UNIVERSITY OF KALYANI

CBCS CURRICULUM FOR THREE YEARS

UNDER-GRADUATE COURSE IN

ZOOLOGY (HONOURS)

COURSES EFFECTIVE FROM THE ACADEMIC SESSION

2018-19

SYLLABUS OF COURSES TO BE OFFERED

Core Courses (CC), Discipline-specific Elective (DSE), Generic Elective (GE), Skill Enhancement Courses (SEC) and Ability Enhancement Compulsory Courses (AECC)

PREAMBLE

In response to the notification (No. FCUG/KU-914/17-18 dt. 16.11.2017) of University of Kalyani, the Undergraduate Board of Studies in Zoology of University of Kalyani has revised and modified syllabi of B.Sc. (Hons) with Zoology under Semester and CBCS (Choice Based Credit System) scheme following the recommendations and Guidelines of UGC (University Grants Commission) and WBHEC (West Bengal Higher Education Council).

The University Grants Commission (UGC) has taken various measures by means of formulating regulations and guidelines and updating them, in order to improve the higher education system and maintain minimum standards and quality across the Higher Educational Institutions in India. The various steps that the UGC has initiated are all targeted towards bringing equity, efficiency and excellence in the Higher Education System of country. These steps include introduction of innovation and improvements in curriculum structure and content, the teaching-learning process, the examination and evaluation systems, along with governance and other matters. The introduction of Choice Based Credit System is one such attempt towards improvement and bringing in uniformity of system with diversity of courses across all higher education institutes in the country. The CBCS provides an opportunity for the students to choose courses from the prescribed courses comprising of core, elective, skill enhancement or ability enhancement courses. The courses shall be evaluated following the grading system, is considered to be better than conventional marks system. This will make it possible for the students to move across institutions within India to begin with and across countries for studying courses of their choice. The uniform grading system shall also prove to be helpful in assessment of the performance of the candidates in the context of employment.

Outline of the Choice Based Credit System being introduced:

1. **Core Course (CC):** A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course.

2. **Elective Course:** Generally, a course which can 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 student's proficiency/skill is termed as an Elective Course.

2.1 **Discipline Specific Elective Course (DSE):** Elective courses that are offered by the main discipline/subject of study is referred to as Discipline Specific Elective. The University/Institute may also offer discipline related Elective courses of interdisciplinary nature (to be offered by main discipline/subject of study).

2.2 **Generic Elective Course (GE):** An elective course chosen generally from an unrelated discipline/subject, with an intention to seek exposure is called a Generic Elective.

3. **Ability Enhancement Courses/ Skill Enhancement Courses:**

3.1 **Ability Enhancement Compulsory Course (AECC):** Ability enhancement courses are the courses based upon the content that leads to Knowledge enhancement. These are (i) Environmental Science (Sem I for Hons.), (ii) Compulsory English/Bengali/Hindi/Arabic as MIL (Sem II for Hons.) and are mandatory for all disciplines.

3.2 **Skill Enhancement Course (SEC):** These courses may be chosen from a pool of courses designed to provide value-based and/or skill-based instruction.

A. TOTAL Number of courses in UG-CBCS (B.Sc. ZOOLOGY Honours):

Types of course	Core course (CC)	Elective course		Ability enhancement course		TOTAL
		Discipline specific elective course (DSE)	Generic elective course (GE)	Ability Enhancement compulsory course (AECC)	Skill Enhancement course (SEC)	
No. of course	14	4	4	2	2	26
Credit/course	6	6	6	2	2	140

Given that each credit/theoretical course will comprise 10 Lectures of 1hr duration each and each credit/practical course will comprise 10 hands-on classes of 2hr duration each.

Structure of B.Sc. Honours Zoology under CBCS

Core Courses (CC) – 14 compulsory courses

Semester	Course Name	Course Detail	Credits
I	ZOOL-H-CC-T-01	Non-chordates I: Protista to Pseudocoelomates	4
	ZOOL-H-CC-P-01	Non-chordates I: Protista to Pseudocoelomates Lab	2
	ZOOL-H-CC-T-02	Non-chordates II: Coelomates	4
	ZOOL-H-CC-P-02	Non-chordates II: Coelomates Lab	2
II	ZOOL-H-CC-T-03	Perspectives in Ecology	4
	ZOOL-H-CC-P-03	Perspectives in Ecology Lab	2
	ZOOL-H-CC-T-04	Cell Biology	4
	ZOOL-H-CC-P-04	Cell Biology Lab	2
III	ZOOL-H-CC-T-05	Diversity of Chordates	4
	ZOOL-H-CC-P-05	Diversity of Chordates Lab	2
	ZOOL-H-CC-T-06	Animal Physiology: Controlling and Coordinating Systems	4
	ZOOL-H-CC-P-06	Animal Physiology: Controlling and Coordinating Systems Lab	2
	ZOOL-H-CC-T-07	Fundamentals of Biochemistry	4
	ZOOL-H-CC-P-07	Fundamentals of Biochemistry Lab	2
IV	ZOOL-H-CC-T-08	Comparative Anatomy of Vertebrates	4
	ZOOL-H-CC-P-08	Comparative Anatomy of Vertebrates Lab	2
	ZOOL-H-CC-T-09	Animal Physiology: Life Sustaining Systems	4
	ZOOL-H-CC-P-09	Animal Physiology: Life Sustaining Systems Lab	2
	ZOOL-H-CC-T-10	Immunology	4
	ZOOL-H-CC-P-10	Immunology Lab	2

Semester	Course Name	Course Detail	Credits
V	ZOOL-H-CC-T-11	Molecular Biology	4
	ZOOL-H-CC-P-11	Molecular Biology Lab	2
	ZOOL-H-CC-T-12	Principles of Genetics	4
V	ZOOL-H-CC-P-12	Principles of Genetics Lab	2
VI	ZOOL-H-CC-T-13	Developmental Biology	4
	ZOOL-H-CC-P-13	Developmental Biology Lab	2
	ZOOL-H-CC-T-14	Evolutionary Biology	4
	ZOOL-H-CC-P-14	Evolutionary Biology Lab	2

Discipline Specific Elective Courses (DSE) – Six courses offered, any four to be opted for in Semesters V and VI, two in each semester*

Semester V (any two from below)			Semester VI (any two from below)*		
ZOOL-H-DSE – 1	**ZOOL-H-DSE – 2**	**ZOOL-H-DSE – 3**	**ZOOL-H-DSE – 4**	**ZOOL-H-DSE – 5**	**ZOOL-H-DSE – 6**
Fish and Fisheries	Microbiology	Wildlife conservation and Management	Parasitology	Endocrinology	Biology of Insecta
*Provided that a candidate will, in Sem. VI, be able to opt for a Dissertation *in lieu* of a DSE paper, on a topic to be chosen from the paper that was opted out of.					

Generic Elective Courses (GEC) – Courses offered to students of other Departments

Semester I	Semester II	Semester III	Semester IV
ZOOL-H-GE-1	**ZOOL-H-GE-2**	**ZOOL- H-GE-3**	**ZOOL-H-GE-4**
Animal Diversity and Taxonomy	Comparative Anatomy, Developmental Biology of Vertebrates and Ecology	Cell Biology, Genetics and Evolutionary Biology	Physiology and Biochemistry

Ability Enhancement Compulsory Courses (AECC) – Two compulsory courses in Semesters I & II

(i) Environmental Science (Sem I for Hons.),
(ii) Compulsory English/Bengali/Hindi/Arabic as MIL (Sem II for Hons.)

Skill Enhancement Courses (SEC): Two courses in Semesters III and IV, any one to be chosen from choices given below for each semester

Semester III		Semester IV	
ZOOL-H-SEC – 1	**ZOOL-H-SEC – 2**	**ZOOL-H-SEC – 3**	**ZOOL-H-SEC – 4**
Aquarium Fish Keeping	Apiculture	Sericulture	Medical Diagnostic Techniques

TABLE-1. DETAILS OF COURSES & CREDIT OF B.SC. ZOOLOGY (HONOURS) UNDER CBCS

S. No.	**Particulars of Course**	**Credit Point**
1.	**Core Course: 14 Papers**	**Theory + Practical**
1.A.	Core Course: Theory (14 papers)	14x4 = 56
1.B.	Core Course (Practical/Tutorial) *(14 papers)	14x2 = 28
2.	**Elective Courses: (8 papers)**	
2.A.	A. Discipline specific Elective (DSE)(4 papers)	4x4 = 16
2.B.	DSE (Practical)* (4 papers)	4x2 =8
2C.	General Elective (GE) (Interdisciplinary) (4 papers)	4x4 = 16
2.D.	GE (Practical)* (4 papers)	4x2 =8
# Optional Dissertation/ Project Work in place of* one *DSE paper (6 credits) in 6th semester		
3. Ability Enhancement Courses		
A.	AECC (2 papers of 2 credits each) ENVS, English Communication/ MIL	2x2 = 4
B.	Skill Enhancement Course(SEC) (2 papers of 2 credits each)	2x2 = 4
Total Credit:		**140**

TABLE-2: SEMESTER-WISE DISTRIBUTION OF COURSE & CREDITS IN B.SC. ZOOLOGY HONOURS

Courses/ (Credits)	**Sem-I**	**Sem-II**	**Sem-III**	**Sem-IV**	**Sem-V**	**Sem-VI**	**Total No. of Courses**	**Total**
CC (6)	2	2	3	3	2	2	14	84
DSE (6)	--	--	--	--	2	2	04	24
GE (6)	1	1	1	1	--	--	04	24
AECC (2)	1 (ENVS)	1 (MIL)	--	--	--	--	02	04
SEC (2)	--	--	1	1	--	--	02	04
Total No. of Course/ Sem.	4	4	5	5	4	4	26	--
Total Credit/ Semester	**20**	**20**	**26**	**26**	**24**	**24**	--	**140**

Full marks of a course, having 6 credits/ 2credits, along with distribution of marks:

Full marks of each course of B.Sc. (Hons.), carrying **6 credits**, be **75**
Full marks of each course B.Sc. (Hons.), carrying **2 credits**, be **50**

For practical, distribution of 75 marks be as follows:

Class **Attendance cum Internal Assessment: 20% of 75 marks = 15 marks** of which 5 marks be reserved for theoretical class attendance in the following manner:

Attendance **50%** & above but **below 60% - 2** marks
Attendance 60% & above but **below 75% - 3** marks
Attendance 75% & above but **below 90% - 4** marks
Attendance **90% & above - 5** marks

and **10 marks** be reserved for **class test/ assignment/ seminar** (theoretical -5 & practical -5).

