UNIVERSITY OF DELHI

DEPARTMENT OF ZOOLOGY

FOUR YEAR UNDERGRADUATE PROGRAMME

(Courses effective from Academic Year 2013-14)

SYLLABUS OF COURSES TO BE OFFERED

Disciplinary Courses I, Disciplinary Courses II

& Applied Courses

Note: The courses are uploaded as sent by the Department concerned. The scheme of marks will be determined by the University and will be corrected in the syllabus accordingly. Editing, typographical changes and formatting will be undertaken further.

Four Year Undergraduate Programme Secretariat
fouryearprog@gmail.com

PREAMBLE

"What Physics and Chemistry were to the 20th century, Biology will be to the 21st". In keeping with this sentiment the present course is designed to help students develop an in-depth understanding of some of the crucial biological issues in modern world. Zoology, the study of animal life, an integral part of biology, aims to understand the behaviour, structure and evolution of animals, using a wide range of approaches, from genes, to molecular and cellular biology, through physiological processes and anatomy, to whole animals, populations and their ecology.

Since Zoologists study life at many levels, from molecules to ecosystems and beyond, the student taking this course will develop knowledge of the full breadth of life, its mechanisms, and the many recent developments in the subject. They will also gain an appreciation of the issues biological developments are presenting to society and understand the scope and limitations of biological knowledge and techniques. The course also combines technical, analytical and communication skills in a way that would make our graduates employable.

Like the physical sciences in the first half of the 20th Century, biology at the start of the 21st Century is achieving a substantive maturity of theory, experimental tools, and fundamental findings thanks to relatively secure foundations in cell and molecular biology, genetics, genomics and biotechnology. These subjects have also forced biologists to connect systematics and evolutionary biology to these modern aspects of the science, leading to a much better understanding from the systems level. Thus, these formerly Balkanized disciplines have been brought together as actors at an integrated level. Biologists are now addressing the evolution of genetic systems using more than the concepts of population biology alone, and the problems of cell biology using more than the tools of biochemistry and molecular biology alone. It is becoming increasingly clear that solutions to such basic problems as aging, sex, development, and genome size potentially involve elements of biological science at every level of organization, from molecule to population.

The course knits together genomics, bioinformatics, evolutionary genetics, and other such general-purpose tools to allow the student to synthesize a complete working hypothesis of the living system. Starting with a judicious mix of the systematic description of the living world, and some of the modern aspects like cell structure and function, the student would be taken through understanding of the logical succession of increasing complexity of the living system to the culmination at the end of the fourth year of study, to a much more synthesised state of knowledge, such that she is in a position to apply the basic knowledge gained to the possible applications for human welfare.

Upon completion of this course students will be able to:

- Have an overview of the world of animals.
- Discover Zoology's contribution to modern society from cloning and gene therapy to pollution control and biodiversity conservation.
- Benefit from dedicated practical laboratories and an optional work placement.
- Carry out detailed fieldwork in the rich diversity of local habitats.
- Gain an appreciation of the issues biological developments are presenting to society and understand the scope and limitations of biological knowledge and techniques.

Even if the student exercises the exit option at the end of the second or third year, he would have the basic expertise to gainfully apply the knowledge gained for economic considerations.

Four Years Undergraduate Program in Zoology

Degree Nomenclature

- Diploma after 2 years
- Bachelor degree after 3 years
- Bachelor with Honours/B. Tech. degree after 4 years

The scheme of papers to be opted in each semester

Year	Semester	FC	DC – I	DC – II	AC	IMBH/CA
First	I	4	2			1 – IMBH
	II	3	2		1*	1 – IMBH
Second	III	2	2	1	1	1 – CA
	IV	2	2	1	1	1 – CA
Third	V		3	1	1	1 – CA
	VI		3	1	1	1 – CA
Fourth	VII		2+ 1 (Research Methodology	1		1 – CA
	VIII		2 + 1 (Research Project)	1		1 – CA

