

H.P. University, Summerhill, Shimla

Structure and Syllabus

of

Zoology Honours

for

B.Sc. Undergraduate Programme

Based on:

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

Model Curriculum

(Effective from academic session July, 2016)

B.Sc. (Honours) Zoology

GENERAL INSTRUCTIONS/ GUIDELINES FOR EXECUTION OF CURRICULUM

I. The B.Sc. (Honours) 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. (Honours) Zoology degree program.

1. The **Core Courses** (14 courses for honours; 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 $14 \times 6 = 84$ 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 $14 \times 6 = 84$ credits could be accumulated under these courses during the Honours 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 $4 \times 6 = 24$ credits could be accumulated under DSE courses during the Honours 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 $4 \times 6 = 24$ credits could be accumulated under GE courses during the Honours 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 $4 \times 4 = 16$ credits could be accumulated under these courses during the Honours degree program *i.e.* $4 \times 2 = 8$ credits for AECC, and $4 \times 2 = 8$ 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. (Honours) 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 Honours 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. (Honours) 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.

**SCHEME AND SYLLABUS FOR CHOICE BASED CREDIT SYSTEM
FOR B.Sc. HONOURS (ZOOLOGY)**

Semester	Core Course(14)	Ability	Skill	Discipline	Generic
		Enhancement Compulsory Course (2)	Enhancement Course SEC (2)	Specific Elective DCE (4)	Elective GE (4)
I	Non-chordates I: Protista to Pseudocoelomates ZOO(H) 101 TH ; ZOO(H) 101 PR	English/Hindi/MIL Communication/ Environmental Sciences			GE-1
	Principles of Ecology ZOO(H) 102 TH; ZOO(H) 102 PR				
II	Non-chordates II: Coelomates ZOO(H) 201 TH; ZOO(H) 201 PR	English/Hindi/MIL Communication/ Environmental Sciences			GE-2
	Cell Biology ZOO(H) 202 TH; ZOO(H) 202 PR				
III	Diversity of Chordates ZOO(H) 301 TH; ZOO(H) 301 PR		SEC -1		GE-3
	Physiology: Controlling and Coordinating Systems ZOO(H) 302 TH; ZOO(H) 302 PR				
	Fundamentals of Biochemistry ZOO(H)303 TH; ZOO (H) 303 PR				
IV	Comparative Anatomy of Vertebrates ZOO(H) 401TH; ZOO (H) 401 PR		SEC -2		GE-4
	Physiology: Life Sustaining Systems ZOO(H) 402 TH; ZOO(H) 402 PR				
	Biochemistry of Metabolic Processes ZOO(H) 403 TH; ZOO(H) 403 PR				
V	Molecular Biology ZOO(H) 501TH; ZOO(H) 501 PR			DSE-1	
	Principles of Genetics ZOO (H) 502 TH; ZOO(H) 502 PR			DSE-2	
VI	Developmental Biology ZOO(H) 601 TH; ZOO(H) 601 PR			DSE -3	
	Evolutionary Biology ZOO (H) 602 TH; ZOO(H) 602 PR			DSE-4	

Semester	Course Opted	Course Name	Credits
I	Ability Enhancement Compulsory Course-I	English communications/ Environmental Science	2
	Core course-I	Non-chordates I: Protista to Pseudocoelomates	4
	Core Course-I Practical		2
	Core course-II	Principles of Ecology	4
	Core Course-II Practical		2
	Generic Elective -1	GE-1	4
	Generic Elective -1 Practical/Tutorial		2
II	Ability Enhancement Compulsory Course-II	Englishcommunications/ EnvironmentalScience	2
	Core course-III	Non-chordates II: Coelomates	4
	Core Course-III Practical		2
	Core course-IV	Cell Biology	4
	Core Course-IV Practical		2
	Generic Elective -2	GE-2	4
	Generic Elective -2 Practical		2
III	Core course-V	Diversity of chordates	4
	Core Course-V Practical		2
	Core course-VI	Physiology: Controlling and Coordinating systems	4
	Core Course-VI Practical		2
	Core course-VII	Fundamentals of Biochemistry	4
	Core Course-VII Practical		2
	Skill Enhancement Course-1	SEC-1	4
	Generic Elective -3	GE-3	4
	Generic Elective -3 Practical		2
IV	Core course-VIII	Comparative anatomy of vertebrates	4
	Course-VIII Practical		2
	Core course-IX	Physiology: Life Sustaining Systems	4
	Course-IX Practical		2
	Core course-X	Biochemistry ofMetabolic Processes	4
	Core Course- X Practical		2
	Skill Enhancement Course-2	SEC-2	4
	Generic Elective -4	GE-4	4
	Generic Elective -		2
	4Practical		
V	Core course-XI	Molecular Biology	4
	Core Course-XI Practical		2
	Core course-XII	Principles of Genetics	4
	Core Course-XII Practical		2

Semester	Course Opted	Course Name	Credits
	Discipline Specific Elective -1	DSE-1	4
	Discipline Specific Elective -1 Practical		2
	Discipline Specific Elective -2	DSE-2	4
	Discipline Specific Elective- 2 Practical/Tutorial		2
VI	Core course-XIII	Developmental Biology	4
	Core Course-XIII Practical/Tutorial		2
	Core course-XIV	Evolutionary Biology	4
	Core Course-XIV Practical/Tutorial		2
	Discipline Centric Elective -3	DSE-3	4
	Discipline Centric Elective -3 Practical/Tutorial		2
	Discipline Centric Elective-4	DSE-4	4
	Discipline Centric Elective -1 Practical/Tutorial		2
Total: 140			

CORE COURSES

CC I	Non-chordates I: Protista to Pseudocoelomates ZOOL(H) 101 TH, ZOOL(H)101 PR
CC II	Perspectives in Ecology ZOOL(H) 102 TH, ZOOL(H) 102 PR
CC III	Non-chordates II: Coelomates ZOOL(H) 201 TH, ZOOL(H) 201 PR
CC IV	Cell Biology ZOOL(H) 202 TH, ZOOL(H) 202 PR
CC V	Diversity of Chordates ZOOL(H) 301 TH, ZOOL(H) 301 PR
CC VI	Physiology: Controlling and Coordinating Systems ZOOL(H) 302 TH, ZOOL(H) 302 PR
CC VII	Fundamentals of Biochemistry ZOOL(H) 303 TH, ZOOL(H) 303 PR
CC VIII	Comparative Anatomy of Vertebrates ZOOL(H) 401 TH, ZOOL(H) 401 PR
CC IX	Physiology: Life Sustaining Systems ZOOL(H) 402 TH, ZOOL(H) PR
CC X	Biochemistry of Metabolic Processes ZOOL(H) 403 TH, ZOOL(H) 403 PR
CC XI	Molecular Biology ZOOL(H)501 TH, ZOOL(H) 501 PR
CC XII	Principles of Genetics ZOOL(H) 502 TH, ZOOL (H) 502 PR
CC XIII	Developmental Biology ZOOL(H) 601TH, ZOOL (H) 601 PR
CC XIV	Evolutionary Biology ZOOL(H) 602 TH, ZOOL(H) 602 PR

DISCIPLINE SPECIFIC ELECTIVE COURSES**DSE 1** Agrochemicals and Pest Management ZOOL(H) 503A-TH, ZOOL(H) 503 A- PR
OR**DSE 2** Animal Behaviour and Chronobiology ZOOL(H) 503B-TH, ZOOL(H)503 B- PR
OR**DSE 3** Animal Biotechnology ZOOL(H) 503 C- TH, ZOOL(H) 503 C-PR**DSE 4** Basics of Neuroscience ZOOL(H) 504 A-TH, ZOOL (H) 504 A-PR
OR**DSE 5** Biology of Insecta ZOOL(H) 504 B-TH, ZOOL(H) 504 B-PR
OR**DSE 6** Computational Biology ZOOL(H) 504 C- TH, ZOOL(H) 504C- PR
OR**DSE 7** Endocrinology ZOOL(H) 603A-TH, ZOOL(H) 603A-PR
OR**DSE 8** Fish and Fisheries ZOOL (H) 603B-TH, ZOOL(H) 603 B-PR
OR**DSE 9** Immunology ZOOL(H) 603C-TH, ZOOL(H) 603 C-PR**DSE 10** Parasitology ZOOL (H) 604A- TH, ZOOL(H) 604A-PR
OR**DSE 11** Reproductive Biology ZOOL (H) 604B- TH, ZOOL (H) 604 B-PR
OR**DSE 12** Wild Life Conservation and Management ZOOL(H) 604 C-TH, ZOOL(H)604C-PR

GENERIC ELECTIVE COURSES

GE 1	Animal Cell Biotechnology ZOOL(H)103A-TH, ZOOL(H) 103A- PR OR
GE 2	Animal Diversity ZOOL(H) 103B-TH, ZOOL (H) 103B-PR
GE 3	Aquatic Biology ZOOL(H) 203A-TH, ZOOL(H) 203A-PR OR
GE 4	Environment and Public Health ZOOL(H) 203B-TH, ZOOL(H) 203B-PR
GE 5	Exploring the Brain: Structure and Function ZOOL(H) 305A-TH, ZOOL(H) 305A-PR OR
GE 6	Food, Nutrition and Health ZOOL(H) 305B-TH, ZOOL(H) 305B-PR
GE 7	Human Physiology ZOOL(H) 405A-TH, ZOOL(H) 405A-TH OR
GE 8	Insect Vectors and Diseases ZOOL(H) 405B-TH, ZOOL(H)405B-TH

SKILL ENHANCEMENT COURSES

SEC 1	Apiculture ZOOL(H) 304A-TH, ZOOL(H) 304A-PR OR
SEC 2	Aquarium Fish Keeping ZOOL(H) 304B-TH, ZOOL(H) 304B-PR
SEC 3	Medical Diagnostics ZOOL(H) 404A-TH, ZOOL (H) 404 A-PR OR
SEC 4	Research Methodology ZOOL(H) 404B-TH, ZOOL(H) 404B-PR OR
SEC 5	Sericulture ZOOL(H) 404C-TH, ZOOL (H) 404C-PR

CORE COURSE I
NON-CHORDATES I: PROTISTS TO PSEUDOCOELOMATES
ZOOL(H) 101 TH

THEORY	(Credits 4)
Unit 1: Protista, Parazoa and Metazoa	19
General characteristics and Classification up to classes Study of <i>Euglena</i> , <i>Amoeba</i> and <i>Paramecium</i> Life cycle and pathogenicity of <i>Plasmodium vivax</i> and <i>Entamoeba histolytica</i> Locomotion and Reproduction in Protista Evolution of symmetry and segmentation of Metazoa	
Unit 2: Porifera	7
General characteristics and Classification up to classes Canal system and spicules in sponges	
Unit 3: Cnidaria	12
General characteristics and Classification up to classes Metagenesis in <i>Obelia</i> Polymorphism in Cnidaria Corals and coral reefs	
Unit 4: Ctenophora	4
General characteristics and Evolutionary significance	
Unit 5: Platyhelminthes	10
General characteristics and Classification up to classes Life cycle and pathogenicity of <i>Fasciola hepatica</i> and <i>Taenia solium</i>	
Unit 6: Nematelminthes	8
General characteristics and Classification up to classes Life cycle, and pathogenicity of <i>Ascaris lumbricoides</i> and <i>Wuchereria bancrofti</i> Parasitic adaptations in helminthes	

Note: Classification to be followed from “Barnes, R.D. (1982). *Invertebrate Zoology*, V Edition”

NON-CHORDATES I: PROTISTS TO PSEUDOCOELOMATES
ZOOL(H) 101PR

PRACTICALS

(Credits 2)

1. Study of whole mount of *Euglena*, *Amoeba* and *Paramecium*, Binary fission and Conjugation in *Paramecium*
2. Examination of pond water collected from different places for diversity in protista
3. Study of *Sycon* (T.S. and L.S.), *Hyalonema*, *Euplectella*, *Spongilla*
4. Study of *Obelia*, *Physalia*, *Millepora*, *Aurelia*, *Tubipora*, *Corallium*, *Alcyonium*, *Gorgonia*, *Metridium*, *Pennatula*, *Fungia*, *Meandrina*, *Madrepora*
5. One specimen/slide of any ctenophore
6. Study of adult *Fasciola hepatica*, *Taenia solium* and their life cycles (Slides/micro-photographs)
7. Study of adult *Ascaris lumbricoides* and its life stages (Slides/micro-photographs)
8. To submit a Project Report on any related topic on life cycles/coral/ coral reefs.