Semester-end-Practical Examination of each course = **20 marks**, distribution of which may be as under:

a) Lab. Note Book = 05
b) Viva- voce = 05
c) Experiment = 10

Semester-end-Theoretical Examination of each course = **40 marks**, distribution of which may be as under:

a) Answer 05 questions out of 08 carrying 02 marks each = 05 x 02 = 10
b) Answer 02 questions out of 04 carrying 05 marks each = 02 x 05 = 10
c) Answer 02 questions out of 04 carrying 10 marks each = 02 x 10 = 20

However, questions, carrying 5 or 10 marks, need not necessarily to be a single question.

In the **Semester-end-Examination of AECC**, carrying **2 credits (ie. FM 50):**

MCQ be set and **OMR** sheet be used. Under AECC, **ENVS be taught in the 1st Semester** and **communicative Eng./ MIL be taught in the 2nd Semester**.

Distribution of 50 marks (for each SEC) be as follows:

Internal Assessment: 20% of 50 marks = **10 marks** be reserved for **class test/ assignment/ seminar**.
40 marks be allotted for Semester-end-Theoretical Examination of each course, distribution of which may be as under:

a) Answer 05 questions out of 08 carrying 02 marks each = 05 x 02 = 10
b) Answer 02 questions out of 04 carrying 05 marks each = 02 x 05 = 10
c) Answer 02 questions out of 04 carrying 10 marks each = 02 x 10 = 20

However, questions, carrying 5 or 10 marks, need not necessarily to be a single question.

Distribution of **total marks (1850)**, equivalent to **148 credits**, **of all courses** to be studied by a student of B.Sc. Hons.

a) **CC** = 75x14 = **1050**
b) **DSE** = 75x4 = **300**
c) **GE** = 75x4 = **300**
d) **AECC** = 50x2 = **100**
e) **SEC** = 50x2 = **100**

University of Kalyani

Course Structure: UG (Zoology Honours) CBCS Curriculum

Semester I			
Course Name	**Course Detail**	**Course wise Class**	**Credits**
ZOOL-H-CC-T-01	Non-chordates I: Protista to Pseudocoelomates	Core (60L)	4
ZOOL-H-CC-P-01	Non-chordates I: Protista to Pseudocoelomates Lab	Core (30P)	2
ZOOL-H-CC-T-02	Non-chordates II: Coelomates	Core (60L)	4
ZOOL-H-CC-P-02	Non-chordates II: Coelomates Lab	Core (30P)	2
ZOOL-H -GE-T-01	Animal Diversity and Taxonomy	General Elective (60L)	4
ZOOL-H -GE-P-01	Animal Diversity and Taxonomy Lab	General Elective (30P)	2
ZOOL-H-AECC-01	English Communication/ Environmental Science	Ability Enhancement Compulsory (30L)	2
TOTAL FOUR (4) COURSES			**20**
Semester II			
Course Name	**Course Detail**	**Course wise Class**	**Credits**
ZOOL-H-CC-T-03	Perspectives in Ecology	Core (60L)	4
ZOOL-H-CC-P-03	Perspectives in Ecology Lab	Core (30P)	2
ZOOL-H-CC-T-04	Cell Biology	Core (60L)	4
ZOOL-H-CC-P-04	Cell Biology Lab	Core (30P)	2
ZOOL-H -GE-T-02	Comparative Anatomy, Developmental Biology of Vertebrates and Ecology	General Elective (60L)	4
ZOOL-H -GE-P-02	Comparative Anatomy, Developmental Biology of Vertebrates and Ecology Lab	General Elective (30P)	2

Semester II			
Course Name	**Course Detail**	**Course wise Class**	**Credits**
UG-H-AECC-02	Environmental Science/ English Communication	Ability Enhancement Compulsory (30L)	2
TOTAL FOUR (4) COURSES			**20**
Semester III			
Course Name	**Course Detail**	**Course wise Class**	**Credits**
ZOOL-H-CC-T-05	Diversity of Chordates	Core (60L)	4
ZOOL-H-CC-P-05	Diversity of Chordates Lab	Core (30P)	2
ZOOL-H-CC-T-06	Animal Physiology: Controlling and Coordinating Systems	Core (60L)	4
ZOOL-H-CC-P-06	Animal Physiology: Controlling and Coordinating Systems Lab	Core (30P)	2
ZOOL-H-CC-T-07	Fundamentals of Biochemistry	Core (60L)	4
ZOOL-H-CC-P-07	Fundamentals of Biochemistry Lab	Core (30P)	2
ZOOL-H-SEC-T-01	**Any One** to be chosen: a. Aquarium Fish Keeping b. Apiculture	Skill Enhancement (30L)	2
ZOOL-H -GE-T-03	Cell Biology, Genetics and Evolutionary Biology	General Elective (60L)	4
ZOOL-H -GE-P-03	Cell Biology, Genetics and Evolutionary Biology Lab	General Elective (30P)	2
TOTAL FIVE (5) COURSES			**26**
Semester IV			
Course Name	**Course Detail**	**Course wise Class**	**Credits**
ZOOL-H-CC-T-08	Comparative Anatomy of Vertebrates	Core (60L)	4
ZOOL-H-CC-P-08	Comparative Anatomy of Vertebrates Lab	Core (30P)	2
ZOOL-H-CC-T-09	Animal Physiology: Life Sustaining Systems	Core (60L)	4
ZOOL-H-CC-P-09	Animal Physiology: Life Sustaining Systems Lab	Core (30P)	2

Semester IV			
Course Name	**Course Detail**	**Course wise Class**	**Credits**
ZOOL-H-CC-T-10	Immunology	Core (60L)	4
ZOOL-H-CC-P-10	Immunology Lab	Core (30P)	2
ZOOL-H-SEC-T-02	**Any One** to be chosen: a. Sericulture b. Medical Laboratory Technology	Skill Enhancement (30L)	2
ZOOL-H-GE-T-04	Physiology and Biochemistry	General Elective (60L)	4
ZOOL-H-GE-P-04	Physiology and Biochemistry Lab	General Elective (30P)	2
TOTAL FIVE (5) COURSES			**26**
Semester V			
Course Name	**Course Detail**	**Course wise Class**	**Credits**
ZOOL-H-CC-T-11	Molecular Biology	Core (60L)	4
ZOOL-H-CC-P-11	Molecular Biology Lab	Core (30P)	2
ZOOL-H-CC-T-12	Principles of Genetics	Core (60L)	4
ZOOL-H-CC-P-12	Principles of Genetics Lab	Core (30P)	2
ZOOL-H-DSE-T-01	**Any Two** to be chosen: a. Fish and Fisheries, Fish and Fisheries Lab b. Microbiology, Microbiology Lab c. Wildlife conservation and Management, Wildlife conservation and Management Lab	DSE (60L)	4
ZOOL-H-DSE-P-01		DSE (30P)	2
ZOOL-H-DSE-T-02		DSE (60L)	4
ZOOL-H-DSE-P-02		DSE (30P)	2
TOTAL FOUR (4) COURSES			**24**
Semester VI			
Course Name	**Course Detail**	**Course wise Class**	**Credits**
ZOOL-H-CC-T-13	Developmental Biology	Core (60L)	4
ZOOL-H-CC-P-13	Developmental Biology Lab	Core (30P)	2
ZOOL-H-CC-T-14	Evolutionary Biology	Core (60L)	4
ZOOL-H-CC-P-14	Evolutionary Biology Lab	Core (30P)	2
ZOOL-H-DSE-T-03	**Any Two** to be chosen: a. Parasitology, Parasitology Lab b. Endocrinology, Endocrinology Lab c. Biology of Insecta, Biology of Insecta Lab	DSE (60L)	4
ZOOL-H-DSE-P-03		DSE (30P)	2
ZOOL-H-DSE-T-04		DSE (60L)	4
ZOOL-H-DSE-P-04		DSE (30P)	2
TOTAL FOUR (4) COURSES			**24**

Core Subjects (CC) Syllabus

Course Code	Course Title	Total credits (FM)	Total no. of Lectures	Total no. of hours
ZOOL-H-CC-T-01	Non-chordates I: Protista to Pseudocoelomates	4 (40)	60	60

Unit 1: Basics of Animal Classification

1. Definitions: Classification, Systematics and Taxonomy; Taxonomic Hierarchy, Taxonomic types.
2. Codes of Zoological Nomenclature; Principle of Priority; Synonymy and Homonymy.

Unit 2: Protista and Metazoa

1. Protozoa
    a. General characteristics and Classification up to phylum (according to Levine et. al., 1981) Locomotion in *Euglena*, *Paramoecium* and *Amoeba*; Conjugation in *Paramoecium.*
    b. Life cycle and pathogenicity of *Plasmodium vivax* and *Entamoeba histolytica*
2. Metazoa
    a. Evolution of symmetry and segmentation of Metazoa

Unit 3: Porifera

General characteristics and Classification up to classes; Canal system in sponges.

Unit 4: Cnidaria

1. General characteristics and Classification up to classes
2. Metagenesis in *Obelia*
3. Polymorphism in Cnidaria
4. Corals and coral reef diversity, function & conservation

Unit 5: Ctenophora

General characteristics

Unit 6: Platyhelminthes

1. General characteristics and Classification up to classes
2. Life cycle and pathogenicity and control measures of *Fasciola hepatica.*

Unit 7: Nematoda

1. General characteristics and Classification up to classes
2. Life cycle, and pathogenicity and control measures of *Ascaris lumbricoides* and *Wuchereria bancrofti*
3. Parasitic adaptations in helminths

Reference Books

- Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, VIII Edition. Holt Saunders International Edition.
- Invertebrates by Brusca & Brusca. Second edition, 2002.

Classification for metazoans to be followed from: Rupert and Barnes, 1994, 6th Edition.

