H.P. University, Summerhill, Shimla

Structure and Syllabus

of

Zoology

for

B.Sc. Undergraduate Programme

Based on:

U.G.C. Choice Based Credit System (CBCS)
Model Curriculum

(Effective from academic session July, 2016)

HIMACHAL PRADESH UNIVERSITY

SUMMER-HILL, SHIMLA-171005

B.Sc. Zoology

GENERAL INSTRUCTIONS/ GUIDELINES FOR EXECUTION OF CURRICULUM

I. The B.Sc. Zoology will be of three years duration semester-based Choice Based Credit System [CBCS] course.

II. There will be broadly three types of courses for B.Sc. Zoology degree program.

1. The **Core Courses** (14 courses for B.Sc. Zoology; and 4 discipline specific papers) will be of 6- credits each including 2 credits assigned to the practical component. Thus a candidate will have to pass 14 courses for earning 14 X 6 = 84 credits during six semesters. Each of the 6-credits courses will carry 100 marks. These 100 marks will be split into marks assigned for Theory [TH]: 40 marks; Practical [P]: 30 marks and Internal Assessment [IA]: 30. The Internal Assessment [30 marks] will include one Multi Choice Questions (MCQ)-based examination of 25 marks each [25 or 50 questions of 1.0 or 0.5 mark each as the case may be]; and Classroom Attendance Incentive marks (5 marks). The Lab-based practical will be of 2-hours [One credit]. A total of 14 X 6 = 84 credits could be accumulated under these courses during the B.Sc. Zoology degree program.

2. The **Elective Courses** will be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline/ subject of study or which provides an extended scope or which enables an exposure to some other discipline/ subject/ domain or nurtures the candidate's proficiency / skill. The Elective Courses will include;

Discipline Specific Elective [**DSE**] Courses: A total of 4 courses offered under the main discipline/ subject of study is referred to as Discipline Specific Elective. These courses are discipline related and/ or interdisciplinary in nature. A total of 4 X 6 = 24 credits could be accumulated under DSE courses during the B.Sc. Zoology degree program.

Generic Elective [GE] Courses: A total of 4 courses of 6-credits each including 2 credits assigned for the practical component of each of these courses *i.e*. one course per 1st to 4th semester will be studied by the candidates. An elective course chosen from an unrelated discipline/ subject, with an intention to seek exposure beyond discipline(s) of choice is called Generic Elective Course. The purpose of this category of papers is to offer the students the option to explore disciplines of interest beyond the choices they make in Core and Discipline Specific Elective papers. Further, a course offered in a discipline/ subject may be treated as an elective by other discipline/ subject and vice versa and such electives may also be referred to as Generic Elective Course. A total of 4 X 6 = 24 credits could be accumulated under GE courses during the B.Sc. degree program.

3. **Ability Enhancement Compulsory Courses [AECC]:** Ability Enhancement Courses are of two types; Ability Enhancement Compulsory Courses [AECC] and Skill Enhancement Courses [SEC]. A total of 4 X 4 = 16 credits could be accumulated under these courses during the B.Sc. degree program i.e. 4 X 2 = 8 credits for AECC, and 4 X 2 = 8 credits for SEC courses.

The AECC courses are the mandatory courses based upon the content that leads to knowledge enhancement; i. Environment Science and ii. English/ Hindi/ MIL Communication. All these are mandatory courses for obtaining a B.Sc. degree in the concerned subject. These courses are mandatory for all disciplines. SEC courses are value-based and/ or skill-based and are aimed at providing hands-on-training, competencies, skills *etc*. A minimum of two such courses for obtaining an B.Sc. degree are selected amongst the courses designed to provide value-based and/ or skill-based knowledge and may contain both theory and lab/ hands-on training. The main purpose of these courses is to provide students life-skills in hands-on mode so as to increase their employability.

III. Practical [P] component has been included in every core and discipline/ generic specific elective paper. The list of practicals to be conducted by the candidates has been provided alongside each of such courses. The marks (30 marks) for the practical examination will be split as follows;

Write up of Practical I:	5 marks
Write up of Practical II:	5 marks
Performance of any one of these practicals:	7 marks
Practical record/ notebook:	5 marks
Viva voce:	8 marks

IV. **Classroom Attendance Incentive**: Those candidates who have greater than 75% attendance (for those participating in Co-curricular activities, 25% will be added to per cent attendance) will be awarded CCA marks as follows:

≥ 75% but < 80%	1 marks
≥ 80% but <85%	2 marks
≥ 85 but <90%	3 marks
≥ 90% but < 95%	4 marks
≥ 95% TO 100%	5 marks

V. The admission to B.Sc. Zoology programme of Himachal Pradesh University will be as per guidelines of Himachal Pradesh University, Shimla from time to time.

i. The candidate should have passed 10+2 (class XII) Examination or its equivalent from a recognized Board/University with any of the three subjects out of Physics, Chemistry and Biology or any other science subjects with 50% or equivalent grade (for SC/ST candidates marks of eligibility will be 45% or equivalent grade).

ii. In case of candidates who are studying in University/ Board/ College/ Schools in any of the foreign countries the eligibility/ Qualifying marks will be the same as recognized/equivalent to 10+2 by the University or the association of the Indian University with 50% marks of equivalent grade (for SC/ST candidates, eligibility will be 45% marks or equivalent grade).

iii. The candidate who has appeared in the qualifying examination but whose result has so far not been declared can also apply but his/her eligibility for the entrance test will be purely provisional subject to the condition that he/she has to produced a passing certificate scoring at least the minimum percentage of marks as prescribed for the qualifying examination on the day and the specified time of counseling.

iv. The candidate shall not be more than 22 years of age as on 01st July of the year of admission. Date of birth as recorded in the Secondary Education Board/ University Certificate Only will be considered as authentic.