Note: Classification to be followed from “Ruppert and Barnes (2006) *Invertebrate Zoology*, 8th edition, Holt Saunders International Edition”

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
- Barrington, E.J.W. (1979). *Invertebrate Structure and Functions*. II Edition, E.L.B.S. and Nelson

CORE COURSE II
PRINCIPLES OF ECOLOGY
ZOOL(H) 102 TH

THEORY **(Credits 4)**

Unit 1: Introduction to Ecology **6**

History of ecology, Autecology and synecology, Levels of organization, Laws of limiting factors, Study of physical factors

Unit 2: Population **24**

Unitary and Modular populations

Unique and group attributes of population: Density, natality, mortality, life tables, fecundity tables, survivorship curves, age ratio, sex ratio, dispersal and dispersion

Exponential and logistic growth, equation and patterns, r and K strategies

Population regulation - density-dependent and independent factors

Population interactions, Gause's Principle with laboratory and field examples, Lotka-Volterra equation for competition and Predation, functional and numerical responses

Unit 3: Community **12**

Community characteristics: species richness, dominance, diversity, abundance, vertical stratification, Ecotone and edge effect; Ecological succession with one example

Theories pertaining to climax community

Unit 4: Ecosystem **14**

Types of ecosystems with one example in detail, Food chain: Detritus and grazing food chains, Linear and Y-shaped food chains, Food web, Energy flow through the ecosystem, Ecological pyramids and Ecological efficiencies

Nutrient and biogeochemical cycle with one example of Nitrogen cycle Human modified ecosystem

Unit 5: Applied Ecology **4**

Ecology in Wildlife Conservation and Management

PRINCIPLES OF ECOLOGY
ZOOL(H) 102 PR

PRACTICALS

(Credits 2)

1. Study of life tables and plotting of survivorship curves of different types from the hypothetical/real data provided
2. Determination of population density in a natural/hypothetical community by quadrat method and calculation of Shannon-Weiner diversity index for the same community
3. Study of an aquatic ecosystem: Phytoplankton and zooplankton, Measurement of area, temperature, turbidity/penetration of light, determination of pH, and Dissolved Oxygen content (Winkler's method), Chemical Oxygen Demand and free CO₂
4. Report on a visit to National Park/Biodiversity Park/Wild life sanctuary

SUGGESTED READINGS

- Colinvaux, P. A. (1993). Ecology. II Edition. Wiley, John and Sons, Inc.
- Krebs, C. J. (2001). Ecology. VI Edition. Benjamin Cummings.
- Odum, E.P., (2008). Fundamentals of Ecology. Indian Edition. Brooks/Cole
- Robert Leo Smith Ecology and field biology Harper and Row publisher
- Ricklefs, R.E., (2000). Ecology. V Edition. Chiron Pres

CORE COURSE III
NON-CHORDATES II: COELOMATES
ZOOL(H) 201 TH

THEORY	(Credits 4)
Unit 1: Introduction to Coelomates	2
Evolution of coelom and metamerism	
Unit 2: Annelida	10
General characteristics and Classification up to classes Excretion in Annelida	
Unit 3: Arthropoda	17
General characteristics and Classification up to classes Vision and Respiration in Arthropoda Metamorphosis in Insects Social life in bees and termites	
Unit 4: Onychophora	4
General characteristics and Evolutionary significance	
Unit 5: Mollusca	15
General characteristics and Classification up to classes Respiration in Mollusca Torsion and detorsion in Gastropoda Pearl formation in bivalves Evolutionary significance of trochophore larva	
Unit 6: Echinodermata	12
General characteristics and Classification up to classes Water-vascular system in Asteroidea Larval forms in Echinodermata Affinities with Chordates	

Note: Classification to be followed from “Ruppert and Barnes (2006) *Invertebrate Zoology*, 8th edition, Holt Saunders International Edition”



NON-CHORDATES II: COELOMATES
ZOOL(H) 201 PR

PRACTICAL


(Credits 2)

1. Study of following specimens:
Annelids - *Aphrodite*, *Nereis*, *Heteronereis*, *Sabella*, *Serpula*, *Chaetopterus*,
Pheretima, *Hirudinaria*
Arthropods - *Limulus*, *Palamnaeus*, *Palaemon*, *Daphnia*, *Balanus*, *Sacculina*, *Cancer*,
Eupagurus, *Scolopendra*, *Julus*, *Bombyx*, *Periplaneta*, termites and honey bees
Onychophora - *Peripatus*
Molluscs - *Chiton*, *Dentalium*, *Pila*, *Doris*, *Helix*, *Unio*, *Ostrea*, *Pinctada*, *Sepia*,
Octopus, *Nautilus*
Echinodermates - *Pentaceros/Asterias*, *Ophiura*, *Clypeaster*, *Echinus*, *Cucumaria* and
Antedon
2. Study of digestive system, septal nephridia and pharyngeal nephridia of earthworm
3. T.S. through pharynx, gizzard, and typhlosolar intestine of earthworm
4. Mount of mouth parts and dissection of digestive system and nervous system of
*Periplaneta**
5. To submit a Project Report on any related topic to larval forms (crustacean, mollusc
and echinoderm)

Note: Classification to be followed from “Ruppert and Barnes (2006) *Invertebrate Zoology*,
8th edition, Holt Saunders International Edition”

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
- Barrington, E.J.W. (1979). *Invertebrate Structure and Functions*. II Edition, E.L.B.S. and Nelson



**CORE COURSE IV
CELL BIOLOGY
ZOOL(H) 202 TH**

THEORY	(Credits 4)
Unit 1: Overview of Cells	3
Prokaryotic and Eukaryotic cells, Virus, Viroids, Mycoplasma, Prions	
Unit 2: Plasma Membrane	7
Various models of plasma membrane structure Transport across membranes: Active and Passive transport, Facilitated transport Cell junctions: Tight junctions, Desmosomes, Gap junctions	
Unit 3: Endomembrane System	10
Structure and Functions: Endoplasmic Reticulum, Golgi Apparatus, Lysosomes	
Unit 4: Mitochondria and Peroxisomes	8
Mitochondria: Structure, Semi-autonomous nature, Endosymbiotic hypothesis Mitochondrial Respiratory Chain, Chemi-osmotic hypothesis Peroxisomes	
Unit 5: Cytoskeleton	8
Structure and Functions: Microtubules, Microfilaments and Intermediate filaments	
Unit 6: Nucleus	12
Structure of Nucleus: Nuclear envelope, Nuclear pore complex, Nucleolus Chromatin: Euchromatin and Hetrochromatin and packaging (nucleosome)	
Unit 7: Cell Division	8
Mitosis, Meiosis, Cell cycle and its regulation	
Unit 8: Cell Signaling	4
GPCR and Role of second messenger (cAMP)	

CELL BIOLOGY**ZOOL(H) 202 PR****PRACTICAL****(Credits 2)**

1. Preparation of temporary stained squash of onion root tip to study various stages of mitosis
2. Study of various stages of meiosis.
3. Preparation of permanent slide to show the presence of Barr body in human female blood cells/cheek cells.
4. Preparation of permanent slide to demonstrate:
 - i DNA by Feulgen reaction
 - ii DNA and RNA by MGP
 - iii Mucopolysaccharides by PAS reaction
 - iv Proteins by Mercurobromophenol blue/Fast Green

SUGGESTED READINGS

- Karp, G. (2010). *Cell and Molecular Biology: Concepts and Experiments*. VI Edition. John Wiley and Sons. Inc.
- De Robertis, E.D.P. and De Robertis, E.M.F. (2006). *Cell and Molecular Biology*. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
- Cooper, G.M. and Hausman, R.E. (2009). *The Cell: A Molecular Approach*. V Edition. ASM Press and Sunderland, Washington, D.C.; Sinauer Associates, MA.
- Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). *The World of the Cell*. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
- Bruce Albert, Bray Dennis, Levis Julian, Raff Martin, Roberts Keith and Watson James (2008). *Molecular Biology of the Cell*, V Edition, Garland publishing Inc., New York and London.

**CORE COURSE V
DIVERSITY OF CHORDATA
ZOOL(H) 301 TH**

THEORY	(Credits 4)
Unit 1: Introduction to Chordates	2
General characteristics and outline classification	
Unit 2: Protochordata	8
General characteristics of Hemichordata, Urochordata and Cephalochordata; Study of larval forms in protochordates; Retrogressive metamorphosis in Urochordata	
Unit 3: Origin of Chordata	3
Dipleurula concept and the Echinoderm theory of origin of chordates Advanced features of vertebrates over Protochordata	
Unit 4: Agnatha	2
General characteristics and classification of cyclostomes up to class	
Unit 5: Pisces	8
General characteristics of Chondrichthyes and Osteichthyes, classification up to order Migration, Osmoregulation and Parental care in fishes	
Unit 6: Amphibia	6
Origin of <i>Tetrapoda</i> (Evolution of terrestrial ectotherms); General characteristics and classification up to order; Parental care in Amphibians	
Unit 7: Reptilia	7
General characteristics and classification up to order; Affinities of <i>Sphenodon</i> ; Poison apparatus and Biting mechanism in snakes	
Unit 8: Aves	8
General characteristics and classification up to order <i>Archaeopteryx</i> -- a connecting link; Principles and aerodynamics of flight, Flight adaptations and Migration in birds	
Unit 9: Mammals	8
General characters and classification up to order; Affinities of Prototheria; Adaptive radiation with reference to locomotory appendages	
Unit 10: Zoogeography	8
Zoogeographical realms, Theories pertaining to distribution of animals, Plate tectonic and Continental drift theory, distribution of vertebrates in different realms	

DIVERSITY OF CHORDATA
ZOOL(H) 301 PR

PRACTICAL

(Credits 2)

1. Protochordata

Balanoglossus, Herdmania, Branchiostoma, Colonial Urochordata Sections of *Balanoglossus* through proboscis and branchiogenital regions, Sections of *Amphioxus* through pharyngeal, intestinal and caudal regions. Permanent slide of *Herdmania* spicules

2. Agnatha

Petromyzon, Myxine

3. Fishes

Scoliodon, Sphyrna, Pristis, Torpedo, Chimaera, Mystus, Heteropneustes, Labeo, Exocoetus, Echeneis, Anguilla, Hippocampus, Tetradon/ Diodon, Anabas, Flat fish

4. Amphibia

Ichthyophis/Ureotyphlus, Necturus, Bufo, Hyla, Alytes, Salamandra

5. Reptilia

Chelone, Trionyx, Hemidactylus, Varanus, Uromastix, Chamaeleon, Ophiosaurus, Draco, Bungarus, Vipera, Naja, Hydrophis, Zamenis, Crocodylus

Key for Identification of poisonous and non-poisonous snakes

6. Aves

Study of six common birds from different orders. Types of beaks and claws

7. Mammalia

Sorex, Bat (Insectivorous and Frugivorous), *Funambulus, Loris, Herpestes, Erinaceous*.

