

Solapur University, Solapur

B. Sc. Part – III Zoology Syllabus

Semester V & VI

(Credit and Grading System - CGPA)

(w.e.f. June 2016)

SOLAPUR UNIVERSITY, SOLAPUR
Faculty of Science
Credit and Grading System (CGPA)
(w.e.f. June 2016)

- **Title of the Course:** B.Sc. Part-III
- **Subject:** Zoology
- **The Credit and Grading System:**

With the view to ensure worldwide recognition, acceptability, horizontal as well as vertical mobility for students completing undergraduate degree, Solapur University has implemented Credit and grading system of Evaluation at Undergraduate level. Credit is a numerical value that indicates students work load (Lectures, Lab work, Seminar, Tutorials, Field work etc.) to complete a course unit. In most of the universities 15 contact hours constitute one credit. The contact hours are transformed into credits. As per present norms, there are 3 contact hours per paper (subject) per week which works out to be 45 contact hours per paper (subject) per semester.

In Solapur University, for B.Sc.-III Zoology, there are 4 papers and Compulsory English. For B.Sc.-III Zoology, there are 3 contact hours per paper (subject) per week for each paper and Compulsory English carry 4 contact hours per week. Therefore, total contact hours per week are 16. Each paper has 45 contact hours, which are transformed into 3 credits. Moreover, the grading system of evaluation is introduced for B.Sc. course wherein process of Continuous Internal Evaluation is ensured. The candidate has to appear for Internal Evaluation of 30 marks and University Evaluation for 70 marks. It is 70+30 pattern of evaluation. It is applicable for theory and practical as well. The details regarding this evaluation system are as under.

- **Conversion of marks into Grades:**

A table for the conversion of the marks obtained by a student in each paper (out of 100) to grade and grade point is as given below:

Sr. No.	Range of Marks	Grade	Grade Point
1	80-100	O	10
2	70-80	A+	9
3	60-69	A	8
4	55-59	B+	7
5	50-54	B	6
6	45-49	C+	5
7	40-44	C	4
8	<39	FC	0(Failed in Term Exam)
9	<39	FR	0(Failed in Internal Assessment)

1. Grade Point Average at the end of the Semester (SGPA)

$$\text{SGPA} = \frac{(G_1 \times C_1) + (G_2 \times C_2) + \dots}{\Sigma C_i}$$

(ΣC_i = The total number of credits offered by the student during a semester)

2. Cumulative Grade Point Average (CGPA)

$$\text{CGPA} = \frac{(G_1 \times C_1) + (G_2 \times C_2) + \dots}{\Sigma C_i}$$

(ΣC_i = The total number of credits offered by the student upto and including the semester for which CGPA is calculated.)

3. Final Grade Point Average (FGPA)

It will be calculated in the similar manner for the total number of credits offered for the completion of the said course.

Where: C_i = Credits allocated for the i^{th} course.

G_i = Grade point scored in the i^{th} paper (subject)

4. Conversion of average grade points into grades:

SGPA/CGPA/FGPA	Letter Grade
9.5 – 10	O
8.5 – 9.49	A+
7.5 – 8.49	A
6.5 – 7.49	B+
5.5 – 6.49	B
4.5 – 5.49	C+
4.0 – 4.49	C
<3.99	FC / F
	FR

Syllabus Structure:

1. The University follows semester system.
2. An academic year shall consist of two semesters.
3. Each B.Sc. course shall consist of three years i.e. six semesters.
4. B.Sc. Part-III Zoology shall consist of two semesters: Semester V and Semester VI. In semester V, there will be four papers of 100 marks for each with compulsory English. Similarly in Semester VI there will be four papers of 100 marks for each with compulsory English.

The scheme of evaluation of performance of candidates shall be based on University assessment as well as College internal assessment as given below. For B.Sc. Part-III Zoology sem V & VI the internal assessment will be based on Unit tests, tutorials, Home assignment, viva, group discussion, attitude, sincerity,

student seminars etc. as given below. Practical course examination of 100 marks for each paper shall be conducted at the end of VIth semester. The practical examination of 100 marks shall also consist of 70 marks for University practical assessment and 30 marks for college internal assessment.

For University practical examination both the examiners will be External and will be appointed by the University. The internal practical assessment shall be done as per scheme given below.

6. Scheme of Evaluation

As per the norms of the grading system of evaluation, out of 100 marks, the candidate has to appear for college internal assessment (CA) of 30 marks and external evaluation, University assessment (UA) of 70 marks. The respective B.O.S. may decide the nature of college internal assessment after referring to scheme given below or may be used as it is.

Semester – V

Theory: (100 marks)

University Examination (70 marks): No. of theory papers: 5 (1English + 4 Subjects)

Internal Continuous Assessment: (30 marks)

Scheme of marking: 20 marks – Internal test

10 marks – Home assignment / tutorials / seminars /
Group discussion.

Semester – VI

Theory: (100 marks)

University Examination (70 marks): No. of theory papers: 5 (1English + 4 Subjects)

Internal Continuous Assessment: (30 marks)

Scheme of marking: 20 marks – Internal test

10 marks – Home assignment / tutorials / seminars /
Group discussion / viva / field visit / Zoological important
places visits.

Practical Examination: (100 marks)

University Examination (70 marks): No. of practical course 4

Internal Continuous Assessment: (30 marks)

Scheme of marking: 20 marks – Internal test on any four practicals

10 marks – Lab Journal /attendance/ sketching of diagrams related to syllabus (A4 Size) /
original print of photography with details.

Thus the course shall be of total 1400 marks including English.