Details of Courses for B.Sc. Undergraduate Program

Course	*Credits	
	Theory+ Practical	Theory+Tutorials
I. Core Course (6 Credits)	12X4= 48	12X5=60
(12 Papers)		
04 Courses from each of the		
03 disciplines of choice		
Core Course Practical / Tutorial*	12X2=24	12X1=12
(12 Practical/ Tutorials*)		
04 Courses from each of the		
03 Disciplines of choice		
II. Elective Course (6 Credits)	6x4=24	6X5=30
(6 Papers)		
Two papers from each discipline of choice		
including paper of interdisciplinary nature.		
Elective Course Practical / Tutorials*	6 X 2=12	6X1=6
(6 Practical / Tutorials*)		
Two Papers from each discipline of choice including paper of interdisciplinary nature		

- **Optional Dissertation or project work in place of one Discipline elective paper (6 credits) in 6th Semester**

III. Ability Enhancement Courses

1**. Ability Enhancement Compulsory Courses (AECC)**	2 X 4=8	2X4=8
(2 Papers of 4 credits each)		
Environmental Science		
English/Hindi/MIL Communication		
2**. Skill Enhancement Course**	4 X 4=16	4 X 4=16
(Skill Based)		
(4 Papers of 4 credits each)		
	_____	_____
	Total credit= 132	**Total credit= 132**

Institute should evolve a system/policy about ECA/ General Interest/Hobby/Sports/NCC/NSS/related courses on its own. *wherever there is practical there will be no tutorials and vice -versa

SCHEME AND SYLLABUS UNDER CHOICE BASED CREDIT SYSTEM

B.Sc. WITH ZOOLOGY

	CORE COURSE (4) Credits	**Ability Enhancement Compulsory Courses AEC (2) Credits**	**Skill Enhancement Courses SEC (4) Credits**	**Discipline Specific Elective DSE (2) Credits**
I	CC- Zoology I Animal Diversity ZOOL 101 TH 04 ZOOL 101 PR 02	(English/Hindi/MIL Communication)/ Environmental Science 04		
II	CC-Zoology II Compararive Anatomy and Developmental Biology of Vertebrates ZOOL 201 TH 04 ZOOL 201 PR 02	Environmental Science (English/Hindi/MIL Communication) 04		
III	CC-Zoology III Physiology and Biochemistry ZOOL 301 TH 04 ZOOL 301 PR 02		SEC-I Medical Diagnostics ZOOL 302 TH 04	
IV	CC-Zoology IV Genetics and Evolutionary Biology ZOOL 401 TH 04 ZOOL 401 PR 02		SEC-II Apiculture ZOOL 402 TH 04	
V			SEC-III Sericulture ZOOL 502 TH 04	DSE-Zoology I 1.Applied Zoology ZOOL 501 (A) TH 04 ZOOL 501 (A) PR 02 OR 2. Animal Biotechnology ZOOL 501 (B) TH 04 ZOOL 501 (B) PR 02 OR 3. Aquatic Biology ZOOL 501 (C) TH 04 ZOOL 501 (C) PR 02
VI			SEC-IV Aquarium Fish Keeping ZOOL 602 (A) TH 04 **OR** Research Methodology	DSE-Zoology II 1. Insect, Vector and Diseases ZOOL 601 (A) TH 04 ZOOL 601 (A) PR 02

		ZOOL 602 (B) TH 04	OR 2. Immunology ZOOL 601 (B) TH 04 ZOOL 601 (B) PR 02 OR 3. Reproductive Biology ZOOL 601 (C) TH 04 ZOOL 601 (C) PR 02

Discipline Core Courses: Zoology

1. Animal Diversity ZOOL 101 TH ; ZOOL 101 PR
2. Comparative Anatomy and Developmental Biology of Vertebrates ZOOL 201 TH; ZOOL 201 PR
3. Physiology and Biochemistry ZOOL 301 TH; ZOOL 301 PR
4. Genetics and Evolutionary Biology ZOOL 401 TH; ZOOL 401 PR

Discipline Specific Electives: Zoology (Any two)

1. Applied Zoology	ZOOL 501 (A) TH
2. Animal Biotechnology	ZOOL 501 (B) TH
3. Aquatic Biology	ZOOL 501 (C) TH
4. Insect,Vector and Diseases	ZOOL 601 (A) TH
5. Immunology	ZOOL 601 (B) TH
6. Reproductive Biology	ZOOL 601 (C) TH

Skill Enhancement Courses: Zoology

1. Medical Diagonistics	ZOOL 302 TH
2. Apiculture	ZOOL 402 TH
3. Sericulture	ZOOL 502 TH
4. Aquarium Fish Keeping	ZOOL 602 (A) TH
5. Research Methodology	ZOOL 602 (B) TH

CORE COURSE I
ANIMAL DIVERSITY
Code: ZOOL 101 TH

THEORY **(CREDITS 4)**

Unit 1: Kingdom Protista **4**
General characters and classification up to classes; Locomotory Organelles and locomotion in Protozoa

Unit 2: Phylum Porifera **3**
General characters and classification up to classes; Canal System in *Sycon*

Unit 3: Phylum Cnidaria **3**
General characters and classification up to classes; Polymorphism in Hydrozoa

Unit 4: Phylum Platyhelminthes **3**
General characters and classification up to classes; Life history of *Taenia solium*

Unit 5: Phylum Nemathelminthes **5**
General characters and classification up to classes; Life history of *Ascaris lumbricoides* and its parasitic adaptations

Unit 6: Phylum Annelida **3**
General characters and classification up to classes; Metamerism in Annelida

Unit 7: Phylum Arthropoda **5**
General characters and classification up to classes; Vision in Arthropoda, Metamorphosis in Insects

Unit 8: Phylum Mollusca **4**
General characters and classification up to classes; Torsion in gastropods

Unit 9: Phylum Echinodermata **4**
General characters and classification up to classes; Water-vascular system in Asteroidea

Unit 10: Protochordates **2**
General features and Phylogeny of Protochordata

Unit 11: Agnatha **2**
General features of Agnatha and classification of cyclostomes up to classes

Unit 12: Pisces **4**
General features and Classification up to orders; Osmoregulation in Fishes

Unit 13: Amphibia **4**

General features and Classification up to orders; Parental care

Unit 14: Reptiles **4**

General features and Classification up to orders; Poisonous and non-poisonous snakes, Biting mechanism in snakes

Unit 15: Aves **5**

General features and Classification up to orders; Flight adaptations in birds

Unit 17: Mammals **5**

Classification up to orders; Origin of mammals

Note: Classification of Unit 1-9 to be followed from "Barnes, R.D. (1982). *Invertebrate Zoology*, V Edition"