Mount of weberian ossicles of *Mystus*, pecten from Fowl head

Dissection of Fowl head (Dissections and mounts subject to permission)

Power point presentation on study of any two animals from two different classes by students (may be included if dissections not given permission)

Classification from Young, J. Z. (2004) to be followed

SUGGESTED READINGS

- Young, J. Z. (2004). *The Life of Vertebrates*. III Edition. Oxford university press.
- Pough H. *Vertebrate life*, VIII Edition, Pearson International.
- Darlington P.J. *The Geographical Distribution of Animals*, R.E. Krieger Pub Co.
- Hall B.K. and Hallgrimsson B. (2008). *U v t k e m d g t i .g l V Edition. Jones and v k q p Bartlett Publishers Inc.*

CORE COURSE VI

ANIMAL PHYSIOLOGY: CONTROLLING AND COORDINATING SYSTEMS ZOOL(H) 302 TH

THEORY	(Credits 4)
Unit 1: Tissues	6
Structure, location, classification and functions of epithelial tissue, connective tissue, muscular tissue and nervous tissue	
Unit 2: Bone and Cartilage	4
Structure and types of bones and cartilages, Ossification, bone growth and resorption	
Unit 3: Nervous System	10
Structure of neuron, resting membrane potential, Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers; Types of synapse, Synaptic transmission and, Neuromuscular junction; Reflex action and its types - reflex arc; Physiology of hearing and vision.	
Unit 4: Muscle	12
Histology of different types of muscle; Ultra structure of skeletal muscle; Molecular and chemical basis of muscle contraction; Characteristics of muscle twitch; Motor unit, summation and tetanus	
Unit 5: Reproductive System	10
Histology of testis and ovary; Physiology of male and female reproduction; Puberty, Methods of contraception in male and female	
Unit 6: Endocrine System	18
Histology of endocrine glands - pineal, pituitary, thyroid, parathyroid, pancreas, adrenal; hormones secreted by them and their mechanism of action; Classification of hormones; Regulation of their secretion; Mode of hormone action, Signal transduction pathways for steroidal and non-steroidal hormones; Hypothalamus (neuroendocrine gland) - principal nuclei involved in neuroendocrine control of anterior pituitary and endocrine system; Placental hormones	

ANIMAL PHYSIOLOGY: CONTROLLING AND COORDINATING SYSTEMS

ZOOL(H) 302 PR

PRACTICALS

(Credits 2)

- *1. Recording of simple muscle twitch with electrical stimulation (or Virtual)
2. Demonstration of the unconditioned reflex action (Deep tendon reflex such as knee jerk reflex)
3. Preparation of temporary mounts: Squamous epithelium, Striated muscle fibres and nerve cells
4. Study of permanent slides of Mammalian skin, Cartilage, Bone, Spinal cord, Nerve cell, Pituitary, Pancreas, Testis, Ovary, Adrenal, Thyroid and Parathyroid
5. Microtomy: Preparation of permanent slide of any five mammalian (Goat/white rat) tissues

(*Subject to UGC guidelines)

SUGGESTED BOOKS

- Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hecourt Asia PTE Ltd. /W.B. Saunders Company.
- Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons
- Victor P. Eroschenko. (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. & Wilkins.

CORE COURSE VII
FUNDAMENTALS OF BIOCHEMISTRY
ZOOL(H) 303 TH

THEORY	(CREDITS 4)
Unit 1: Carbohydrates	8
Structure and Biological importance: Monosaccharides, Disaccharides, Polysaccharides and Glycoconjugates	
Unit 2: Lipids	8
Structure and Significance: Physiologically important saturated and unsaturated fatty acids, Tri-acylglycerols, Phospholipids, Glycolipids, Steroids	
Unit 3: Proteins	14
Amino acids: Structure, Classification and General properties of α -amino acids; Physiological importance of essential and non-essential α -amino acids	
Proteins: Bonds stabilizing protein structure; Levels of organization in proteins; Denaturation; Introduction to simple and conjugate proteins	
Immunoglobulins: Basic Structure, Classes and Function, Antigenic Determinants	
Unit 4: Nucleic Acids	12
Structure: Purines and pyrimidines, Nucleosides, Nucleotides, Nucleic acids Cot Curves: Base pairing, Denaturation and Renaturation of DNA Types of DNA and RNA, Complementarity of DNA, Hypo-Hyperchromaticity of DNA	
Unit 5: Enzymes	18
Nomenclature and classification; Cofactors; Specificity of enzyme action; Isozymes; Mechanism of enzyme action; Enzyme kinetics; Factors affecting rate of enzyme-catalyzed reactions; Derivation of Michaelis-Menten equation, Concept of K_m and V_{max} , Lineweaver-Burk plot; Multi-substrate reactions; Enzyme inhibition; Allosteric enzymes and their kinetics; Regulation of enzyme action	

FUNDAMENTALS OF BIOCHEMISTRY

ZOOL(H) 303 PR

PRACTICAL

(CREDITS 2)

1. Qualitative tests of functional groups in carbohydrates, proteins and lipids.
2. Paper chromatography of amino acids.
3. Action of salivary amylase under optimum conditions.
4. Effect of pH, temperature and inhibitors on the action of salivary amylase.
5. Demonstration of proteins separation by SDS-PAGE.

SUGGESTED READING

- Cox, M.M and Nelson, D.L. (2008). *Principles of Biochemistry*, 6th Edition, W.H. Freeman and Co., New York.
- Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). *Biochemistry*, VI Edition, W.H. Freeman and Co., New York.
- Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well, P.A. (2009). *Lehninger Principles of Biochemistry*, 6th Edition, International Edition, The McGraw- Hill Companies Inc.
- Hames, B.D. and Hooper, N.M. (2000). *Instant Notes in Biochemistry*, II Edition, BIOS Scientific Publishers Ltd., U.K.
- Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2008). *Molecular Biology of the Gene*, VI Edition, Cold Spring Harbor Lab. Press, Pearson Pub.

CORE COURSE VIII
COMPARATIVE ANATOMY OF VERTEBRATES
ZOOL(H) 401 TH

THEORY	(CREDITS 4)
Unit 1: Integumentary System	8
Structure, functions and derivatives of integument	
Unit 2: Skeletal System	8
Overview of axial and appendicular skeleton, Jaw suspensorium, Visceral arches	
Unit 3: Digestive System	8
Alimentary canal and associated glands, dentition	
Unit 4: Respiratory System	8
Skin, gills, lungs and air sacs; Accessory respiratory organs	
Unit 5: Circulatory System	8
General plan of circulation, evolution of heart and aortic arches	
Unit 6: Urinogenital System	6
Succession of kidney, Evolution of urinogenital ducts, Types of mammalian uteri	
Unit 7: Nervous System	8
Comparative account of brain Autonomic nervous system, Spinal cord, Cranial nerves in mammals	
Unit 8: Sense Organs	6
Classification of receptors Brief account of visual and auditory receptors in man	

COMPARATIVE ANATOMY OF VERTEBRATES
ZOOL(H) 401 PR

PRACTICAL

(CREDITS 2)

1. Study of placoid, cycloid and ctenoid scales through permanent slides/photographs
2. Disarticulated skeleton of Frog, *Varanus*, Fowl, Rabbit
3. Carapace and plastron of turtle /tortoise
4. Mammalian skulls: One herbivorous and one carnivorous animal
5. Dissection of rat to study arterial and urinogenital system(subject to permission)
6. Study of structure of any two organs (heart, lung, kidney, eye and ear) from video recording (may be included if dissection not permitted)
7. Project on skeletal modifications in vertebrates (may be included if dissection not permitted)

SUGGESTED READINGS

- Kardong, K.V. (2005) *X g t v g d t c v g u ø " E q o r c t c v k x g " C p c v q o 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

CORE COURSE IX
ANIMAL PHYSIOLOGY: LIFE SUSTAINING SYSTEMS
ZOOL(H) 402 TH

THEORY	(Credits 4)
Unit 1: Physiology of Digestion	14
Structural organization and functions of gastrointestinal tract and associated glands; Mechanical and chemical digestion of food; Absorptions of carbohydrates, lipids, proteins, water, minerals and vitamins; Hormonal control of secretion of enzymes in Gastrointestinal tract.	
Unit 2: Physiology of Respiration	12
Histology of trachea and lung; Mechanism of respiration, Pulmonary ventilation; Respiratory volumes and capacities; Transport of oxygen and carbon dioxide in blood; Respiratory pigments, Dissociation curves and the factors influencing it; Carbon monoxide poisoning; Control of respiration	
Unit 3: Renal Physiology	8
Structure of kidney and its functional unit; Mechanism of urine formation; Regulation of water balance; Regulation of acid-base balance	
Unit 4: Blood	14
Components of blood and their functions; Structure and functions of haemoglobin Haemostasis: Blood clotting system, Kallikrein-Kininogen system, Complement system& Fibrinolytic system, Haemopoiesis Blood groups: Rh factor, ABO and MN	
Unit 5: Physiology of Heart	12
Structure of mammalian heart; Coronary circulation; Structure and working of conducting myocardial fibers. Origin and conduction of cardiac impulses Cardiac cycle; Cardiac output and its regulation, Frank-Starling Law of the heart, nervous and chemical regulation of heart rate. Electrocardiogram, Blood pressure and its regulation	

ANIMAL PHYSIOLOGY: LIFE SUSTAINING SYSTEMS

ZOOL(H) 402 PR

PRACTICALS

(CREDITS 2)

1. Determination of ABO Blood group
2. Enumeration of red blood cells and white blood cells using haemocytometer
3. Estimation of haemoglobin using Sahli's haemoglobinometer
4. Preparation of haemin and haemochromogen crystals
5. Recording of frog's heart beat under *in situ* and perfused conditions*
6. Recording of blood pressure using a sphygmomanometer
7. Examination of sections of mammalian oesophagus, stomach, duodenum, ileum, rectum liver, trachea, lung, kidney

(*Subject to UGC guidelines)

SUGGESTED READINGS

- Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Harcourt Asia PTE Ltd. W.B. Saunders Company.
- Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons,
- Victor P. Eroschenko. (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. & Wilkins.
- Vander A, Sherman J. and Luciano D. (2014). Vander's Human Physiology: The Mechanism of Body Function. XIII Edition, McGraw Hills

CORE COURSE X
BIOCHEMISTRY OF METABOLIC PROCESSES
ZOOL(H) 403 TH

THEORY	(CREDITS 4)
Unit 1: Overview of Metabolism	10
Catabolism vs Anabolism, Stages of catabolism, Compartmentalization of metabolic pathways, Shuttle systems and membrane transporters; ATP as "Energy Currency of cell"; coupled reactions; Use of reducing equivalents and cofactors; Intermediary metabolism and regulatory mechanisms	
Unit 2: Carbohydrate Metabolism	16
Sequence of reactions and regulation of glycolysis, Citric acid cycle, Phosphate pentose pathway, Gluconeogenesis, Glycogenolysis and Glycogenesis	
Unit 3: Lipid Metabolism	14
β -oxidation and omega -oxidation of saturated fatty acids with even and odd number of carbon atoms; Biosynthesis of palmitic acid; Ketogenesis	
Unit 4: Protein Metabolism	10
Catabolism of amino acids: Transamination, Deamination, Urea cycle; Fate of C-skeleton of Glucogenic and Ketogenic amino acids	
Unit 5: Oxidative Phosphorylation	10
Redox systems; Review of mitochondrial respiratory chain, Inhibitors and un-couplers of Electron Transport System	

BIOCHEMISTRY OF METABOLIC PROCESS

ZOOL(H) 403PR

PRACTICALS

(CREDITS 2)

1. Estimation of total protein in given solutions by Lowry's method.
2. Detection of SGOT and SGPT or GST and GSH in serum/ tissue
3. To study the enzymatic activity of Trypsin and Lipase.
4. Study of biological oxidation (SDH) [goat liver]
5. To perform the Acid and Alkaline phosphatase assay from serum/ tissue.
6. Dry Lab: To trace the labelled C atoms of Acetyl-CoA till they evolve as CO₂ in the TCA cycle

SUGGESTED READINGS

- Cox, M.M and Nelson, D.L. (2008). *Lehninger Principles of Biochemistry*, V Edition, W.H. Freeman and Co., New York.
- Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). *Biochemistry*, VI Edition, W.H. Freeman and Co., New York.
- Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well, P.A. (2009). *J c t r g t ø u " K n n w u y XXVIIIg EditionD k q e j g o k u v t* International Edition, The McGraw-Hill Companies Inc.
- Hames, B.D. and Hooper, N.M. (2000). *Instant Notes in Biochemistry*, II Edition, BIOS Scientific Publishers Ltd., U.K.