7. Passing Standard

The student has to secure a minimum of 4.0 grade points (Grade C) in each paper. A student who secure less than 4.0 grade point (39% or less marks, Grade FC/FR) will be declared fail in that paper and shall be required to reappear for respective paper. A student who failed in University Examination (theory) and passed in internal assessment of a same paper shall be given FC Grade. Such student will have to reappear for University Examination only. A student who fails in internal assessment and passed in University examination (theory) shall be given FR Grade. Such student will have to reappear for both University examination as well as internal assessment. In case of Annual pattern/old semester pattern students/candidates from the mark scheme

the candidates shall appear for the same 70 marks of external examination and his performance shall be scaled to 100 marks.

8. ATKT Candidate passed in all papers except 6 (six) papers combined together of semester III and IV of B.Sc. Part-II Zoology examination and clearly passed in B.Sc. Part-I Zoology shall be permitted to enter upon the course of Semester V of B.Sc. III Zoology.

SOLAPUR UNIVERSITY, SOLAPUR

Faculty of Science

Credit & Grading System (CGPA) Structure for B.Sc – III Zoology Theory

Semester V

Paper No.	Title of Paper	Hrs/Week			Paper Marks	UA	CA	Credits
		L	T	P				
	Compulsory English	4	-	-	100	70	30	3
VII	Non-chordates	3	-	-	100	70	30	3
VIII	Biostatistics, Bioinformatics, Medical Zoology and Evolutionary Genetics	3	-	-	100	70	30	3
IX	Comparative Anatomy of Chordates	3	-	-	100	70	30	3
X	Developmental Biology	3	-	-	100	70	30	3
Total		16			500			15

Semester VI

Paper No.	Title of Paper	Hrs/Week			Paper Marks	UA	CA	Credits
		L	T	P				
	Compulsory English	4	-	-	100	70	30	3
XI	Physiology	3	-	-	100	70	30	3
XII	Endocrinology, Environmental Biology and Toxicology	3	-	-	100	70	30	3
XIII	Molecular Biology and Biotechnology	3	-	-	100	70	30	3
XIV	Biotechniques and Applied Zoology	3	-	-	100	70	30	3
Total		16			500			15

Partical Course

Paper No. based on	Title of Paper	Hrs/Week			Paper Marks	UA	CA	Credits
		L	T	P				
VII & VIII	Non-chordates, Biostatistics, Bioinformatics, Medical Zoology and Evolutionary Genetics		-	5	100	70	30	3
IX & X	Comparative Anatomy of Chordates and Developmental Biology		-	5	100	70	30	3
XI & XII	Physiology, Endocrinology, Environmental Biology and Toxicology		-	5	100	70	30	3
XIII & XIV	Molecular Biology and Biotechnology and Applied Zoology		-	5	100	70	30	3
Total				20	400			12

Abbreviations: L: lectures, T: tutorials, P: practicals; UA: University Assessment by End Semester Examination; CA: College Assessment by Internal Continuous Examination.

UA (University Assessment): University Theory paper shall be of 70 marks.

CA (College Assessment): The internal examination for theory and practical course.

B.Sc. Zoology Part – III
Theory Syllabus
Semester V

SOLAPUR UNIVERSITY, SOLAPUR
Credit & Grading System (CGPA)
B.Sc. III Zoology (Semester – V)
w. e. f. June 2016

Paper- VII: Non-chordates

[Credits -3, Total Lectures-45]

UNIT - I. Protozoa –	(4)
1. Nutrition in Protozoa.	
2. Reproduction in Protozoa.	
UNIT -II. Porifera –	
1. Types of Canal Systems.	(2)
UNIT -III A) Coelenterata –	(4)
1. Polymorphism.	
2. Corals and Coral reefs	
B) Salient features and affinities of Ctenophora. -	(2)
UNIT -IV. Annelida –Type study - Leech : -	(10)
1. Systematic position, Habits and Habitat.	
2. Morphology, body wall, & Locomotion.	
3. Food, feeding and digestive system.	
4. Haemo-coelomic system.	
5. Excretory system.	
6. Nervous system and Sense organs.	
7. Reproductive system, copulation and cocoon formation.	
8. Parasitic adaptations and economic importance.	
UNIT -V Arthropoda –	(8)
1. Evolutionary Significance of Peripatus and Limulus	
2. Study of Crustacean larvae.	
3. Types of Insect larvae.	
4. Insect metamorphosis & its hormonal control.	
UNIT –VI Mollusca –	
1. Torsion and Detorsion.	(2)
UNIT - VII Echinodermata –	
A)Type study –Sea star	(9)
a) Systematic position, Habits and Habitat.	
b) Morphology and body wall.	
c) Food, feeding and digestive system.	
d) Water vascular system and locomotion.	
e) Reproductive system.	
f) Haemal and perihemal system.	
B). Echinoderm larvae -	(2)
C). Minor phyla - Salient features and affinities of- Lingula	(2)

Paper- VIII
Biostatistics, Bioinformatics, Medical Zoology
and Evolutionary Genetics [Credits -3, Total Lectures-45]

A. Biostatistics:

- UNIT -I.** A) Classification and Tabulation. - (3)
B) Frequency distribution & Graphical representation. - (2)
- UNIT -II** A) Measures of Central Tendency - Mean, Median and Mode. (4)
B) Dispersion – Mean Deviation, Standard Deviation & Standard Error, Student-T-test - (4)
- UNIT -III** Correlation – (3)
a) Scatter diagram,
b) Types of correlation & Correlation coefficient.
i) Spearman’s Rank Correlation Coefficient.
ii) Karl Pearson’s Correlation Coefficient.

B. Bioinformatics :

- UNIT - IV** 1. Introduction and applications of Bioinformatics (7)
2. Introduction to proteomics and genomics
3. Applications of search Engine: Entrez, BLAST.

