomology II (special) or Genetics II (special)	4C	ZY 401 P	Practical Animal Physiology II/ Entomology II/ Genetics II	3C
ZY 402 T	Economic Zoology / Bacteria and phage Genetics	2C	ZY 402 P	Practical Economic Zoology / Bacteria and phage Genetics	2C
ZY 403T	Mammalian reproductive physiology / Biodiversity assessment	2C	ZY 403 P	Practical Mammalian reproductive physiology / Biodiversity assessment	2C
ZY404T	Histology and histochemistry	2C	ZY404 P	Practical Histology and histochemistry	2C
ZY405T	Pollution biology	2C	ZY405 P	Practical Pollution biology	2C
ZY406T	Apiculture	2C	ZY406 P	Practical Apiculture	2C
ZY 407T	Pest control	2C	ZY308 P	Research Project	2C
ZY 408 T	Toxicology II	2C	ZY 408 P	Practicals in Toxicology II	2C
		18C			17C

(T = Theory ; P = Practicals)

**Total credits = 35**

**Note:- courses equivalent to Atleast 25 credits should be taken by the students.**

**Equivalence of Previous Syllabus: Sem. III and Sem IV**

<b>Old Course -2008 Pattern Sem III</b>	<b>New Course- 2013 Pattern Sem III</b>
ZY 311 Entomology I	ZY 301 T Entomology I (Special )
ZY 312 Genetics I	ZY 301 T Genetics I (Special )
ZY 313 Physiology I	ZY 301 T Animal Physiology I (Special )
ZY 321 Immunology	ZY 302 T Immunology
ZY 322 Environmental Biology	ZY 302 T Environmental Biology
ZY 323 Fundamentals of Systematics	ZY 307 T Fundamentals of Systematics
ZY 324 Aquaculture	ZY 303 T Aquaculture
ZY 325 Insect Ecology	ZY 308 T Insect Ecology
ZY 331 Parasitology	ZY 306 T Parasitology
ZY332 Insect Physiology and Biochemistry	ZY 304 T Insect Physiology and Biochemistry
ZY333 Modern Concepts in Animal Evolution	ZY 309 T Toxicology I
ZY 334 Genetic Toxicology	ZY 303 T Genetic Toxicology
ZY 335 Insect Behaviour	No equivalence
ZY 341 Research Project	ZY 308 P Research Project
ZY 351 A Practicals for Special Paper I	ZY 301 P Practicals in corresponding Course
ZY 351 B Laboratory exercises in related courses Zy 321-325 and Zy 331-335	ZY 302 - 309 Practicals in Corresponding courses.

<b>Old Course -2008 Pattern Sem IV</b>	<b>New Course- 2013 Pattern Sem IV</b>
ZY 411 Entomology II	ZY 401 T Entomology II
ZY 412 Genetics II	ZY 401 T Genetics II
ZY 413 Physiology II	ZY 401 T Animal Physiology II
ZY 421 Animal tissue Culture	ZY 408 T Toxicology II
ZY 422 Pollution Biology	ZY 405 Pollution Biology
ZY 423 Marine Biology	ZY 402 Economic Zoology
ZY 424 Bacterial and Phage Genetics	ZY 402 T Bacterial and Phage Genetics
ZY 425 Medical Entomology	ZY 407 T Pest Control
ZY 431 Physiology of Mammalian reproduction	ZY 403 T Mammalian Reproductive Physiology
ZY 432 Comparative Invertebrate Histology and Histochemistry	ZY 404 T Histology and Histochemistry
ZY 433 Biodiversity Assessment	ZY 403 T Biodiversity Assessment
ZY 434 Protozoology	No equivalence
ZY 435 Apiculture	ZY 406 T Apiculture
ZY 441 Laboratory Experiments in Special Paper II	ZY 401 P Practicals in corresponding Course
ZY 451 Laboratory Exercises in related courses Zy 421-425 and ZY 431-435	ZY 402 -408 Practicals in Corresponding courses.

**ZY 301 (T) – Animal Physiology I (4 credits)**

<b>Sr.No</b>	<b>Topic</b>	<b>Hours</b>
1	<b>Bioluminescence and Animal electricity</b> 1.1 Bioluminescence: phyletic distribution, structure of luminescent organs, biochemical and molecular mechanism. 1.2 Animal electricity: electro receptors electro organs and their structure and	10
2	<b>Buoyancy:</b> definition, density reduction, gas floats with examples swim bladder with example.	7
3	<b>External and Internal environment:</b> 3.1 External environment: the atmosphere, aquatic & terrestrial environment 3.2 Internal environment: Extracellular and intra cellular environment 3.3 Homeostasis and regulation: tolerance and resistance, acclimatisation and acclimation, regulatory mechanism. 3.4 Biological clock and their regulation: Circadian rhythms lunar and tidal rhythm, circa annual rhythm, photoperiodism.	7
4	<b>Membrane physiology</b> 4.1 Membrane structure, membrane permeation, diffusion mediated transport, dynamics of semi permeable membrane. 4.2 resting membrane potential, diffusion, equilibrium potential, Goldman-Hodkin- Katz potential, conductance, current, capacitance 4.3 Excitable cell membrane: action potential, role of various ion channels, role of $\text{Na}^+$ $\text{K}^+$ pump, properties of action potentials	10
5	<b>Energy metabolism:</b> 5.1 Metabolic rate 5.2 Energy storage: Fat and glycogen 5.3 Effect of $\text{O}_2$ concentration: acclimation to low $\text{O}_2$ level, anaerobic metabolism, lactic acid and glycolysis 5.4 Problem of diving and deep sea hydro thermal vent 5.5 Metabolic rate and body size: mammals, birds, marsupials & monotremes 5.6 Energy cost of locomotion: running, swimming, flying 5.7 Effect of high altitude	15
6	<b>Excretion:</b> 6.1 Nitrogenous waste- ammonia and its excretion, urea, urea cycle, uric acid and its excretion, products of nucleoprotein metabolism, miscellaneous end product of nitrogen metabolism. 6.2 Organ of excretion and urine formation 6.3 Renal regulation and acid –base balance.	6
7	<b>Osmoregulation -</b> Maintaining water and electrolyte balance and its regulation in aquatic invertebrates & vertebrate, moist skinned animals, arthropods, terrestrial, vertebrate and marine air breathing vertebrates	5

References

1. Guyton A.C and Hall J.E, Text book of medical physiology, Hartcort brace and co. Asia Pvt.Ltd., Singapore.
2. Baldwin, E. An introduction to Comp Biochemistry. Cambridge.
3. Hill, R.W. & GA Wyse, . Animal physiology. Harper & Row, NW.
4. Randall, D, W.Burggen & K, French. Eckert Animal Physiology : Mechanism and adaptation, W H Freeman, NY
5. Schmidt-Nielsen, Animal Physiology: Adaptation and Environment. Cambridge.
6. Hoar, W S General and Comparative physiology. Prentice Hall, India, New Delhi.
7. Vernberg, F.J. & Vernberg, WB . Animal and the environment. Holt, Rienhart & Winston, NY.
8. Prosser and Brown. Comparative physiology.

**ZY 301 (P) – Animal Physiology I (3 credits) (1P: 3 hrs) (15PX3= 30 hrs)**

1	Estimation serum uric acid	1p
2	Body size and oxygen consumption in aquatic animals	1p
3	Effect of salinity on oxygen consumption in aquatic animals	1p
4	Absorption spectra of blood pigment	1p
5	Osmotic stress and volume change in earthworm	1p
6	Effect of temperature on water loss in cockroach	1p
7	Carbohydrates in mammalian gut	1p
8	Detection of allantoin in mammalian urine	1p
9	Glomerular filtration rate by creatinine clearance	1p
10	Effect of starvation on liver and muscle glycogen in mouse	2p
11	Induction of heat shock puff in salivary gland chromosomes of Drosophila	1p
12	Estimation of blood Sodium, potassium, Calcium	1p
13	Estimation of blood alkaline & acid phosphatases	1p
14	Normal & abnormal constituents of human urine	1p



### **ZY- 301 T Entomology I (Special) 4 Credits**

1. Introduction to Entomology: Definition, Origin , Evolution and Inter-relationship of insects with other arthropods. 03L
2. General outline of Classification and Phylogeny of insects: Aptrygote insects (1-4 order), Exopterygote insects (5-20 order) and Endopterygote insects (21-29 order). 20L
3. Integument and it's derivatives. 02L
4. Comparative study of : Head and its appendages; Thorax and its appendages ; Abdomen and it's appendages. 08L
5. Comparative and histological studies of the following systems: Digestive system, Respiratory system, Circulatory system and Excretory system and Reproductive system, Nervous system. 20L
6. Studies of the following systems: The Sense organs, Endocrine glands and Exocrine glands. 05L
7. Light and sound producing organ. 02L

#### **Reference Books**

1. Imms' Text book of Entomology- By O. W. Richards and R. G. Davies, (Methuen &Cc., London, ), Vols. I & II.
2. Principles of Insect Morphology- By R. E. Snodgrass, (Tata, McGraw- Hill, Bombay, .
3. Introduction of Comparative Entomology- By R. M. Fox & J. W. Fox, (Reinhold, New York,).
4. The Insect: Structure & Function- By R.F. Chapman (E. L.B.S., & E.U.P. London, ).
5. General & Applied Entomology- By K.K. Nayar, T.N. Anathakrishnan & B.V.David, (Tata,McGraw-Hill, New Dehli, ).
6. A Text book of Entomology' by H. H. Ross (John Wiley and Sons, Ins. New York,).