**CORE COURSE XI
MOLECULAR BIOLOGY
ZOOL(H) 501 TH**

THEORY	(CREDITS 4)
Unit 1: Nucleic Acids	4
Salient features of DNA and RNA Watson and Crick model of DNA	
Unit 2: DNA Replication	12
DNA Replication in prokaryotes and eukaryotes, mechanism of DNA replication, Semi-conservative, bidirectional and semi-discontinuous replication, RNA priming, Replication of circular and linear <i>ds</i> -DNA, replication of telomeres	
Unit 3: Transcription	10
RNA polymerase and transcription Unit, mechanism of transcription in prokaryotes and eukaryotes, synthesis of rRNA and mRNA, transcription factors	
Unit 4: Translation	12
Genetic code, Degeneracy of the genetic code and Wobble Hypothesis; Process of protein synthesis in prokaryotes: Ribosome structure and assembly in prokaryotes, fidelity of protein synthesis, aminoacyl tRNA synthetases and charging of tRNA; Proteins involved in initiation, elongation and termination of polypeptide chain; Inhibitors of protein synthesis; Difference between prokaryotic and eukaryotic translation	
Unit 5: Post Transcriptional Modifications and Processing of Eukaryotic RNA	6
Structure of globin mRNA; Split genes: concept of introns and exons, splicing mechanism, alternative splicing, exon shuffling, and RNA editing, Processing of tRNA	
Unit 6: Gene Regulation	10
Transcription regulation in prokaryotes: Principles of transcriptional regulation with examples from <i>lac</i> operon and <i>trp</i> operon; Transcription regulation in eukaryotes: Activators, repressors, enhancers, silencer elements; Gene silencing, Genetic imprinting	
Unit 7: DNA Repair Mechanisms	3
Pyrimidine dimerization and mismatch repair	
Unit 8: Regulatory RNAs	3
Ribo-switches, RNA interference, miRNA, siRNA	

MOLECULAR BIOLOGY
ZOOL(H) 501 PR

PRACTICAL

(CREDITS 2)

1. Study of Polytene chromosomes from Chironomous / *Drosophila* larvae
2. Preparation of liquid culture medium (LB) and raise culture of *E. coli*
3. Estimation of the growth kinetics of *E. coli* by turbidity method
4. Preparation of solid culture medium (LB) and growth of *E. coli* by spreading and streaking
5. Demonstration of antibiotic sensitivity/resistance of *E. coli* to antibiotic pressure and interpretation of results
6. Quantitative estimation of salmon sperm/calf thymus DNA using colorimeter (Diphenylamine reagent) or spectrophotometer (A260 measurement)
7. Quantitative estimation of RNA using Orcinol reaction
8. Study and interpretation of electron micrographs/ photograph showing
 - (a) DNA replication
 - (b) Transcription
 - (c) Split genes

SUGGESTED READINGS

- Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). *The World of the Cell*. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
- Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter: *Molecular Biology of the Cell*, IV Edition.
- Cooper G. M. and Robert E. Hausman R. E. *The Cell: A Molecular Approach*, V Edition, ASM Press and Sinauer Associates.
- De Robertis, E.D.P. and De Robertis, E.M.F. (2006). *Cell and Molecular Biology*. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
- Karp, G. (2010) *Cell and Molecular Biology: Concepts and Experiments*. VI Edition. John Wiley and Sons. Inc.
- Lewin B. (2008). *Gene XI*, Jones and Bartlett
- McLennan A., Bates A., Turner, P. and White M. (2015). *Molecular Biology* IV Edition. GS, Taylor and Francis Group, New York and London.

**CORE COURSE XII
PRINCIPLES OF GENETICS
ZOOL(H) 502 TH**

THEORY	(CREDITS 4)
Unit 1: Mendelian Genetics and its Extension	8
Principles of inheritance, Incomplete dominance and co-dominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Sex-linked, sex-influenced and sex-limited characters inheritance.	
Unit 2: Linkage, Crossing Over and Chromosomal Mapping	12
Linkage and crossing over, Cytological basis of crossing over, Molecular mechanisms of crossing over including models of recombination, Recombination frequency as a measure of linkage intensity, Two factor and three factor crosses, Interference and coincidence, Somatic cell hybridization.	
Unit 3: Mutations	10
Types of gene mutations (Classification), Types of chromosomal aberrations (Classification, figures and with one suitable example of each), Molecular basis of mutations in relation to UV light and chemical mutagens; Detection of mutations: CLB method, attached X method.	
Unit 4: Sex Determination	4
Chromosomal mechanisms of sex determination in <i>Drosophila</i> and Man	
Unit 5: Extra-chromosomal Inheritance	6
Criteria for extra-chromosomal inheritance, Antibiotic resistance in <i>Chlamydomonas</i> , Mitochondrial mutations in <i>Saccharomyces</i> , Infective heredity in <i>Paramecium</i> and Maternal effects	
Unit 6: Polygenic Inheritance	3
Polygenic inheritance with suitable examples; simple numericals based on it.	
Unit 7: Recombination in Bacteria and Viruses	9
Conjugation, Transformation, Transduction, Complementation test in Bacteriophage	
Unit 8: Transposable Genetic Elements	8
Transposons in bacteria, Ac-Ds elements in maize and P elements in <i>Drosophila</i> , Transposons in humans	

PRINCIPLES OF GENETICS
ZOOL(H) 502 PR

PRACTICALS

(CREDITS 2)

1. To study the Mendelian laws and gene interactions.
2. Chi-square analyses using seeds/beads/*Drosophila*.
3. Linkage maps based on data from conjugation, transformation and transduction.
4. Linkage maps based on data from *Drosophila* crosses.
5. Study of human karyotype (normal and abnormal).
6. Pedigree analysis of some human inherited traits.

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
- Fletcher H. and Hickey I. (2015). *Genetics*. IV Edition. GS, Taylor and Francis Group, New York and London.

**CORE COURSE XIII
DEVELOPMENTAL BIOLOGY
ZOOL(H) 601 TH**

THEORY	(CREDITS 2)
Unit 1: Introduction	4
Historical perspective and basic concepts: Phases of development, Cell-Cell interaction, Pattern formation, Differentiation and growth, Differential gene expression, Cytoplasmic determinants and asymmetric cell division	
Unit 2: Early Embryonic Development	28
Gametogenesis, Spermatogenesis, Oogenesis; Types of eggs, Egg membranes; Fertilization (External and Internal): Changes in gametes, Blocks to polyspermy; Planes and patterns of cleavage; Types of Blastula; Fate maps (including Techniques); Early development of frog and chick up to gastrulation; Embryonic induction and organizers	
Unit 3: Late Embryonic Development	8
Fate of Germ Layers; Extra-embryonic membranes in birds; Implantation of embryo in humans, Placenta (Structure, types and functions of placenta)	
Unit 4: Post Embryonic Development	12
Metamorphosis: Changes, hormonal regulations in amphibians and insects; Regeneration: Modes of regeneration, epimorphosis, morphallaxis and compensatory regeneration (with one example each); Ageing: Concepts and Theories	
Unit 5: Implications of Developmental Biology	8
Teratogenesis: Teratogenic agents and their effects on embryonic development; <i>In vitro</i> fertilization, Stem cell (ESC), Amniocentesis	

**DEVELOPMENTAL BIOLOGY
ZOO(H) 601 PR**

PRACTICALS

(CREDITS 2)

1. Study of whole mounts and sections of developmental stages of frog through permanent slides: Cleavage stages, blastula, gastrula, neurula, tail-bud stage, tadpole (external and internal gill stages)
2. Study of whole mounts of developmental stages of chick through permanent slides: Primitive streak (13 and 18 hours), 21, 24, 28, 33, 36, 48, 72, and 96 hours of incubation (Hamilton and Hamburger stages)
3. Study of the developmental stages and life cycle of *Drosophila* from stock culture
4. Study of different sections of placenta (photomicrograph/ slides)
5. Project report on *Drosophila* culture/chick embryo development

SUGGESTED READINGS

- Gilbert, S. F. (2010). Developmental Biology, IX Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA
- Balinsky B. I. and Fabian B. C. (1981). An Introduction to Embryology, V Edition, International Thompson Computer Press
- Carlson, R. F. Patten's Foundations of Embryology
- Kalthoff (2008). Analysis of Biological Development, II Edition, McGraw-Hill Publishers
- Lewis Wolpert (2002). Principles of Development. II Edition, Oxford University Press

**CORE COURSE XIV
EVOLUTIONARY BIOLOGY
ZOOL(H) 602 TH**

THEORY	(CREDITS 4)
Unit 1: Life's Beginnings: Chemogeny, RNA world, Biogeny, Origin of photosynthesis, Evolution of eukaryotes	7
Unit 2: Historical review of evolutionary concept: Lamarckism, Darwinism, Neo-Darwinism	4
Unit 3: Evidences of Evolution: Fossil record (types of fossils, transitional forms, geological time scale, evolution of horse, Molecular (universality of genetic code and protein synthesising machinery, three domains of life, neutral theory of molecular evolution, molecular clock ,example of globin gene family, rRNA/cyt c	10
Unit 4: Sources of variations: Heritable variations and their role in evolution	8
Unit 5: Population genetics: Hardy-Weinberg Law (statement and derivation of equation, application of law to human Population); Evolutionary forces upsetting H-W equilibrium; Natural selection (concept of fitness, selection coefficient, derivation of one unit of selection for a dominant allele, genetic load, mechanism of working, types of selection, density-dependent selection, heterozygous superiority, kin selection, adaptive resemblances, sexual selection. Genetic Drift (mechanism, founder's effect, bottleneck phenomenon; Role of Migration and Mutation in changing allele frequencies	14
Unit 6: Product of evolution: Micro evolutionary changes (inter-population variations, clines, races, Species concept, Isolating mechanisms, modes of speciation—allopatric, sympatric, Adaptive radiation / macroevolution (exemplified by Galapagos finches	7
Unit 7: Extinctions, Back ground and mass extinctions (causes and effects), detailed example of K-T extinction	2
Unit 8: Origin and evolution of man, Unique hominin characteristics contrasted with primate characteristics, primate phylogeny from <i>Dryopithecus</i> leading to <i>Homo sapiens</i> , molecular analysis of human origin	6
Unit 9: Phylogenetic trees, Multiple sequence alignment, construction of phylogenetic trees, interpretation of trees	2



EVOLUTIONARY BIOLOGY
ZOOL(H) 602 PR

PRACTICALS

(CREDITS 2)

1. Study of fossils from models/ pictures
2. Study of homology and analogy from suitable specimens
3. Study and verification of Hardy-Weinberg Law by chi square analysis
4. Demonstration of role of natural selection and genetic drift in changing allele frequencies using simulation studies
5. Graphical representation and interpretation of data of height/ weight of a sample of 100 humans in relation to their age and sex.
6. Construction of phylogenetic trees with the help of bioinformatics tools (Clustal X, Phylip, NJ) and its interpretation.