ANIMAL DIVERSITY
Code: ZOOL 101 PR

PRACTICAL **(CREDITS 2)**

1. Study of the following specimens:
Amoeba, Euglena, Plasmodium, Paramecium, Sycon, *Hyalonema,* and *Euplectella, Obelia, Physalia, Aurelia, Tubipora, Metridium, Taenia solium,* Male and female *Ascaris lumbricoides, Aphrodite, Nereis, Pheretima, Hirudinaria, Palaemon, Cancer*, *Limulus*, *Palamnaeus, Scolopendra, Julus*, *Periplaneta*, *Apis, Chiton, Dentalium, Pila, Unio, Loligo, Sepia, Octopus, Pentaceros, Ophiura, Echinus, Cucumaria* and *Antedon, Balanoglossus, Herdmania, Branchiostoma, Petromyzon, Sphyrna, Pristis, Torpedo, Labeo, Exocoetus, Anguilla, Ichthyophis/Ureotyphlus, Salamandra, Bufo, Hyla, Chelone, Hemidactylus, Chamaeleon, Draco, Vipera, Naja, Crocodylus, Gavialis,* Any six common birds from different orders, *Sorex,* Bat, *Funambulus, Loris*

2. Study of the following permanent slides:
T.S. and L.S. of *Sycon*, Study of life history stages of *Taenia,* T.S. of Male and female *Ascaris*

3. Key for Identification of poisonous and non-poisonous snakes

An "**animal album**" containing photographs, cut outs, with appropriate write up about the above mentioned taxa. Different taxa/ topics may be given to different sets of students for this purpose.

SUGGESTED READINGS

- Ruppert and Barnes, R.D. (2006). *Invertebrate Zoology*, VIII Edition. Holt Saunders International Edition.
- Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). *The Invertebrates: A New Synthesis*, III Edition, Blackwell Science
- Young, J. Z. (2004). *The Life of Vertebrates*. III Edition. Oxford university press.
- Pough H. *Vertebrate life,* VIII Edition, Pearson International.
- Hall B.K. and Hallgrimsson B. (2008). *Strickberger's Evolution*. IV Edition. Jones and Bartlett Publishers Inc.

CORE COURSE II

COMPARATIVE ANATOMY AND DEVELOPMENTAL BIOLOGY OF VERTEBRATES

Code: ZOOL 201 TH

THEORY **(CREDITS 4)**

Unit 1: Integumentary System **4**
Derivatives of integument w.r.t. glands and digital tips

Unit 2: Skeletal System **3**
Evolution of visceral arches

Unit 3: Digestive System **4**
Brief account of alimentary canal and digestive glands

Unit 4: Respiratory System **5**
Brief account of Gills, lungs, air sacs and swim bladder

Unit 5: Circulatory System **4**
Evolution of heart and aortic arches

Unit 6: Urinogenital System **4**
Succession of kidney, Evolution of urinogenital ducts

Unit 7: Nervous System **3**
Comparative account of brain

Unit 8: Sense Organs **3**
Types of receptors

Unit 9: Early Embryonic Development **12**
Gametogenesis: Spermatogenesis and oogenesis w.r.t. mammals, vitellogenesis in birds; Fertilization: external (amphibians), internal (mammals), blocks to polyspermy; Early development of frog and humans (structure of mature egg and its membranes, patterns of cleavage, fate map, up to formation of gastrula);types of morphogenetic movements; Fate of germ layers; Neurulation in frog embryo.

Unit 10: Late Embryonic Development **10**
Implantation of embryo in humans, Formation of human placenta and functions, other types of placenta on the basis of histology; Metamorphic events in frog life cycle and its hormonal regulation.

Unit 11: Control of Development **8**

Fundamental processes in development (brief idea) – Gene activation, determination, induction, Differentiation, morphogenesis, intercellular communication, cell movements and cell death.

COMPARATIVE ANATOMY AND DEVELOPMENTAL BIOLOGY OF VERTEBRATES

Code: ZOOL 201 PR

PRACTICAL (CREDITS 2)

1. Osteology:
   a) Disarticulated skeleton of fowl and rabbit
   b) Carapace and plastron of turtle /tortoise
   c) Mammalian skulls: One herbivorous and one carnivorous animal.

2. Frog - Study of developmental stages - whole mounts and sections through permanent slides – cleavage stages, blastula, gastrula, neurula, tail bud stage, tadpole external and internal gill stages.

3. Study of the different types of placenta- histological sections through permanent slides or photomicrographs.

4. Study of placental development in humans by ultrasound scans.

5. Examination of gametes - frog/rat - sperm and ova through permanent slides or photomicrographs.

SUGGESTED READINGS

- Kardong, K.V. (2005) *Vertebrates' Comparative Anatomy, Function and Evolution*. IV Edition. McGraw-Hill Higher Education.
- Kent, G.C. and Carr R.K. (2000). *Comparative Anatomy of the Vertebrates*. IX Edition. The McGraw-Hill Companies.
- Hilderbrand, M and Gaslow G.E. *Analysis of Vertebrate Structure*, John Wiley and Sons.
- Walter, H.E. and Sayles, L.P; *Biology of Vertebrates*, Khosla Publishing House.
- Gilbert, S. F. (2006). Developmental Biology, VIII Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.
- Balinsky, B.I. (2008). An introduction to Embryology, International Thomson Computer Press.
- Carlson, Bruce M (1996). Patten's Foundations of Embryology, McGraw Hill, Inc.

CORE COURSE III
PHYSIOLOGY AND BIOCHEMISTRY
Code: ZOOL 301 TH

THEORY (CREDITS 4)

Unit 1: Nerve and muscle **8**
Structure of a neuron, Resting membrane potential, Graded potential, Origin of Action potential and its propagation in myelinated and non-myelinated nerve fibres, Ultra-structure of skeletal muscle, Molecular and chemical basis of muscle contraction

Unit 2: Digestion **5**
Physiology of digestion in the alimentary canal; Absorption of carbohydrates, proteins, lipids

Unit 3: Respiration **5**
Pulmonary ventilation, Respiratory volumes and capacities, Transport of Oxygen and carbon dioxide in blood

Unit 4: Excretion **5**
Structure of nephron, Mechanism of Urine formation, Counter-current Mechanism

Unit 5: Cardiovascular system **6**
Composition of blood, Hemostasis, Structure of Heart, Origin and conduction of the cardiac impulse, Cardiac cycle

Unit 6: Reproduction and Endocrine Glands **7**
Physiology of male reproduction: hormonal control of spermatogenesis; Physiology of female reproduction: hormonal control of menstrual cycle
Structure and function of pituitary, thyroid, Parathyroid, pancreas and adrenal

Unit 7: Carbohydrate Metabolism **8**
Glycolysis, Krebs Cycle, Pentose phosphate pathway, Gluconeogenesis, Glycogen metabolism, Review of electron transport chain