**ZY- 301P Entomology I Practical Course (3 Credits)**

1. Method of collection, preservation & presentation of insect. 1P
2. Study of generalized insect including Systematic position, Habit and Habitat, Important morphological features and Dissection of so as to study: Digestive. Nervous and Reproductive system and Retrocerebral complex. 3P
3. Study of head capsule, mouthparts and antenna and their modification. 2P
4. Study of generalized wing and their modification with significance. 1P
5. Study of insect orders; (i) Apterygote insects, (ii) Exopterygote insects and (iii) Endopterygote insects inclusive of Taxonomy and diagnostic features upto family ( atleast one insect from each order). 6P
6. Dissection of an insect pest (Plant bug or any insect pest as per local availability and legal permissibility) so as to study Taxonomy, Diagnostic features and Anatomy pertaining to Digestive, Nervous and Reproductive systems. 3P
7. Temporary mounting of Mouth parts, Antenna, Wings and Appendage of the insect pest used in practical number 4. 1P

**Note:- 15 practicals are to be performed by the students.**

**ZY-301T: Genetics I****4 Credits.****1. Model Genetic System: Life cycles and advantages of the following organisms commonly used in genetic studies** 08 L

- 1.1 T4 and T1 phages
- 1.2 *Neurospora*
- 1.3 *E.coli*
- 1.4 *Saccharomyces cerevisea* and *Schizosaccharomyces pombe*
- 1.5 *Caenorhabditis*
- 1.6 *Drosophila*
- 1.7 Zebra fish
- 1.8 Mouse

**2. Advanced Population Genetics:** 13L

- 2.1 Recapitulation of basic concepts and H-W law
- 2.2 Estimation of gene frequencies in population through mutation, migration and selection, selection-mutation equilibrium, derivation and genetic equations for above.
- 2.3 Assortative matings, inbreeding, genetic drift

**3. Evolutionary genetics:** 13L

- 3.1 Concept of continuous variation, phenotypic variance and its partitioning into subcomponents.
- 3.2 Co-variance, correlation and regression, degree of genetic determination, measurement of heritability, quantitative inheritance in humans.

**4. Evolutionary Genetics:** 13L

- 4.1 Genetic polymorphism
- 4.2 Selection strategies and effects
- 4.3 Genetics of speciation- classical and modern concepts
- 4.4 Use of molecular information in understanding phylogenetic relationship

**5. Applications of Molecular methodologies in genetic analysis:** 13L

- 5.1 Introduction to gene localization on chromosomes
- 5.2 Chromosomal Probes and Paints
- 5.3 Gene Therapy: Ex vivo and In vivo gene therapy and two examples of gene delivery system
- 5.4 Reverse Genetics

**Reference books**

1. Strickberger, M.W., genetics, Edn III, Mac Millan,
2. Gardner, E.J., Simmons, M.J. and Snustad, D.P. Principles of genetics, John Wiley and Sons, NY,
3. Griffiths, A.J.F., Miller, J.H., Suzuki, D.T., Lewontin, R.C. and Gelbert, W.M. An introduction to Genetics analysis. W.H. Freeman and Co. NY,
4. Trends in genetics, Elsevier Publication, Amsterdam.
5. Genetics: Analysis of Genes and Genomes, D.L. Hartl, E. W Jones, Jones and Bartlett Publ. 2009.
6. Genes X: Benjamin Lewin, Jones and Bartlett Publications 2014.

**ZY 301 P Practicals in Genetics I Credits - 03**

1. Analysis of metric trait and estimation of phenotypic variance. [1P]
2. Partitioning of phenotypic variance in genetic and nongenetic components in a simulated population. Estimation of DGD. [1P]
3. Detection of polymorphism in a population – Biochemical (Enzyme, protein etc.) [1P]
4. To study population cage experiments using *Drosophila*: [1p]
  - a) Genetic Drift
  - b) Artificial selection- Experimental simulation and modeling.
5. Extraction of Genomic DNA from *Drosophila*. [2P]
6. Microbial genetics: Basic methodology, colony count, growth curve [2P]
7. Microbial genetics: Isolation of Auxotroph (Estimation of frequency) Replica plate technique. [2P]
8. Bacterial transformation and blue white selection. Calculation of transformation efficiency. [1P]
9. Study of conventions of nomenclature of genes and gene products in different model systems. [2P]

**ZY 302 (T) – Immunology (2 credits)**

<b>Sr. No.</b>	<b>Topic</b>	<b>Lectures</b>
<b>1</b>	Immune System: a) Introduction to Immunology b) Concept of immunity (self –nonself, antigen, antibody, immune response, immunological tolerance, autoimmune disease) and active and passive immunization, c) Primary and Secondary lymphoid organ. Tissue, cells and molecules of the human immune system.	<b>3</b>
<b>2</b>	Humoral immunity, and cell mediated immunity, T cell receptors.	<b>2</b>
<b>3</b>	Immediate response to infection:, Inflammation, cell migration, acute phase response interferon's and NK cell.	<b>3</b>
<b>4</b>	Antibody structure, antibody classes, subclasses, structure- function relationship, iso, idio and allo types	<b>4</b>
<b>5</b>	Theories of antibody synthesis, generation of antibody diversity ( molecular basis), Antibody class switching	<b>3</b>
<b>6</b>	Antigen antibody reaction and complement fixation pathways.	<b>2</b>
<b>7</b>	Immunogenetics: HLA and Disease association, immune deficiencies and disorders. Antigen processing and MHC	<b>5</b>
<b>8</b>	Hybridoma principle and application, ELISA, Immunofluorescence, Immunoelectrophoresis, RIA and Monoclonal & Polyclonal Antibody and its application	<b>5</b>
<b>9</b>	Immunological Memory and Vaccination	<b>3</b>

**Reference books**

1. Essential immunology, Ivon Roitt, Blackwell scientific publications, London.
2. Immunology, I.V. Roitt, Butterworth publishers, USA
3. Kuby Immunology: Kindt T.J., Goldsby R.A., Osborne B.A., Kuby J. : Freeman WH Publ.

**ZY 302 (P) – Immunology (2 credits) (1P: 3 hrs) (10PX3= 30 hrs)**

1	Ouchterlony technique of agar gel diffusion	2p
2	Immunoelectrophoresis	2p
3	Haemagglutination inhibition test	2p
4	Histology of Lymphoid organ- Skin, Spleen, Thymus, Ilium, Lymph node, Bone marrow	2p
5	Blood smear preparation to study various blood cells	2p
6	Blood group analysis with reference to cross matching	2p
7	To estimate the antigen concentration using rocket electrophoresis	2p
8	Dot immunobinding assay to detect antibodies in the serum	2p
9	To perform ELISA.	2p

## **ZY302 T Environmental Biology (2 C= 30 Lectures)**

1. Introduction: Fundamentals of Ecology, Ecosystems: Definition and, concept of ecosystems, energy flow in ecosystems, Nutritional Flux. Development and evolution of the ecosystems. Biogeochemical cycles, Food-chains, ecotone, edge effects, ecological niche, and ecosystem stability. (6 L)
2. Environmental Microbiology: Microbes - classification and their applications in the environmental sciences. Cultivation and growth of microorganisms. Microorganisms and their association with man, animals and plants. Microbes as anti-microbial agents. (2L)
3. Biomes and Habitat Diversity: Classification of biomes, major biotic elements of each biome and their characteristics. Human impact on the natural environment. (2L)
4. Biological diversity of India: Definition and nature, India's biogeographically history, physiography, climate and its impact on biodiversity. Indian forest and vegetation types and diversity of flora and fauna. (4L)
5. Population and Community Ecology. (2L)
6. Wetlands Forests and Semi-arid Habitats of India: Definition and types of wetlands, important wetlands of India and their conservation issues. Forests and semi-arid habitats of India: their distribution in India, ecological status of forests and arid lands, and their conservation. (4L)
7. Endangered, Endemic and Extinct Species of India: Threatened species categories of IUCN, threatened species of plants and animals in India and their reasons, Red data books. (3L)
9. Wildlife management and conservation. Protected Areas Network in India: Goals of management, Strategies for planning. Factors influencing wildlife management such as habitats, population, behavior, food-habits, health, etc., tools for data collection and analysis. Human land-use and wildlife management units, important projects for the conservation of wildlife in India, Role of local communities in wildlife management. (7L)

### **References:**

1. Fundamentals of Ecology: E. P. Odum
2. Modern concepts in Ecology: H: D. Kumar
3. Microbes, Man and Animals: The Natural History of Microbial Interactions: Linton, A. H. and Burns, R.G. John Wiley and Sons.
4. Elements of Microbiology: Pelczar, M.J. and Chan ECS, McGraw Hill.
5. General Microbiology: Stainer, R.Y .. , Adelberg, EA and Ingraham, J.L. . Macmillan Press.
6. Microbial Methods for Environmental Biotechnology: Grainer, J.M. and Lynch, J.M. . Academic Press.
7. Microbiological Methods for Environmental Scientists and Enginners : Gaudy, A.F. and Guady, E.T. McGraw Hill.