SUGGESTED READINGS

- Ridley, M (2004) Evolution III Edition Blackwell publishing
- Hall, B.K. and Hallgrimson, B (2008). Evolution IV Edition. Jones and Barlett Publishers.
- Campbell, N.A. and Reece J.B (2011). Biology. IX Edition. Pearson, Benjamin, Cummings.
- Douglas, J. Futuyma (1997). Evolutionary Biology. Sinauer Associates.
- Snustad. S Principles of Genetics.
- Pevsner, J (2009). Bioinformatics and Functional Genomics. II Edition Wiley-Blackwell

DISCIPLINE CENTRIC ELECTIVE COURSES

DSE 1

ANIMAL BEHAVIOUR AND CHRONOBIOLOGY ZOOL(H) 503 B TH

THEORY (Credits 4)

Unit 1: Introduction to Animal Behaviour 10

Origin and history of Ethology; Brief profiles of Karl Von Frish, Ivan Pavlov, Konrad Lorenz, Niko Tinbergen, Proximate and ultimate causes of behaviour, Methods and recording of a behaviour

Unit 2: Patterns of Behaviour 10

Stereotyped Behaviours (Orientation, Reflexes); Individual Behavioural patterns; Instinct vs. Learnt Behaviour; Associative learning, classical and operant conditioning, Habituation, Imprinting.

Unit 3: Social and Sexual Behaviour 16

Social Behaviour: Concept of Society; Communication and the senses; Altruism; Insects' society with Honey bee as example; Foraging in honey bee and advantages of the waggle dance.

Sexual Behaviour: Asymmetry of sex, Sexual dimorphism, Mate choice, Intra-sexual selection (male rivalry), Inter-sexual selection (female choice), Sexual conflict in parental care.

Unit 4: Introduction to Chronobiology 8

Historical developments in chronobiology; Biological oscillation: the concept of Average, amplitude, phase and period. Adaptive significance of biological clocks

Unit 5: Biological Rhythm 12

Types and characteristics of biological rhythms: Short- and Long- term rhythms; Circadian rhythms; Tidal rhythms and Lunar rhythms; Concept of synchronization and masking; Photic and non-photic zeitgebers; Circannual rhythms; Photoperiod and regulation seasonal reproduction of vertebrates; Role of melatonin.

Unit 8: Biological Clocks 4

Relevance of biological clocks; Chronopharmacology, Chronomedicine, Chronotherapy.

**ANIMAL BEHAVIOUR AND CHRONOBIOLOGY
ZOOLOGY 503 B PR**

PRACTICAL

(Credits 2)

1. To study nests and nesting habits of the birds and social insects.
2. To study the behavioural responses of wood lice to dry and humid conditions.
3. To study geotaxis behaviour in earthworm.
4. To study the phototaxis behaviour in insect larvae.
5. Visit to Forest/ Wild life Sanctuary/Biodiversity Park/Zoological Park to study behavioural activities of animals and prepare a short report.
6. Study and actogram construction of locomotor activity of suitable animal models.
7. Study of circadian functions in humans (daily eating, sleep and temperature patterns).

SUGGESTED READINGS

- David McFarland, Animal Behaviour, Pitman Publishing Limited, London, UK.
- Manning, A. and Dawkins, M. S, An Introduction to Animal Behaviour, Cambridge, University Press, UK.
- John Alcock, Animal Behaviour, Sinauer Associate Inc., USA.
- Paul W. Sherman and John Alcock, Exploring Animal Behaviour, Sinauer Associate Inc., Massachusetts, USA.
- Chronobiology Biological Timekeeping: Jay. C. Dunlap, Jennifer. J. Loros, Patricia J. DeCoursey (ed). 2004, Sinauer Associates, Inc. Publishers, Sunderland, MA, USA
- Insect Clocks D.S. Saunders, C.G.H. Steel, X., Afopoulou (ed.)R.D. Lewis. (3rd Ed) 2002 Barends and Noble Inc. New York, USA
- Biological Rhythms: Vinod Kumar (2002) Narosa Publishing House, Delhi/ Springer-Verlag, Germany.

DSE 2

ANIMAL BIOTECHNOLOGY ZOO(H) 503CTH

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, knock out mice.	
Production of transgenic plants: <i>Agrobacterium</i> 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

ZOOL(H) 503C 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 3
BASICS OF NEUROSCIENCE
ZOOL(H) 504A TH**

THEORY	(Credits 4)
Unit 1: Introduction to Neuroscience	6
Origins of Neuroscience; Neuroanatomy, Neurophysiology, and Systems Neurobiology	
UNIT 2: The Nervous system-An Introduction	14
Introduction to the structure and function of the nervous system: Cellular components: Neurons; Neuroglia; Neuron doctrine; The prototypical neuron – axons and dendrites as unique structural components of neurons. The ionic bases of resting membrane potential; The action potential- its generation and properties; The action potential conduction.	
UNIT 3: Cellular and Molecular Neurobiology	14
Molecular and cellular approaches used to study the CNS at the level of single molecules, Synapse: Synaptic transmission, Types of synapses; synaptic function; Principles of chemical synaptic transmission; Principles of synaptic integration; EPSPs and IPSPs. Ion channels, Neural transmission,	
Unit 4. Neurotransmitters	10
Different types of neurotransmitters– catecholamines, amino acidergic and peptidergic neurotransmitters; Transmitter gated channels; G-protein coupled receptors and effectors, neurotransmitter receptors; Ionotropic and metabotropic receptors.	
UNIT 5: Neurobiology and Neuropharmacology of Behaviour	16
The principles of signal transduction and information processing in the vertebrate central nervous system, and the relationship of functional properties of neural systems with perception and behavior; sensory systems, molecular basis of behavior including learning and memory. Molecular pathogenesis of pain and neurodegenerative diseases such as Parkinson's, Alzheimer's, psychological disorders, addiction, etc.	



**BASICS OF NEUROSCIENCE
ZOOL(H) 504A PR**


PRACTICAL

(CREDITS 2)

1. Dissection and study of *Drosophila* nervous system using GFP reporter.
2. Observation and quantitation of *Drosophila* photoreceptor neurons in healthy and diseased condition.
3. Nerve Cell preparation from the spinal cord.
4. Study of neurons and/ or myelin by Nissl, Giemsa or Luxol Fast Blue staining.
5. Study of olfaction in *Drosophila*.
6. Study of novelty, anxiety and spatial learning in mice.

SUGGESTED READINGS

- Neuroscience: Exploring the brain by Mark F. Baer; Barry W. Connors. 2015
- From Molecules to Networks: An Introduction to Cellular and Molecular Neuroscience by John H. Byrne. Ruth Heidelberg and M. Neal Waxham
- Neuroscience-Eds. Dale Purves et. al. (3rd Edn)-Sinauer Associates, Inc.-2004
- Principles of Neural Science-4th Edn-Eds. Kandel, Schwartz and Jessell-McGraw-Hill Companies-2000
- Nerve Cells and Animal Behaviour-2nd Edn-Peter J Simmons and David Young-CUP-2003
- Essential Psychopharmacology- Neuroscientific Basis and Practical Applications-2nd Edn.-Stephan M. Stahl-CUP-2000
- Phantoms in the Brain - Vilayanur S. Ramachandran and Sandra Blakeslee-1998
- The Human Brain Book - Rita Carter-2009



**DSE 4
BIOLOGY OF INSECTA
ZOOL(H) 504B TH**

THEORY	(Credits 4)
Unit I: Introduction	4
General Features of Insects	
Distribution and Success of Insects on the Earth	
Unit II: Insect Taxonomy	4
Basis of insect classification; Classification of insects up to orders	
Unit III: General Morphology of Insects	8
External Features; Head – Eyes, Types of antennae, Mouth parts w.r.t. feeding habits	
Thorax: Wings and wing articulation, Types of Legs adapted to diverse habitat	
Abdominal appendages and genitalia	
Unit IV: Physiology of Insects	28
Structure and physiology of Insect body systems - Integumentary, digestive, excretory, circulatory, respiratory, endocrine, reproductive, and nervous system	
Sensory receptors	
Growth and metamorphosis	
Unit IV: Insect Society	6
Group of social insects and their social life	
Social organization and social behaviour (w.r.t. any one example)	
Unit V: Insect Plant Interaction	4
Theory of co-evolution, role of allelochemicals in host plant mediation	
Host-plant selection by phytophagous insects, Insects as plant pests	
Unit VI: Insects as Vectors	6
Insects as mechanical and Biological vectors, Brief discussion on houseflies and mosquitoes as important insect vectors	

**BIOLOGY OF INSECTA
ZOOLOGY 504B PR**

PRACTICAL

(CREDITS 2)

1. Study of one specimen from each insect order
2. Study of different kinds of antennae, legs and mouth parts of insects
3. Study of head and sclerites of any one insect
4. Study of insect wings and their venation.
5. Study of insect spiracles
6. Methodology of collection, preservation and identification of insects.
7. Morphological studies of various castes of *Apis*, *Camponotus* and *Odontotermes*
8. Study of any three insect pests and their damages
9. Study of any three beneficial insects and their products

Field study of insects and submission of a project report on the insect diversity

SUGGESTED READINGS

- A general text book of entomology, Imms , A. D., Chapman & Hall, UK
- The Insects: Structure and function, Chapman, R. F., Cambridge University Press, UK
- Principles of Insect Morphology, Snodgrass, R. E., Cornell Univ. Press, USA
- Introduction to the study of insects, Borror, D. J., Triplehorn, C. A., and Johnson, N. F., M Saunders College Publication, USA
- The Insect Societies, Wilson, E. O., Harward Univ. Press, UK
- Host Selection by Phytophagous insects, Bernays, E. A., and Chapman, R. F., Chapman and Hall, New York, USA
- Physiological system in Insects, Klowden, M. J., Academic Press, USA
- The Insects, An outline of Entomology, Gullan, P. J. , and Cranston, P. S., Wiley Blackwell, UK
- Insect Physiology and Biochemistry, Nation, J. L., CRC Press, USA

DSE 5
COMPUTATIONAL BIOLOGY
ZOOL(H) 504C TH

THEORY	(Credits 4)
Unit 1: Introduction to Bioinformatics	5
Importance, Goal, Scope; Genomics, Transcriptomics, Systems Biology, Functional Genomics, Metabolomics, Molecular Phylogeny; Applications and Limitations of Bioinformatics	
Unit 2: Biological Databases	10
Introduction to biological databases; Primary, secondary and composite databases; Nucleic acid databases (GenBank, DDBJ, EMBL and NDB); Protein databases (PIR, SWISS-PROT, TrEMBL, PDB); Metabolic pathway database (KEGG, EcoCyc, and MetaCyc); Small molecule databases (PubChem, Drug Bank, ZINC, CSD)	
Unit 3: Data Generation and Data Retrieval	14
Generation of data (Gene sequencing, Protein sequencing, Mass spectrometry, Microarray), Sequence submission tools (BankIt, Sequin, Webin); Sequence file format (flat file, FASTA, GCG, EMBL, Clustal, Phylip, Swiss-Prot); Sequence annotation; Data retrieval systems (SRS, Entrez)	
Unit 3: Basic Concepts of Sequence Alignment	14
Scoring Matrices (PAM, BLOSUM), Methods of Alignment (Dot matrix, Dynamic Programming, BLAST and FASTA); Local and global alignment, pair wise and multiple sequence alignments; Similarity, identity and homology of sequences.	
Unit 4: Applications of Bioinformatics	7
Structural Bioinformatics (3-D protein, PDB), Functional genomics (genome-wide and high throughput approaches to gene and protein function), Drug discovery method (Basic concepts)	
Unit 5: Biostatistics	10
Introduction, calculation of standard deviation, standard error, Co-efficient of Variance, Chi-square test, Z test, t-Test	

COMPUTATIONAL BIOLOGY

ZOOL(H) 504C PR

PRACTICAL

(Credits 2)

1. Accessing biological databases
2. Retrieval of nucleotide and protein sequences from the databases.
3. To perform pair-wise alignment of sequences (BLAST) and interpret the output
4. Translate a nucleotide sequence and select the correct reading frame of the polypeptide from the output sequences
5. Predict the structure of protein from its amino acid sequence.
6. To perform a “two-sample t- test” for a given set of data
7. To learn graphical representations of statistical data with the help of computers (e.g. MS Excel).