- FC: Foundation Course
- DC-I: Discipline Course-I
- DC-II: Discipline Course-II
- AC: Applied Course
- IMBH: Integrating Mind Body and Heart
- CA: Cultural Activities include NCC, Sports, NSS, etc.
- *Language Course

The four years undergraduate Program envisages effective teaching in Zoology using innovative methods, projects, visits to science laboratories, practical training and fieldwork. The students opting for Zoology as major subject are required to take

- All the papers of Discipline Courses-I.
- Four papers of Applied Courses from any discipline of Science.
- All the papers of Foundation Courses, IMBH/CA
- Papers from Discipline Courses-II from subjects other than Zoology.

Students opting for subjects other than Zoology as major may take Zoology as minor by taking all the papers of Discipline Courses-II. **The scheme of courses is as follows:**

<table>
<tr><td colspan="2">Discipline Courses – I (DC – I)
Semester I to VIII</td></tr>
<tr><td>Theory</td><td>Practical</td></tr>
<tr><td>5 hrs./week
(4 lectures and 1 hr presentation per week)</td><td>4 hrs./week
(One Practical)</td></tr>
<tr><td>100 Marks
(75 Marks for final exam and 25 marks for internal assessment)</td><td>50 Marks
(Continuous Evaluation)</td></tr>
<tr><td colspan="2">Discipline Courses – II (DC – II)
Semester III to VIII</td></tr>
<tr><td>Theory</td><td>Practical</td></tr>
<tr><td>5 hrs./week
(4 lectures and 1 hr presentation per week)</td><td>4 hrs./week
(One Practical)</td></tr>
<tr><td>100 Marks
(75 Marks for final exam and 25 marks for internal assessment)</td><td>50 Marks
(Continuous Evaluation)</td></tr>
<tr><td colspan="2">Applied Courses (AC)
Semester III to VI</td></tr>
<tr><td colspan="2">3 hrs./week (Lecture-cum-practical for hands-on experience)
75 Marks</td></tr>
<tr><td colspan="2">Research Work
Semester VII to VIII</td></tr>
<tr><td>Research Methodology (Semester – VII): 150 Marks</td><td>Research Project (Semester – VIII): 150 Marks</td></tr>
</table>

DISTRIBUTION OF PAPERS FOR FOUR YEAR UNDERGRADUATE PROGRAM IN ZOOLOGY

SEMESTER	Discipline Courses-I (DC – I)	Discipline Courses –II (DC - II)	Applied Courses (AC)
Semester - I	1. Diversity and Evolution of Non-Chordata – I 2. Perspectives in Ecology		
Semester - II	3. Diversity and Evolution of Non-Chordata – II 4. Cell and Cellular Processes		
Semester - III	5. Diversity and Distribution of Chordata 6. Physiology: Life Sustaining Systems	Biology of Non-Chordata	Medical Diagnostics
Semester - IV	7. Comparative Anatomy of Vertebrata 8. Fundamentals of Biochemistry	Biology of Chordata	Health and Life Style
Semester - V	9. Principles of Genetics 10. Biochemistry of Metabolic Processes 11. Physiology: Controlling and Coordinating Systems	Foundations of Developmental Biology	Economic Zoology (Aquaculture, Poultry, Animal Husbandry, Apiculture, Sericulture)
Semester - VI	12. Bioinformatics and Biostatistics 13. Molecular Biology 14. Animal Behaviour	Evolutionary Biology	Agro-Chemicals and Pest Management
Semester - VII	15. Concepts and Mechanisms of Evolution 16. Immunology 17. Research Methodology	Human Physiology	
Semester - VIII	18. Biotechnology: Microbes to Animals 19. Developmental Biology 20. Research Project (Initiated in Semester VII)	Applied Zoology	