### ZY302 P Environmental Biology (2C)

1.	A visit to aquatic ecosystem and methods for water and plankton collection	2P
2.	Plankton identification and quantification from river / lake water samples.	2P
4.	Vegetation studies by line, quadrates and belt transect methods and their analysis.	2P
5.	Preparation of media for microbial culture, Isolation and culturing of microbes from soil/water samples.	2P
5.	Water analysis for physico-chemical characteristics.	1P
6.	Physico chemical analysis of soil.	1P

### ZY 303 (T) – Genetic Toxicology (2 credits)

Sr.No.	Topic	Lectures
1	Toxicology: Definition and its subdivisions, scope and significance of genetic toxicology	3
2	Mutations at molecular, functional and chromosomal levels. Mechanisms of Mutagenesis End point mutations and its function, carcinogenicity and transformation. Biological significance of mutagenesis	7
3	Mutagenic agents in human environment. Applications of genetic toxicology to human and environmental monitoring	5
4	Methodologies used in detection of mutation, functional, cytogenetic effects. Use of Ames test, mammalian systematics, Drosophila etc.	5
5	Screening chemicals for genotoxic properties: Screening tests, hazard assessment, Risk analysis tests. Common assays used for testing mutagenic activity using bacteria, yeasts, insects, plants, animals.	7
6	Genetic toxicology and its role in the study of congenital malformations	3

#### Reference books

1. Chemical mutagens- principles and methods for their detection, Ed. Hollander, A. Vol. 1-5, Plenum press
2. Chemical mutagenesis in mammals and men. Eds. Vogel, F. and Rohtborn, G. Springer Verlag
3. Mutagenic effects of Environmental contaminants, Eds. Suttoa, H.E. and Harris, M.I., Academic press
4. Mutation research (section on genetic toxicology testing)
5. Journal of environmental pathology and toxicology, Patnotox Publ. Inc.
6. Genetic Toxicology: Principles and methods, Parry J.M., Parry E.M. (eds) Springer Publ. (2012)
7. Principles of Genetic Toxicology: David Brusick. Springer

**ZY 303 (P) – Genetic Toxicology (2 credits) (1P: 3 hrs) (10PX3= 30 hrs)**

1	Dominant lethal test in <i>Drosophila</i>	2 P
2	Sex linked recessive lethal test in <i>Drosophila</i>	2 P
3	Micronucleus test in mouse	2 P
4	Bone marrow chromosome analysis in mouse	2P
5	Auxotroph mutation induction in bacteria	2P
6	Ame's test	2P
7	Study of <i>Drosophila</i> mutants and maintaining <i>Drosophila</i> culture.	2p

**ZY 303 T: AQUACULTURE (2 Credits = 30 lectures)**

I. Aquaculture concept, Culture systems: Freshwater aquaculture systems: Freshwater prawn culture, fish culture in paddy fields, Brackish water culture, Mariculture: Oyster culture, Crab culture, Lobster culture, mussel culture, culture of Eels, Culture of aquatic weeds. (3 L)

**2. Composite fish culture: (5L)**

- 2.1 Definition and various patterns.
- 2.2 Mixed fish farming in India.
- 2.3 Techniques of composite culture.
  - 2.3.1 Culture of buffalo fish ..
  - 2.3.2 Culture of Catfishes.
  - 2.3.3 Culture of miscellaneous fishes.
  - 2.3.4 Cray fish culture.

**3. Preparation and management of fish culture ponds. (3L)**

- 3.1 Nursery ponds.
  - 3.1.1 Predatory and Weed fishes and their control.
  - 3.1.2 Fish toxicants.
  - 3.1.3 Fertilization.
  - 3.1.4 Aquatic insects and their control.
  - 3.1.5 Fish food organisms and their production.
  - 3.1.6 Stocking.
  - 3.1.7 Supplementary feeding.
- 3.2 Rearing ponds
- 3.3 Stocking ponds.
- 3.4 Fish breeding: Natural & Artificial.

**4. Transport of fish seed and Brood fish. (5L)**

- 4.1 Causes of mortality in transport.
- 4.2 Methods for packaging and transport.
  - 4.2.1 Open systems.
  - 4.2.2 Closed systems.
- 4.3 Use of chemicals in live fish transport.
  - 4.3.1 Anesthetic drugs.
  - 4.3.2 Antiseptics & Antibiotics.

**5. Harvesting: Fishing techniques, preservation & processing of fish, (2L)****6. Fish pathology:**

- 6.1 Parasitic infections.
  - 6.1.1 Fungus infections.
  - 6.1.2 Protozoan diseases.



- 6.1.3 Worm diseases.  
6.2 Non parasitic diseases.
- 7. Fresh water prawn culture. (2L)**
- 7.1 Introduction.  
7.2 Breeding characteristics.  
7.3 Juvenile prawn migration.  
7.4 Seasonal & regional distribution of seeds.  
7.5 Identification of juveniles.  
7.6 Controlled breeding.  
7.7 Culture:  
7.7.1 Ponds.  
7.7.2 Monoculture.  
7.7.3 Mixed culture.  
7.7.4 Role of hard water in culture of *Macrobrachium* species.  
7.7.5 Fertilization & feeds. (3L)
- 8. Pearl culture:** Introduction, Pearl producing mollusks, pearl formation, collection of oysters, rearing of oysters, insertion of nucleus, harvesting of pearls, composition & quality of pearl. (4L)
- 9. Technologies in Fisheries development:** Recirculation technology, Geographic Information System (GIS) technology, passive Acoustics in fisheries, Use of Information Communication Technology (ICT) in fishes: production aspects, marketing aspects. (3L)

### **REFERENCE BOOKS**

1. Fish and fisheries of India, V. G. Jingran, Hindustan pub. corp. New Delhi.
2. Textbook of fish culture, Marcel Hute and Heny Kahn, Blackwell Scientific Publication, Australia.
3. Text book of Aquaculture, M. Srinivasulu, Reddy, KRS Sambhasiva Rao, Discovery Publishing House New Delhi.
4. Fisheries & Aquaculture Biotechnology. Yawn Mehta, Campus Books International, Prahalad street, Ansari Road, Durga Ganj, New Delhi.

**ZY 303 P: PRACTICALS IN AQUACULTURE (2 Credits) (1P: 3 hours) (IOPX 3= 30 hours)**

1. Culture of Daphnia & Rotifers as fish food animals. (IP)
2. Histopathological & Biochemical investigations to test freshness of the fish, Prawn tissue. (This is necessary as the fresh fish are good.) (3P)
3. Study of Indian Oysters (Shells & their brief biology) . (IP)
4. Visit to artificial pearl culture. (IP)
5. Methods of processing, storing fish & prawns (ex. Salting & Drying) (2P)
6. To study the habit & habitat of some important culturable freshwater fishes. (IP)
7. Estimation of productivity of water bodies. (IP)
8. Hypophysation of fishes. (IP)

**ZY 304 T Insect Physiology and Biochemistry (02 Credits)**

1. Integument : Structure, Chemistry, sclerotization, functions. 03 L
2. Digestion and absorption of proteins, Carbohydrates and lipids. 03 L
3. Fat body : Structure, physiology, biochemistry, functions. Integration of carbohydrate, fat and acid metabolism 04 L
4. Ventilatory mechanisms and their control 03 L
5. Haemolymph :Physico-chemical characteristics of plasma : types and structure of haemocytes, functions. 03 L
6. Muscle : structure, physiology and biochemistry of flight muscles 03 L
7. Excretion and water balance: Structure and function of malphigian tubules. Water balance and nitrogen excretion. 04 L
8. Microsomal and extramicrosomal enzymes insecticide degradation and detoxification. 03 L
9. Endocrines, neurosecretory hormones, chemistry, function and mechanism of hormone action, moulting and juvenile hormones ; chemistry and physiology, other peptide and steroid hormones 04 L

## Reference books :

1. Fundamentals of insect physiology, Blum N.S., John Wiley and sons, NY
2. An introduction to insect physiology, Bursell, e. academic press, NY
3. Insect biochemistry and function Candy D.J. and Kilby D.A. Chapman and hall, London

4. Comprehensive insect physiology, biochemistry and pharmacology, Kerkut G.A and Gilbert L.I., Vol 1 to 13 Pergamon press, Oxford, NY

**ZY 304 P Practicals in Insect Physiology And Biochemistry (02 Credits)**

1. Kymographic study of ventilatory movement in beetle.	01 P
2. Oxygen consumption in dragon fly nymph	01 P
3. Study of heart and haemocytes of cockroach	01 P
4. To determine the trehalase activity in haemolymph of any insect.	01 P
5. Amino acid in haemolymph of any insect by chromatographic technique.	02 P
6. Study of fat body glycogen of cockroach and effect of starvation	01 P
7. Assay of amylase in midgut of cockroach	01 P
8. Effect of temperature on water loss in cockroach	01 P
9. Von Wisingh's test for presence of chitin in insect cuticle	01 P

**ZY 305 T RESEARCH METHODOLOGY :(2 Credits - 30 h)**

01. Research Methodology: Literature review, Defining the research question, Approaches and Methodology, Documentation and presentation of data, Analysis and interpretation of data, manuscript preparation (3L)