Unit 8: Lipid Metabolism **5**
Biosynthesis and β oxidation of palmitic acid

Unit 9: Protein metabolism **5**
Transamination, Deamination and Urea Cycle

Unit 10: Enzymes **6**
Introduction, Mechanism of action, Enzyme Kinetics, Inhibition and Regulation

PHYSIOLOGY AND BIOCHEMISTRY

Code: ZOOL 301 PR

PRACTICAL(CREDITS 2)

1. Preparation of hemin and hemochromogen crystals
2. Study of permanent histological sections of mammalian pituitary, thyroid, pancreas, adrenal gland
3. Study of permanent slides of spinal cord, duodenum, liver, lung, kidney, bone, cartilage
4. Qualitative tests to identify functional groups of carbohydrates in given solutions (Glucose, Fructose, Sucrose, Lactose).
5. Estimation of total protein in given solutions by Lowry's method.
6. Study of activity of salivary amylase under optimum conditions

SUGGESTED READINGS

- Tortora, G.J. and Derrickson, B.H. (2009). *Principles of Anatomy and Physiology*, XII Edition, John Wiley & Sons, Inc.
- Widmaier, E.P., Raff, H. and Strang, K.T. (2008) *Vander's Human Physiology*, XI Edition., McGraw Hill
- Guyton, A.C. and Hall, J.E. (2011). T*extbook of Medical Physiology*, XII Edition, Harcourt Asia Pvt. Ltd/ W.B. Saunders Company
- Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). *Biochemistry*. VI Edition. W.H Freeman and Co.
- Nelson, D. L., Cox, M. M. and Lehninger, A.L. (2009). *Principles of Biochemistry*. IV Edition. W.H. Freeman and Co.
- Murray, R.K., Granner, D.K., Mayes, P.A. and Rodwell, V.W. (2009). *Harper's Illustrated Biochemistry*. XXVIII Edition. Lange Medical Books/Mc Graw3Hill.

CORE COURSE IV
GENETICS AND EVOLUTIONARY BIOLOGY
Code: ZOOL 401 TH

THEORY **(CREDITS 4)**

Unit 1: Introduction to Genetics **3**
Mendel's work on transmission of traits, Genetic Variation, Molecular basis of Genetic Information

Unit 2: Mendelian Genetics and its Extension **8**
Principles of Inheritance, Chromosome theory of inheritance, Incomplete dominance and co-dominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, sex linked inheritance, extra-chromosomal inheritance

Unit 3: Linkage, Crossing Over and Chromosomal Mapping **9**
Linkage and crossing over, Recombination frequency as a measure of linkage intensity, two factor and three factor crosses, Interference and coincidence, Somatic cell genetics - an alternative approach to gene mapping

Unit 4: Mutations **7**
Chromosomal Mutations: Deletion, Duplication, Inversion, Translocation, Aneuploidy and Polyploidy; Gene mutations: Induced versus Spontaneous mutations, Back versus Suppressor mutations,

Unit 5: Sex Determination **2**
Chromosomal mechanisms, dosage compensation

Unit 6: History of Life **2**
Major Events in History of Life

Unit 7: Introduction to Evolutionary Theories **4**
Lamarckism, Darwinism, Neo-Darwinism

Unit 8: Direct Evidences of Evolution **4**
Types of fossils, Incompleteness of fossil record, Dating of fossils, Phylogeny of horse

Unit 9: Processes of Evolutionary Change **8**
Organic variations; Isolating Mechanisms; Natural selection (Example: Industrial melanism); Types of natural selection (Directional, Stabilizing, Disruptive), Artificial selection

Unit 10: Species Concept **5**

Biological species concept (Advantages and Limitations); Modes of speciation (Allopatric, Sympatric)

Unit 11: Macro-evolution **4**

Macro-evolutionary Principles (example: Darwin's Finches)

Unit 12: Extinction **4**

Mass extinction (Causes, Names of five major extinctions, K-T extinction in detail), Role of
extinction in evolution

GENETICS AND EVOLUTIONARY BIOLOGY

Code: ZOOL 401 PR

PRACTICAL **(CREDITS 2)**

1. Study of Mendelian Inheritance and gene interactions (Non Mendelian Inheritance) using suitable examples. Verify the results using Chi-square test.
2. Study of Linkage, recombination, gene mapping using the data.
3. Study of Human Karyotypes (normal and abnormal).
4. Study of fossil evidences from plaster cast models and pictures
5. Study of homology and analogy from suitable specimens/ pictures
6. Charts:
   a) Phylogeny of horse with diagrams/ cut outs of limbs and teeth of horse ancestors
   b) Darwin's Finches with diagrams/ cut outs of beaks of different species
7. Visit to Natural History Museum and submission of report

SUGGESTED READINGS

- Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). *Principles of Genetics*. VIII Edition. Wiley India.
- Snustad, D.P., Simmons, M.J. (2009). *Principles of Genetics*. V Edition. John Wiley and Sons Inc.
- Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). *Concepts of Genetics*. X Edition. Benjamin Cummings.
- Russell, P. J. (2009). *Genetics- A Molecular Approach.* III Edition. Benjamin Cummings.
- Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. *Introduction to Genetic Analysis*. IX Edition. W. H. Freeman and Co.
- Ridley, M. (2004). *Evolution*. III Edition. Blackwell Publishing
- Barton, N. H., Briggs, D. E. G., Eisen, J. A., Goldstein, D. B. and Patel, N. H. (2007). *Evolution*. Cold Spring, Harbour Laboratory Press.
- Hall, B. K. and Hallgrimsson, B. (2008). *Evolution*. IV Edition. Jones and Bartlett Publishers
- Campbell, N. A. and Reece J. B. (2011). *Biology*. IX Edition, Pearson, Benjamin, Cummings.
- Douglas, J. Futuyma (1997). *Evolutionary Biology*. Sinauer Associates.

DISCIPLINE CENTRIC ELECTIVE COURSES

DSE 1

ANIMAL BIOTECHNOLOGY

Code: ZOOL 501 (B) TH

THEORY **(Credits 4)**

Unit 1: Introduction **8**

Concept and scope of biotechnology

Unit 2: Molecular Techniques in Gene manipulation **24**

Cloning vectors: Plasmids, Cosmids, Phagemids, Lambda Bacteriophage, M13, BAC, YAC, MAC and Expression vectors (characteristics)

Restriction enzymes: Nomenclature, detailed study of Type II

Transformation techniques: Calcium chloride method and electroporation.