Foundation Courses

- Language, Literature, and Creativity-I (Hindi/MIL)
- Language, Literature, and Creativity-II (English)
- Information Technology
- Business, Entrepreneurship and Management
- Governance and Citizenship
- Psychology, Communication and Life Skills
- Geographic and Socio-Economic Diversity
- Science and Life
- History, Culture and Civilization
- Building Mathematical Ability
- Environment and Public Health

Teaching Hours

- Foundation Course: **Language, Literature, and Creativity** to be offered in Semester I and Semester II: **5 periods/week** (4 lectures+1 student's presentation) Hindi/Sanskrit/ MIL/Persian/Arabic/English
- Others foundation papers: **3 periods/week** (2 lectures+1 student's presentation)
- DC-I and DC-II: **5 periods/week** (4 lectures+1 student's presentation)
- Applied Course: **3 periods/week** (2 lectures+1 student's presentation)
- IMBH/CA: **2 periods/week** (to be part of the workload)
- Tutorial/ Practical will continue wherever applicable

Four Year Undergraduate Program in Zoology

Discipline Courses – I (DC-I)

First Year

First Semester

Paper 1

Diversity and Evolution of Non-Chordata-I
(Page 12)

Paper 2

Perspectives in Ecology
(Page 15)

Second Semester

Paper 3

Diversity and Evolution of Non-Chordata – II
(Page 17)

Paper 4

Cell and Cellular Processes
(Page 19)

Second Year

Third Semester

Paper 5

Diversity and Distribution of Chordata
(Page 21)

Paper 6

Physiology: Life Sustaining Systems
(Page 24)

Fourth Semester

Paper 7

Comparative Anatomy of Vertebrata
(Page 26)

Paper 8

Fundamentals of Biochemistry
(Page 28)

Third Year

Fifth Semester

Paper 9

Principles of Genetics

(Page 30)

Paper 10

Biochemistry of Metabolic Processes

(Page 32)

Paper 11

Physiology: Controlling and Coordinating Systems

(Page 34)

Sixth Semester

Paper 12

Bioinformatics and Biostatistics

(Page 36)

Paper 13

Molecular Biology

(Page 38)

Paper 14

Animal Behaviour

(Page 40)

Fourth Year

Seventh Semester

Paper 15

Concepts and Mechanisms of Evolution

(Page 42)

Paper 16

Immunology

(Page 44)

Paper 17

Research Methodology

(Page 46)

Eighth Semester

Paper 18

Biotechnology: Microbes to Animals

(Page 48)

Paper 19

Developmental Biology

(Page 50)

Paper 20

Research Project

Four Year Undergraduate Program in Zoology
Discipline Courses – II (DC-II)

Second Year

Third Semester

Paper 1

Biology of Non-Chordata (Page 53)

Fourth Semester

Paper 2

Biology of Chordata (Page 56)

Third Year

Fifth Semester

Paper 3

Developmental Biology (Page 58)

Sixth Semester

Paper 4

Evolutionary Biology (Page 60)

Fourth Year

Seventh Semester

Paper 5

Human Physiology (Page 62)

Eighth Semester

Paper 6

Applied Zoology (Page 64)

Four Year Undergraduate Program in Zoology
Applied Courses (AC)

Second Year

Third Semester

Paper 1

Medical Diagnostics
(Page 68)

Fourth Semester

Paper 2

Health and Life Style
(Page 69)

Third Year

Fifth Semester

Paper 3

Economic Zoology
(Page 70)

Sixth Semester

Paper 4

Agro-chemicals and Pest Management
(Page 72)

Four Year Undergraduate Program
in
Zoology

Discipline Courses - I

DIVERSITY AND EVOLUTION OF NON-CHORDATA – I (PROTISTA TO PSEUDOCOELOMATES)

DC-I: Paper 1

THEORY (48 Periods)

Unit 1: Kingdom Protista (14)