02. Quantitative methods: Biostatistics used for analysis of Biological data (06L)
03. Computer application: bioinformatics, databases and their applications (03L)
04. Tools and techniques: (18L)
- Techniques used Purification and characterization of biomolecules: Centrifugation, Ultrafiltration, Chromatography, electrophoresis, spectrophotometry, GC-MS, IC-MS, NMR, MALDI-TOF, X-ray crystallograpy, Circular Dichroism CD
  - Microscopic techniques including Fluroscence microscopy, Confocal microscopy, Atomic force microscopy and live cell imaging FACS analysis
  - Histology and histochemistry: Fixation and sectioning of tissue, embryos and cells.
  - Immunohistochemistry, immunoflurosecence, histochemical staining for characterization of cell type.
  - Real time PCR, DNA microarray, New generation DNA sequencing, Protein Microarry, protein sequencing, FRET analysis

#### References:

1. O'conner, M. and Woodford, F.P. Writing scientific papers in English. Elsevier – Ecerpta Medica- North Holland Publ., Amsterdam.
2. Trelease, S.F. How to write Scientific and Technical papers. Williams & Willikins Co., Baltimore, USA.
3. Day, R.A. How to write and publish a Scientific Paper. Cambridge University Press.
4. McMillan, V.E., writing Papers in the Biological Sciences, W.H. Freeman, NY
5. Principles and Techniques of Biochemistry and Molecular Biology, Wilson K and Walker J.M., Cambride University Press
6. Biophysical & Biochemical Techniques, Wilson K and Walker J.M.,
7. Laboratory Exercises and techniques in Cellular Biology, Anthony Contanto, Wiley Publ. 2012
8. Histological and Histochemical methods: Theory and Practice, Kiernan J.A. Scion Publ Ltd.
9. Histochemistry, Pearse A.G.E, Garfield.

### **ZY 305 P - RESEARCH METHODOLOGY :(2 Credits)**

- |   |  |    |
|---|--|----|
| 1 | Selecting a title for the paper, writing the abstract and key words    | 1P |
| 2 | Writing the Discussion Conclusions and Results: Citation of references | 1P |
| 3 | Importance of scientific surveys, primary data and secondary data in   | 1P |

	research	
4	. Writing a project proposal to a funding agency.	1P
5	Use of MS Excel in data presentation.	1P
6	Examples of some common statistical tests	2P
7	Purification of a biomolecule	2P
8	Making a ICT enabled scientific presentation	1P
9	Microscopic techniques	1P

**ZY 306 T: PARASITOLOGY      02 credits**

1. **Host-Parasite systems:** (7L)

- 1.1 Preadaptation to infectiousness, Myiasis: Classification according to tissue, vectors specific, sub specific, accidental; clinical presentation humans, syndrome, symptoms, diagnostic, control method prevention, treatment.;  
Transmission: Types, categories: A. Conspecific: Contact, Transplacental, Transovarian, B. Heterospecific: Mechanical (Indirect & Direct), Biological, Paratenic, Hyper parasitic, Parasitoidal.
- 1.2 Manipulation of Host behavior, Parasitism & Altruism, parasites & social behavior of hosts, parasitism & life history, parasitic effects benefiting the host.
2. **Type study:** (8L)  
Classification geographical distribution, morphology, life-cycle, transmission, pathogenicity, treatment and prophylaxis of:  
2.1 Protozoa: *Trypanosoma* Sps. , *Leishmania* Sps.  
2.2 Platyhelminthes: *Schistosoma* Sps., *Echinococcus* Sps.  
2.3 Nematoda: *Ancylostoma* Sps., *Dracunculus* Sps.
3. **Genetics & Molecular Biology:** (7L)  
3.1 *Trypanosoma*: Diploid & Sexual stage, Molecular characteristics of surface coat, Variable surface glycoprotein (VSG) and VSG gene expression.  
3.2 *Plasmodium*: Diploid & haploid stages, Chromosome polymorphism, gene encoding Circum sporozoite protein & merozoites S- antigens, surface antigen diversity.  
Resistance of Malaria to drugs, its mechanism & assessment.  
3.3 Platyhelminthes: Inseminative behaviour, parthenogenesis and polyspermy, sex determination, sex linked inheritance in Schistosomes.  
3.4 Nematoda: chromosome germ line limited DNA & chromatin diminution in *Ascaris*.
4. **Serology & immunodiagnostic methods:** (6L)  
4.1 Serology & antibody synthesis, preparation & demonstration of specific antigens of *Entamoeba*, *Plasmodium*, *Trypanosoma* & *Leishmania*  
4.2 Immunodiagnostic assays, Immunodiffusion, Indirect haemagglutination test, indirect fluorescent antibody test, Radio immuno assay, ELISA, complement fixation test, Latex agglutination test
5. **Prophylaxis & control:** Biologic, Genetic, Chemical, Physical & Other methods (2L)  
chemical, Physical & Other methods

### **REFERENCE BOOKS:**

1. Comparative protozoology, Ecology, Physiology, Life history, Anderson, O.R. , Springer verlag, Berlin.
2. General Parasitology, Cheng T. C., Academic Press.
3. Modern Parasitology, Cox F.E.G.,Eds.Parasitology in focus, facts & trends, Melhorn h., Eds., Spriger Verlag, Beriin.
4. Medical Parasitology, Piakarsky G. L., Springer Verlag, Berlin.
5. Modern Parasitology, Cellular immunological & immunological aspects, Wyler D. J., Eds., W. H. Freeman, NY

### **ZY 306 P PRACTICALS IN PARASITOLOGY (2 Credits) (10p x3= 30 Hrs.)**

1. Study of life cycle, role as vector & control measures of: (2P)  
Ticks(*Argas*, *Boophilus*)  
Mosquito - anyone from- *Anopheles*/ *Aedes*/ *Culex*

- Any two flies: *Tabanus/ Phlebotomus/ Sarcophaga*.  
Cyclops
2. Ectoparasites & Endoparasites of wild rat, cattle, dog, chick & human including stages in excreta. (2P)
  3. Study of life cycle of parasitic protozoa: *Trypanosoma, Leishmania* (1P)
  4. Study of life cycle of helminth parasites: *Schistosoma, Echinococcus, Ancylostoma, Dracunculus*. (2P)
  5. Culturing of *Entamoeba & Plasmodium* (2P)
  6. Study of Parasites from digestive tract of Cockroach/gut / parasites of hen (1P)

### **ZY 307 (T) – Fundamentals of Systematics (2 credits)**

Sr.No.	Topic	lectures
1	Fundamental of Systematics: Biological classification, Hierarchy of categories and higher taxa, Taxonomic characters – procedures and keys, Species concepts: varieties, subspecies, sibling species, race etc.	7
2	Kingdoms of Life : General outline of kingdoms including Monera& Protista; Broad outline & Diversity in kingdom Animalia	3
3	Methodologies in systematics : Morphology based taxonomy, Numerical taxonomy, Cyto-taxonomy and chemotaxonomy, Molecular systematics, DNA fingerprinting & Molecular markers for detection/evaluation of polymorphism,RFLP, RAPD etc.	8
4	Taxonomic keys: Types of taxonomic keys, their merits and demerits .International code of Zoological nomenclature. Its operative principles, interpretation and application of important rules, zoological nomenclature, formation of names and various taxa	6
5	Taxonomic procedures: taxonomic collection preservation, curation process and identification.	3
6	Molecular phylogenetics and phylogeography.	3

### **Reference books:**

1. Kato., The biology of biodiversity, Springer.
2. Avise J.C., Molecular markers, Natural history and evolution, Chapman and Hill, NY.
3. Wilson A.O., biodiversity, Academic Press, Washington.
4. Principals of systematic Zoology by Ernst Mayr.

### **ZY 307 (P) – Fundamentals of Systematics (2 credits) (10PX3= 30 hrs)**

Sr.No.	Topic
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1	Minor phyla-specimen Study	1p
2	Study of museum specimens and slides( invertebrates,1-2 examples from each phyla)	2p
3	Study of museum specimens( protochordates and chordates,1-2 examples from each phyla)	2p
4	Identification of animals with the help of keys-House fly, Honey bee etc.	1p
5	Identification of animals with the help of keys- Cockroach, Earthworm.	1p
6	Method of collection, Preservation, and Curing of any insect Specimen	2p
7	Visits to Scientific Institute like Zoological Survey of India and Report writing	1p

### **ZY : 308. T:Insect Ecology (2 credits/30h)**

1.	Introduction to Insect ecology: History of ecology & Entomology Ecological associations Insect and humans	(5L)
2.	Insect and Climate: Temperature Photoperiod Rainfall Wind Climate change	(5L)
3.	Insect Herbivores: Feeding strategies of herbivorous insects Plant defences	(5L)
4.	Natural enemies and insect population dynamics: The variety of Natural enemies Impact of enemies on insect populations The Concept of niche & competition among insects	(5L)
5.	Insects in ecosystems Fundamentals of ecosystem ecology Leaf shredding insects, Insect defoliators & cycling of nutrients insect, plant community :structure and successor.	(5L)
6.	Insect conservation: Threats to insects Conservation and restoration Prospects for insect conservation	(5L)

### **ZY-308P- Research Project (2C)**



The project course would involve training to students in literature survey, planning and execution of experimental work, analysis of data and its presentation.

Students would utilize few of the practical's from their course more intensively for this course. Project should start at third semester and will be assessed at end of fourth semester. The experimentation work during the project should be equivalent to minimum 10 practicals in each semester.