Course Code	Course Title	Total credits (FM)	Total no. of Lectures	Total no. of hours
ZOOL-H-CC-P-01	Non-chordates I: Protista to Pseudocoelomates Lab	2 (20)	30	60

List of Practicals:

1. Identification of *Amoeba*, *Euglena*, *Entamoeba*, *Opalina*, *Paramecium*, *Plasmodium vivax* and/or *Plasmodium falciparum* (from the prepared slides)
2. Identification of *Sycon*, Neptune's Cup, *Obelia*, *Physalia*, *Millepora*, *Aurelia*, *Tubipora*, *Corallium*, *Alcyonium*, *Gorgonia*, *Metridium*, *Pennatula*, *Fungia*, *Meandrina*, *Madrepora*
3. Identification and significance of adult *Fasciola hepatica*, *Taenia solium* and *Ascaris lumbricoides*
4. Staining/mounting of any protozoa/helminth from gut of cockroach

1 - 3: Identification upto subclass, with characters, with drawing and labeling.
4: Mounting, with submission of slides.

Course Code	Course Title	Total credits (FM)	Total no. of Lectures	Total no. of hours
ZOOL-H-CC-T-02	Non-Chordates II: Coelomates	4 (40)	60	60

Unit 1: Introduction

Evolution of coelom and metamerism

Unit 2: Annelida

1. General characteristics and Classification up to classes Excretion in Annelida through nephridia.
2. Metamerism in Annelida.

Unit 3: Arthropoda

1. General characteristics and Classification up to classes.
2. Respiration in Arthropoda
3. Metamorphosis in Lepidopteran Insects.
4. Social life in termite

Unit 4: Onychophora

General characteristics and Evolutionary significance

Unit 5: Mollusca

1. General characteristics and Classification up to classes
2. Nervous system and torsion in Gastropoda

Unit 6: Echinodermata

1. General characteristics and Classification up to classes
2. Water-vascular system in Asteroidea
3. Larval forms in Echinodermata
4. Affinities with Chordates

Unit 7: Hemichordata

General characteristics of phylum Hemichordata. Relationship with non-chordates and chordates

Reference Books

- Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, VIII Edition. Holt Saunders International Edition
- The Invertebrates: A New Synthesis, III Edition, Blackwell Science

Note: Classification to be followed from Rupert and Barnes, 1994, 6th Edition.

Course Code	Course Title	Total credits (FM)	Total no. of Lectures	Total no. of hours
ZOOL-H-CC-P-02	Non-Chordates II: Coelomates Lab	2 (20)	30	60

List of Practicals

1. Study of following specimens:
    a. Annelids - *Aphrodite, Nereis, Sabella, Chaetopterus, Pheretima, Hirudinaria*
    b. Arthropods – *Limulus, Palaemon, Daphnia, Balanus, Sacculina, Cancer, Eupagurus, Scolopendra, Julus, Bombyx, Periplaneta*, termites and honey bees *Onychophora – Peripatus*
    c. Molluscs - *Chiton, Pila, Unio, Sepia, Octopus*
    d. Echinodermates - *Asterias, 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 (Diagram/study of mounted specimen)
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)

1, a – e, 2, 3: Identification upto subclass, with characters, with drawing and labelling.

Course Code	Course Title	Total credits (FM)	Total no. of Lectures	Total no. of hours
ZOOL-H-CC-T-03	Perspectives in Ecology	4 (40)	60	60

Unit 1: Introduction to Ecology

Autecology and synecology, Levels of organization, Laws of limiting factors.

Unit 2: Population

1. Unique and group attributes of population: Demographic factors, life tables, fecundity tables, survivorship curves, dispersal.
2. Geometric, exponential and logistic growth, equation, r and K strategies Population regulation - density-dependent and independent factors.
3. Gause's Principle with laboratory and field examples, Lotka-Volterra equation for competition, predator-prey cycling.

Unit 3: Community

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

Unit 4: Ecosystem

1. Pond ecosystem 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
2. Nitrogen cycle

Unit 5: Applied Ecology

1. Wildlife Conservation (in-situ and ex-situ conservation).
2. Management strategies for tiger conservation; Wild life protection act (1972).

Reference Books

- 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
- Ecology: Theories & Application (2001). 4th Edition by Peter Stilling.
- Ecology by Cain, Bowman & Hacker. 3rd edition. Sinauer associates

Course Code	Course Title	Total credits (FM)	Total no. of Lectures	Total no. of hours
ZOOL-H-CC-P-03	Perspectives in Ecology Lab	2 (20)	30	60

List of Practicals

1. Study of life tables and plotting of survivorship curves of different types from the hypothetical/real data provided
2. Determination of population parameters (dominance, diversity, frequency) in a natural/hypothetical community by quadrate method and calculation of Shannon-Weiner diversity index and Importance Value Index for the same community.
3. Study of an aquatic ecosystem: Phytoplankton and zooplankton, determination of pH, and Dissolved Oxygen content (Winkler's method), Chemical Oxygen Demand and free CO_2
4. Report on a visit to National Park/Biodiversity Park/Wild life sanctuary

1, 2: Theoretical, dry-lab.
4: Major excursion.

Course Code	Course Title	Total credits (FM)	Total no. of Lectures	Total no. of hours
ZOOL-H-CC-T-04	Cell Biology	4 (40)	60	60

Unit 1: Overview of Cells

Basic structure of Prokaryotic and Eukaryotic cells, Viruses

Unit 2: Plasma Membrane

1. Ultra structure and composition of Plasma membrane: Fluid mosaic model
2. Transport across membrane: Active and Passive transport, Facilitated transport
3. Cell junctions: Tight junctions, Gap junctions, Desmosomes

Unit 3: Cytoplasmic organelles I

1. Structure and Functions: Endoplasmic Reticulum, Golgi Apparatus, Lysosomes
2. Protein sorting and mechanisms of vesicular transport

Unit 4: Cytoplasmic organelles II

Mitochondria: Structure, Semi-autonomous nature, Endosymbiotic hypothesis Mitochondrial Respiratory Chain, Chemi-osmotic hypothesis

Unit 5: Cytoskeleton

Type, structure and functions of cytoskeleton

Unit 6: Nucleus

Chromatin: Euchromatin and Heterochromatin and packaging (nucleosome)

Unit 7: Cell Division

Cell cycle and its regulation, Cancer (Concept of oncogenes and tumor suppressor genes with special reference to p53, Retinoblastoma and Ras and APC.

Unit 8: Cell Signaling

1. Cell signalling transduction pathways; Types of signaling molecules and receptors
2. GPCR and Role of second messenger (cAMP)
3. Apoptosis and Necrosis

Reference Books

- Lewin's Cells – 3rd Edition – Cassimeris/Lingappa/Plopper – Johns & Bartlett Publishers
- Biology of Cancer by Robert. A. Weinberg. 2nd edition.
- 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.
- 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.

Course Code	Course Title	Total credits (FM)	Total no. of Lectures	Total no. of hours
ZOOL-H-CC-P-04	Cell Biology Lab	2 (20)	30	60

List of Practicals

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 demonstrate:
    a. DNA by Feulgen reaction
    b. Cell viability study by Trypan Blue staining

Either 3a or 3b.

Lab note book, with drawing and labelling; methods where applicable.

Course Code	Course Title	Total credits (FM)	Total no. of Lectures	Total no. of hours
ZOOL-H-CC-T-05	Diversity of Chordata	4 (40)	60	60

Unit 1: Introduction to Chordates

General characteristics and outline classification of Phylum Chordata

Unit 2: Protochordata

General characteristics and classification of sub-phylum Urochordata and Cephalochordata up to Classes. Retrogressive metamorphosis in *Ascidia*. Chordate Features and Feeding in *Branchiostoma*

Unit 3: Origin of Chordata

Dipleurula concept and the Echinoderm theory of origin of chordates

Unit 4: Agnatha

General characteristics and classification of cyclostomes up to order

Unit 5: Pisces

1. General characteristics and classification of Chondrichthyes and Osteichthyes up to Subclasses
2. Accessory respiratory organ, migration and parental care in fishes
3. Swim bladder in fishes.

Unit 6: Amphibia

1. General characteristics and classification up to living Orders.
2. Metamorphosis and parental care in Amphibia

Unit 7: Reptilia

1. General characteristics and classification up to living Orders.
2. Poison apparatus and Biting mechanism in Snake

Unit 8: Aves

1. General characteristics and classification up to Sub-Classes
2. Migration in Birds
3. Principles and aerodynamics of flight

Unit 9: Mammals

1. General characters and classification up to living orders
2. Affinities of Prototheria
3. Echolocation in Micro chiropterans.

Unit 10: Zoogeography

Zoogeographical realms, Plate tectonic and Continental drift theory, distribution of birds and mammals in different realms

Reference Books

- 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). Strickberger's Evolution. IV Edition. Jones and Bartlett Publishers Inc.
- Parker, T. J. &Haswell, W. (1972). Text Book of Zoology, Volume II: Marshall and William (Eds.) 7th Ed. Macmillan Press, London.
- Kardong, K. V. (2002). Vertebrates: Comparative anatomy, function evolution. Tata McGraw Hill.
- Kent, G. C. & Carr, R. K. (2001). Comparative anatomy of the Vertebrates. 9th ed., McGraw Hill.
- Nelson, J.S., (2006) : Fishes of the World, 4th edn., Wiley.
- Romer, A. S. & Parsons, T. S. (1986). The vertebrate body. 6th Ed. Saunders College Publishing.
- Jordan, E.L. &Verma, P.S. (2003). Chordate Zoology. S. Chand & Company Ltd. New Delhi.
- Sinha, K. S., Adhikari, S., Ganguly, B. B. &Bharati Goswami, B. C. (2001). Biology of Animals. Vol. II. New Central Book Agency (p) Ltd.
- Futuyma, D. (1997). Evolutionary Biology. 3rd ed. Sinauer Associates, INC.

Note: Classifications for Protochordata, Agnatha, Reptilia, Aves and Mammalia to be followed from Young (1981), for Pisces to be followed from Romer (1959), for Amphibia to be followed from Duellman and Trueb (1986).