General characteristics and classification up to classes
Morphology and Physiology of *Paramecium*
Life cycle, pathogenicity and prophylaxis of *Plasmodium vivax*, *Trypanosma gambiense* and *Entamoeba histolytica*
Locomotion and Reproduction in Protista

Unit 2: Evolution of Parazoa and Metazoa (3)

Unit 3: Phylum Porifera (4)

General characteristics and classification up to classes
Canal system in sponges

Unit 4: Phylum Cnidaria (5)

General characteristics and classification up to classes
Morphology and Physiology of *Obelia*
Polymorphism in Cnidaria; Corals and coral reefs

Unit 5: Phylum Ctenophora (3)

General characteristics and evolutionary significance

Unit 6: Phylum Platyhelminthes (10)

General characteristics and classification up to classes
Life cycle, pathogenicity and prophylaxis of *Schistosoma haematobium* and *Taenia solium*
Parasitism and parasitic adaptations

Unit 7: Phylum Nemathelminthes (9)

General characteristics and classification up to classes
Life cycle, pathogenicity and prophylaxis of *Ascaris lumbricoides* and *Wuchereria bancrofti*
Parasitic adaptations in nematodes

Note: Classification to be followed from "Barnes, R.D. (1982). *Invertebrate Zoology*, VI Edition, Holt Saunders International Edition"

DIVERSITY AND EVOLUTION OF NON-CHORDATA – I (PROTISTA TO PSEUDOCOELOMATES)

DC-I: Paper 1

PRACTICAL

Kingdom Protista

1. Study of *Paramecium,* Binary fission and Conjugation in *Paramecium*
2. Life stages of *Plasmodium vivax, Trypanosma gambiense* and *Entamoeba histolytica* (Slides/Micro-photographs)
3. Examination of pond water for protists

Phylum Porifera

4. Study of *Sycon* (including T.S. and L.S.), *Hyalonema,* and *Euplectella*
5. Temporary mounts of spicules, gemmules and spongin fibres

Phylum Cnidaria

6. Study of *Obelia, Sertularia, Physalia, Millepora, Aurelia,* Ephyra larva, *Tubipora, Alcyonium, Gorgonia, Metridium* (including T.S. and L.S.)

Phylum Ctenophora

7. Any one specimen/slide

Phylum Platyhelminthes

8. Study of adult *Schistosoma haematobium* and *Taenia solium*
9. Life stages of above Platyhelminthes (Slides/micro-photographs)

Phylum Nemathelminthes

10. Study of adult *Ascaris lumbricoides, Wuchereria bancrofti* and their life stages (Slides/micro-photographs)

Submission of Project Report on any human disease related to the animals discussed above

Note: Classification to be followed from "Barnes, R.D. (1982). *Invertebrate Zoology*, VI Edition, Holt Saunders International Edition"

ESSENTIAL READINGS

- Barnes, R.D. (1982). *Invertebrate Zoology*, VI 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

SUGGESTED READING

- Boradale, L.A. and Potts, E.A. (1961). *Invertebrates: A Manual for the use of Students*. Asia Publishing Home

\

PERSPECTIVES IN ECOLOGY

DC-I: Paper 2

THEORY (48 Periods)

Unit 1: Introduction to Ecology (6)

Relevance of studying ecology, History of ecology, Autecology and synecology, Laws of limiting factors and levels of organization.

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.

Malthus and logistic growth patterns, Verhulst-Pearl growth equation, r and k strategies, Population regulation: density-dependent and independent factors.

Population interactions, Gause's Principle with examples, Lotka-Volterra equation (competition), Predation: Functional and numerical responses, Trends in human population, Growth and demographic transition.

Unit 3: Community (7)

Community characteristics: Dominance, diversity, species richness, abundance, stratification; Ecotone and edge effect; Ecosystem development with one example

Unit 4: Ecosystem (8)

Types of ecosystem 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.