C. Medical Zoology:

- UNIT - V** Study of following diseases with respect to their mode of infection , symptoms and treatment (7)
a) Rabies
b) Ebola
c) Tuberculosis
- UNIT -VI** Study of following diseases with respect to their mode of infection , symptoms and treatment (7)
a) Malaria
b) Fascioliasis
c) Elephantiasis
d) Dengue

UNIT –VII Evolutionary Genetics:

1. Hardy-Weinberg Law of genetic equilibrium. (08)
2. Destabilizing forces of Natural selection with reference to:
a) Genetic drift
b) Migration

Reference Books- (for Paper VIII and VIII)

- There are few websites providing free downloadable books. Website of NCBI provides more than thirty books on microbiology, molecular biology, genetics and Biotechnology
- Website named Books4Doctor gives books on histology, physiology, molecular biology and Human genetics.

The books can be searched alphabetically.

1. Invertebrate Zoology- (W.B. Saunders Co.) – Barnes R.D.
2. Treatise in Zoology Sedgwick Vol III
3. Modern Text Book of Zoology, Invertebrates – R.L.Kotpal.
4. life of Invertebrates – S.N. Prasad, Vikas publishing House, New Delhi.
5. A Life of Invertebrates- Russell & Hunter.
6. Practical Zoology, Invertebrates- S.S. Lal.
7. Info technology- S. Chand and Co.
8. Bioinformatics- Murti, Himalaya Publications.
9. Introduction to Bioinformatics Attwood Pearson Education Delhi
10. General Parasitology- Cheng, T.C. Academic Press.
11. Parasitology-Chandler, Allied Agency, Kolkata.
12. Essentials of Parasitology – Gerald D. Smith.
13. Introduction to Biostatistics Pranab Kumar Banerjee S. Chand and Company. New Delhi
14. Wikipedia: Free encyclopedia Major topics in Population genetics and related examples can be searched.
15. Evolution: Mark Ridley Blackwell Publishing In India marketed by John Wiley and Sons.
16. Textbook of medical Parasitology: K.D.Chatterjee

Paper- IX
Comparative Anatomy of Chordates
[Credits -3, Total Lectures-45]

UNIT I.	a)Integument and its derivatives -	(7)
	b) Endoskeleton - Appendicular skeleton.	(5)
UNIT II	Digestive system – Alimentary canal and associated glands. -	(6)
UNIT III	Respiratory system – Cutaneous respiration, Gills and Lungs, Air sacs in birds. -	(5)
UNIT IV	Circulatory system – Evolution of heart and Aortic arches, Portal systems. -	(7)
UNIT V	Excretory system – Evolution of Kidney and its ducts -	(4)
UNIT VI	Nervous system – Comparative anatomy of Vertebrate Brain -	(6)
UNIT VII	Sense organs – Comparative anatomy of Ear and Eye. -	(5)

Paper- X
Developmental Biology
[Credits -3, Total Lectures-45]

UNIT - I Gametogenesis- Spermatogenesis and Oogenesis (3)

UNIT - II Process of fertilization - (3)

UNIT - III Types of eggs and cleavages - (5)

UNIT - IV Development of Amphioxus - (10)

- a. Structure of egg and sperm
- b. Fertilization and cleavage
- c. Blastula and its fate map
- d. Gastrulation
- e. Primary organ formation: Nerve chord, Noto chord, Mesoderm, Coelom and Gut

UNIT - V Development of Chick (15)

- a. Structure of Egg and Sperm
- b. Fertilization and cleavage
- c. Blastula and its fate map
- d. Gastrulation
- e. Structure of 24 hrs. Chick embryo.
- f. Development of nervous, digestive and circulatory systems in second day of incubation (Structure of 48 hrs. Chick embryo)
- g. Development of nervous, digestive and circulatory systems in Third day of incubation (Structure of 72 hrs. Chick embryo)

UNIT – VI Foetal membranes (Amnion, Chorion, Allantois and Yolk sac) & their significance in chick.(4)

UNIT – VII Placentae –Types and significance. - (5)

Reference Books – (for Paper IX and X):

1. An Introduction to Embryology 2003, Balinsky B.L., Saunders College, Philadelphia.
2. Developmental Biology; Patterns/Principles/Problems, 1982, Saunders J. W. Collier MacMillan, Publishers, London.
3. Developmental Biology, 2004 , 3rd Edition, Gilbert S.F. Saunder Associates Inc. U.S.A.
4. Developmental Biology, 1992 3rd edition, Browder L.W. Erickson C.A. & Williams, R.J. Saunders College, Publications, London.
5. A Text Book of Embryology, Dr. Puranik P. G. , S. Chand & Co.
6. Developmental Biology, 1984, Browder L.W. , Saunders College Publications, U.S.A.
7. Development of Chick embryo, 1972, Lillie.
8. Outlines of comparative Anatomy, Romer & Parsons, Central Book Depot, The Vertebrate Body (Saunders).
9. Biology of Vertebrates Walter & Sayles; (McMillan).
10. Modern Textbook of Zoology, R. L. Kotpal, Rastogi Publications, Meerut.
11. The Life of Vertebrates, 3rd Edition, 1993, J. Z. Young E. L. B.S. Oxford.
12. Chordate Zoology – E.L. Jordan, S. Chand & Co., New Delhi.
13. The Phylum Chordata – 1987, H.H. Newman, Distributor Satish Book Enterprise, Agra.
14. Comparative Anatomy of the Vertebrates G. C. Kent.