Construction of genomic and cDNA libraries and screening by colony and plaque hybridization

Southern, Northern and Western blotting; DNA sequencing: Sanger method

Polymerase Chain Reaction, DNA Finger Printing and DNA micro array

Unit 3: Genetically Modified Organisms **18**

Production of cloned and transgenic animals: Nuclear Transplantation, Retroviral Method, DNA microinjection

Applications of transgenic animals: Production of pharmaceuticals, production of donor organs, knockout mice.

Production of transgenic plants: *Agrobacterium* mediated transformation.

Applications of transgenic plants: insect and herbicide resistant plants.

Unit 4: Culture Techniques and Applications **10**

Animal cell culture, Expressing cloned genes in mammalian cells, Molecular diagnosis of genetic diseases (Cystic fibrosis, Sickle cell anemia)

Recombinant DNA in medicines: Recombinant insulin and human growth hormone, Gene therapy

ANIMAL BIOTECHNOLOGY
Code: ZOOL 501 (B) PR

PRACTICAL **(Credits 2)**

1. Genomic DNA isolation from *E. coli*
2. Plasmid DNA isolation (pUC 18/19) from *E. coli*
3. Restriction digestion of plasmid DNA.
4. Construction of circular and linear restriction map from the data provided.
5. Calculation of transformation efficiency from the data provided.
6. To study following techniques through photographs

   a) Southern Blotting

   b) Northern Blotting

   c) Western Blotting

   d) DNA Sequencing (Sanger's Method)

   e) PCR

   f) DNA fingerprinting
7. Project report on animal cell culture

SUGGESTED READINGS

- Brown, T.A. (1998). *Molecular Biology Labfax II: Gene Cloning and DNA Analysis*. II Edition, Academic Press, California, USA.
- Glick, B.R. and Pasternak, J.J. (2009). *Molecular Biotechnology - Principles and Applications of Recombinant DNA*. IV Edition, ASM press, Washington, USA.
- Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M. (2009). *An Introduction to Genetic Analysis*. IX Edition. Freeman and Co., N.Y., USA.
- Snustad, D.P. and Simmons, M.J. (2009). *Principles of Genetics.* V Edition, John Wiley and Sons Inc.
- Watson, J.D., Myers, R.M., Caudy, A. and Witkowski, J.K. (2007). *Recombinant DNA-Genes and Genomes- A Short Course*. III Edition, Freeman and Co., N.Y., USA.
- Beauchamp, T.I. and Childress, J.F. (2008). *Principles of Biomedical Ethics.* VI Edition, Oxford University Press.

DSE 2
APPLIED ZOOLOGY
ZOOL 501(A) TH

THEORY **(CREDITS 4)**

Unit 1: Introduction to Host-parasite Relationship **3**
Host, Definitive host, Intermediate host, Parasitism, Symbiosis, Commensalism, Reservoir, Zoonosis

Unit 2: Epidemiology of Diseases **7**
Transmission, Prevention and control of diseases: Tuberculosis, typhoid

Unit 3: Rickettsiae and Spirochaetes **6**
Brief account of *Rickettsia prowazekii*, *Borrelia recurrentis* and *Treponema pallidum*

Unit 4: Parasitic Protozoa **8**
Life history and pathogenicity of *Entamoeba histolytica*, *Plasmodium vivax* and *Trypanosoma gambiense*

Unit 5: Parasitic Helminthes **5**
Life history and pathogenicity of *Ancylostoma duodenale* and *Wuchereria bancrofti*

Unit 6: Insects of Economic Importance **8**
Biology, Control and damage caused by *Helicoverpa armigera*, *Pyrilla perpusilla* and *Papilio demoleus*, *Callosobruchus chinensis*, *Sitophilus oryzae* and *Tribolium castaneum*

Unit 7: Insects of Medical Importance **8**
Medical importance and control of *Pediculus humanus corporis*, *Anopheles, Culex, Aedes*, *Xenopsylla cheopis*

Unit 8: Animal Husbandry **5**
Preservation and artificial insemination in cattle; Induction of early puberty and synchronization of estrus in cattle

Unit 9: Poultry Farming **5**
Principles of poultry breeding, Management of breeding stock and broilers, Processing and preservation of eggs

Unit 10: Fish Technology **5**
Genetic improvements in aquaculture industry; Induced breeding and transportation of fish see

APPLIED ZOOLOGY

Code: ZOOL 501 (A) PR

PRACTICAL **(CREDITS 2)**

1. Study of *Plasmodium vivax*, *Entamoeba histolytica, Trypanosoma gambiense, Ancylostoma duodenale* and *Wuchereria bancrofti* and their life stages through permanent slides/photomicrographs or specimens.
2. Study of arthropod vectors associated with human diseases: *Pediculus, Culex, Anopheles, Aedes* and *Xenopsylla.*
3. Study of insect damage to different plant parts/stored grains through damaged products/photographs.
4. Identifying feature and economic importance of *Helicoverpa* (*Heliothis*) *armigera*, *Papilio demoleus, Pyrilla perpusilla, Callosobruchus chinensis, Sitophilus oryzae* and *Tribolium castaneum*
5. Visit to poultry farm or animal breeding centre. Submission of visit report
6. Maintenance of freshwater aquarium

SUGGESTED READINGS

- Park, K. (2007). *Preventive and Social Medicine*. XVI Edition. B.B Publishers.
- Arora, D. R and Arora, B. (2001). *Medical Parasitology*. II Edition. CBS Publications and Distributors.
- Kumar and Corton. *Pathological Basis of Diseases*.
- Atwal, A.S. (1986). *Agricultural Pests of India and South East Asia*, Kalyani Publishers.
- Dennis, H. (2009). *Agricultural Entomology.* Timber Press (OR).
- Hafez, E. S. E. (1962). *Reproduction in Farm Animals*. Lea & Fabiger Publisher
- Dunham R.A. (2004). *Aquaculture and Fisheries Biotechnology Genetic Approache*s. CABI publications, U.K.
- Pedigo, L.P. (2002). *Entomology and Pest Management*, Prentice Hall.

DSE 3

AQUATIC BIOLOGY

Code: ZOOL 501 (C) TH

THEORY **(Credits 4)**

UNIT 1: Aquatic Biomes **15**

Brief introduction of the aquatic biomes: Freshwater ecosystem (lakes, wetlands, streams and rivers), estuaries, intertidal zones, oceanic pelagic zone, marine benthic zone and coral reefs.