1. **Basic Concept of Toxicology:** Introduction of toxicology, history of toxicology, definition of toxicology, definition of poison, definition of toxicity and classification of toxicants. 2 L
2. **Toxic agent and their mode of action:** Introduction, Toxic agent and mode of action of toxic agents. 3L
3. **Xenobiotics:** Introduction, Important of xenobiotics concerned to Human health, Adverse effects of xenobiotics through Biological Magnification and Biotransformation, mechanism of Xenobiotic Translocation, Membrane permeability and mechanism of chemical transfer, absorption of xenobiotics, distribution of xenobiotics, accumulation of xenobiotics, elimination, biotransformation and excretion. 8L
4. **Pesticides and Heavy Metal Toxicity: Pesticides and their toxicological effects:** Classification of Pesticides, Insecticides, Mode of action of Insecticide. 4L
5. **Heavy Metal Toxicity:** Introduction, dispersion, general principle of metal toxicity, sources, toxic metals and their toxicity. Arsenic, Aluminium, Cadmium (Itai-Itai disaster), Chromium Lead, Mercury, Manganese, Zinc and Nickel. 6L
6. **Evaluation of toxicity.** Acute subacute and chronic assays LD<sub>50</sub>, LC<sub>50</sub>, NOEL. 3L
7. Maintenance and general handling of animals for toxicological laboratory. 2L
8. **Ecotoxicology**, clinical toxicology, occupational and nanotoxicology. 2L

#### **Reference Books:**

1. Principles of Toxicology: Environmental and Industrial Applications – Eds. : Phillip L. Williams, Robert C. James, Stephen M. Roberts; JOHNWILEY & SONS, INC.
2. Casarett and Doull's Toxicology The basic science of poisons – Ed: Curtis Klaassen; McGraw-Hill.
3. Fundamental Toxicology – Eds: John Duffs & Howard Worth; RSC Publishing.

**ZY 309 P - Toxicology I (2 credits: 30hr) 3hr = 1P**

1. To determine LC<sub>50</sub> of pesticide using suitable animal model 1P
2. Effect of heavy metal ions on heart beat of Daphnia 1P
3. *In situ* toxicity assessment using avian model 1P
4. *In vitro* toxicity testing using chick embryo 2P
5. Sediment-water toxicity test using chironomids 1P
6. Hydra and zebra fish as a model for various toxicity testing 2P
7. Acute dermal toxicity testing 1P
8. Acute oral testing 1P
9. Skin sensitizing assay. 1P
10. Effect of heavy metal/pesticide on organ system in test organism 1P
11. Carcinogenicity studies 1P
12. Visit to toxicity/ genotoxicity testing facility 1P

**ZY 401 T ANIMAL PHYSIOLOGY II (04 Credits)**

1. Nutrition and digestion (10)
- Nutrition
  - Nutrients and Nutritive types
  - Calorimetry and BMR
  - Digestion
  - Components of digestive system
  - General mechanism of digestion; Autonomous smooth muscle function, intrinsic nerve flexes, extrinsic nerve and gastrointestinal hormones
2. Respiration (11)
- Internal and external respiration ; Anatomy of respiratory system
  - Pulmonary respiration: Partial pressure, inspiration and expiration, Lung volume and capacities
  - Gas exchange across the pulmonary and systemic capillaries
  - Gas transport; O<sub>2</sub> transport, CO<sub>2</sub> transport and abnormalities in the blood gas content
  - Neuronal control of respiration, role of central and peripheral receptors
  - Other functions of respiratory system
3. Blood and blood vessels (9)
- Blood composition and function, Haematopoiesis
  - Blood clotting and it's molecular mechanism
  - Blood vessels and blood pressure: Blood vessel types, Arteries, role as pressure reservoir and arterial pressure: Aeteriole:role in distribution in cardiac output and maintainance of arterial blood pressure, Capillaries and it's functions, veins:its role as blood reservoir and venous return
  - Blood pressure-Hypertension and Hypotension
4. Cardiac Physiology (10)
- Anatomy of heart
  - Electrical activity of the heart pace makers, spread of cardial coupling, action potential of cardiac cells
  - Electrocardiography
  - Mechanism events of cardiac cycle, Heart sound
  - Neuronal and Hormonal control of heart
  - Cardiovascular response of exercise
5. Neuronal Physiology (8)
- Nerve cells : Structure & Function
  - Excitation and conduction of nerve fiber: Resting membrane potential, Action potential, all or none law, electronic potential, saltatory conduction
  - Ionic basis of excitation and conduction
  - Neurotransmitter types and receptors: Metabolism of neurotransmitters, Neuropeptides
  - Synapse and Neuronal integration
  - impact of drugs and disease on synaptic transmission
6. Muscle Physiology (05)

- a) Structure of skeletal muscle and molecular basis of skeletal muscle contraction, types of contraction, twitch summation and tetanus, relation between muscle length and tension, velocity of contraction
- b) Pathways of ATP formation during contraction
- c) Skeletal muscle fiber types, contractile machinery of smooth muscle

7. Sensory Physiology (07)

- a) Receptor types, receptor potential and receptor adaptation
- b) Eye-structure and physiology of vision
- c) Ear-Hearing and equilibrium, sound waves and it's characters, structure of ear and physiology of hearing and equilibrium
- d) Chemical senses : Taste and smell

References:

1. Guyton A.C and Hall J.E, Text book of medical physiology, Hartcort bracc and co. Asia Pvt.Ltd., Singapore.
2. Baldwin, E. An introduction to Comp biochemistry. Cambridge.
3. Hill, R.W. & GA Wyse, Animal physiology. Harper & Row, NW.
4. Randall, D, W.Burggen & K, French. Eckert Animal Physiology : Mechanism and adaptation , W H Freeman, NY
5. Schmidt-Nielsen,. Animal Physiology: Adaptation and Environment. Cambridge.
6. Hoar, W S General and Comparative physiology. Prentice Hall, India, New Delhi.
7. Vernberg, F.J. & Vernberg, WB . Animal and the environment. Holt, Rienhart & Winston, NY.
8. Prosser and Brown. Comparative physiology.

**ZY 401 P - ANIMAL PHYSIOLOGY II (03 Credits)**

1. Effect of exercise on breathing rate, pulse rate and blood lactate of man
2. Determination of bleeding time and clotting time in man
3. Study of invertebrate (earthworm and crab) heart
4. Ionic effects on perfused heart of frog
5. Effect of vagotomy on frog heart
6. Effect of adrenalin and acetylcholine on perfused heart of frog
7. Capillary circulation in frog and cockroach/Fish.
8. Study of glycerinated muscles fibers
9. LDH isoenzymes isolation and detection using agarose gel electro phoresis in heart / skeletal muscle of rat
10. Phosphagen kinase in mouse and crab muscle phosphagen
11. Effect of load on muscles contraction in frog
12. Cobalt back filling of cockroach ventral nerve cord
13. Detection and measuring of heart beats(Manually) in Drosophila larva/Daphnia.
14. Estimation of Respiratory Quotient by Warburg's Respirometer
15. Mapping of taste areas on human tongue.
16. Study of Types of heart (Myogenic and Neurogenic )
17. Effect of pH, temperature and incubation on human salivary amylase activity.
18. Determination of protein, glucose in Urine.
19. Determination of protein, glucose in Urine from diabetic patient.
20. Qualitative Analysis:
  - 1) Preparation and study of Urine crystals.
  - 2) Estimation of serum urea.

**Any 15 Practicals to be completed by the students**

### **ZY-401T: Entomology II (Special)- 4 Credits**

1. Gametogenesis: Spermatogenesis , Oogenesis, Seminal transfer, Fertilization and oviposition. **08L**
2. Insect early embryonic development: Cleavage and Blastoderm formation, Germ band, Gastrulation, Blastokinesis, differentiation of germ layers, Segmentation, Appendages formation and organogenesis in brief. **21L**
3. The post embryonic development; Eclosion from the egg. The developmental stages: larva, Pupa, Nymph, Emergence from the pupa/cocoon. Metamorphosis and Growth. **20L**
4. Hadorn's experiments with imaginal disc, Regeneration and Aging. **06L**
5. Diapause: Occurrence, Initiation and Preparations for diapauses, Diapause development and Controls. **05L**

#### *Reference Books*

1. 'The Insect- structure and Function' by R.F. Chapman ,ELBS, London
2. 'A Text book of Entomology' by H. H. Ross (John Wiley and Sons, Ins. New York,
3. 'Imms' Text Book of Entomology- By O. W. Richards and R. G. Davies, (Methuen &Cc., London, ), Vols. I & II.
4. 'Embryology of Insects and Mariapods' by O. A. Johanson and F.H. Butt, (McGraw Hill, New York, ).
5. 'The ecology of insect populations in theory and practice' by L.R. Clarks P. W. Geier, R.D. Hughes, R.F. Morris (Methen, London ).
6. 'Developmental system: Insects' Vol. I, by S. J. Counce and C.H. Waddington (Academic Press, London, ).
7. 'Developmental system: Insects' Vol. II, by S. J. Counce and C.H. Waddington (Academic Press, London, ).