Course Code	Course Title	Total credits (FM)	Total no. of Lectures	Total no. of hours
ZOOL-H-CC-P-05	Diversity of Chordata Lab	2 (20)	30	60

List of Practicals

1. Protochordata: *Balanoglossus*, *Branchiostoma*
2. Agnatha: *Petromyzon* or *Myxine*
3. Fishes: *Scoliodon*, *Sphyrna*, *Torpedo*, *Mystus*, *Heteropneustes*, *Labeo*, *Exocoetus*, *Echeneis*, *Anguilla*, *Hippocampus*, *Tetrodon*/ *Diodon*, *Anabas*, Flat fish
4. Amphibia: *Bufo*, *Hyla*, *Axolotl*, *Tylototriton*
5. Reptilia: *Chelone*, *Trionyx*, *Hemidactylus*, *Varanus*, *Chamaeleon*, *Ophiosaurus*, *Draco*, *Vipera*, *Naja*, *Crocodylus*.

   Key for Identification of poisonous and non-poisonous snakes
6. Mammalia: Bat (Insectivorous and Frugivorous)
7. Pecten from Fowl head
8. Dissection of brain and pituitary of Rohu/Catla/Mrigal
9. Power point presentation on study of any two animals from two different classes by students (may be included if dissections not given permission)

1 – 6: Identification, upto Order, with labeled diagrams and characters

Students can opt for only 9, in place of 7 and 8

Course Code	Course Title	Total credits (FM)	Total no. of Lectures	Total no. of hours
ZOOL-H-CC-T-06	Animal Physiology: Controlling & Coordinating Systems	4 (40)	60	60

Unit 1: Tissues

Structure, location, classification and functions of epithelial tissue.

Unit 2: Bone and Cartilage

Structure and types of bones and cartilages, Ossification

Unit 3: Nervous System

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

Unit 4: Muscular system

Histology of different types of muscle; Ultra structure of skeletal muscle; Molecular and chemical basis of muscle contraction; Characteristics of muscle fibre

Unit 5: Reproductive System

Histology of testis and ovary Physiology of Reproduction

Unit 6: Endocrine System

1. Histology and function of pituitary, thyroid, pancreas and adrenal
2. Classification of hormones; Mechanism of Hormone action
3. Hypothalamus (neuroendocrine gland) - principal nuclei involved in neuroendocrine control of anterior pituitary and endocrine system.

Reference Books

- Histology: A Text and Atlas. Sixth Edition. Ross & Pawlina. Lippincott Williams & Wilkins.
- Eckert Animal Physiology by David Randall and Warren Burggren. 4th edition. W.H. Freeman.

Course Code	Course Title	Total credits (FM)	Total no. of Lectures	Total no. of hours
ZOOL-H-CC-P-06	Animal Physiology: Controlling & Coordinating Systems Lab	2 (20)	30	60

List of Practicals

1. Preparation of temporary mounts: Squamous epithelium or Striated muscle fibres or nerve cells
2. Study of permanent slides of Mammalian skin, Cartilage, Bone, Spinal cord, Nerve cell, Pituitary, Pancreas, Testis, Ovary, Adrenal, Thyroid and Parathyroid
3. Microtomy: Preparation of permanent slide of any five mammalian (Goat/white rat) tissues

Lab note book, with drawing and labelling; methods to be mentioned wherever applicable.

Course Code	Course Title	Total credits (FM)	Total no. of Lectures	Total no. of hours
ZOOL-H-CC-T-07	Fundamentals of Biochemistry	4 (40)	60	60

Unit 1: Carbohydrates

Carbohydrate metabolism: Glycolysis, Citric acid cycle, Pentose phosphate pathway, Gluconeogenesis

Unit 2: Lipids

Lipid metabolism: β-oxidation of fatty acids; Fatty acid biosynthesis

Unit 3: Proteins

1. Amino acids

   Structure, Classification, General and Electro chemical properties of α-amino acids; Physiological importance of essential and non-essential amino acids
2. Proteins

   Bonds stabilizing protein structure; Levels of organization

   Protein metabolism: Transamination, Deamination, Urea cycle, Fate of C-skeleton of Glucogenic and Ketogenic amino acids

Unit 4: Nucleic Acids

1. Structure: Purines and pyrimidines, Nucleosides, Nucleotides, Nucleic acids
2. Types of DNA and RNA, Complementarity of DNA, Hpyo- and Hyperchromaticity of DNA
3. Basic concept of nucleotide metabolism

Unit 5: Enzymes

Nomenclature and classification; Cofactors; Specificity of enzyme action; Isozymes; Mechanism of enzyme action; Enzyme kinetics; Derivation of Michaelis-Menten equation, Lineweaver-Burk plot; Factors affecting rate of enzyme-catalyzed reactions; Enzyme inhibition; Allosteric enzymes and their kinetics.

Unit 6: Oxidative Phosphorylation

Redox systems; Review of mitochondrial respiratory chain, Inhibitors and un-couplers of Electron Transport System

Reference Books

- Cox, M.M and Nelson, D.L. (2008). Lehninger's 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). Harper's Illustrated Biochemistry, XXVIII 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.

Course Code	Course Title	Total credits (FM)	Total no. of Lectures	Total no. of hours
ZOOL-H-CC-P-07	Fundamentals of Biochemistry Lab	2 (20)	30	60

List of Practicals

1. Qualitative tests of functional groups in carbohydrates, proteins and lipids.
2. Demonstration/Virtual lab/Dry lab of paper chromatography of amino acids.
3. Quantitative estimation of proteins by Lowry Method.
4. Demonstration/Virtual lab/Dry lab of proteins separation by SDS-PAGE.
5. Wet lab: to study the enzymatic activity of Trypsin or Lipase.
6. Wet lab: To perform the Acid and Alkaline phosphatase assay from serum/ tissue/soil.

Either 2 or 4.
Lab note book, with methods where applicable.

Course Code	Course Title	Total credits (FM)	Total no. of Lectures	Total no. of hours
ZOOL-H-CC-T-08	Comparative Anatomy of Vertebrates	4 (40)	60	60

Unit 1: Integumentary System

Structure, function and derivatives of integument in amphibian, birds and mammals.

Unit 2: Skeletal System

Jaw suspension; structure of branchial and visceral arches.

Unit 3: Digestive System

Comparative anatomy of stomach; dentition in mammals.

Unit 4: Circulatory System

Comparative account of heart and aortic arches.

Unit 5: Respiratory System

Respiratory organs in Pisces, Aves and Mammalia.

Unit 6: Urinogenital System

Succession of kidney, Types of mammalian uteri.

Unit 7: Nervous System

Cranial nerves in mammals.

Unit 8: Sense Organs

Classification of receptors, Brief account of auditory receptors in vertebrate.

Reference Books

- Kardong, K.V. (2005) Vertebrates' Comparative Anatomy, Function and Evolution. IV Edition. McGraw-Hill Higher Education.
- Kent, G.C. and Carr R.K. (2000). Comparative Anatomy of the Vertebrates. IX Edition. The McGraw-Hill Companies
- Hilderbrand, M and Gaslow G.E. Analysis of Vertebrate Structure, John Wiley and Sons Saxena, R.K. &Saxena, S.C.(2008) : Comparative Anatomy of Vertebrates, Viva Books Pvt. Ltd.

Course Code	Course Title	Total credits (FM)	Total no. of Lectures	Total no. of hours
ZOOL-H-CC-P-08	Comparative Anatomy of Vertebrates Lab	2 (20)	30	60

List of Practicals

1. Study of placoid, cycloid and ctenoid scales through permanent slides/photographs
2. Study of disarticulated skeleton of Toad, Pigeon and Guineapig.
3. Demonstration of Carapace and plastron of turtle OR
4. Identification of mammalian skulls: One herbivorous (Guineapig) and one carnivorous (Dog) animal
5. Dissection of Tilapia: Circulatory system, Brain, pituitary, urinogenital system.

Either 3 or 4.
Lab note book, with labelled diagrams and identifications, with reason.

Course Code	Course Title	Total credits (FM)	Total no. of Lectures	Total no. of hours
ZOOL-H-CC-T-09	Animal Physiology: Life Sustaining Systems	4 (40)	60	60

Unit 1: Physiology of Digestion

Structural organisation and functions of Gastrointestinal tract and Associated glands; Mechanical and chemical digestion of food

Unit 2: Physiology of Respiration

Mechanism of Respiration, Respiratory volumes and capacities, transport of Oxygen and Carbon dioxide in blood, Dissociation curves and the factors influencing it, respiratory pigments; Carbon monoxide poisoning

Unit 3: Physiology of Circulation

1. Components of Blood and their functions; Structure and functions of haemoglobin
2. Haemostasis; Blood clotting system, Fibrinolytic system
3. Haemopoiesis; Basic steps and its regulation
4. Blood groups; ABO and Rh factor

Unit 4: Physiology of Heart

1. Structure of mammalian heart, Coronary Circulation, Origin and conduction of cardiac impulses
2. Cardiac Cycle and cardiac output
3. Blood pressure and its regulation

Unit 5: Thermoregulation & Osmoregulation

1. Physiological classification based on thermal biology.
2. Thermal biology of endotherms
3. Osmoregulation in aquatic vertebrates
4. Extrarenal osmoregulatory organs in vertebrates

Unit 6: Renal Physiology

Structure of Kidney and its functional unit, Mechanism of urine formation, Regulation of acid-base balance

Reference Books

- 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,
- Eckert Animal Physiology: Mechanisms and adaptations Randall, Burggren and French.
- 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

Course Code	Course Title	Total credits (FM)	Total no. of Lectures	Total no. of hours
ZOOL-H-CC-P-09	Animal Physiology: Life Sustaining Systems Lab	2 (20)	30	60

List of Practicals

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 from mammal/fish blood.
5. Recording of blood pressure using a sphygmomanometer

Lab note book with methods and results.

Course Code	Course Title	Total credits (FM)	Total no. of Lectures	Total no. of hours
ZOOL-H-CC-T-10	Immunology	4 (40)	60	60

Unit 1: Overview of Immune System

Basic concepts of health and diseases, Cells and organs of the Immune system

Unit 2: Innate and Adaptive Immunity

Anatomical barriers, Inflammation, Cell and molecules involved in innate immunity, Adaptive immunity (Cell mediated and humoral).