UNIT 2: Freshwater Biology **20**

Lakes: Origin and classification, Lake as an Ecosystem, Lake morphometry, Physico–chemical Characteristics: Light, Temperature, Thermal stratification, Dissolved Solids, Carbonate, Bicarbonates, Phosphates and Nitrates, Turbidity; dissolved gases (Oxygen, Carbon dioxide). Nutrient Cycles in Lakes-Nitrogen, Sulphur and Phosphorous.

Streams: Different stages of stream development, Physico-chemical environment, Adaptation of hill-stream fishes.

UNIT 3: Marine Biology **10**

Salinity and density of Sea water, Continental shelf, Adaptations of deep sea organisms, Coral reefs, Sea weeds.

UNIT 4: Management of Aquatic Resources **15**

Causes of pollution: Agricultural, Industrial, Sewage, Thermal and Oil spills,

Eutrophication, Management and conservation (legislations), Sewage

treatment Water quality assessment- BOD and COD.

AQUATIC BIOLOGY

Code: ZOOL 501 (C) PR

PRACTICAL **(Credits 2)**

1. Determine the area of a lake using graphimetric and gravimetric method.
2. Identify the important macrophytes, phytoplanktons and zooplanktons present in a lake ecosystem.
3. Determine the amount of Turbidity/transparency, Dissolved Oxygen, Free Carbon dioxide, Alkalinity (carbonates & bicarbonates) in water collected from a nearby lake/ water body.
4. Instruments used in limnology (Secchi disc, Van Dorn Bottle, Conductivity meter, Turbidity meter, PONAR grab sampler) and their significance.
5. A Project Report on a visit to a Sewage treatment plant/Marine bio-reserve/Fisheries Institutes.

SUGGESTED READINGS

- **Anathakrishnan** : Bioresources Ecology 3rd Edition
- **Goldman** : Limnology, 2nd Edition
- **Odum and Barrett** : Fundamentals of Ecology, 5th Edition
- **Pawlowski** : Physicochemical Methods for Water and Wastewater Treatment, 1st Edition
- **Wetzel** : Limnology, 3rd edition
- **Trivedi and Goyal** : Chemical and biological methods for water pollution studies
- **Welch** : Limnology Vols. I-II

DSE 4
INSECT, VECTORS AND DISEASES
ZOOL 601(A) TH

THEORY **(Credits 4)**

Unit I: Introduction to Insects **6**
General Features of Insects, Morphological features, Head – Eyes, Types of antennae, Mouth parts w.r.t. feeding habits

Unit II: Concept of Vectors **6**
Brief introduction of Carrier and Vectors (mechanical and biological vector), Reservoirs, Host-vector relationship, Vectorial capacity, Adaptations as vectors, Host Specificity

Unit III: Insects as Vectors **8**
Classification of insects up to orders, detailed features of orders with insects as vectors – Diptera, Siphonaptera, Siphunculata, Hemiptera

Unit IV: Dipteran as Disease Vectors **24**
Dipterans as important insect vectors – Mosquitoes, Sand fly, Houseflies;
Study of mosquito-borne diseases – Malaria, Dengue, Chikungunya, Viral encephalitis, Filariasis; Control of mosquitoes Study of sand fly-borne diseases – Visceral Leishmaniasis, Cutaneous Leishmaniasis, Phlebotomus fever; Control of Sand fly Study of house fly as important mechanical vector, Myiasis, Control of house fly

Unit IV: Siphonaptera as Disease Vectors **6**
Fleas as important insect vectors; Host-specificity, Study of Flea-borne diseases – Plague, Typhus fever; Control of fleas

Unit V: Siphunculata as Disease Vectors **4**
Human louse (Head, Body and Pubic louse) as important insect vectors; Study of louse-borne diseases –Typhus fever, Relapsing fever, Trench fever, Vagabond's disease, Phthiriasis; Control of human louse

Unit VI: Hempitera as Disease Vectors **6**
Bugs as insect vectors; Blood-sucking bugs; Chagas disease, Bed bugs as mechanical vectors,Control and prevention measures

INSECT VECTORS AND DISEASES

Code: ZOOL 601 (A) PR

PRACTICAL **(CREDITS 2)**

1. Study of different kinds of mouth parts of insects
2. Study of following insect vectors through permanent slides/ photographs: *Aedes, Culex, Anopheles, Pediculus humanus capitis, Pediculus humanus corporis, Phithirus pubis, Xenopsylla cheopis, Cimex lectularius, Phlebotomus argentipes, Musca domestica,* through permanent slides/ photographs
3. Study of different diseases transmitted by above insect vectors

Submission of a project report on any one of the insect vectors and disease transmitted

SUGGESTED READINGS

- Imms, A.D. (1977). *A General Text Book of Entomology*. Chapman & Hall, UK
- Chapman, R.F. (1998). *The Insects: Structure and Function.* IV Edition, Cambridge University Press, UK
- Pedigo L.P. (2002). *Entomology and Pest Management.* Prentice Hall Publication
- Mathews, G. (2011). *Integrated Vector Management: Controlling Vectors of Malaria and Other Insect Vector Borne Diseases*. Wiley-Blackwell

DSE 5
IMMUNOLOGY
ZOOL 601(B) TH

THEORY **(CREDITS 4)**

Unit 1: **Overview of the Immune System** **10**
Introduction to basic concepts in immunology, components of immune system, principles of innate and adaptive immune system

Unit 2: **Cells and Organs of the Immune System** **8**
Haematopoeisis, Cells of immune system and organs (primary and secondary lymphoid organs) of the immune system

Unit 3: Antigens **8**
Basic properties of antigens, B and T cell epitopes, haptens and adjuvants

Unit 4: **Antibodies** **8**
Structure, classes and function of antibodies, monoclonal antibodies, antigen antibody interactions as tools for research and diagnosis

Unit 5: **Working of the immune system** **12**
Structure and functions of MHC, exogenous and endogenous pathways of antigen presentation and processing, Basic properties and functions of cytokines, Complement system: Components and pathways.