B.Sc. Zoology Part – III
Theory Syllabus
Semester VI

Paper - XI
Physiology

[Credits -3, Total Lectures-45]

- UNIT I. Nutrition and Metabolism – (14)**
- a) Digestion and absorption.
 - b) Vitamins- (with reference to source, Physiological role and deficiency)
Water soluble –B complex and C ; Fat soluble – A, D, E and K.
 - c) **Carbohydrate metabolism -**
Glycogenesis, Glycogenolysis, Glycolysis, Krebs cycle, and Gluconeogenesis.
 - d) **Protein metabolism:**
Transamination, Deamination and Ornithine cycle
 - e) **Lipid metabolism.**
 β - Oxidation.
- UNIT II Physiology of Respiration – (4)**
- 1. Transport of respiratory gases
 - 2. Chemical and nervous regulation of Respiration
- UNIT III. Physiology of Circulation (7)**
- 1. Origin and conduction of heart beat, Cardiac cycle
 - 2. ECG, Blood pressure
- UNIT IV. Physiology of Excretion (4)**
- 1. Structure of nephrons
 - 2. Physiology of urine formation.
 - 3. Dialysis.
- UNIT V Physiology of Muscle (6)**
- 1. Ultra structure of striated muscle fiber
 - 2. Molecular mechanism of muscle contraction.
- UNIT - VI Physiology of Nerve (7)**
- 1. Ultra structure of neuron
 - 2. Origin and conduction of nerve impulse
 - 3. Synapse and synaptic transmission
- UNIT - VII Physiology of Stress (3)**
- 1. Introduction to stress physiology
 - 2. Managing stress by exercise, yoga and meditation

Paper- XII
Endocrinology, Environmental Biology and
Toxicology

[Credits -3, Total Lectures-45]

A. Endocrinology:

UNIT I Study of endocrine glands – : (12)
Anatomy, histology and hormones – Nature, role(functions), regulation and disorders with reference to the following glands :

- a. Thyroid gland
- b. Parathyroid gland
- c. Adrenal gland
- d. Islets of Langerhans.

UNIT II

Prostaglandins and Neurohormones - GnRH , CRH and TRH (4)

B. Environmental Biology:

UNIT III

1. Concept of Biodiversity - Introduction to species ,genetic and ecosystem diversity (3)
2. Conservation of endangered species with reference to Great Indian Bustard (*Ardeotis nigriceps*) (3)

UNIT IV

1. Characteristics and faunal adaptations with reference to following habitats Fresh water (lentic lotic,) Marine (off –shore:Rocky, Muddy,Sandy) water and Terrestrial (Grassland, Desert) ecosystem. (7)
2. Biological indicators of pollution. (2)

UNIT V

1. Solid waste management. (2)
2. Rain Water harvesting (2)
3. Animal Ethics- Introduction, prevention of cruelty to animals, need of virtual dissection (2)

C. Toxicology –

UNIT VI (4)

1. Classification of toxicants.
2. Toxic agents and their action – Pesticides
3. Determination of LC₅₀ Values

UNIT VII

- 1 Bioaccumulation and biomagnification
2. Applications of Toxicology (4)

Reference Books (for Paper XI and XII)

1. General and Comparative Physiology – Hoar (Prentice Hall).
2. Animal Physiology – Nelson (Cambridge).
3. Comparative Animal Physiology – Prosser (Satish Book Enterprise).
4. Animal physiology: Usha Gavhane and Mohan Babare , Wizcraft publication and distribution Pvt Lyd ,Solapur
5. Endocrinology – Hadley Pearson Education Delhi
6. General Endocrinology – Bagnara & Turner (W.B. Saunders)
7. Ecology – Odum (Amerind)
8. Limnology – Welch (McGraw Hill)
9. Introduction to Environmental Science – Y Anjaneyulu (B.S. Publications)
10. Animal Physiology – Adaptation and Environmental – Schiemdt Nielson (Cambridge)
11. Physiology : A regulatory systems approach – Strand F.L. (McMillon Publications Co.).
12. Environmental and Metabolic Animal Physiology – Prosser C.L. (Wiley –Liss Inc.)
13. Environment Physiology- Willmet P.G., Stone & Johnsion (Blackwell Science, Oxford).
14. Physiological Animal Ecology – Loan G.N. (Longman Harlog, UK)
15. Principles and methods of Toxicology – Hayes (Edited A. Wallace, Hayes Publications, Raven Press, N.Y.)
16. Books4Doctors Website Downloadable book of Endocrinology Nussey

Paper – XIII
Molecular Biology and Biotechnology
[Credits -3, Total Lectures-45]

A. Molecular Biology:

UNIT I Organization of DNA (7)

- a) Nucleosome concept and Solenoid model
- b) Evidences for DNA as genetic material- Transformation Experiment by Griffith, McLeod & McCarty Experiment, Hershey & Chase Experiment
- c) Replication of DNA in Prokaryotes
- d) DNA damage and repair mechanism

UNIT II Transcription - (5)

- a) Process of transcription in prokaryotes and eukaryotes
- b) RNA polymerase in Prokaryotes.
- c) Post transcriptional modifications in RNA in Eukaryotes

UNIT III Translation – (5)

- i. Activation of amino acids
- ii. Binding or transfer of amino acid to t RNA.
- iii. Initiation
- iv. Elongation
- v. Termination.

UNIT IV Genetic Code (3)

- i. Properties of Genetic Code
- ii. Codon assignments.
- iii. Initiation codon
- iv. Termination codon
- v. Codon and anticodon pairing
- vi. Wobble hypothesis

B. Biotechnology

(3)

UNIT V 1. Recombinant DNA technology

- a. Mechanism and role of restriction enzymes, DNA ligase and DNA polymerase
- b. Cloning vectors- Plasmid and Cosmid

UNIT VI Techniques in genetic engineering-

(12)

A) Polymerase chain reaction:

- a. Introduction
- b. Mechanism
- c. Applications

B) DNA probes:

- a. Introduction
- b. Mechanism of synthesis of probe
- c. Applications

C) Blotting (Southern, Northern, Western blotting)

- a. Introduction
- b. Mechanism
- c. Applications

D) DNA fingerprinting:

- a. Introduction
- b. Mechanism
- c. Applications

UNIT VII

1). Immunological techniques:

(4)