Unit 3: Antigens

Antigenicity and immunogenicity, Immunogens, Adjuvants and haptens, Factors influencing immunogenicity.

Unit 4: Immunoglobulins

Structure and functions of different classes of immunoglobulins, Antigen- antibody interactions, Immunoassays (ELISA and RIA), Hybridoma technology, Monoclonal antibody production.

Unit 5: Major Histocompatibility Complex

Structure and functions of MHC molecules. Structure of T cell Receptor and its signaling.

Unit 6: Cytokines

Types, properties and functions of cytokines.

Unit 7: Complement System

Components and pathways of complement activation.

Unit 8: Hypersensitivity

Gell and Coombs' classification and brief description of various types of hypersensitivities.

Unit 9: Immunology of diseases

Malaria, Filariasis, Dengue.

Unit 10: Vaccines

Various types of vaccines. Active & passive immunization (Artificial and natural).

Reference Books

- Kindt, T. J., Goldsby, R.A., Osborne, B. A. and Kuby, J (2006). Immunology, VI Edition. W.H. Freeman and Company.
- Abbas, K. Abul and Lichtman H. Andrew (2003.) Cellular and Molecular Immunology. V Edition. Saunders Publication.

Course Code	Course Title	Total credits (FM)	Total no. of Lectures	Total no. of hours
ZOOL-H-CC-P-10	Immunology Lab	2 (20)	30	60

List of Practicals

1. Demonstration/virtual lab/dry lab 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. ABO blood group determination.
5. Demonstration/virtual lab/dry lab of ELISA.

The experiments can be performed depending upon usage of animals in UG courses.
Lab notebook with labelled drawings and results. Methods to be mentioned where applicable.

Course Code	Course Title	Total credits (FM)	Total no. of Lectures	Total no. of hours
ZOOL-H-CC-T-11	Molecular Biology	4 (40)	60	60

Unit 1: Nucleic Acids

Salient features of DNA and DNA Watson and Crick Model of DNA

Unit 2: DNA Replication

Mechanism of DNA Replication in Prokaryotes, Semi-conservative, bidirectional and discontinuous Replication, RNA priming, Replication of telomeres

Unit 3: Transcription

Mechanism of Transcription in prokaryotes and eukaryotes, Transcription factors. Difference between prokaryotic and eukaryotic transcription.

Unit 4: Translation

Mechanism 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; Genetic code, Degeneracy of the genetic code and Wobble Hypothesis; Inhibitors of protein synthesis; Difference between prokaryotic and eukaryotic translation

Unit 5: Post Transcriptional Modifications and Processing of Eukaryotic RNA

Capping and Poly A tail formation in mRNA; Split genes: concept of introns and exons, splicing mechanism, alternative splicing, and RNA editing.

Unit 6: Gene Regulation

Regulation of Transcription in prokaryotes: *lac* operon and *trp* operon;
Regulation of Transcription in eukaryotes: Activators, enhancers, silencer, repressors, miRNA mediated gene silencing.

Unit 7: DNA Repair Mechanisms

Types of DNA repair mechanisms, RecBCD model in prokaryotes, nucleotide and base excision repair, SOS repair

Unit 8: Molecular Techniques

PCR, Western and Southern blot, Northern Blot, Sanger DNA sequencing

Reference Books

- Molecular Cell Biology by Harvey Lodish. 7th Edition. W.H. Freeman.
- Molecular Biology of The Gene by Watson. 7th Edition. Pearson.
- *i*Genetics: A Molecular Approach by Peter. J. Russell. 3rd edition. Pearson Benjamin Cummings.

Course Code	Course Title	Total credits (FM)	Total no. of Lectures	Total no. of hours
ZOOL-H-CC-P-11	Molecular Biology Lab	2 (20)	30	60

List of Practicals

1. Demonstration of polytene and lampbrush chromosome from photograph
2. Isolation and quantification of genomic DNA usingspectrophotometer (A260 measurement) either by Instrument or by demonstration/virtual lab/dry lab.
3. Agarose gel electrophoresis for DNA either by Instrument or by demonstration/virtual lab/dry lab.

Lab notebook with labelled diagrams, methods and results.

Course Code	Course Title	Total credits (FM)	Total no. of Lectures	Total no. of hours
ZOOL-H-CC-T-12	Principles of Genetics	4 (40)	60	60

Unit 1: Mendelian Genetics and its Extension

1. Principles of inheritance, Incomplete dominance and co-dominance, Epistasis Multiple alleles, Lethal alleles, Pleiotropy,
2. Sex-linked, sex- influenced and sex-limited inheritance, Polygenic Inheritance.

Unit 2: Linkage, Crossing Over and Chromosomal Mapping

Linkage and Crossing Over, molecular basis of crossing over, Measuring Recombination frequency and linkage intensity using three factor crosses, Interference and coincidence

Unit 3: Mutations

Types of gene mutations (Classification), Types of chromosomal aberrations (Classification with one suitable example of each), Non-disjunction and variation in chromosome number; Molecular basis of mutations in relation to UV light and chemical mutagens

Unit 4: Sex Determination

1. Mechanisms of sex determination in *Drosophila*
2. Sex determination in mammals
3. Dosage compensation in *Drosophila* & Human

Unit 5: Extra-chromosomal Inheritance

1. Criteria for extra chromosomal inheritance
2. Kappa particle in *Paramoecium*

Unit 6: Recombination in Bacteria and Viruses

Conjugation, Transformation, Transduction, Complementation test in Bacteriophage

Unit 7: Transposable Genetic Elements

Transposons in bacteria, P elements in *Drosophila*, LINE, SINE, Alu elements in humans

Reference Books

- 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. 3d. ed. Benjamin Cummings

Course Code	Course Title	Total credits (FM)	Total no. of Lectures	Total no. of hours
ZOOL-H-CC-P-12	Principles of Genetics Lab	2 (20)	30	60

List of Practicals

1. Chi-square analyses
2. Linkage maps based on conjugation
3. Identification of chromosomal aberration in *Drosophila* and man from photograph
4. Pedigree analysis of some human inherited traits

Lab notebook with labelled diagrams, methods (wherever applicable) and results.

Course Code	Course Title	Total credits (FM)	Total no. of Lectures	Total no. of hours
ZOOL-H-CC-T-13	Developmental Biology	4 (40)	60	60

Unit 1: Early Embryonic Development

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); Embryonic induction and organizers

Unit 2: Late Embryonic Development

Fate of Germ Layers; Extra-embryonic membranes in birds; Implantation of embryo in humans, Placenta (Structure, types and functions of placenta)

Unit 3: Post Embryonic Development

Development of brain and Eye in Vertebrate
Regeneration: Modes of regeneration, epimorphosis, morphallaxis and compensatory regeneration (with one example each)

Unit 4: Implications of Developmental Biology

Teratogenesis: Teratogenic agents and their effects on embryonic development; *In vitro* fertilization, Stem cell (ESC), Amniocentesis

Reference Books

1. Gilbert, S. F. (2010). Developmental Biology, IX Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA
2. Slack JMW, Essential Developmental Biology.

Course Code	Course Title	Total credits (FM)	Total no. of Lectures	Total no. of hours
ZOOL-H-CC-P-13	Developmental Biology Lab	2 (20)	30	60

List of Practicals

1. Study of whole mounts of developmental stages of chick through permanent slides: Primitive streak (13 and 18 hours), 24, 48, 72, and 96 hours of incubation (Hamilton and Hamburger stages)
2. Study of the developmental stages and life cycle of *Drosophila* from stock culture
3. Study of different sections of placenta (photomicrograph/ slides)
4. Project report on *Drosophila* culture/aspects of chick embryo development under normal or stressed condition

Either 1 or 2.
Lab notebook with labelled diagrams, methods (wherever applicable) and results.

Course Code	Course Title	Total credits (FM)	Total no. of Lectures	Total no. of hours
ZOOL-H-CC-T-14	Evolutionary Biology	4 (40)	60	60

Unit 1

1. Geological time scale; evolution of horse
2. Neutral theory of molecular evolution, Molecular clock

Unit 2

1. Population genetics: Hardy-Weinberg Law (statement and derivation of equation, application of law to biallelic Population); Evolutionary forces upsetting H-W equilibrium; Natural selection (concept of fitness, types of selection, selection coefficient, mode of selection heterozygous superiority).
2. Genetic Drift mechanism (founder's effect, bottleneck phenomenon)

Unit 3

Species concept, Isolating mechanisms, modes of speciation
Adaptive radiation/macroevolution (exemplified by Galapagos finches)

Unit 4

Origin and Evolution of Man (from *Sahelanthropus* to *Homo sapiens*), Unique Hominid characteristics contrasted with primate characteristics.

Unit 5

Phylogenetic trees, Construction & interpretation of Phylogenetic tree using parsimony, distance methods, Convergent & Divergent evolution.

Reference Books

- Campbell, N.A. and Reece J.B (2011). Biology. IX Edition. Pearson, Benjamin, Cummings.
- Douglas J. Futuyma (1997). Evolutionary Biology. Sinauer Associates.
- iGeneics: A Molecular Approach. 3rd edition. Peter.J.Russell.

Course Code	Course Title	Total credits (FM)	Total no. of Lectures	Total no. of hours
ZOOL-H-CC-P-14	Evolutionary Biology Lab	2 (20)	30	60

List of Practicals

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. Graphical representation and interpretation of data of height/ weight of a sample of 20 humans in relation to their age and sex.

   Lab notebook with labelled diagrams, methods and results.

Discipline Specific Electives (DSE) Subjects Syllabus

Course Code	Course Title	Total credits (FM)	Total no. of Lectures	Total no. of hours
ZOOL-H-DSE-T-01	Fish and Fisheries	4 (40)	60	60

Unit 1: Introduction and Classification

1. Feeding habit, habitat and manner of reproduction
2. Classification of fish (up to Subclasses)

Unit 2: Morphology and Physiology

Types of fins and their modifications; 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 fish); Electric organ.

Unit 3: Fisheries

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.