Unit 5: Biodiversity Conservation (3)

Types, Significance, Loss of biodiversity, Conservation strategies, Application of ecology in wild life conservation

PERSPECTIVES IN ECOLOGY

DC-I: Paper 2

PRACTICAL

1. Study of life tables and plotting of survivorship curves of different types from the hypothetical data.
2. Study of fecundity table and plotting of fecundity curves from the hypothetical data.
3. Determination of population density in a natural/hypothetical community by quadrate method and calculation of Shannon-Weiner diversity index for the same community.
4. Study of an aquatic ecosystem: Measurement of area, temperature, turbidity/penetration of light, determination of pH, and Dissolved Oxygen content (Winkler's method) and free CO_2.
5. Report on a visit to National Park/Biodiversity Park.

ESSENTIAL 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

SUGGESTED READING

- Ricklefs, R.E., (2000). *Ecology*. V Edition. Chiron Press

DIVERSITY AND EVOLUTION OF NON-CHORDATA – II (COELOMATE NON-CHORDATES)

DC-I: Paper 3

THEORY (48 Periods)

Unit 1: Phylum Annelida **(9)**

General characteristics and classification up to classes
Coelom
Morphology and Physiology of *Pheretima*
Excretion in Annelids

Unit 2: Phylum Arthropoda **(18)**

General characteristics and classification up to classes
External morphology of *Periplaneta americana*
Vision in Arthropoda; Respiration in Arthropoda
Moulting and metamorphosis in Insects
Social life in insects (w.r.t. ants and termites)
Life cycle, transmission of disease, and control of mosquitoes, sand fly and human louse

Unit 3: Phylum Onychophora **(2)**

General characteristics and evolutionary significance

Unit 4: Phylum Mollusca **(10)**

General characteristics and classification up to classes
Respiration in Mollusca
Torsion and detorsion in Gastropoda
Pearl formation
Evolutionary significance of trochophore larva

Unit 5: Phylum Echinodermata **(9)**

General characteristics and classification up to classes
Water-vascular system in Asteroidea
Larval forms in Echinodermata
Evolutionary significance (Affinities with Chordates)

Note: Classification to be followed from "Barnes, R.D. (1982). *Invertebrate Zoology*, VI Edition, Holt Saunders International Edition"

DIVERSITY AND EVOLUTION OF NON-CHORDATA – II (COELOMATE NON-CHORDATES)

DC-I: Paper 3

PRACTICAL

Phylum Annelida

1. Dissection of digestive and nervous systems of earthworm
2. Temporary mount of Ovary, pharyngeal and septal nephridia of earthworm
3. Study of *Aphrodite, Nereis, Heteronereis, Chaetopterus, Pheretima, Hirudinaria*
4. T.S. through pharynx, gizzard, and typhlosolar intestine of earthworm.

Phylum Arthropoda

5. Dissection of digestive system of *Periplaneta* and temporary mount of mouth parts
6. Study of *Limulus*, *Palamnaeus, Palaemon, Daphnia*, *Balanus*, *Sacculina*, *Cancer*, *Eupagurus*, *Scolopendra*, *Julus*, termite, louse, honeybee, silk moth, mosquitoes, sand fly

Phylum Onychophora

7. Any one specimen/slide

Phylum Mollusca

8. Study of *Chiton, Dentalium, Pila, Unio, Ostrea, Mytilus, Loligo, Sepia, Octopus* and *Nautilus*

Phylum Echinodermata

9. Study of Echinoderm larvae
10. Study of *Pentaceros*/*Asterias, Ophiura, Clypeaster, Echinus, Cucumaria* and *Antedon*

Note: Classification to be followed from "Barnes, R.D. (1982). *Invertebrate Zoology*, VI Edition, Holt Saunders International Edition"

ESSENTIAL READINGS

- Barnes, R.D. (1982). *Invertebrate Zoology*, VI 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

SUGGESTED READING

- Boradale, L.A. and Potts, E.A. (1961). *Invertebrates: A Manual for the use of Students*. Asia Publishing Home