Unit 6: **Immune system in health and disease** **10**
Gell and Coombs' classification and brief description of various types of hypersensitivities, Introduction to concepts of autoimmunity and immunodeficiency,

Unit 7: Vaccines **4**
General introduction to vaccines, Various types of vaccines

IMMUNOLOGY
ZOOL 601(B) PR

PRACTICAL **(CREDITS 2)**

1*. Demonstration of lymphoid organs
2. Histological study of spleen, thymus and lymph nodes through slides/ photographs
3. Preparation of stained blood film to study various types of blood cells.
4. Ouchterlony's double immuno-diffusion method.
5. ABO blood group determination.
6*. Cell counting and viability test from splenocytes of farm bred animals/cell lines.
7. Demonstration of
   a) ELISA
   b) Immunoelectrophoresis

(*Subject to UGC guidelines)

SUGGESTED READINGS

- Kindt, T. J., Goldsby, R.A., Osborne, B. A. and Kuby, J (2006). *Immunology*, VI Edition. W.H. Freeman and Company.

- David, M., Jonathan, B., David, R. B. and Ivan R. (2006). *Immunology,* VII Edition, Mosby, Elsevier Publication.

- Abbas, K. Abul and Lechtman H. Andrew (2003.) *Cellular and Molecular Immunology*. V Edition. Saunders Publication.

DSE 6

REPRODUCTIVE BIOLOGY

Code: ZOOL 601 (C) TH

THEORY **(CREDITS 4)**

Unit 1: Reproductive Endocrinology 15

Gonadal hormones and mechanism of hormone action, steroids, glycoprotein hormones, and prostaglandins, hypothalamo – hypophyseal – gonadal axis, regulation of gonadotrophin secretion in male and female; Reproductive System: Development and differentiation of gonads, genital ducts, external genitalia, mechanism of sex differentiation.

Unit 2: Functional anatomy of male reproduction 15

Outline and histological of male reproductive system in rat and human; Testis: Cellular functions, germ cell, system cell renewal; Spermatogenesis: kinetics and hormonal regulation; Androgen synthesis and metabolism; Epididymal function and sperm maturation; Accessory glands functions; Sperm transportation in male tract

Unit 3: Functional anatomy of female reproduction 20

Outline and histological of female reproductive system in rat and human; Ovary: folliculogenesis, ovulation, corpus luteum formation and regression; Steroidogenesis and secretion of ovarian hormones; Reproductive cycles (rat and human) and their regulation, changes in the female tract; Ovum transport in the fallopian tubes; Sperm transport in the female tract, fertilization; Hormonal control of implantation; Hormonal regulation of gestation, pregnancy diagnosis, foeto – maternal relationship; Mechanism of parturition and its hormonal regulation; Lactation and its regulation

Unit 4: Reproductive Health 10

Infertility in male and female: causes, diagnosis and management; Assisted Reproductive Technology: sex selection, sperm banks, frozen embryos, in vitro fertilization, ET, EFT, IUT, ZIFT, GIFT, ICSI, PROST; Modern contraceptive technologies; Demographic terminology used in family planning

REPRODUCTIVE BIOLOGY

Code: ZOOL 601 (C) PR

PRACTICAL **(CREDITS 2)**

1. Study of animal house: set up and maintenance of animal house, breeding techniques, care of normal and experimental animals.
2. Examination of vaginal smear rats from live animals.
3. Surgical techniques: principles of surgery in endocrinology. Ovarectomy, hysterectorny, castration and vasectomy in rats.
4. Examination of histological sections from photomicrographs/ permanent slides of rat/human: testis, epididymis and accessory glands of male reproductive systems; Sections of ovary, fallopian tube, uterus (proliferative and secretory stages), cervix and vagina.
5. Human vaginal exfoliate cytology.
6. Sperm count and sperm motility in rat
7. Study of modern contraceptive devices

SUGGESTED READINGS

- Austin, C.R. and Short, R.V. reproduction in Mammals. Cambridge University Press.
- Degroot, L.J. and Jameson, J.L. (eds). Endocrinology. W.B. Saunders and Company.
- Knobil, E. et al. (eds). The Physiology of Reproduction. Raven Press Ltd.
- Hatcher, R.A. et al. The Essentials of Contraceptive Technology. Population Information Programme.

SKILL ENHANCEMENT COURSES

SEC 1
MEDICAL DIAGNOSTICS

Code: ZOOL 302 TH

THEORY **(Credits 4)**
(3+01)

Unit 1: Introduction to Medical Diagnostics and its Importance **2**

Unit 2: Diagnostics Methods Used for Analysis of Blood **15**

Blood composition, Preparation of blood smear and Differential Leucocyte Count (D.L.C) using Leishman's stain, Platelet count using haemocytometer, Erythrocyte Sedimentary Rate (E.S.R), Packed Cell Volume (P.C.V.)

Unit 3: Diagnostic Methods Used for Urine Analysis **6**

Urine Analysis: Physical characteristics; Abnormal constituents

Unit 4:Non-infectious Diseases **10**

Causes, types, symptoms, complications, diagnosis and prevention of Diabetes (Type I and Type II), Hypertension (Primary and secondary), Testing of blood glucose using Glucometer/Kit

Unit 5: Infectious Diseases **6**

Causes, types, symptoms, diagnosis and prevention of Tuberculosis and Hepatitis

Unit 6: Tumours **6**

Types (Benign/Malignant), Detection and metastasis; Medical imaging: X-Ray of Bone fracture, PET, MRI and CT Scan (using photographs).

SUGGESTED READINGS

- Park, K. (2007), *Preventive and Social Medicine*, B.B. Publishers
- Godkar P.B. and Godkar D.P. *Textbook of Medical Laboratory Technology*, II Edition, Bhalani Publishing House
- Cheesbrough M., *A Laboratory Manual for Rural Tropical Hospitals, A Basis for Training Courses*
- Guyton A.C. and Hall J.E. T*extbook of Medical Physiology*, Saunders
- Robbins and Cortan, *Pathologic Basis of Disease*, VIIIEdition, Saunders
- Prakash, G. (2012), *Lab Manual on Blood Analysis and Medical Diagnostics*, S. Chand and Co. Ltd.

Tutorial – 01 Credit

SEC 2
APICULTURE
ZOOL 402 TH

(CREDIT 4)
(3+01)

Unit 1: Biology of Bees **(10)**
History, Classification and Biology of Honey Bees
Social Organization of Bee Colony

Unit 2: Rearing of Bees **(15)**
Artificial Bee rearing (Apiary), Beehives – Newton and Langstroth
Bee Pasturage
Selection of Bee Species for Apiculture
Bee Keeping Equipment
Methods of Extraction of Honey (Indigenous and Modern)

Unit 3: Diseases and Enemies **(8)**
Bee Diseases and Enemies
Control and Preventive measures

Unit 4: Bee Economy **(6)**
Products of Apiculture Industry and its Uses (Honey, Bees Wax, Propolis), Pollen Etc

Unit 5: Entrepreneurship in Apiculture **(6)**
Bee Keeping Industry – Recent Efforts, Modern Methods in employing artificial Beehives for cross pollination in horticultural gardens

SUGGESTED READINGS

- Prost, P. J. (1962). *Apiculture*. Oxford and IBH, New Delhi.
- Bisht D.S., *Apiculture*, ICAR Publication.