Unit 4: Aquaculture

Sustainable Aquaculture; Extensive, semi-intensive and intensive culture of fish; Pen and cage culture; Polyculture; Composite fish culture; Induced breeding of fish; Management of finfish hatcheries; 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

Transgenic fish.

Zebrafish as a model organism in research

Reference Books

- Q Bone and R Moore, Biology of Fishes, Taylor 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.

Note: Classification to be followed from: Romer A. S. (1959)

Course Code	Course Title	Total credits (FM)	Total no. of Lectures	Total no. of hours
ZOOL-H-DSE-P-01	Fish and Fisheries Lab	2 (20)	30	60

List of Practicals

1. Morphometric and meristic characters of fishes.
2. Study of *Petromyzon*, *Myxine*, *Pristis*, *Chimaera*, *Exocoetus*, *Hippocampus*, *Gambusia*, *Labeo*, *Heteropneustes*, *Anabas*, *Echeneis*, exotic carps – Identification with characters.
3. Study of different types of scales (through permanent slides/ photographs).
4. Study of crafts and gears used in Fisheries (Pictures/models). Characters.
5. Water quality criteria for Aquaculture: Assessment of pH, DO, free CO_2, productivity, alkalinity, hardness, chloride (by titration/refractometer).
6. Study of air breathing organs in *Channa*, *Heteropneustes*, *Anabas* and *Clarias.* Drawing with characters.
7. Project Report on a visit to any fish farm/ pisciculture unit/Zebrafish rearing Lab.

Lab notebook with labelled diagrams, methods and results.

Course Code	Course Title	Total credits (FM)	Total no. of Lectures	Total no. of hours
ZOOL-H-DSE-T-02	Microbiology	4 (40)	60	60

Unit 1: Morphology of Bacteria and Virus

Cell wall (Structure of peptidoglycan), Cell envelope (Cell membrane, Differences between gram- positive and gram-negative species, External capsule and glycocalyx, Plasmids and episomes. Nuclear material, Bacterial Chromosome (Fundamental differences with eukaryotic chromosome). Reserve materials (carbon and phosphate reserve, cyanophycin), Cytoplasmic inclusions (Chlorosome, magnetosome, carboxysome, gas vesicles, ribosome).

Unit 2: Normal flora

Distribution of normal flora in the-intestinal tract and urino-genital tract, Beneficial functions of normal flora. Harmful effects of normal flora.

Unit 3: Pathogenicity of Microorganisms

Bacterial pathogenesis: Entry to the host, Adherence to host cells, Invasiveness, Bacterial toxins: Exotoxins, Endotoxins, Cellular level (Cell death, Transformation, Cell fusion, Cytopathic effect). Initial infections: Routes of entry and dissemination to secondary sites, Typical secondary sites of localization.

Unit 4: Infection of pathogens to human populations

Communicable, Non-communicable, Endemic, Epidemic, Pandemic and Sporadic

Unit 7: Diagnostic Microbiology and Bacteria culture

Koch's postulates, Sensitivity and specificity of test results, Principles and applications: Simple staining, Gram-staining, Acid-fast staining, Collection of specimens, Growth requirements and Growth factors, Oxygen requirement. Culture Media: Simple media, Complex media, Selective media and Enriched media

Unit 8: Genetic recombination in bacteria

Transformation, Conjugation- F+, F-, Hfr & F' strain, Transduction, Generalised & specialized types.

Unit 9: Microbial Diseases

Name of pathogen, symptoms, pathogenesis, mode of action & preventive measures of following diseases: Typhoid, Staphylococcal Food Poisoning, AIDS

Reference Books

- Alexander, M. (1977). Introduction to Soil Microbiology. John Wiley and Sons, New York.
- Atlas, R. M. and Bartha, R. (1997). Microbial Ecology: Fundamentals and Applications, 4th ed., Benjamin/ Cummings.
- Black, J. G. (2011). Microbiology: Principles and Explorations. 8th ed. John Wiley and Sons, New York.
- Campbell, R. (1983). Microbial Ecology. 2nd ed. Oxford, Blackwell.

- Pinehuk, G. (2003). Schaum's outline Series: Theory and Problems of Immunology. McGrawHill.
- Presscott, L. M., Harley, J. P. and Klein, D. A. (2011). Microbiology, 8th ed. McGrawHill, New York.
- Schlegel, H. G. (1993). General Microbiology. 7th ed. Cambridge University Press.
- Slonczeweski, J.L. and Foster, J.W. (2009). Microbiology- An Evolving Science. Norton.
- Stanier, R. Y., Adelberg, E. A. and Ingraham, J. L. (1986). General Microbiology. 5th ed. Macmillan.
- Talaro, K. and Talaro, A. (1999). Foundations in Microbiology. 3rd ed. Dubuque, McGraw Hill.
- Tortora, G. J., Funke, B. R., and Case. C. L. (2008). Microbiology. An Introduction. 9th ed. Benjamin/Cummings Publishing. Menlo Park Calif.
- Voyleys, B. A. (2002). The biology of viruses, 2nd ed. McGraw-Hill.

Course Code	Course Title	Total credits (FM)	Total no. of Lectures	Total no. of hours
ZOOL-H-DSE-P-02	Microbiology Lab	2 (20)	30	60

List of Practicals

1. Simple staining and Gram's staining of bacteria.
2. Preparation of liquid media (broth) and solid media for routine cultivation of bacteria.

Demonstration, with pictures/slides/virtual lab of (with write-up in lab note book):

3. Preparation of slant and stab.
4. Pure culture techniques: Spread plate, Pour plate and Streak plate
5. Biochemical test for characterization:

   Catalase, Nitrate-reduction, Indole production, Methyl Red and Voges-Proskauer Test.
6. Microbiological examination of milk (Methylene blue reductase test).
7. Sugar fermentation test.

Lab notebook with labelled diagrams, methods and results.

Course Code	Course Title	Total credits (FM)	Total no. of Lectures	Total no. of hours
ZOOL-H-DSE-T-03	Wildlife conservation and Management	4 (40)	60	60

Unit 1: Introduction to Wild Life

Brief introduction to Conservation: Importance of conservation; Causes of depletion.

Unit 2: Evaluation and management of wild life

Habitat analysis: Physical parameters – Topography, soil and water; Biological Parameters – food and cover estimation; Brief idea on remote sensing and GIS in wildlife status estimation.

Unit 3: Management of habitats

Setting back succession; Advancing the successional process; Cover construction; Restoration of degraded habitats.

Unit 4: Population estimation

Population density, Natality, Birth rate, Mortality, fertility schedules and sex ratio computation; Faecal analysis of ungulates and carnivores; Pug marks and census method.

Unit 5: Aims and objectives of wildlife conservation

Necessity for wildlife conservation; modes of conservation – in-situ conservation and ex-situ conservation.

Unit 6: Management planning of wild life in protected areas

Estimation of carrying capacity; Eco tourism / wild life tourism in forests.

Unit 7: Man and Wildlife

Causes and consequences of human-wildlife conflicts.

Unit 8: Protected areas

National parks & sanctuaries. Tiger conservation - Tiger reserves in India; Management challenges in Tiger reserve.

Reference Books

- 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.

Course Code	Course Title	Total credits (FM)	Total no. of Lectures	Total no. of hours
ZOOL-H-DSE-P-03	Wildlife conservation and Management Lab	2 (20)	30	60

List of Practicals

1. Identification (at least 5 each) of flora, mammalian fauna, avian fauna, herpeto-fauna of locality; field notebook with pictures/sketches and brief description.
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); note book with pictures/sketches and short description.
3. Familiarization and study of animal evidences in the field; Identification of animals through pug marks, hoof marks, scats, pellet groups, nest, antlers, etc. Descriptions to be noted in field notebook.
4. Monitoring for estimation of faunal abundance and diversity in locality (direct and indirect evidences): setting pitfall, spring and light traps and recording results from collections therein; pellet collection, dissection and recording; bird counts, migratory bird counts.

Animals collected from traps should be released back into their own habitat as far as possible; only pictures/sketches and descriptions should be retained submitted. Nests/eggs should not be disturbed/collected unless abandoned. In no case should wildlife be harmed – only non-invasive recording and data collection is permitted.

Course Code	Course Title	Total credits (FM)	Total no. of Lectures	Total no. of hours
ZOOL-H-DSE-T-04	Parasitology	4 (40)	60	60

Unit 1: Introduction to Parasitology

Brief introduction of Parasitism, Parasite, Parasitoid and Vectors (mechanical and biological vector) Host parasite relationship

Unit 2: Parasitic Protists

Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Trypanosoma gambiense, Leishmania donovani*

Unit 3: Parasitic Platyhelminthes

Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Schistosoma haematobium*.

Unit 4: Parasitic Nematodes

Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Ascaris lumbricoides, Ancylostoma duodenale, Wuchereria bancrofti.*

Unit 5: Parasitic Arthropods

Biology, importance and control of ticks (Soft tick *Ornithodoros,* Hard tick *Ixodes*), mites (*Sarcoptes*), Lice (*Pediculus*), Flea (*Xenopsylla*) .

Unit 6: Parasite Vertebrates

Brief account of Vampire bat

Reference Books

- 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 & Distributers, 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.

Course Code	Course Title	Total credits (FM)	Total no. of Lectures	Total no. of hours
ZOOL-H-DSE-P-04	Parasitology Lab	2 (20)	30	60

List of Practicals

1. Study of life stages of any one: *Giardia intestinalis*, *Trypanosoma gambiense*, *Leishmania donovani* through permanent slides/micro photographs
2. Study of adult and life stages of any one: *Schistosoma haematobium*, *Taenia saginata* through permanent slides/micro photographs
3. Study of adult and life stages of any one: *Ancylostoma duodenale*, *Brugia malayi* and *Trichinella spiralis* through permanent slides/micro photographs
4. through permanent slides/micro photographs
5. Study of any one: *Pediculus humanus*, *Xenopsylla cheopis* and *Cimex lectularius* through permanent slides/ photographs
6. Study of monogenea from the gills of fresh/marine fish [Gills can be procured from fish market as by product of the industry]
7. 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

6 and 7: Wet lab.

Lab notebook with labelled diagrams, methods and results.