- a) Hybridoma & synthesis of Monoclonal antibodies
- b) Applications of Monoclonal antibodies

2) ELISA:

(4)

- a) Introduction
- b) Applications

3) Application of Biotechnology – Cloning and Medicine

(2)

Paper – XIV
Biotechniques and Applied Zoology
[Credits -3, Total Lectures-45]

A. Biotechniques:

UNIT I

i. Tools and Techniques (Basic principles and uses) (3)

pH meter, colorimeter, spectrophotometer and ultracentrifuge

ii. Separation techniques (4)

i. Chromatography- TLC and Column chromatography.

ii. Gel Electrophoresis- Polyacrylamide Gel Electrophoresis and Agarose Gel Electrophoresis

UNIT II

a. Animal Cell Culture (6)

i. Introduction and principle, Requirements and applications

ii. Stem cells and their culture

b. Cryopreservation of gametes and its application (2)

B. Applied zoology

UNIT III Fisheries : (5)

1. Marine Capture fisheries

a) Coastal fishery – Sardine, Mackerel, Bombay duck

b) Off – shore fishery – Sole, Tuna, Pomphret

c) Crustacean fishery – Lobsters, Crabs, Shrimps

2. Economic importance of Fish Products and by products (2)

3. Pearl Culture (1)

UNIT IV 1. Fishing Crafts and Gears- (7)

a) Crafts

i. Rafts

ii. Trawler

iii. Shampan

iv. Canoe

v. Catamaran

b) Gears

i. Hooks and lines

ii. Cast net

iii. Gill net

iv. Trap net

v. Rampani net

vi. Trawl net

UNIT V Agricultural Pest Management- (6)

- i. Agricultural pests – Pyrilla, Tribolium (Jowar grain borer), Cotton Boll worm, Grass hopper and Rat.
- ii. Biological control of crop pests.
- iii. Integrated Pest Management (IPM)

UNIT VI Rearing Technology of Silk worm (6)

- i. Varieties of silkworms
- ii. Silkworm rearing appliances and maintenance
- iii. Silkworm rearing methods and rearing houses
- iv. Government schemes for propagation of sericulture

UNIT VII Silkworm diseases :- (3)

- i. Protozoon diseases
- ii. Bacterial diseases
- iii. Viral diseases
- iv. Fungal diseases

Reference Books- (for Paper XIII and XIV)

1. Cell and Molecular Biology, 8th Edition, De. Robertis EDP and De Robertis Jr. EMF, Lippincott Williams and Wilkins, Philadelphia,
2. Cell Biology, C.B. Powar, Himalaya Publication House.
3. Cell and Molecular Biology, E.J. Dupraw, Academic Press, New York.
4. Cell Structure and Function – A. G. Loewy, P. Siekevitz, J. R. Meninger & J. A. N. Gallant, Saunder College, Philadelphia.
5. Molecular Biololgy of the Cell – 3rd Edition, Bruce Alberts, Dennis Bray, Julian Lewis, Martin Raff, Keith Roberts & James D. Watson, Garland Publishing, New York.
6. Text Book of histological techniques- S G Bansode and A L Deshmukh
7. Elements of Biotechnology – P. K. Gupta, Rastogi Publications.
8. Gene V & VI, 1994, Lewin B., Oxford University Press, Oxford.
9. Prawn and Prawn Fishery of India – Kurian.
10. Fish Culture – K. H. Alikuhni.
11. Fish Culture – Lagler.
12. Fishes of India. – Zingran
13. Manual of sericulture – Krishnaswami et. al
14. Introduction to sericulture – Ganga and Shetty.
15. Economic Zoology –Upadya and Shukla

B.Sc. Zoology
Part – III
Practical Syllabus

Practical – I (Based on Theory paper VII & VIII)

Non-chordates, Biostatistics, Bioinformatics and Medical Zoology, and Evolutionary Genetics

1) Leech: Anatomical observations and detailed explanation of Leech with the help of CD/Model/Chart of the following systems-

1. Digestive system.
2. Nervous system.
3. Reproductive system.

Study of Nephridium, Salivary glands and jaw of Leech with the help of CD/Model/Chart /Slides.

(During regular practical and while annual examination students should be provided with unlabelled figures and are expected to **label and write** a brief account on location, structure and function of various parts and submit the labeled figure and a **viva-voce** on the same is expected for the thorough understanding of his/her knowledge).

2) Sea Star: Anatomical Observations and detailed explanation of Sea star with the help of CD/Model/Chart of the following systems

1. Digestive system.
2. Water vascular System.
3. Study of tube foot of sea star with the help of CD/Model/Chart /Slides

(During regular practical and while annual examination students should be provided with unlabelled figures and are expected to **label and write** a brief account on location, structure and function of various parts and submit the labeled figure and a **viva-voce** on the same is expected for the thorough understanding of his/her knowledge).

3) *Lingula*: Study of Lophophore and Nephridium of *Lingula*- with the help of CD/Model/Chart/Slides/Museum Specimens

(During regular practical and while annual examination students should be provided with unlabelled figures and are expected to **label and write** a brief account on location, structure and function of various parts and submit the labeled figure and a **viva-voce** on the same is expected for the thorough understanding of his/her knowledge).

4) *Squilla*: Anatomical Observations and detailed explanation of Nervous System of *Squilla* with the help of CD/Model/Chart

(During regular practical and while annual examination students should be provided with unlabelled figures and are expected to **label and write** a brief account on location, structure and function of various parts and submit the labeled figure and a **viva-voce** on the same is expected for the thorough understanding of his/her knowledge).