SUGGESTED READINGS

- Ghosh Z and Mallick B. (2008). *Bioinformatics: Principles and Applications*, Oxford University Press.
- Pevsner J. (2009). *Bioinformatics and Functional Genomics*, II Edition, Wiley Blackwell.
- Zvelebil, Marketa and Baum O. Jeremy (2008). *Understanding Bioinformatics*, Garland Science, Taylor and Francis Group, USA.
- Zar, Jerrold H. (1999). *Biostatistical Analysis*, IV Edition, Pearson Education Inc and Dorling Kindersley Publishing Inc. USA
- Antonisamy, B., Christopher S. and Samuel, P. P. (2010). *Biostatistics: Principles and Practice*. Tata McGraw Hill Education Private Limited, India.
- Pagana, M. and Gavreau, K. (2000). *Principles of Biostatistics*, Duxberry Press, USA

**DSE 6
ENDOCRINOLOGY
ZOOL(H) 603A TH**

THEORY	(Credits 4)
Unit 1: Introduction to Endocrinology	12
History of endocrinology, Classification, Characteristic and Transport of Hormones, Neurosecretions and Neurohormones	
Unit 2: Epiphysis, Hypothalamo-hypophysial Axis	15
Structure of pineal gland, Secretions and their functions in biological rhythms and reproduction.	
Structure of hypothalamus, Hypothalamic nuclei and their functions, Regulation of neuroendocrine glands, Feedback mechanisms	
Structure of pituitary gland, Hormones and their functions, Hypothalamo-hypophysial portal system, Disorders of pituitary gland.	
Unit 3: Peripheral Endocrine Glands	18
Structure, Hormones, Functions and Regulation of Thyroid gland, Parathyroid, Adrenal, Pancreas, Ovary and Testis	
Hormones in homeostasis, Disorders of endocrine glands	
Unit 4: Regulation of Hormone Action	15
Hormone action at Cellular level: Hormone receptors, transduction and regulation Hormone action at Molecular level: Molecular mediators, Genetic control of hormone action	

ENDOCRINOLOGY

ZOOL(H) 603A PR

PRACTICAL

(Credits 2)

1. Dissect and display of Endocrine glands in laboratory bred rat*
2. Study of the permanent slides of all the endocrine glands
3. Compensatory ovarian/ adrenal hypertrophy *in vivo* bioassay in laboratory bred rat*
4. Demonstration of Castration/ ovariectomy in laboratory bred rat*
5. Estimation of plasma level of any hormone using ELISA
6. Designing of primers of any hormone

SUGGESTED READINGS

- General Endocrinology C. Donnell Turner Pub- Saunders Toppan
- Endocrinology: An Integrated Approach; Stephen Nussey and Saffron Whitehead.
- Oxford: BIOS Scientific Publishers; 2001.
- Hadley, M.E. and Levine J.E. 2007. Endocrinology, 6th Edition. Pearson Prentice-Hall, Pearson Education Inc., New Jersey.
- Vertebrate Endocrinology by David O. Norris,

DSE 7

FISH AND FISHERIES

ZOOL(H) 603B TH

THEORY (Credits 4)

UNIT 1: Introduction and Classification: 6

General description of fish; Account of systematic classification of fishes (upto classes); Classification based on feeding habit, habitat and manner of reproduction.

UNIT 2: Morphology and Physiology: 18

Types of fins and their modifications; Locomotion in fishes; Hydrodynamics; Types of Scales, Use of scales in Classification and determination of age of fish; Gills and gas exchange; Swim Bladder: Types and role in Respiration, buoyancy; Osmoregulation in Elasmobranchs; Reproductive strategies (special reference to Indian fishes); Electric organs; Bioluminescence; Mechanoreceptors; Schooling; Parental care; Migration

UNIT 3: Fisheries 12


Inland Fisheries; Marine Fisheries; Environmental factors influencing the seasonal variations in fish catches in the Arabian Sea and the Bay of Bengal; Fishing crafts and Gears; Depletion of fisheries resources; Application of remote sensing and GIS in fisheries; Fisheries law and regulations

Unit 4: Aquaculture 20

Sustainable Aquaculture; Extensive, semi-intensive and intensive culture of fish; Pen and cage culture; Polyculture; Composite fish culture; Brood stock management; Induced breeding of fish; Management of finfish hatcheries; Preparation and maintenance of fish aquarium; Preparation of compound diets for fish; Role of water quality in aquaculture; Fish diseases: Bacterial, viral and parasitic; Preservation and processing of harvested fish, Fishery by-products

UNIT 5: Fish in research 4

Transgenic fish, Zebrafish as a model organism in research



FISH AND FISHERIES
ZOOL(H) 603B PR

PRACTICAL

(Credits 2)

1. Morphometric and meristic characters of fishes
2. Study of *Petromyzon*, *Myxine*, *Pristis*, *Chimaera*, *Exocoetus*, *Hippocampus*, *Gambusia*, *Labeo*, *Heteropneustes*, *Anabas*
3. Study of different types of scales (through permanent slides/ photographs).
4. Study of crafts and gears used in Fisheries
5. Water quality criteria for Aquaculture: Assessment of pH, conductivity, Total solids, Total dissolved solids
6. Study of air breathing organs in *Channa*, *Heteropneustes*, *Anabas* and *Clarias*
7. Demonstration of induced breeding in Fishes (video)
8. Demonstration of parental care in fishes (video)
9. Project Report on a visit to any fish farm/ pisciculture unit/Zebrafish rearing Lab.

SUGGESTED READINGS

- Q Bone and R Moore, *Biology of Fishes*, Talyor and Francis Group, CRC Press, U.K.
- D. H. Evans and J. D. Claiborne, *The Physiology of Fishes*, Taylor and Francis Group, CRC Press, UK von der Emde, R.J. Mogdans and B.G. Kapoor. *The Senses of Fish: Adaptations for the Reception of Natural Stimuli*, Springer, Netherlands
- C.B.L. Srivastava, *Fish Biology*, Narendra Publishing House
- J.R. Norman, *A history of Fishes*, Hill and Wang Publishers
- S.S. Khanna and H.R. Singh, *A text book of Fish Biology and Fisheries*, Narendra Publishing House

**DSE 8
IMMUNOLOGY
ZOOL(H) 603C TH**

THEORY	(Credits 4)
Unit 1: Overview of Immune System	10
Historical perspective of Immunology, Early theories of Immunology, Cells and organs of the Immune system	
Unit 2: Innate and Adaptive Immunity	10
Anatomical barriers, Inflammation, Cell and molecules involved in innate immunity, Adaptive immunity (Cell mediated and humoral), Passive: Artificial and natural Immunity, Active: Artificial and natural Immunity, Immune dysfunctions (brief account of autoimmunity with reference to Rheumatoid Arthritis and tolerance, AIDS).	
Unit 3: Antigens	8
Antigenicity and immunogenicity, Immunogens, Adjuvants and haptens, Factors influencing immunogenicity, B and T-Cell epitopes	
Unit 4: Immunoglobulins	10
Structure and functions of different classes of immunoglobulins, Antigen-antibody interactions, Immunoassays (ELISA and RIA), Polyclonal sera, Hybridoma technology: Monoclonal antibodies in therapeutics and diagnosis	
Unit 5: Major Histocompatibility Complex	6
Structure and functions of MHC molecules. Endogenous and exogenous pathways of antigen processing and presentation	
Unit 6: Cytokines	4
Properties and functions of cytokines, Therapeutics Cytokines	
Unit 7: Complement System	4
Components and pathways of complement activation.	
Unit 8: Hypersensitivity	3
Gell and Coombs' classification and brief description of various types of hypersensitivities	
Unit 9: Vaccines	5
Various types of vaccines.	

IMMUNOLOGY

ZOOL(H) 603C 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

* The experiments can be performed depending upon usage of animals in UG courses.

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 9
PARASITOLOGY
ZOOL(H) 604A TH

THEORY	(CREDITS 4)
Unit I: Introduction to Parasitology	3
Brief introduction of Parasitism, Parasite, Parasitoid and Vectors (mechanical and biological vector) Host parasite relationship	
Unit II: Parasitic Protists	15
Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of <i>Entamoeba histolytica</i> , <i>Giardia intestinalis</i> , <i>Trypanosoma gambiense</i> , <i>Leishmania donovani</i> , <i>Plasmodium vivax</i>	
Unit III: Parasitic Platyhelminthes	15
Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of <i>Fasciolopsis buski</i> , <i>Schistosoma haematobium</i> , <i>Taenia solium</i> and <i>Hymenolepis nana</i>	
Unit IV: Parasitic Nematodes	15
Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of <i>Ascaris lumbricoides</i> , <i>Ancylostoma duodenale</i> , <i>Wuchereria bancrofti</i> and <i>Trichinella spiralis</i> . Study of structure, life cycle and importance of <i>Meloidogyne</i> (root knot nematode), <i>Pratylenus</i> (lesion nematode)	
Unit IV: Parasitic Arthropoda	10
Biology, importance and control of ticks, mites, <i>Pediculus humanus</i> (head and body louse), <i>Xenopsylla cheopis</i> and <i>Cimex lectularius</i>	
Unit V: Parasitic Vertebrates	2
A brief account of parasitic vertebrates; Cookicutter Shark, Candiru, Hood Mockingbird and Vampire bat	

PARASITOLOGY ZOOL(H) 604A PR

PRACTICAL

(Credits2)

- Study of life stages of *Entamoeba histolytica*, *Giardia intestinalis*, *Trypanosoma gambiense*, *Leishmania donovani* and *Plasmodium vivax* through permanent slides/micro photographs
- Study of adult and life stages of *Fasciolopsis buski*, *Schistosoma haematobium*, *Taenia solium* and *Hymenolepis nana* through permanent slides/micro photographs
- Study of adult and life stages of *Ascaris lumbricoides*, *Ancylostoma duodenale*, *Wuchereria bancrofti* and *Trichinella spiralis* through permanent slides/micro photographs
- Study of plant parasitic root knot nematode, *Meloidogyne* from the soil sample
- Study of *Pediculus humanus* (Head louse and Body louse), *Xenopsylla cheopis* and *Cimex lectularius* through permanent slides/ photographs
- Study of monogenea from the gills of fresh/marine fish [Gills can be procured from fish market as by product of the industry]
- Study of nematode/cestode parasites from the intestines of Poultry bird [Intestine can be procured from poultry/market as a by product]

Submission of a brief report on parasitic vertebrates

SUGGESTED READINGS

- Arora, D. R and Arora, B. (2001) *Medical Parasitology*. II Edition. CBS Publications and Distributors
- E.R. Noble and G.A. Noble (1982) *Parasitology: The biology of animal parasites*. V Edition, Lea & Febiger
- Ahmed, N., Dawson, M., Smith, C. and Wood, Ed. (2007) *Biology of Disease*. Taylor and Francis Group
- Parija, S. C. Textbook of medical parasitology, protozoology & helminthology (Text and colour Atlas), II Edition, All India Publishers & Distributors, Medical Books Publishers, Chennai, Delhi
- Rattan Lal Ichhpujani and Rajesh Bhatia. *Medical Parasitology*, III Edition, Jaypee Brothers Medical Publishers (P) Ltd., New Delhi
- Meyer, Olsen & Schmidt's *Essentials of Parasitology*, Murray, D. Dailey, W.C. Brown Publishers
- K. D. Chatterjee (2009). *Parasitology: Protozoology and Helminthology*. XIII Edition, CBS *Publishers* & Distributors (P) Ltd.