Course Code	Course Title	Total credits (FM)	Total no. of Lectures	Total no. of hours
ZOOL-H-DSE-T-05	Endocrinology	4 (40)	60	60

Unit 1: Introduction to Endocrinology

General idea of Endocrine systems, Classification, Characteristic and Transport of Hormones.

Unit 2: Epiphysis, Hypothalamo-hypophysial Axis

1. Structure of pineal gland, Secretions and their functions in biological rhythms and reproduction.
2. Regulation of neuroendocrine glands, Feedback mechanisms
3. Structure of pituitary gland, Hormones and their functions, Hypothalamo-hypophysial portal system, Disorders of pituitary gland.

Unit 3: Peripheral Endocrine Glands

1. Structure, Hormones, Functions and Regulation of Thyroid gland, Pancreas, Ovary and Testis
2. Hormones in homeostasis, Disorders of endocrine glands

Unit 4: Regulation of Hormone Action

1. Bioassays of hormones using RIA & ELISA
2. Estrous cycle in rat and menstrual cycle in human
3. Multifaceted role of Vasopressin & Oxytocin.

Reference Books

- Guyton and Hall. Textbook of Medical Physiology. 13th Edition
- Histology: A Text and Atlas. Sixth Edition. Ross & Pawlina. Lippincott Williams & Wilkins.
- Vertebrate Endocrinology by David O. Norris.

Course Code	Course Title	Total credits (FM)	Total no. of Lectures	Total no. of hours
ZOOL-H-DSE-P-05	Endocrinology Lab	2 (20)	30	60

List of Practicals

1. Dissect and display of Endocrine glands in laboratory bred rat.
2. Study of the permanent slides of all the endocrine glands
3. Tissue fixation, embedding in paraffin, microtomy and slide preparation of any endocrine gland
4. Estimation of plasma level of any hormone using ELISA (either on Instrument or by demonstration/virtual lab).
5. Designing of primers of any hormone.

Lab notebook with labelled diagrams, methods (wherever applicable) and results.

Course Code	Course Title	Total credits (FM)	Total no. of Lectures	Total no. of hours
ZOOL-H-DSE-T-06	Biology of Insecta	4 (40)	60	60

Unit 1: Introduction to Biology of Insecta

General Features of Insects.

Unit 2: Insect Taxonomy

Classification of insects up to orders (according to Brusca and Brusca, 2016).

Unit 3: General Morphology of Insects

Head – Types of antennae, Mouth parts w.r.t. feeding habits; Thorax: Wings and wing articulation, Types of Legs adapted to diverse habitat.

Unit 4: Physiology of Insects

Structure and physiology of Insect digestive, reproductive, and nervous systems; Metamorphosis: Types and Neuroendocrine control of metamorphosis.

Unit 5: Insect Society

Social insects with special reference to termites. Trophallaxis.

Unit 6: Insect Plant Interaction

role of allelochemicals in host plant mediation. Major insect pests in paddy.

Unit 7: Insects as Vectors

Brief discussion on houseflies and mosquitoes as important vectors.

Reference Books

- A general text book of entomology, Imms , A. D., Chapman & Hall, UK
- The Insects: Structure and function, Chapman, R. F., Cambridge University Press, UK.
- 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.
- Medical Entomology, Hati A. K., Allied Book Agency, 2010.

Note: Classification to be followed from IMMS A. D. (1938).

Course Code	Course Title	Total credits (FM)	Total no. of Lectures	Total no. of hours
ZOOL-H-DSE-P-06	Biology of Insecta Lab	2 (20)	30	60

List of Practicals

1. Study of life cycle of Mosquito, various castes of *Apis*, *Camponotus Odontotermes.* Diagrams and descriptions in note-book.
2. Methodology of collection and preservation. Key to common insect orders.
3. Mounting of wings, different kinds of antennae, legs and mouth parts of insects (at least 4, one of each).
4. Submission of collected, preserved and mounted representative insects from at least ten orders from locality.

Lab notebook with labelled diagrams (1 and 2); Submissions (3 and 4).

Skill Enhancement Course (SEC) Syllabus

Course Code	Course Title	Total credits (FM)	Total no. of Lectures	Total no. of hours
ZOOL-H-SEC- 01	Aquarium Fish Keeping	2 (20)	30	30

Unit 1: Introduction to Aquarium Fish Keeping

Exotic and Endemic species of Aquarium Fishes

Unit 2: Biology of Aquarium Fishes

Common characters and sexual dimorphism of Fresh water and Marine Aquarium fishes such as Guppy, Molly, Sword tail, Gold fish, Anemone fish and Butterfly fish

Unit 3: Food and feeding of Aquarium fishes

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

Unit 4: Fish Transportation

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

Course Code	Course Title	Total credits (FM)	Total no. of Lectures	Total no. of hours
ZOOL-H-SEC- 02	Apiculture	2 (20)	30	30

Unit 1: Biology of Bees

Biology and social organization of honey bees.

Unit 2: Rearing of Bees

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

Bee Diseases and Enemies; Control and Preventive measures.

Unit 4: Bee Economy

Products of Apiculture Industry and its Uses (Honey, Bees Wax, Propolis), Pollen etc

Unit 5: Entrepreneurship in Apiculture

Report on a visit to an apiculture farm.

Course Code	Course Title	Total credits (FM)	Total no. of Lectures	Total no. of hours
ZOOL-H-SEC- 03	Sericulture	2 (20)	30	30

Unit 1: Introduction

Types of silkworms, Distribution and Races

Exotic and indigenous races

Mulberry and non-mulberry Sericulture

Unit 2: Biology of Silkworm

Life cycle of *Bombyx mori*

Structure of silk gland and secretion of silk

Unit 3: Rearing of Silkworms

Rearing house and rearing appliances

Disinfectants: Formalin, bleaching powder

Silkworm rearing technology: Early age and Late age rearing

Types of mountages.

Spinning, harvesting and storage of cocoons

Unit 4: Pests and Diseases

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

Report on a visit to a sericulture center.

Course Code	Course Title	Total credits (FM)	Total no. of Lectures	Total no. of hours
ZOOL-H-SEC- 04	Medical Diagnostic Techniques	2 (20)	30	30

Unit 1: Diagnostics Methods Used for Analysis of Blood

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 2: Diagnostic Methods Used for Urine Analysis

Urine Analysis: Physical characteristics; Abnormal constituents

Unit 3: Non-infectious Diseases

Testing of blood glucose using Glucometer/Kit

Unit 4: Infectious Diseases

Diagnosis of Tuberculosis and Hepatitis, Malarial parasite (Microscope based and ELISA based)

Unit 5: Clinical Biochemistry

LFT, Lipid profiling

Unit 6: Clinical Microbiology

Antibiotic Sensitivity Test

Unit 7: Tumors

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

Unit 8: Lab visit

Visit to Pathological Laboratory and Submission of Project.

Generic Elective (GE) Course Syllabus

Course Code	Course Title	Total credits (FM)	Total no. of Lectures	Total no. of hours
ZOOL-H-GE-T-01	Animal Diversity and Taxonomy	4 (40)	60	60

Unit 1: Basics of Animal Classification

Codes of Zoological Nomenclature; Principle of priority; Synonymy and Homonymy.

Unit 2: Protista

Protozoa. Outline of classification (salient features and classification scheme upto subphylum only).

a. Locomotion in *Amoeba*; Conjugation in *Paramoecium*.

b. Life cycle and pathogenicity of *Entamoeba histolytica*.

Unit 3: Porifera

Outline of classification (salient features and classification scheme upto subclass only). Canal system in sponges.

Unit 4: Cnidaria

Outline of classification (salient features and classification scheme upto subclass only). Metagenesis in *Obelia.*

Unit 5: Platyhelminthes

Outline of classification (salient features and classification scheme upto subclass only). Life cycle and pathogenicity and control measures of *Fasciola hepatica.*

Unit 6: Nematoda

Outline of classification (salient features and classification scheme upto subclass only). Life cycle, and pathogenicity and control measures of *Ascaris lumbricoides.*

Unit 7: Annelida

Outline of classification (salient features and classification scheme upto subclass only). Excretion in Annelida through nephridia.

Unit 8: Arthropoda

Outline of classification (salient features and classification scheme upto class only). Social life in termite.

Unit 9: Mollusca

Outline of classification (salient features and classification scheme upto subclass only). Respiration in *Pila.*

Unit 10: Echinodermata

Outline of classification (salient features and classification scheme upto subclass

only). Water-vascular system in Asteroidea

Unit 11: Protochordata

Retrogressive metamorphosis in *Ascidia*.

Unit 12: Pisces

Outline of classification (salient features and classification scheme upto subclass only). Swim bladder in fishes.

Unit 13: Amphibia

Outline of classification (salient features and classification scheme upto order only). Parental care in Amphibia.

Unit 14: Reptilia

Outline of classification (salient features and classification scheme upto order only). Poison apparatus and Biting mechanism in Snake.

Unit 15: Aves

Outline of classification (salient features and classification scheme upto subclass only). Exoskeleton and Migration in Birds.

Unit 16: Mammalia

Outline of classification (salient features and classification scheme upto infraclass only). Exoskeletal derivatives of mammals.

Classification scheme to be followed from Ruppert and Barnes for Invertebrates and Young for Vertebrates.

Reference Books

- Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, VIII Edition. Holt Saunders International Edition
- The Invertebrates: A New Synthesis, III Edition, Blackwell Science
- Young, J. Z. (2004). The Life of Vertebrates. III Edition. Oxford university press.
- Parker, T. J. &Haswell, W. (1972). Text Book of Zoology, Volume II: Marshall and Willam (Eds.) 7th Ed. Macmillan Press, London.
- Jordan, E.L. &Verma, P.S. (2003). Chordate Zoology. S. Chand & Company Ltd. New Delhi.
- Sinha, K. S., Adhikari, S., Ganguly, B. B. & BharatiGoswami, B. D. (2001). Biology of Animals. Vol. II. New Central Book Agency (P) Ltd.