5) Study of Zooids of *Porpita* and *Obelia* colony with the help of CD/Model/Chart/Permanent Slides and Museum Specimens

6) Study of locomotion in Protozoa– Amoeba, Paramecium and Euglena using Permanent slides/photographs / Permanent Slides and Museum Specimens

7) Study of Canal systems– T.S. and L.S of Sycon using Permanent slides/photographs / Permanent Slides and Museum Specimens

8) Study of Physalia and any four Corals using models / photographs / Museum specimens / Permanent Slides and Museum Specimens

9) Study of following using photographs / Permanent Slides or Museum Specimens

- | | |
|---------------------------|----------------------|
| 1. Crustacean larvae. | 2. Insect larvae. |
| 3. Peripatus and Limulus. | 4. Echinoderm larvae |

10) Examples on Biostatistics. (Any Ten Examples)

11) Study & observation of Parasites from Fecal samples of the animal (**Permanent slides / Charts/Models**)

12) Study of Pathogens: *Plasmodium*, *Fasciola hepatica*, *Wuchereria bancropti* using slides/photographs

13) Bioinformatics –

- a) Data search by ‘text and sequence based search engines’: Entrez and BLAST tool
- b) Examples based on bioinformatics: Searching sequences of any five genes or proteins using NCBI and submission of sequences in FASTA format.

(During regular practical students are expected to use INTERNET and access the NCBI website and study the ‘home page menu of NCBI, Entrez and BLAST search engine/tool’ and ‘perform sequence search of any five proteins or genes using Entrez tool’. At the time of examination students are expected to perform searching of any one protein or gene using INTERNET and get target sequence and submit the print of the same **or** they may directly explain the **home page or sequence format** which they had already performed and obtained during regular practicals of any five genes or proteins. For eg. Hemoglobin, Insulin, Trypsin, Myoglobin, and Collagen or any suitable protein).

14) Graphical representation of data using MS-EXCEL (Bar, Line, Pie, and Histogram using suitable data).

15) Examples based on Hardy Weinberg Law (08 examples)

Practical – II (Based on Theory paper IX & X)
Comparative Anatomy of Chordates & Developmental Biology

- 1) **Scoliodon:** Anatomical observations and detailed explanation of Cranial Nerves of Scoliodon with the help of CD/Model/Chart (During regular practical and while annual examination students should be provided with unlabelled figures and are expected to **label and write** a brief account on location, structure and function of various parts and submit the labeled figure and a **viva-voce** on the same is expected for the thorough understanding of his/her knowledge).
- 2) **Scoliodon:** Anatomical Observations and detailed explanation of **Membranous labyrinth of Scoliodon** with the help of CD/Model/Chart (During regular practical and while annual examination students should be provided with unlabelled figure of membranous labyrinth of Scoliodon and are expected to **label and write** a brief account on location, structure and functions of various parts and submit the labeled figure and **viva-voce** on the same is expected for the thorough understanding of his/her knowledge).
- 3) **Scoliodon:** Anatomical Observations and detailed explanation of **Eye Muscles and nerve innervations of Scoliodon** with the help of CD/Model/Chart (During regular practical and while annual examination students should be provided with unlabelled figures and are expected to **label and write** a brief account on location, structure and function of various parts and submit the labeled figure and a **viva-voce** on the same is expected for the thorough understanding of his/her knowledge).
- 4) **Rat:** Anatomical observations and detailed explanation of Reproductive System of rat with the help of CD/Model/Chart (During regular practical and while annual examination students should be provided with unlabelled figures and are expected to **label and write** a brief account on location, structure and function of various parts and submit the labeled figure and a **viva-voce** on the same is expected for the thorough understanding of his/her knowledge).
- 5) **Rat:** Anatomical Observations and detailed explanation of **Neck Nerves of Rat** with the help of CD/Model/Chart (During regular practical and while annual examination students should be provided with unlabelled figures and are expected to **label and write** a brief account on location, structure and function of various parts and submit the labeled figure and a **viva-voce** on the same is expected for the thorough understanding of his/her knowledge).
- 6) **Study of Scales– Placoid, Cycloid and Ctenoid/Ampulla of Lorenzini ,Weberian ossicle of Labeo** with the help of CD/Model/Chart/ permanent slides (During regular practical and while annual examination students should be provided with unlabelled figures and are expected to **label and write** a brief account on location, structure and function of various parts and submit the labeled figure and a **viva-voce** on the same is expected for the thorough understanding of his/her knowledge).
- 7) Study of Eggs of Insects, Amphioxus, Frog and Chick with the help of CD/Chart/Model/Permanent slides and museum specimens
- 8) Study of Cleavage, Blastula and Gastrula Amphioxus with the help of CD/Chart/Model/Permanent slides
- 9) Study of Whole mounts and T.S. of 18, 24, 33, 48, and 72 hrs Chick embryos with the help of CD/Chart/Model/Permanent slides

10) Study of ‘procedure to understand embryological stages of chick up to 72hrs’ **by non invasive method** using CD/Model/Chart (During regular practical students are expected to learn flow chart for the whole mount of chick embryo starting from incubation of egg - location of embryo - transferring of embryo on glass slide – fixation – dehydration – staining – identification – drawing - labeling and submission. **At the time examination** students will be provided an unlabelled figure of any one developmental stage of chick embryo which they are expected to identify, label and write the procedure for making a whole mount and defend viva-voce).

11) Study of placenta of Rat/ Human using CD/Chart/Model / museum specimens

12) Study of following using CD/Chart/Permanent Slides / Museum Specimens

- | | |
|---------------------------------------|------------------------------------------------------------------------|
| 1. T.S. / V.S. of skin of vertebrates | 2. Scales- Fishes and Reptiles. |
| 3. Feathers | 4. Gills of Fishes and Lungs of Amphibian, Reptiles, Birds and Mammals |
| 5. Hearts of Vertebrates | 6. Brains of Vertebrates. |

13) Project work- Research project should be prepared in consultation with faculty either individually or in group as required. The research guide will support students in selecting and executing the entire topic and preparing the report for final submission during examination after approval of the guide in the following format

a) Research project should be based on an original research topic

b) Format of Report:

1. Title
2. Introduction
3. Review of literature
4. Objectives
5. Material and Methodology
6. Result and discussion
7. Conclusion
8. References

c) At the time of practical examination submit the final project report (hard copy) and present your research findings using PowerPoint.