**ZY- 401P- Entomology II Practical Course (3 Credits)**

1. Study of different types of insect Eggs. **1P**
2. Early embryology of insect: egg, cleavage, blastula, germ band, gastrula, embryo- 1 day old, 2 day old and 3 day old in suitable insect. **1P**
3. Study of post embryonic development of insects: Collection and study of types of larvae, pupae, Nymph (Aquatic and Terrestrial). **2P**
4. Histological studies of male reproductive system (Testes, Vasa deference, Ejaculatory duct, Accessory gland and spermatogenesis). **1P**
5. Histological studies of female reproductive system (Ovariole, oviduct, common oviduct, Accessory glands and bursa copulatrix, spermatheca). **1P**
6. Dissection of House fly: The digestive system, Nervous system, Male and Female Reproductive System, Temporary mountings of antenna, haltere, legs and ovipositor. **3P**
7. Dissection of butterfly: The digestive system, Nervous system, Male and Female Reproductive System, Temporary mountings of antenna, scales and ovipositor. **3P**
8. Study of Beneficial Insects: Any 5 insects to be studied inclusive of their Systematics, Habit and Habitat, Diagnostic features, Economics and Ecological significance, Threats and Conservation measures. **1P**
9. Study of Harmful Insects: Any 5 insect Pests, Predators, Parasites and Vectors of diseases to be studied inclusive of their Systematics, Habit and Habitat, Diagnostic features, Nature of damage and control measures. **1P**
10. Morphological and taxonomic study of insect pest of agricultural importance. (any 10). **1P**
- 11 Study of insect pests and veterinary and public health importance. Nonconventional pests. **1P**
- 12 Study of efforts of contact poison on pests:
  - a) Chlorinated hydrocarbons,
  - b) Organophosphates
  - c) Carbamate.
 Calculation of LD<sub>50</sub> and effects on behavior. **1P**
- 13 Study of respiratory poisons (fumigants)- Carbon tetrachloride, ethylene dichloride, Nicotine. **1P**
- 14 Study of insect repellants (any two). **1P**
- 15 Study of insect attractants (any two). **1P**

**Note: 15 practicals are to be performed by the students.**



**ZY401 T Genetics II****4 Credits**

1. Solving problems (Numerical Probability estimation) of Mendelian and non-mendelian genetics. 03 L
  
2. Basic Human Genetics: 18L
  - 2.1 History of Human Genetics
  - 2.2 Pedigree- Gathering Family history, pedigree symbols, construction of pedigrees, Autosomal inheritance- Dominant & Recessive, Monogenic traits (Sex Linked inheritance, Sex Limited & Sex-influenced traits, mitochondrial traits), MIM number.
  - 2.3 Presentation of molecular genetic data in pedigrees
  - 2.4 Complications to the basic pedigree patterns- non penetrance, variable expressivity, pleiotropy, late onset, dominance problems, genetic heterogeneity, genomic imprinting & uniparental disomy, spontaneous mutations, mosaicism & chimerism, male lethality, X- inactivation.
  - 2.5 Parametric and non- parametric analysis, identifying recombinants & non recombinants in pedigree, two- point mapping- LOD score analysis, genetic & physical map distances, genetic markers.
  
3. Clinical Genetics: 16L
  - 3.1 Monogenic diseases
    - 2.1.1 Cystic Fibrosis
    - 2.1.2 Tay-Sachs syndrome
    - 2.1.3 Marphan syndrome
  - 3.2 Triplet repeat based disorders
  - 3.3 Inborn metabolic errors-
    - 3.3.1 Disorders of carbohydrate metabolism
    - 3.3.2 Disorders of nucleic acid metabolism
  
    - 3.3.3 Disorders of lipid metabolism
    - 3.3.4 Lysosomal storage disorders
    - 3.3.5 Peroxisomal disorders
  - 3.4 Disorders of Hematopoietic systems-
    - 3.4.1 Over view of blood cell types & haemoglobin
    - 3.4.2 Sickle cell anemia
    - 3.4.3 Thalassemias
    - 3.4.4 Hemophilia's
  - 3.5 Prenatal and pre-implantation diagnosis
    - 3.5.1 Indications for prenatal diagnosis
    - 3.5.2 Indications for chromosomal testing

## 3.5.3 Non- invasive methods

## 3.5.4 Invasive methods

4. Physical mapping methods: 3L  
 4.1 Low resolution mapping- cell hybrids, radiation hybrid mapping, syntenic homology.  
 4.2 Restriction maps, clone contig maps, STS map, EST map, DNA sequence map.
5. Immunogenetics: 4L  
 4.1 Genetic basis of antibody diversity.  
 4.2 Regeneration of TCR diversity.  
 4.3 HLA polymorphism and disease association.
5. Oncogenetics: 3L  
 5.1 Concepts of oncogenes and tumor suppressor genes.  
 5.2 Role of oncogenes.  
 5.3 Cytogenetic studies.
6. Behavioural Genetics: 5L  
 6.1 Rothen Buhler's experiment on genetics of Bee behavior (hygienic and unhygienic Trait).  
 6.2 Nature- nurture and behavior-  
 6.2.1. Genetics experiments to investigate animal behavior  
     6.2.1.1 Selection studies.  
     6.2.1.2 Inbred strain studies.  
 6.3 Identifying genes for controlling behavior  
     6.3.1 Induced mutations  
     6.3.2 Quantitative trait loci.  
     6.3.3 Syntenic orthology  
 6.4 Twin and adoption study designs.  
 6.5 Environmental influence- shared and non- shared environment.  
 6.6 Genetics of human behavioural defects- Schizophrenia.
7. Neurogenetics: 3L  
 7.1 Circadian rhythms, learning and memory mutants in *Drosophila*.  
 7.2 Psychopathology- Alzheimer's disease
8. *Drosophila* genetics: 6L  
 8.1 History of *Drosophila* genetics.  
 8.2 Genetic basis of Sex determination and dosage compensation in *Drosophila*.  
 8.3 Genetic Regulation of *Drosophila* early embryonic development and pattern formation:  
 Maternal genes and formation of body axis, Segmentation genes, Homeotic gene functions, Regulation of Hox- gene expression;

**REFERENCE BOOKS:**

1. Strickberger, M.W., Genetics, MacMillan,
2. Gardner, E.J., Peter & Simmons, M.J. and Snustad, D.P. Principles of Genetics, John Wiley AND Sons, New York,
3. William S Klug and Michael R Cummings. Concepts of Genetics. Prentice Hall Internatl, Inc., New York,
4. Trends in Genetics. Elsevier Publications, Amsterdam.
5. Lewin, Benjamin. Genes X. John Wiley and Sons, New York,
6. Develpmental Biology, S.F. Gilbert, Sinaur Associates.
7. Genetics: Analysis of Genes and Genomes, D.L. Hartl , E .W Jones, Jones and Barlett Publ. 2009.
8. Genetics By Sarin,C., Tata McGraw Hill,New Delhi
9. Genetics: Daniel J Fairbanks, W. Ralph Andersen; Brooks / Cole Publ. co.
10. Genetics-A Molecular Approach: Peter J. Russell;Pearson Inc. publishing as Bejnamin Cummings;

**ZY 401 P Practical in Genetics II 03 credits.**

1. Methodology for constructing Human Pedigree. [IP]
  2. Analysis and construction of typical pedigrees for autosomal dominant and recessive genes, sex linked dominant and recessive genes. [IP]
  3. Preparation of metaphase chromosomal spreads of one vertebrate. [2P]
  4. Enzyme polymorphism in natural population. [2P]
  5. Visit to a medical genetics laboratory for cytogenetic, biochemical and other studies. [IP]
  6. G banding on mouse metaphase spread [IP]
  7. In-silico design of PCR primers for a gene of interest. [IP]
  8. C banding on mouse metaphase chromosomes. [2P]
  9. Study of courtship behavior in wild type and mutant *Drosophila*. [IP]
  10. Study of maternal effect mutants for genes- Bicoid and Nanos. [IP]
  11. Preparation of metaphase chromosomal spread of 3'd instar larva of *Drosophila* ( from brain Ganglion) [2P]
  12. Measurement of olfaction activity in *Drosophila* larvae and Adult Fly. [1P]
  13. Measurement of locomotor activity in *Drosophila* larvae and Adult Fly. [1P]
  14. Larval mechanosensation assay in *Drosophila*. [1P]
  15. Chromatography of *Drosophila* eye colour pigment. [1p]
  16. To Study effect of mitogen induction on lymphocytes. [2p]
  17. Concept of genetic disorder databases and demonstration of use of OMIM. [IP]
  18. Genetic monitoring ( using immunogenetic marker) in laboratory animals. [ by skin grafting] [2P]
  19. Open field Activity test and Elevated plus maze test for anxiety levels in laboratory mice. [IP]
- Any 15 Practicals to be performed by the students.**

**ZY 402 (T) Economic Zoology (2 Credits) 30 Lectures**

- 1) Parasitic protozoans and their role in human welfare, soil protozoans and their role in agriculture. (2L)
- 2) Sponge culture and its importance in industry. (1L)
- 3) Concept of Coral reef and its significance. (1L)
- 4) Helminths as human and animal parasites. (2L)
- 5) Nematodes- parasitic roundworms of animals and plants. (1L)
- 6) Vermiculture industry in India. (1L)
- 7) Household insects, Apiculture, Lac culture, Sericulture, Prawn culture, Insects of commercial value and stored grain pests. (10L)
- 8) Economic importance of amphibian, reptiles and birds (2L)
- 9) Poultry, Piggery, Dairy industry and wool industry. (8L)
- 10) Model animals in pharmaceutical industry. (2L)

**References:**

- 1) Economic Zoology-Shukla and Upadhaya
- 2) Economic Zoology-P.D.Srivastava
- 3) Economic Zoology-Manju Yadav
- 4) Economic Zoology-K.R.Ravindranathan
- 5) Textbook of Economic Zoology- P.R.Venkitaraman

**ZY 402 P / Economic Zoology (2Credits)**

- 1 ) Prawn culture in laboratory aquarium 1P
- 2) Apiculture equipments. 1P
- 3) Poultry breeds, feeding utensils in poultry 2P
- 4) A visit to piggery/poultry/pearl culture centre/ apiculture centre/sericulturecentre. 1P
- 5) Fishing tools, crafts and gear. 1P
- 6) Morphology of Edible, freshwater fishes-Catla,Rohu, Labeo, Mrigala, Notopterus, Mystus sp. , Clarius, Channa, Heteropneustes, Reba,Wallago . 2P
- 7) Collection and identification of locally available/cultured fishes. 2P

REFERENCE BOOKS

A Handbook on Economic Zoology , Dr Jawaid Ahsan And Dr Subhas Prasad Sinha S. Chand Group.