Tutorial – 01 Credit

SEC - 3

SERICULTURE
Code: ZOOL 502 TH (CREDITS 4)

Unit 1: Introduction **(8)**

Sericulture: Definition, history and present status; Silk route

Types of silkworms, Distribution and Races
Exotic and indigenous races
Mulberry and non-mulberry Sericulture

Unit 2: Biology of Silkworm **(6)**
Life cycle of *Bombyx mori*
Structure of silk gland and secretion of silk

Unit 3: Rearing of Silkworms **(15)**
Selection of mulberry variety and establishment of mulberry garden
Rearing house and rearing appliances
Disinfectants: Formalin, bleaching powder, RKO
Silkworm rearing technology: Early age and Late age rearing
Types of mountages
Spinning, harvesting and storage of cocoons

Unit 4: Pests and Diseases **(10)**
Pests of silkworm: Uzi fly, dermestid beetles and vertebrates
Pathogenesis of silkworm diseases: Protozoan, viral, fungal and bacterial
Control and prevention of pests and diseases

Unit 5: Entrepreneurship in Sericulture **(6)**
Prospectus of Sericulture in India: Sericulture industry in different states, employment, potential in mulberry and non-mulberry sericulture. Visit to various sericulture centres.

SUGGESTED READINGS

- Handbook of Practical Sericulture: S.R. Ullal and M.N. Narasimhanna CSB, Bangalore
- Appropriate Sericultural Techniques; Ed. M. S. Jolly, Director, CSR & TI, Mysore.
- Handbook of Silkworm Rearing: Agriculture and Technical Manual-1, Fuzi Pub. Co. Ltd., Tokyo, Japan1972.
- Manual of Silkworm Egg Production; M. N. Narasimhanna, CSB, Bangalore 1988.
- Silkworm Rearing; Wupang—Chun and Chen Da-Chung, Pub. By FAO, Rome 1988.
- A Guide for Bivoltine Sericulture; K. Sengupta, Director, CSR & TI, Mysore 1989.
- Improved Method of Rearing Young age silkworm; S. Krishnaswamy, reprinted CSB, Bangalore, 1986.

Tutorial – 01 Credit

SEC – 4

AQUARIUM FISH KEEPING

Code: ZOOL 602 (A) TH (CREDITS 4)
(3+01)

Unit1: Introduction to Aquarium Fish Keeping 10

The potential scope of Aquarium Fish Industry as a Cottage Industry, Exotic and Endemic species of Aquarium Fishes

Unit 2: Biology of Aquarium Fishes 15

Common characters and sexual dimorphism of Fresh water and Marine Aquariumfishes such as Guppy, Molly, Sword tail, Gold fish, Angel fish, Blue morph, Anemone fish and Butterfly fish

Unit 3: Food and feeding of Aquarium fishes 6

Use of live fish feed organisms. Preparation and composition of formulated fish feeds

Unit 4: Fish Transportation 8

Live fish transport - Fish handling, packing and forwarding techniques.

Unit 5: Maintenance of Aquarium 6

General Aquarium maintenance – budget for setting up an Aquarium Fish Farm as a Cottage Industry

SUGGESTED READINGS

- Mary Bailey, Gina Sandford; *The Complete Guide to Aquarium Fish Keeping (Practical Handbook)* Publishers: Lorenz Books
- Mills, Dick; *Keeping Aquarium Fish (Teach Yourself General)* Publisher : Teach Yourself

Tutorial – 01 Credit

SEC - 5

RESEARCH METHODOLOGY

Code: ZOOL 602 (B) TH **(CREDITS 4)**
(3+01)

Unit 1: Foundations of Research **8**

Meaning, Objectives, Motivation: Research Methods *vs* Methodology, Types of Research: Analytical *vs* Descriptive, Quantitative *vs* Qualitative, Basic *vs* Applied

Unit 2: Research Design **15**

Need for research design: Features of good design, Important concepts related to good design- Observation and Facts, Prediction and Explanation, Development of Models. Developing a research plan: Problem identification, Experimentation, Determining experimental and sample designs

Unit 3: Data Collection, Analysis and Report Writing **15**

Observation and Collection of Data-Methods of data collection- Sampling Methods, Data Processing and Analysis Strategies, Technical Reports and Thesis writing, Preparation of Tables and Bibliography. Data Presentation using digital technology

Unit 4: Ethical Issues **7**

Intellectual property Rights, Commercialization, Copy Right, Royalty, Patent law, Plagiarism, Citation, Acknowledgement

SUGGESTED READINGS

- Anthony, M, Graziano, A.M. and Raulin, M.L. 2009. Research Methods: A Process of Inquiry, Allyn and Bacon.
- Walliman, N. 2011.Research Methods- The Basics. Taylor and Francis, London, New York.
- Wadhera, B.L.: Law Relating to Patents, Trade Marks, Copyright Designs and Geographical Indications, 2002, Universal Law publishing
- C.R.Kothari: Research Methodology, New Age International, 2009
- Coley, S.M. and Scheinberg, C.A. 1990, "Proposal writing". Stage Publications.

Tutorial – 01 Credit

END SEMESTER EXAMINATION (ESE) OF ZOOLOGY IN B.Sc. PROGRAMME
THEORY EXAMINATION

SCHEME OF EXAMINATION

1. English shall be the medium of instruction and examination.
2. Examinations shall be conducted at the end of each semester as per the Academic Calendar notified by Himachal Pradesh University.
3. Each course will carry **100 marks** and will have following components

1.	**Theory Paper End-Semester examination**	**50 marks**
2.	**Practicals**	**30 marks**
3.	**Internal Assessment**	**20 Marks**
Theory Paper + Practicals + Internal Assessment		**(50+30+ 20) =100 marks**

Scheme of Examination for every course (Core Course, Discipline Specific Elective Course, Generic Elective Course):

End Semester Examination	50 marks	Time 3 hrs
Practical for every course	30 marks	Time 3 hrs
Internal Assessment	20 Marks	

Skill Enhancement Course & Ability Enhancement Compulsory Course:

Theory Paper End Semester Examination	100 marks