Practical – III (Based on Theory paper XI & XII)
Physiology, Endocrinology, Environmental Biology and
Toxicology

1) Demonstration of physiological practical with the help of CD/Virtual Dissection

- a) Demonstration of preparation of gastrocnemius muscle with sciatic nerve in frog;
- b) Study of Simple muscle twitch and obtaining the computer generated graph;
- c) Study of normal cardiogram and obtaining the computer generated graph;
- d) Study of effect of temperature, Adrenaline, Nicotine on normal heart and obtaining the computer generated graph;

(At the time of examination students are supposed to ‘Analyze the given graph and provide details of principle, procedure, result, inference and viva-voce based on the given practical)

2) Estimation of hemoglobin.

3) Total count of R.B.C., W.B.C and differential count of WBC

4) Measurement of blood pressure and heart beat under normal and stress condition.

5) To perform ‘Erythrocyte Sedimentation Rate (ESR)’ of the given blood sample.

6) Preparation of Haemin crystals

7) To determine blood clotting time using capillary method

8) To study effect of hypotonic, hypertonic and isotonic solution on RBC

9) Endocrine glands – Anatomy and Histology using slides/photographs

Testis, Ovary, Adrenal, Thyroid, Pancreas.

10) Estimation of dissolved O₂ and free CO₂

11) Testing of hardness of water.

12) Study of animals in relation to their habitats using charts/videos

1. Lotic – Guppies.

2. Lentic – Anabas/ Indian major Carp

3. Pelagic – Puffer fish/Mackerel, Sardine

4. Benthic – Lobster, Prawn

5. Grass land – Stick insect/Grasshopper

6. Desert – Phrynosoma, Uromastix.

13) Study of ecological pyramid using charts

Presentation of given data in the form of ecological pyramids. Data for the ecological pyramids.

a. Members of Grass land ecosystem –

Grasshopper, Rat Snake, Grass, Herbs, Shrubs, Weeds, Trees, Vulture, Squirrel, Earthworm, Centipede, Scorpion, Rabbit and Indian Bustard.

b. Members of Pond ecosystem –

Sponge, Nepa, Leech, Planaria, Hydra, Lymnea, Planorbis, Heron, Kingfisher, Cyclops, Daphnia, Tortoise, Diatoms Vallisneria, Hydrilla, Chara and Spirogyra.

c. Members of Forest ecosystem-

Monkey, Tree Snake, Hyla, Python, Vulture, Giant Squirrel, Gaur, Tiger, Leopard, Deer, Loris, Millipede, King Cobra, Shrub, Herb, Tree, Jungle Fowl, Moss and Fern.

d. Members of Desert ecosystem-

Opuntia, Aloe, Wild Ass, Camel, Ground Spider, Scorpion, Phrynosoma, Uromastix, vitis, Blackbuck, Pencil tree, Nerium.

14) Study of Diversity indices (Shannon/Simpson) using line transect method

16) Excursion Tour (Any one- of duration maximum ten days)

a) Visit to National Parks/ Zoo parks

b) Visit to marine water / freshwater habitat

c) Wildlife Sanctuaries

d) National / State Research Institutes / University departments and other appropriate Institutes.

e) Central Research Institutes

f) Zoological Survey of India

g) Suitable Ecosystem etc.

Note:

1. Kindly note that during field visits students shall observe only animals and make record of the observations without disturbing natural habitat nor kill the animals. Students should be told about the importance of biodiversity and conservation;

2. Students are encouraged to prepare and submit a concise report of the excursion;

3. Report on multiple excursion tours may be clubbed for preparing and submitting report at the time of final examination will be allowed.

4. All necessary precautions must be taken while organizing study tour with special reference to the safety of students as per Higher Education rules and regulations .

Practical – IV (Based on Theory paper XIII & XIV)
Molecular Biology, Biotechnology, Biotechniques and Applied Zoology

1) Study of procedure to understand whole mounts of Protozoa, coelenterate colony, planktons, insect larvae, echinoderm larvae, crustacean larvae, fish scales, filoplume and down feather using CD/Chart (During regular practical students are expected to learn protocol for whole mount starting from acquisition of material – fixation if required – dehydration as necessary – staining – mounting - identification – drawing – labeling. **At the time examination** students will be given an unlabelled figure which they need to identify, label and write the protocol for making the whole mount)

2) Study of Microtomy and its applications by using CD/Chart:

- a) Principle and applications of microtome machine
- b) Study of ‘Types of stains’(vital, nuclear, cytoplasmic)
- c) Theoretical study of flow chart of microtechnique (Introduction to autopsy and biopsy – Fixation – washing if needed – dehydration – clearing – embedding – block making – trimming – fixing of trimmed block to block holder- Demonstration of working of microtome machine – sectioned ribbon – spreading on slide)
- d) Theoretical study of ‘Principle, staining and application of HE method

At the time examination students will be asked to write principle, procedure and applications of microtomy along with the flowchart of the Microtomy and HE staining and defend viva-voce).