Economic Zoology , G.S Shukla and V. B Upadhyay. Rastoi Publications

Encyclopedia of Economic Zoology, A.A. Khan. Anmol Publications

Economic Zoology by. Manju Yadav, Discovery Publishing House Pvt. Limited.

Economic Zoology by Malhotra ,Prakash, Adhyayan Puhlishers & Distributers

**ZY 402 T Bacterial and Phage Genetics -2Credits**

1. Bacterial Chromosome, Mechanism of gene transfer: Conjugation, transformation and transduction, chromosomal mapping, two-three point crosses, concept of cistron, complementation and complementation groups, mutations: auxotrophs, conditional, suppressors, transposable elements and chromosomal mapping. [14]
2. Bacteriophages: General introduction and properties [01]
3. Bacteriophage lambda: morphology and structure of nucleic acids, lytic cycle and lysogeny [03]
4. T even and odd phages: bacteriophage T2 and T4 morphology, nucleic acid structure and life cycle. Special features compared to lambda [05]
5. Bacteriophage T7: morphology and structure of nucleic acid , salient features [03]
6. RNA phages: Q beta and MS2, replication nd concept of overlapping genes [03]
7. Bacteriophage Mu [01]

Reference books:

1. Microbial Genetics, Frifielder D.
2. Genetics, Strickberger, M.W. millan Pub.
3. Genes of Bacteria and their viruses, Hays [www.,CBS](http://www.CBS Press) Press.

**ZY 402 P Practicals in Bacterial and Phage Genetics 02 Credits.(10Px3hrs.)**

1. Bacterial viable count, determination of growth curve, gram staining [1P]
2. Mutagenesis and auxotroph selection, replica plating [2P]
3. Bactriophage lambda titration, determination of pfu/ml [2P]
4. UV survival curve and phage mutagenesis [2P]
5. Transduction in bacteria [1P]
6. Conjugation and selection with genomic markers [2P]
7. Tetrad analysis in Fungi [1P]

**ZY 403 (T) Mammalian Reproductive Physiology (2 Credits)**

1. Reproductive organ: male and female gonads, duct systems and sex accessories, external sexual dimorphisms (3L)
2. Reproductive patterns: Environmental factors and breeding, continuous and seasonal breeders (3L)
3. Sexual cycles: puberty, oestrous and menstrual cycles. Ovarian event: follicular phase, cycling of non-pregnant uterus and vagina. (5L)
4. Hormonal regulation: hypothalamus –pituitary and gonad axis; other hormones. Hypothalamic GnRH, pituitary gonadotropins, behavioural effects, testicular hormones, testosterone derivatives, inhibin, ovarian hormones: oestrogen, progesterone's feedback relationships (4L)
5. Pregnancy: conception and blastocyst formation , implantation and delayed implantation, placenta: formation, types and functions, hormones in pregnancy (2L)
6. Parturition; birth process and its neuroendocrine control, puerperium (3L)
7. Lactation: mammary glands, milk synthesis, secretion. Hormonal regulation and suckling reflex. (3L)
8. Reproductive dysfunctions: Aging and reproduction. Climacteric, anatomical, endocrine and genetic disorders. (3L)
9. Artificial control of reproduction: increasing reproductive potential, artificial insemination, *in vitro* fertilization and embryo transfer, induced breeding, synchronisation of oestrus and ovulation, chemical and hormonal aspect, limiting reproductive potential, physical, physiological, surgical, chemical methods of contraception in male , female. Infertility: its causes and treatment, hormonal aspects. (4L)

**Reference books**

1. Austin C.R. and short R V., reproduction in mammals Books 1-5, Univ of Cambridge
2. Hogarth PH Biology of Reproduction, Blackie and Son, Glasgow, London.
3. Nalbandov, AV, reproductive Physiology, Lea and Febiger, Philadelphia

**ZY 403(P) – Mammalian reproductive physiology**  
**(2 credits) (1P: 3 hrs) (10PX3= 30 hrs)**

- |  |    |
|--|----|
| 1. Anatomy of male and female reproductive system in rat/mouse         | 1P |
| 2. Histology of male reproductive organs                               | 1P |
| 3. Histology of female reproductive organs                             | 1P |
| 4. Vaginal smear technique in mice.                                    | 1P |
| 5. Ovaryectomy in white rats   | 1P |
| 6. Study of placental type   | 1P |
| 7. Archectomy in white rat   | 1P |
| 8. Study of uterine smooth muscles                                     | 1P |
| 9. Study of contraceptive devices                                      | 1P |
| 10. Visit to artificial insemination centre and family planning clinic | 1P |

**ZY403 T Biodiversity assessment (2Credits = 30 lectures)**

1. Concepts of Biodiversity : Biodiversity as natural ,biological capital of the earth. It's importance at global and local level. Genetic biodiversity, Species biodiversity, Agro biodiversity. ( 3L)
2. Kingdom of life: General outline of all kingdom - Broad outline and diversity of kingdom animalia ( Major phyla with unique characteristics and examples) (2L)
3. Biodiversity distribution: Hot spots of biodiversity of the world. Biogeographical classification of India .India as a megadiversity Nation. (2L)
4. Value of Biodiversity: Consumptive, productive, social ethical aesthetic and option values. ( 2L)
5. Wild life: Wild life in India, Rare and endangered species, wild life values and human culture. (2L)
6. Threats to biodiversity: Loss of Biodiversity and its causes. Patterns of Losses Causes and factors of mass extinction. Listing of threatened biodiversity including vulnerable, rare, and threatened. Endangered and extinct animal species. Red data Book, Blue data book. (5L)
7. Conservation: Objective of, conservation, strategies and conservation. Modern tools and techniques to assess biodiversity in situ vs ex situ conservation. Action plan of conservation. Conservation of rare and endangered species. Conservation through a network of protected areas. Role of N G O s in conservation. Ecodevelopment for biodiversity conservation. Conservation movements in India - Chipko, Devrai , Bishnoi's movements etc. (8L)

8. Conservation and Prevention Acts in India: Forest conservation Act Protection Act 1971,1972 ,1980, Wild life (2L)
9. Case studies: Project Tiger, Project breeding. Vulture culture project. Elephant, Project Rhino, Project Crocodile and Turtle (4 L)

### **REFERENCE BOOKS**

Guide to India's wild life A.N.Jagnnath Rao
Biodiversity .E.O Wilson ,Academic Press 1988
Biodiversity status and prospects by Tandon.
An Introduction to Biodiversity. Prithipalsingh
Biodiversity and biotechnology. Ray
Biodiversity and its significance. Y.A. Abrol
Conservation Biology S.K. Jain
The Preservation of species: The value of Biological Diversity by Norton B.G.

### **ZY403 P Biodiversity assessment 2 Credits**

1. Study of fauna of different zoogeographical regions - with minimum three examples from each region. (1P)
2. Biodiversity studies of fishes, amphibians ,reptiles, aves ,mammals available in the local area. (1P)
3. Study of biodiversity indices with suitable examples (1P)
4. Qualitative analysis of zooplanktons. (1P)
5. Study of community characteristics by quadrat and transect method. (1P)
6. Sampling technique and experimental design in soil/water/forest. (1P)
7. Checklist preparation of fish/ birds/ mammal fauna in local area. (1P)
8. Study of endangered fauna of Maharashtra . (1P)
9. Supportive instruments in Biodiversity assessment. (1P)
10. Visit to wild life sanctuary. (1P)



**ZY 404 (T) Histology and Histochemistry (2 Credits)**

1. Fundamentals of histology: Epithelial, connective, muscular, nervous and other specialized tissues. (5)

2. Tools in histology: Principles, design and functioning of microtomes, automated microtomes, ultra microtome, cryostat, problems and troubleshooting (3)

3 Techniques in histology:

Sample preparation, obtaining tissue samples, handling reagents, fixatives (types of fixatives and effect on tissue ), processing of fixed samples, dehydration( procedure and significance), embedding, block making, staining( staining methods histochemical and immunohistological methods), dyes and dye binding reactive groups, mordants and mordanting, temporary and permanent preparations, whole mount preparation (7)