Course Code	Course Title	Total credits (FM)	Total no. of Lectures	Total no. of hours
ZOOL-H-GE-P-01	Animal Diversity, Taxonomy Lab	2 (20)	30	60

List of Practicals

1. Identification of:
    a. Porifera - *Sycon, Obelia, Physalia, Corallium, Metridium, Pennatula.*
    b. Annelids - *Nereis, Pheretima,Hirudinaria.*
    c. Arthropods – *Limulus, Palaemon, Eupagurus, Scolopendra, Bombyx, Periplaneta,* termites and honey bees.
    d. Onychophora – *Peripatus.*
    e. Molluscs - *Pila, Sepia.*
    f. Echinodermata - *Asterias, Echinus.*
    g. Protochordata – *Balanoglossus.*
    h. Fishes - *Sphyrna, Torpedo, Labeo, Exocoetus, Echeneis, Hippocampus.*
    i. Amphibia - *Hyla, Tylototriton.*
    j. Reptilia - *Trionyx, Hemidactylus, Chamaeleon, Draco, Naja.*
    k. Mammalia: Bat
2. Pecten from Fowl head
3. Dissection of brain and pituitary of Rohu/Catla/Mrigal
4. Identification and significance of adult *Fasciola hepatica,* and *Ascaris lumbricoides*

Identification upto Subclass in invertebrates and upto Order in vertebrates, with labeled diagrams, systematic position and characters, in Lab Notebook.

Course Code	Course Title	Total credits (FM)	Total no. of Lectures	Total no. of hours
ZOOL-H-GE-T-02	Comparative Anatomy, Developmental Biology of Vertebrates and Ecology	4 (40)	60	60

Unit 1: Integumentary System

Structure, function and derivatives of integument in mammals

Unit 2: Skeletal System

Jaw suspensions.

Unit 3: Digestive System

Teeth.

Unit 4: Circulatory System

Comparative account of heart and aortic arches

Unit 5: Urinogenital System

Succession of kidney, Types of mammalian uteri.

Unit 6: Nervous System

Cranial nerves in mammals.

Unit 7: Early Embryonic Development

Spermatogenesis, Oogenesis; Types of eggs, Egg membranes; Fertilization (External and Internal): Planes and patterns of cleavage; Embryonic induction and organizers

Unit 8: Late Embryonic Development

Fate of Germ Layers; Extra-embryonic membranes in birds.

Unit 9: Post Embryonic Development

Regeneration: Modes of regeneration, epimorphosis, morphallaxis and compensatory regeneration (with one example each)

Unit 10: Introduction to Ecology

Autecology and synecology, Levels of organization.

Unit 11: Population and Community

Geometric, exponential and logistic growth, equation, Gause's Principle with laboratory and field examples.

Community characteristics: species diversity, abundance, dominance, richness. Vertical stratification. Ecological succession with one example.

Unit 12: Ecosystem

Food chain: Detritus and grazing food chains, Linear and Y-shaped food chains, Food web, Energy flow through the ecosystem, Ecological pyramids.

Unit 13: Applied Ecology

Wildlife Conservation (in-situ and ex-situ conservation).
Management strategies for tiger conservation; Wild life protection act (1972)

Reference Books

- Gilbert, S. F. (2010). Developmental Biology, IX Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA
- Slack JMW, Essential Developmental Biology.
- Kardong, K.V. (2005) Vertebrates' Comparative Anatomy, Function and Evolution. IV Edition. McGraw-Hill Higher Education.
- Kent, G.C. and Carr R.K. (2000). Comparative Anatomy of the Vertebrates. IX Edition. The McGraw-Hill Companies
- Hilderbrand, M and Gaslow G.E. Analysis of Vertebrate Structure, John Wiley and Sons Saxena, R.K. &Saxena, S.C.(2008) : Comparative Anatomy of Vertebrates, Viva Books Pvt. Ltd.
- 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
- Ecology: Theories & Application (2001). 4th Edition by Peter Stilling.
- Ecology by Cain, Bowman & Hacker. 3rd edition. Sinauer Associates

Course Code	Course Title	Total credits (FM)	Total no. of Lectures	Total no. of hours
ZOOL-H-GE-P-02	Comparative Anatomy and Developmental Biology of Vertebrates Lab	2 (20)	30	60

List of Practicals

1. Study of placoid, cycloid and ctenoid scales through permanent slides/photographs
2. Study of disarticulated skeleton of Toad, Pigeon and Guineapig.
3. Demonstration of Carapace and plastron of turtle OR
4. Identification of mammalian skulls: One herbivorous (Guineapig) and one carnivorous (Dog) animal
    a. Dissection of Tilapia: Circulatory system, Brain, pituitary, urinogenital system.
    b. Study of whole mounts of developmental stages of chick through permanent slides: 24, 48, 72, and 96 hours of incubation.
5. Study of an aquatic ecosystem: Phytoplankton and zooplankton, determination of pH, and Dissolved Oxygen content (Winkler's method) and free CO_2.
6. Report on a one-day visit to Sanctuary/Zoo/Sericulture station/Fishery/apiculture station/pond ecosystem/agroecosystem.

Either 3 or 4.
Lab note book, with labelled diagrams and identifications, with reason.

Separate Lab Notebooks for Identification and Ecology.
Separate Field Notebook.

Course Code	Course Title	Total credits (FM)	Total no. of Lectures	Total no. of hours
ZOOL-H-GE-T-03	Cell Biology, Genetics and Evolutionary Biology	4 (40)	60	60

Unit 1: Overview of Cells

Basic structure of Prokaryotic and Eukaryotic cells

Unit 2: Plasma Membrane

Ultrastructure and composition of Plasma membrane: Fluid mosaic model. Transport across membrane: Active and Passive transport, Facilitated transport. Cell junctions: Tight junctions, Gap junctions, Desmosomes.

Unit 3: Cytoplasmic organelles I

Structure and Functions: Endoplasmic Reticulum, Golgi Apparatus, Lysosomes

Unit 4: Cytoplasmic organelles II

Mitochondria: Structure, Mitochondrial Respiratory Chain.

Unit 5: Nucleus

Chromatin: Euchromatin and Heterochromatin and packaging (nucleosome)

Unit 6: Cell Division

Cell cycle and its regulation.

Unit 7: Cell Signaling

Cell signaling transduction pathways; Types of signaling molecules and receptors

Unit 8: Mendelian Genetics and its Extension

Principles of inheritance. Sex-linked, sex- influenced and sex-limited inheritance.

Unit 9: Linkage, Crossing Over and Chromosomal Mapping

Linkage and Crossing Over

Unit 10: Mutations

Types of gene mutations (Classification), Types of chromosomal aberrations (Classification with one suitable example of each)

Unit 11: Sex Determination

Mechanisms of sex determination in *Drosophila*

Unit 12: Evolution – 1: Idea

Geological time scale

Unit 13: Evolution - 2: Mechanism

Natural selection (concept of fitness, types of selection, selection coefficient, mode of selection heterozygous superiority).

Unit 14: Evolution - 3: Effect

Species concept, Isolating mechanisms, modes of speciation

Unit 15: Evolution - 4: Humans

Unique Hominid characteristics contrasted with primate characteristics.

Reference Books

- Campbell, N.A. and Reece J.B (2011). Biology. IX Edition. Pearson, Benjamin, Cummings.
- Douglas J. Futuyma (1997). Evolutionary Biology. Sinauer Associates.
- iGenetics: A Molecular Approach. 3rd edition. Peter.J.Russell.
- Developmental biology by Scott F. Gilbert, 9th edition.
- 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. 3d. ed. Benjamin Cummings
- Lewin's Cells – 3rd Edition – Cassimeris/Lingappa/Plopper – Johns & Bartlett Publishers
- Biology of Cancer by Robert. A. Weinberg. 2nd edition.
- 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.
- 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.

Course Code	Course Title	Total credits (FM)	Total no. of Lectures	Total no. of hours
ZOOL-H-GE-P-03	Cell Biology, Genetics and Evolutionary Biology Lab	2 (20)	30	60

List of Practicals

1. Study of various stages of meiosis.
2. Study of fossils from models/ pictures.
3. Chi-square analyses.

Lab note book, with drawing and labelling; methods where applicable.

Course Code	Course Title	Total credits (FM)	Total no. of Lectures	Total no. of hours
ZOOL-H-GE-T-04	Physiology and Biochemistry	4 (40)	60	60

Unit 1: Digestion and Absorption of Food

Structure and function of digestive glands; Digestion and absorption of carbohydrates, fats and proteins.

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.

Unit 3: Respiratory Physiology

Transport of oxygen and carbon dioxide in blood, Factors affecting transport of gases.

Unit 4: Renal Physiology

Functional anatomy of kidney, Mechanism and regulation of urine formation

Unit 5: Cardiovascular Physiology

Structure of heart, Coordination of heartbeat, Cardiac cycle, ECG

Unit 6: Endocrine and Reproductive Physiology

Structure and function of endocrine glands (pituitary, thyroid, parathyroid, pancreas, adrenal, ovaries, and testes), Brief account of Menstrual cycle.

Unit 7: Carbohydrates

Glycolysis, Citric acid cycle

Unit 8: Lipids

Fatty acid biosynthesis

Unit 9: Proteins

Amino acids: Structure, Classification
Proteins: Levels of organization; Protein metabolism: Urea cycle

Unit 10: Nucleic Acids

Structure: Purines and pyrimidines, Nucleosides, Nucleotides, Nucleic acids

Unit 11: Enzymes

Classification; Cofactors; Specificity; Isozymes; Mechanism of enzyme action; Enzyme kinetics; Factors affecting rate of enzyme-catalyzed reactions.

Reference Books

- Cox, M.M and Nelson, D.L. (2008). Lehninger's 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). Harper's Illustrated Biochemistry, XXVIII 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.

Course Code	Course Title	Total credits (FM)	Total no. of Lectures	Total no. of hours
ZOOL-H-GE-P-04	Physiology and Biochemistry Lab	2 (20)	30	60

List of Practicals

1. Preparation of temporary mounts: Blood film.
2. Estimation of haemoglobin using Sahli's haemoglobinometer.
3. Examination of permanent histological sections of mammalian duodenum, lung, kidney, thyroid, pancreas, adrenal, testis, ovary.
4. Qualitative tests of functional groups in carbohydrates, proteins and lipids.

Lab notebook with labelled diagrams, methods and results.