3) **Staining:** Histochemical Techniques

- a) Staining of chromatin using ‘Feulgen Method’ in onion root tip
- b) Staining of DNA and RNA using methyl green and pyronin method in onion root tip

4) **Molecular Biology and Biotechnology**

- a) Isolation of DNA: from any suitable plant material
- b) Estimation of DNA by Diphenyl Amine method (DPA)
- c) Estimation of RNA by Orcinol method
- d) Paper chromatography: separation of amino acids
- e) Thin Layer Chromatography (TLC): Separation of amino-acids using Thin Layer Chromatography (TLC)
- f) Electrophoresis: understanding of banding pattern of gel electrophoresis of DNA / protein and determination of molecular weight of an unknown sample within the band using photographs
- g) Theoretical study of animal cell and tissue culture using CD/Model/Chart
- h) Prepration of meiotic phases in onion bud
- i) Study of human Karyotype using photographs: Normal male and female (classification of chromosomes according to size and position of centromere)

5) To find out codon sequences for known polypeptide chain of ten amino acids or to find out

amino acid sequence from given codons (chart will be provided)

6) Economic importance of Leech, Prawn, Lobster, Crab, Oyster, Sepia using CD/Model/Chart

7) Economic importance of Shark, Pomphret, Oil Sardine, Mackerel, Bombay duck, Eel, Ophiocephalus, Catala, Rohu, Mrugal and Cyprinus using CD/Model/Chart

8) Study of fish products- Fish meal, Fish glue, Fish liver oil, Fish body oil, Fish manure, and shagreen using CD/Model/Chart

9) Study of different Fishing Crafts and Gears using CD/Model/Chart using CD/Model/Chart

10) Study of Crop pests – Pyrilla, Jawar grain borer, Cotton ball worm, Grass hopper using CD/Model/Chart

11) Excursion visits to study(Anyone- One Day Visit) : Sericulture, Agriculture research center, Yoga & Meditation center and Pearl Culture , Biotechnology lab , Blood bank visit etc. **All necessary precautions must be taken while organizing study tour with special reference to the safety of students as per Higher Education rules and regulations.**

Note:

As per the guidelines of **UGC notification number F.14-6/2014(CPP-II) dated 1st August, 2014** it is now essential to make necessary modifications to stop dissection and promote and orient students towards the knowledge component rather than skill development. However, ITC based virtual dissections are promoted. Now, the responsibility to discontinue dissections and use of animals in experiments totally rests on concerned authorities of respective colleges/Institutes. As per the notification it is important to encourage the field trips and observations without disturbing the biodiversity. For laboratory observations existing permanent slides and specimens should be shown. As per the guidelines of UGC , all the Zoology departments should be empowered with infrastructure to adopt Information communication technology (ICT) required for the purpose of virtual dissections for which virtual class room / laboratory to be enriched with few computers (according to the strength of students),internet facility , printer etc.

STRUCTURE FOR PRACTICALS EXAMINATION MARKING PATTERN

Practical I : 100 Marks [UA:70 Marks + CA: 30 Marks]

Practical II : 100 Marks [UA:70 Marks + CA: 30 Marks]

Practical III: 100 Marks [UA:70 Marks + CA: 30 Marks]

Practical IV: 100 Marks [UA:70 Marks + CA: 30 Marks]

Skeleton paper for practical examination (University Examination for 70 Marks)

Practical – I	Marks
Q.1: Biostatistics example	10
Q.2: Example based on Bioinformatics	
OR	
Graphical representation using MS-EXCEL	10
Q.3: Example based on Hardy-Weinberg Law	10
Q.4: Identification	10
Q.5: Analysis and explanation of anatomical parts of given figure/CD/Chart/Model of Leech/Sea star/Squilla as per practical syllabus	10
Q.6: Analysis and explanation of given permanent slide/CD/Chart (Lingula lophophore, nephridium; Porpita zooids; and Obelia colony)	10
Q.7: Certified Practical Record Book	10
	Total - 70

Practical – II:	
Q.1: Analysis and explanation of anatomical parts of given figure/CD/Chart/Model of Scoliodon- cranial nerves and Rat- reproductive system as per practical syllabus -	10
Q.2: Analysis and explanation of given Model/CD/Chart (Scoliodon- Internal Ear, Eye Muscles; Rat: Neck Nerves as per practical syllabus)	10
Q.3: Identification-	10
Q.4: Study of ‘procedure to understand embryological stages of chick up to 72hrs’ by non invasive method’ using CD/Model/Chart-	10
Q.5: Submission, PowerPoint presentation and viva-voce of Project report- (10 Marks for submission of project & 10 Marks for presentation)	20
Q.6: Certified Practical record book-	10
	Total - 70

Practical – III:

Q.1: Estimation of Dissolved O ₂ from given Sample/Free CO ₂ from given sample/Hardness of water	10
Q.2: Hemoglobin percentage /Blood Cell counts/Blood Pressure/ESR/Haemin Crystal/Blood Clotting Time/ Effect of hypotonic, hypertonic and isotonic solution on RBC	10
Q.3: Ecological pyramid/Diversity Indices	10
Q.4: Analysis of given graph of Frog- muscle twitch or cardiogram	
Q.5: Identification	10
Q.6: Submission of Excursion long Tour report visits to sea-shore, Fishery Centers ,National Parks ,Wildlife Sanctuaries ,National Research Institutes , Central Research Institutes ,Zoological Survey of India ,Fresh & Marine Water Ecosystem etc.	10
Q.7: Certified Practical record book	10
Total - 70	

Practical – IV:

Q.1: Cytological preparation- Meiosis/ Feulgen technique/Methyl-green & Pyronin –	10
Q.2: Examples based on codon/Analysis of Karyotype	10
Q.3: Isolation of DNA/Estimation of DNA/RNA	
OR	
Chromatographic separation of amino acids/Electrophoresis	10
Q.4: Principle and applications of Microtomy/whole mount preparation	10
Q.5: Identification	10
Q.6: Excursion report (short tours/visits to Sericulture, agriculture research center, yoga & meditation center and Pearl Culture, Biotech Lab/Blood Bank Visit etc.)	10
Q.7: Certified Practical record book	10
Total – 70	

B.O.S
Chariman, Zoology