4. Fundamentals of histochemical techniques: principle and practice, detection of glycogen, neutral and acid mucopolysaccharides, detection of basic proteins, detection of specific and nonspecific lipids, detection of nonspecific esterases, detection of acid /alkaline phosphatase. (15)

## Reference Books:

1. Text book of Histology Roland lesson DL. WB Saunders Company, Tokyo.
2. Histology: Roland lesson and Thomas Leesan WB Saunders company Co., Canada
3. Histochemistry Vol. I II III A G E pearse Churchill Livingstone NY

**ZY 404 (P) – Histology and histochemistry (2 credits) (1P: 3 hrs) (10PX3= 30 hrs)**

1. Enzyme detection: acid phosphatase, alkaline phosphatase, esterases (1P)
2. Nucleic acid staining: methyl green, pyronine, feulgen stain (1P)
3. Study of different types of tissue with help of permanent slides (2P)
4. Effect of fixatives, fixation of tissues (1P)
5. Block preparation and sectioning (2P)
6. Mucopolysaccharide staining, AB pH 1.5, 2.5 (1P)
7. Proteins (basic mellrg) and lipid staining by sudan black (1P)
8. Comparative study of effect of fixative on a given tissue (1P)
9. Effect of fixatives on tissue sections- liver (1P)

**ZY 405T: Pollution Biology (2 credits = 30 lectures)**

1. Biosphere: Introduction, hydrosphere, lithosphere, atmosphere. (2L)
2. Pollution: Kinds of pollution and pollutants(Air, Water, Agricultural). (3L)
3. Noise pollution: Characteristics of sound, source and effects of noise pollution. (3L)
4. Pesticide pollution: Pesticides and their kinds, possible sources and pathways of pesticide Pollution. Impact of pesticides on living organisms. (3L)
5. Radioactive pollution: Types , sources and effects, radioactivity assessments and control. (2L)
6. Bioassay: Purpose of bioassay, selection and test organisms, pollutant bioassay using fish. (3L)
7. Pollution monitoring: strategies for water, soil, noise. (2L)
8. Histological, biochemical and physiological methods to study Impact of pollutants on animals. (3L)
9. Bioconcentration, Bioaccumulation and Biomagnifications of pollutants. Causes and Consequences. (3L)
10. Biological methods for assessment of environmental quality. (3L)
11. Biomedical waste – Handling and Management, Hazardous Waste in India. (3L)

**References**

1. Ecology, E.P. Odum, Amerind publ.
2. Environmental biology, P.D. Sharma, Rastogi Publ.
3. Environmental pollution, H.M. Dix, John Wiley Publ.
4. Pesticides in aquatic environment, M.A. Q. Khar, Plenum Press.
5. Environmental pollution and its control under international law, R.A. Malviya , Chay Publ.
6. Ecology, Ricklefs, freeman, W.H.
7. Limnology, Welch McGrew Hill Publ.
8. Practical Ecology – K.S. Rao, Ujjain (M.P) Anmol Publ. New Delhi ( India )

### **ZY-405P: Practicals in Pollution Biology (2 Credits) (10P =30hrs.)**

1. Study of bio – indicators of pollution. (1P)
2. Analysis of CO, CO<sub>2</sub> NO pollution level data in collaboration with district pollution dept. of Maharashtra state. (1P)
3. Study of Eutrophic ponds /lakes /river. (1P)
4. Visit to water filtration plant/Pollution. (1P)
5. Analysis of pH and salinity form water /soil sample. (1P)
6. Determination of LC<sub>50</sub>/ LD<sub>50</sub> for insecticide / pollution /molluscicide etc. (1P)
7. Estimation of Biomass by:- (1P)
  - i) Wet weight and ii) Dry weight.
8. Estimation of calcium and magnesium in polluted water. (1P)
9. Soil analysis for calcium carbonate. (1P)
10. Estimation of sulphate in polluted water (1P)

### **ZY- 406 (T) Apiculture, 2 Credits/30 L**

1. **Introduction to Apiculture:** History of Bees and Beekeeping, Systematics, Bee species, Bee morphology, Colony organization, Polymorphism, Caste system, Division of labour, Bee flora, Foraging and Honey flow periods. (7 L)
2. **Bee keeping as an occupation:** Extent of Beekeeping in Maharashtra and India, Limitations on the development of beekeeping, Advantages of extensive beekeeping, Beekeeping equipments and initiation into keeping a colony, the future of beekeeping. (7 L)
3. **The first step in beekeeping:** Purchase of a colony, the Apiary site, how to manage a colony, the manipulation of a colony, taking care of bee diseases and enemies. (7 L)
4. **Beekeeping techniques and Apiary management:** Establishment of a colony,, Routine management, Seasonal management, Migratory beekeeping, Harvesting and marketing of bee products, Bee flora and planned pollination services. (7 L)
5. **Important Institutions pertinent to Apiculture:** National Bee Board, Bee Research and Training Institute, Apiaries. Economics and extension of Bee keeping. (2 L)

### **Reference Books**

1. Bees and Beekeeping  
D. P. Abrol , Kalyani Publisher, New Delhi.

2. A Comprehensive guide to Bees and Beekeeping.  
D. P. Abrol. Scientific Publisher, New Delhi.
3. Honey bees and their management  
S. B. Withhead. Axis books Publisher, Jodhpur.
4. Honey bees: Diseases, Parasites, Pests, Predator and their management. N. Nagaraja and D. Rajagopal , M.J.P Publisher, Chennai.
5. A Handbook of Beekeeping Dharamsing and D. P. Singh (, Agrobios India (Publisher), Jodhpur.

**ZY- 406(P) Apiculture, 2 Credits/10 Practical.**

1. Study of Honey bee species, Castes and Bee morphology. (3P)
2. Study of Beekeeping equipments: Bee box and tools. (2P)
3. Study of Bee products: Honey, Bees wax, Pollens, Royal Jelly, Propolis and Bee venom. (2P)
4. A compulsory visit to an Apiary or Central Bee Research & Training Institute or a Beekeeper to gain a first hand experience in handling bees. (2P)
5. Study of bee flora in the locality and observations on bee foraging Behaviour. (1P)

### **ZY 407 T -Pest Control ( 2 Credits)**

1. Introduction of the pest control, types of pests and their importance, Damage caused by pests. **02L**
2. Brief outline of medical and veterinary entomology with reference to important measures to control the vectors. House hold and stored grain pest and their control measures. **06L**
3. Principles and methods of pest control: Cultural control measures, Physical control measures, Mechanical Control measures, Chemical control measures. Types and mode of action. Insecticidal formulations and dilutions. Drawbacks of chemical control. Biological control measures: Biological agents, Advantages and Drawbacks of Biological control, Biological Control Management. **12L**
4. Autocidal control ,Chemosterilents,Kniplings model,Pheromonal and hormonal control. Concept of Integrated pest management. **06L**
5. Non- insect pest and their control: Rat, Bandicoots, Crabs, Snails, Slugs, Birds and Squirrels. **02L**
6. Pesticide- Appliances: Sprayers and Dusters, Hazards of Pesticides and Antidotes. **02L**

### ***Reference Books***

1. "Pest control- A Survey" By A. Woods. (McGraw-Hill, London, 1974).
2. Pest control" – By W. W. Kilgore and R. L. Doult (Academic Press, New York, 1967).

**ZY 408 T Toxicology II (2 credits : 30hr )**

1. Absorption, distribution, and elimination of toxic agents: transfer of molecules across membranes, absorption from GI tract and lung, and across the skin, deposition/ distribution, biotransformation and excretion 7h
2. Bioactivation & detoxification: metabolism of xenobiotic, enzymology of xenobiotic metabolism, bioactivation & inactivation of xenobiotics (Any two OP and CP compounds) 8h
3. Toxicogenomics: microarray, proteomics, metabolomics 3h
4. Toxicity testing: Regulatory agencies, Regulatory testing methods 6h
5. Lab safety, disposal of bio-medical waste, GLP 3h
6. Legal aspects: CPCSEA guidelines, IAEC, rational use of animals, alternatives for animal models 3h

**Reference books:**

1. Principles of Toxicology : Environmental and Industrial Applications – Ed. : Phillip L. Williams, Robert C. James, Stephen M. Roberts; JOHNWILEY & SONS, INC.
2. Casarett and Doull's Toxicology The basic science of poisons – Ed: Curtis Klaassen; McGraw-Hill
3. Fundamental Toxicology – Eds: John Duffs & Howard Worth; RSC Publishing
4. <http://envfor.nic.in/division/committee-purpose-control-and-supervision-experiments-animals-cpcsea>.

**ZY 408 P Practicals in Toxicology II (2 credits : 30hr ) 3hr = 1P**

1. Estimation of phosphate in water 1P
2. Effect of pollution on the oxygen consumption of suitable animal 1P
3. Qualitative assessment of polluted water sample for presence of lead or mercury pollution. 1P
4. Developmental toxicity testing by using *Drosophila* model 1P
5. Bacterial reverse mutation test in *S. typhimurium* 1P
6. Sperm shape abnormality assay 1P
7. Prenatal developmental toxicity test 1P
8. MTT test for cytotoxicity 1P
9. Monitoring cell death by LDH (Lactate dehydrogenase) 1P
10. Alternatives to animals in toxicity testing 1P
11. Visit to authorized Animal House facility 1P
12. Estimation of Acetyl cholinesterase activity on exposure to OP compounds on test organism. 1P