**REPRODUCTIVE BIOLOGY
ZOO(H) 604B 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, stem 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
ZOOL(H) 604B 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. Ovaryectomy, hysterectomy, 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.

DSE 11
WILD LIFE CONSERVATION AND MANAGEMENT
ZOOL(H) 604C TH

THEORY

(CREDITS 4)

Unit 1: Introduction to Wild Life	10
Values of wild life - positive and negative; Conservation ethics; Importance of conservation; Causes of depletion; World conservation strategies.	
Unit 2: Evaluation and management of wild life	12
Habitat analysis, Physical parameters: Topography, Geology, Soil and water; Biological Parameters: food, cover, forage, browse and cover estimation; Standard evaluation procedures: remote sensing and GIS.	
Unit 3: Management of habitats	10
Setting back succession; Grazing logging; Mechanical treatment; Advancing the successional process; Cover construction; Preservation of general genetic diversity; Restoration of degraded habitats	
Unit 4: Population estimation	14
Population density, Natality, Birth rate, Mortality, fertility schedules and sex ratio computation; Faecal analysis of ungulates and carnivores: Faecal samples, slide preparation, Hair identification, Pug marks and census method.	
Unit 5: Management planning of wild life in protected areas	5
Estimation of carrying capacity; Eco tourism / wild life tourism in forests; Concept of climax persistence; Ecology of perturbation.	
Unit 7: Management of excess population	4
Bio- telemetry; Care of injured and diseased animal; Quarantine; Common diseases of wild animal	
Unit 8: Protected areas	5
National parks & sanctuaries, Community reserve; Important features of protected areas in India; Tiger conservation - Tiger reserves in India; Management challenges in Tiger reserve.	



**WILD LIFE CONSERVATION AND MANAGEMENT
ZOOLOGY 604C PR**

PRACTICALS

(CREDITS 2)

1. Identification of flora, mammalian fauna, avian fauna, herpeto-fauna
2. Demonstration of basic equipment needed in wildlife studies use, care and maintenance (Compass, Binoculars, Spotting scope, Range Finders, Global Positioning System, Various types of Cameras and lenses)
3. Familiarization and study of animal evidences in the field; Identification of animals through pug marks, hoof marks, scats, pellet groups, nest, antlers etc.
4. Demonstration of different field techniques for flora and fauna
5. PCQ, Ten tree method, Circular, Square & rectangular plots, Parker's 2 Step and other methods for ground cover assessment, Tree canopy cover assessment, Shrub cover assessment.
6. Trail / transect monitoring for abundance and diversity estimation of mammals and bird (direct and indirect evidences)

SUGGESTED READINGS

- Caughley, G., and Sinclair, A.R.E. (1994). *Wildlife Ecology and Management*. Blackwell Science.
- Woodroffe R., Thirgood, S. and Rabinowitz, A. (2005). *People and Wildlife, Conflict or Co-existence?* Cambridge University.
- Bookhout, T.A. (1996). *Research and Management Techniques for Wildlife and Habitats*, 5 th edition. The Wildlife Society, Allen Press.
- Sutherland, W.J. (2000). *The Conservation Handbook: Research, Management and Policy*. Blackwell Sciences
- Hunter M.L., Gibbs, J.B. and Sterling, E.J. (2008). *Problem-Solving in Conservation Biology and Wildlife Management: Exercises for Class, Field, and Laboratory*. Blackwell Publishing.

GENERIC ELECTIVE COURSES

GE 1

ANIMAL CELL BIOTECHNOLOGY

ZOOL(H) 103A TH

THEORY	(CREDITS 4)
UNIT 1: Introduction	5
Concept and Scope of Biotechnology	
UNIT2:Techniques in Gene manipulation	20
Outline process of genetic engineering and recombinant DNA technology, Isolation of genes, Concept of restriction and modification: Restriction endonucleases, DNA modifying enzymes	
Cloning Vectors: Plasmids, Phage vectors, Cosmids, Phagemids, BAC, YAC, HAC. Shuttle and Expression Vectors.	
Construction of Genomic libraries and cDNA libraries	
Transformation techniques: microbial, plants and animals: Cloning in mammalian cells, Integration of DNA into mammalian genome- Electroporation and Calcium Phosphate Precipitation method.	
UNIT 3: Animal cell Culture	15
Basic techniques in animal cell culture and organ culture, Primary Culture and Cell lines, Culture media- Natural and Synthetic, Stem cells, Cryopreservation of cultures.	
Agarose and Polyacrylamide Gel Electrophoresis, Southern, Northern and Western blotting, DNA sequencing: Sanger method, Polymerase chain reaction, DNA Fingerprinting and DNA microarrays.	
UNIT 4: Fermentation	8
Different types of Fermentation: Submerged & Solid state; batch, Fed batch &Continuous; Stirred tank, Air Lift, Fixed Bed and Fluidized.	
Downstream Processing: Filtration, centrifugation, extraction, chromatography, spray drying and lyophilization.	
UNIT 5: Transgenic Animal Technology	5
Production of transgenic animals: nuclear transplantation, Retroviral method, DNA microinjection method, Dolly and Polly.	
UNIT6: Application in Health	5
Development of recombinant Vaccines, Hybridoma technology, Gene Therapy.	
Production of recombinant Proteins: Insulin and growth hormones.	
UNIT 7: Bio safety Physical and Biological containment.	2

ANIMAL CELL BIOTECHNOLOGY

ZOOL(H) 103A PR

PRACTICAL

(CREDITS 2)

1. Packing and sterilization of glass and plastic wares for cell culture.
2. Preparation of culture media.
3. Preparation of genomic DNA from *E. coli*/animals/ human.
4. Plasmid DNA isolation (pUC 18/19) and DNA quantitation using agarose gel electrophoresis (by using lambda DNA as standard).
5. Restriction digestion of lambda (λ) DNA using EcoR1 and Hind III.
6. Preparation of competent cells and Transformation of *E. coli* with plasmid DNA using CaCl₂, Selection of transformants on X-gal and IPTG (Optional).
7. Techniques: Western Blot, Southern Hybridization, DNA Fingerprinting, PCR, DNA Microarrays

SUGGESTED READINGS

- Animal Cells Culture and Media, D.C. Darling and S.J. Morgan, 1994. BIOS Scientific Publishers Limited.
- Methods in Cell Biology, Volume 57, Jennie P. Mathur and David Barnes, 1998. Animal Cell Culture Methods Academic Press.
- P.K. Gupta: Biotechnology and Genomics, Rastogi publishers (2003).
- B.D. Singh: Biotechnology, Kalyani publishers, 1998 (Reprint 2001).
- T.A. Brown: Gene cloning and DNA analysis: An Introduction, Blackwell Science (2001).
- Bernard R. Click & Jack J. Pasternak: Molecular Biotechnology, ASM Press, Washington (1998).
- Methods in Gene Biotechnology, W. Wu, M.J. Welsh, P.B. Kaufman & H.H. Zhang, 1997, CRC Press, New York
- 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 & Co., N.Y., USA

GE 2
ANIMAL DIVERSITY
ZOOL(H) 103B TH

THEORY	(CREDITS 4)
Unit 1. Protista General characters of Protozoa; Life cycle of Plasmodium	4
Unit 2. Porifera General characters and canal system in Porifera	3
Unit 3. Radiata General characters of Cnidarians and polymorphism	3
Unit 4. Aceolomates General characters of Helminthes; Life cycle of <i>Taenia solium</i>	3
Unit 5. Pseudocoelomates General characters of Nemethehelminthes; Parasitic adaptations	3
Unit 6. Coelomate Protostomes General characters of Annelida ; Metamerism.	3
Unit 7. Arthropoda General characters. Social life in insects.	4
Unit 8. Mollusca General characters of mollusca; Pearl Formation	4
Unit 9. Coelomate Deuterostomes General characters of Echinodermata, Water Vascular system in Starfish.	4
Unit 10. Protochordata Salient features	2
Unit 11. Pisces Osmoregulation, Migration of Fishes	4
Unit 12. Amphibia General characters, Adaptations for terrestrial life, Parental care in Amphibia.	5
Unit 13. Amniotes; Origin of reptiles. Terrestrial adaptations in reptiles.	6
Unit 14. Aves: The origin of birds; Flight adaptations	5
Unit 15. Mammalia Early evolution of mammals; Primates; Dentition in mammals.	7

PRACTICAL

1. Study of following specimens:
Non Chordates: *Euglena, Noctiluca, Paramecium, Sycon, Physalia, Tubipora, Metridium, Taenia, Ascaris, Nereis, Aphrodite, Leech, Peripatus, Limulus, Hermitcrab, Daphnia, Millipede, Centipede, Beetle, Chiton, Dentalium, Octopus, Asterias, and Antedon.*
Chordates: *Balanoglossus, Amphioxus, Petromyzon, Pristis, Hippocampus, Labeo, Ichthyophis/Uraeotyphlus, Salamander, Rhacophorus Draco, Uromastix, Naja, Viper, model of Archaeopteryx, any three common birds-(Crow, duck, Owl), Squirrel and Bat.*
2. Study of following Permanent Slides:
Cross section of Sycon, Sea anemone and *Ascaris*(male and female). T. S. of Earthworm passing through pharynx, gizzard, and typhlosolar intestine. Bipinnaria and Pluteus larva.
3. Temporary mounts of
 - Septal & pharyngeal nephridia of earthworm.
 - Unstained mounts of Placoid, cycloid and ctenoid scales.
4. Dissections of
 - Digestive and nervous system of Cockroach.
 - Urinogenital system of Rat

SUGGESTED BOOKS

- Barnes, R.D. (1992). Invertebrate Zoology. Saunders College Pub. USA.
- Ruppert, Fox and Barnes (2006) Invertebrate Zoology. A functional Evolutionary Approach 7th Edition, Thomson Books/Cole
- Campbell & Reece (2005). Biology, Pearson Education, (Singapore) Pvt. Ltd.
- Kardong, K. V. (2002). Vertebrates Comparative Anatomy. Function and Evolution. Tata McGraw Hill Publishing Company. New Delhi.
- Raven, P. H. and Johnson, G. B. (2004). Biology, 6th edition, Tata McGraw Hill Publications. New Delhi.

GE 3
AQUATIC BIOLOGY
ZOOL(H) 203A TH

THEORY (Credits 4) UNIT 1: Aquatic Biomes **10**

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 **30**

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 **8**

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

UNIT 4: Management of Aquatic Resources **12**

Causes of pollution: Agricultural, Industrial, Sewage, Thermal and Oil spills, Eutrophication, Management and conservation (legislations), Sewage treatment Water quality assessment- BOD and COD.

PRACTICAL

(Credits 2)

ZOOL(H)203 A PR

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

GE 4

ENVIRONMENT AND PUBLIC HEALTH

ZOOL(H) 203B TH

THEORY	(Credits 4)
UNIT I: Introduction	15
Sources of Environmental hazards, hazard identification and accounting, fate of toxic and persistent substances in the environment, dose Response Evaluation, exposure Assessment.	
UNIT II Climate Change	8
Greenhouse gases and global warming, Acid rain, Ozone layer destruction, Effect of climate change on public health	
Unit III Pollution	5
Air, water, noise pollution sources and effects, Pollution control	
Unit IV Waste Management Technologies	26
Sources of waste, types and characteristics, Sewage disposal and its management, Solid waste disposal, Biomedical waste handling and disposal, Nuclear waste handling and disposal, Waste from thermal power plants, Case histories on Bhopal gas tragedy, Chernobyl disaster, Seveso disaster and Three Mile Island accident and their aftermath.	
Unit 5 Diseases	6
Causes, symptoms and control of tuberculosis, Asthma, Cholera, Minamata disease, typhoid	



**ENVIRONMENT AND PUBLIC HEALTH
ZOOL(H) 203B PR**

PRACTICAL

(Credits 2)

1. To determine pH, Cl, SO₄, NO₃ in soil and water samples from different locations.

SUGGESTED BOOKS

- Cutter, S.L., Environmental Risk and Hazards, Prentice-Hall of India Pvt. Ltd., New Delhi, 1999.
- Kolluru Rao, Bartell Steven, Pitblado R and Stricoff “Risk Assessment and Management Handbook”, McGraw Hill Inc., New York, 1996.
- Kofi Asante Duah “Risk Assessment in Environmental management”, John Wiley and sons, Singapore, 1998.
- Kasperson, J.X. and Kasperson, R.E. and Kasperson, R.E., Global Environmental Risks, V.N. University Press, New York, 2003.
- Joseph F Louvar and B Diane Louver Health and Environmental Risk Analysis fundamentals with applications, Prentice Hall, New Jersey 1997.

GE 5

EXPLORING THE BRAIN: STRUCTURE AND FUNCTION ZOO(H) 305A TH

THEORY

(Credits 4)

Unit 1: Introduction:

6

Early and Nineteenth century views of the Brain; Neuroscience today; Evolution of brain in vertebrates

Unit 2: Neurons and Glia:

6

Neurons – Soma, Axon, Dendrite; Classification of Neurons; Glia – Astrocytes, Myelinating Glia, Non-neuronal cells

Unit 3: Evolution and Adaptation of Brain:

8

Brain evolution and behavioral adaptation; Theories of brain evolution – involving addition of structure or areas, involving new formation and reorganization of circuits.

Unit 4: Organization of the Brain:

8

Anatomical references, Cerebrum, cerebellum, brain stem, spinal cord; Cranial nerves, Meninges, ventricular system; CT and MRI imaging of the brain

Unit 5: Understanding Brain Structure through Development: 10

Formation of neural tube, Primary brain vesicles; Differentiation of forebrain, midbrain and hindbrain. Cerebral cortex – neocortical evolution and structure-function relationship

Unit 6: Chemical Control of Brain and Behaviour:

10

Structure and connection of the secretory hypothalamus; Diffuse modulatory systems of the brain – noradrenergic, serotonergic, dopaminergic and cholinergic system; Drugs and diffuse modulatory systems.

Unit 7: Rhythms of the Brain:

6

Electroencephalogram; Sleep – why do we sleep, Non-REM and REM sleep, neural mechanisms of sleep; Circadian rhythms.

Unit 8: Mental illness and the Brain:

6

Psychosocial and biological approaches to mental illness; Anxiety disorders; Mood disorders; Schizophrenia.

EXPLORING THE BRAIN: STRUCTURE AND FUNCTION

ZOOL(H) 305A PR

PRACTICAL

(CREDITS 2)

1. Dissection and study of *Drosophila* nervous system using GFP reporter.
2. Observation and quantitation of *Drosophila* photoreceptor neurons in healthy and diseased condition.

SUGGESTED READINGS

1. Neuroscience: Exploring the Brain by Mark F. Bear, Barry W. Connors and Michael A. Paradiso.
2. Comparative vertebrate Neuroanatomy by Ann B. Butler and William Hoods.

Project work/ Home assignment

GE 6

FOOD, NUTRITION AND HEALTH

ZOOL(H) 305B TH

THEORY	(Credits 4)
Unit 1: Basic concept of food and nutrition	10
Food Components and food-nutrients	
Concept of a balanced diet, nutrient needs and dietary pattern for various groups-adults, pregnant and nursing mothers, infants, school children, adolescents and elderly	
Unit 2: Nutritional Biochemistry:	20
Carbohydrates, Lipids, Proteins- Definition, Classification, their dietary source and role	
Vitamins- Fat-soluble and Water-soluble vitamins- their dietary source and importance	
Minerals- Iron, calcium, phosphorus, iodine, selenium and zinc: their biological functions	
Unit 3: Health	15
Introduction to health- Definition and concept of health	
Major nutritional Deficiency diseases- Protein Energy Malnutrition (kwashiorkor and marasmus), Vitamin A deficiency disorders, Iron deficiency disorders, Iodine deficiency disorders- their causes, symptoms, treatment, prevention and government programmes, if any.	
Life style related diseases- hypertension, diabetes mellitus, and obesity- their causes and prevention through dietary and lifestyle modifications	
Social health problems- smoking, alcoholism, drug dependence and Acquired Immuno Deficiency Syndrome (AIDS) - their causes, treatment and prevention	
Common ailments- cold, cough, and fevers, their causes and treatment	
Unit 4: Food hygiene:	15
Potable water- sources and methods of purification at domestic level	
Food and Water borne infections: Bacterial infection: Cholera, typhoid fever, dysentery; Viral infection: Hepatitis, Poliomyelitis, Protozoan infection: amoebiasis, giardiasis; Parasitic infection: taeniasis and ascariasis their transmission, causative agent, sources of infection, symptoms and prevention	
Brief account of food spoilage: Causes of food spoilage and their preventive measures	

PRACTICAL

(Credits 2)

ZOOL(H) 305B PR

1. To detect adulteration in a) Ghee b) Sugars c) Tea leaves and d) Turmeric
3. Estimation of Lactose in milk
4. Ascorbic acid estimation in food by titrimetry
5. Estimation of Calcium in foods by titrimetry
6. Study of the stored grain pests from slides/ photograph(*Sitophilus oryzae*, *Trogoderma granarium*, *Callosobruchus chinensis* and *Tribolium castaneum*): their identification, habitat and food sources, damage caused and control. Preparation of temporary mounts of the above stored grain pests.
7. Project- Undertake computer aided diet analysis and nutrition counseling for different age groups.

OR

Identify nutrient rich sources of foods (**fruits and vegetables**), their seasonal availability and price

OR

Study of nutrition labeling on selected foods


SUGGESTED BOOKS

- Mudambi, SR and Rajagopal, MV. Fundamentals of Foods, Nutrition and Diet Therapy; Fifth Ed; 2007; New Age International Publishers
- Srilakshmi B. Nutrition Science; 2002; New Age International (P) Ltd.
- Srilakshmi B. Food Science; Fourth Ed; 2007; New Age International (P) Ltd.
- Swaminathan M. Handbook of Foods and Nutrition; Fifth Ed; 1986; BAPPCO.
- Bamji MS, Rao NP, and Reddy V. Text Book of Human Nutrition; 2009; Oxford & IBH Publishing Co. Pvt Ltd.
- Wardlaw GM, Hampl JS. Perspectives in Nutrition; Seventh Ed; 2007; McGraw Hill.
- Lakra P, Singh MD. Textbook of Nutrition and Health; First Ed; 2008; Academic Excellence.
- Manay MS, Shadaksharaswamy. Food-Facts and Principles; 1998; New Age International (P) Ltd.
- Gibney et al. Public Health Nutrition; 2004; Blackwell Publishing

GE 7

HUMAN PHYSIOLOGY ZOOLOGY 405A TH

THEORY	(CREDITS 4)
Unit 1: Digestion and Absorption of Food Structure and function of digestive glands; Digestion and absorption of carbohydrates, fats and proteins; Nervous and hormonal control of digestion (<i>in brief</i>)	12
Unit 2: Functioning of Excitable Tissue (Nerve and Muscle) Structure of neuron, Propagation of nerve impulse (myelinated and non-myelinated nerve fibre); Structure of skeletal muscle, Mechanism of muscle contraction (Sliding filament theory), Neuromuscular junction	10
Unit 3: Respiratory Physiology Ventilation, External and internal Respiration, Transport of oxygen and carbon dioxide in blood, Factors affecting transport of gases.	6
Unit 4: Renal Physiology Functional anatomy of kidney, Mechanism and regulation of urine formation,	8
Unit 5: Cardiovascular Physiology Structure of heart, Coordination of heartbeat, Cardiac cycle, ECG	10
Unit 6: Endocrine and Reproductive Physiology Structure and function of endocrine glands (pituitary, thyroid, parathyroid, pancreas, adrenal, ovaries, and testes), Brief account of spermatogenesis and oogenesis, Menstrual cycle	14



HUMAN PHYSIOLOGY
ZOOL(H) 405A PR


PRACTICAL

(CREDITS 2)

1. Preparation of temporary mounts: Neurons and Blood film.
2. Preparation of haemin and haemochromogen crystals.
3. Estimation of haemoglobin using Sahli's haemoglobinometer.
4. Examination of permanent histological sections of mammalian oesophagus, stomach, duodenum, rectum, lung, kidney, thyroid, pancreas, adrenal, testis, ovary.

SUGGESTED READINGS

- Tortora, G.J. and Derrickson, B.H. (2009). *Principles of Anatomy and Physiology*, XII Edition, John Wiley and Sons, Inc.
- Widmaier, E.P., Raff, H. and Strang, K.T. (2008). *X c p f g t ø u " " J w o c p Physiology*, XI Edition, McGraw Hill.
- Guyton, A.C. and Hall, J.E. (2011). *Textbook of Medical Physiology*, XII Edition, Harcourt Asia Pvt. Ltd/ W.B. Saunders Company.
- Marieb, E. (1998). *Human Anatomy and Physiology*, IV Edition, Addison-Wesley.
- Kesar, S. and Vashisht, N. (2007). *Experimental Physiology*, Heritage Publishers.
- Prakash, G. (2012). *Lab Manual on Blood Analysis and Medical Diagnostics*, S. Chand and Company Ltd.



GE 8
INSECT VECTORS AND DISEASES
ZOOL(H) 405B 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: Hemiptera 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
ZOOL(H) 405B 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, Phthirus 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

SKILL ENHANCEMENT COURSES

SEC 1

APICULTURE

ZOOL(H) 304ATH

(CREDITS 4)
(3+1)

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.
- Singh S., *Beekeeping in India*, Indian council of Agricultural Research, NewDelhi.

Tutorial 601 Credit

SEC 62

AQUARIUM FISH KEEPING ZOOL(H) 304B 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 Aquarium fishes 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 601 Credit

**SEC 3
MEDICAL DIAGNOSTICS**

ZOOL(H) 404A 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. *Textbook of Medical Physiology*, Saunders
- Robbins and Cortan, *Pathologic Basis of Disease*, VIII Edition, Saunders
- Prakash, G. (2012), *Lab Manual on Blood Analysis and Medical Diagnostics*, S. Chand and Co. Ltd.

Tutorial 601 Credit

SEC 4

RESEARCH METHODOLOGY ZOO(H) 404B 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.
- Wadhwa, 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

SEC 5
SERICULTURE
ZOOL(H) 404C TH

(CREDITS 4)

(3+01)

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

- Manual on Sericulture; Food and Agriculture Organisation, Rome 1976
- Handbook of Practical Sericulture: S.R. Ullal and M.N. Narasimhanna CSB, Bangalore
- Silkworm Rearing and Disease of Silkworm, 1956, Ptd. By Director of Ptg., Stn. & Pub. Govt. Press, 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, Japan 1972.
- 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 601 Credit

**END SEMESTER EXAMINATION (ESE) OF ZOOLOGY HONOURS 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 + Practical + 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
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