CELL AND CELLULAR PROCESSES

DC-I: Paper 4

THEORY (48 Periods)

Unit 1: An Overview of Cells **(3)**

Prokaryotic and Eukaryotic cells, Virus, Viroids, Mycoplasma

Unit 2: The Plasma Membrane **(5)**

Membrane structure, Fluid mosaic model, Liposome, Transport across membranes, Endocytosis, Cell junctions: Occluding junctions (Tight junctions), Anchoring junctions (desmosomes), Communicating junctions (gap junctions) and Plasmodesmata

Unit 3: The Nucleus **(7)**

Nuclear Envelope - Structure of nuclear pore complex, Nuclear lamina, Chromosomal DNA and its packaging, Nucleolus and its role in ribosome biogenesis

Unit 4: Protein Sorting and Transport **(5)**

The Endoplasmic Reticulum, Golgi Apparatus, Mechanism of vesicular transport, Lysosomes

Unit 5: Mitochondria and Peroxisomes **(7)**

Structural organization, Function, Mitochondrial Respiratory Chain, Chemi-osmotic hypothesis, Mitochondrial biogenesis, Protein transport into mitochondria, Semi-autonomous nature of mitochondria, Peroxisomes

Unit 6: Cytoskeleton and Cell Movement **(5)**

Cytoskeletal structure and functions: intermediate filament, microtubules, microfilaments and mitotic apparatus

Unit 7: The Cell Cycle **(5)**

Cell cycle, Regulation of cell cycle, Events of mitotic phase, Meiosis mechanism and its significance

Unit 8: Cell Signaling **(7)**

Signaling molecules and their receptors; Intracellular signal transduction pathways

Unit 9: Cell Death Mechanisms **(4)**

Apoptosis and Necrosis

CELL AND CELLULAR PROCESSES

DC-I: Paper 4

PRACTICAL

1. Preparations of temporary mount of *Allium cepa* root tip to study the different stages of mitosis.
2. Preparations of temporary mount of grasshopper testis to study the different stages of meiosis.
3. Cytochemical staining of DNA (Feulgen).
4. Cytochemical staining of polysaccharides (Periodic Acid Schiff's - PAS).
5. Stained preparation of the mitochondria in striated muscle cells/cheek epithelial cells using Janus green.
6. Study of mammalian sex chromatin through temporary preparations.

ESSENTIAL 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.

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 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.

DIVERSITY AND DISTRIBUTION OF CHORDATA

DC-I: Paper 5

THEORY (48 Periods)

Outline classification of Chordates **(2)**

Unit 1: Protochordata **(4)**
General characters of Hemichordata, Urochordata and Cephalochordata and their larval forms.
Retrogressive metamorphosis in Urochordata.

Unit 2: Chordate Origin **(2)**
Dipleurula concept and the Echinoderm theory of origin of chordates.

Unit 3: Vertebrata **(1)**
Advanced features over Protochordata.

Unit 4: Agnatha **(1)**
General characters and classification of cyclostomes up to class

Unit 5: Pisces **(6)**
General characters of *Chondrichthyes* and *Osteichthyes* and classification up to order
Migration in fishes, Osmoregulation, Parental care

Unit 6: Amphibia **(6)**
Origin of *Tetrapoda* (Evolution of terrestrial ectotherms)
General characters and classification up to order
Parental care in Amphibians

Unit 7: Reptilia **(4)**
General characters and classification up to order
Affinities of *Sphenodon*
Poison apparatus, Types of fangs, Biting mechanism in snakes

Unit 8: Aves **(6)**
General characters and classification up to order
Principles and aerodynamics of flight, Flight adaptations
Archaeopteryx-- a connecting link
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 (Tabular form)

DIVERSITY AND DISTRIBUTION OF CHORDATA

DC-I: Paper 5

PRACTICAL

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

3. Fishes

Sphyrna, Pristis, Torpedo, Chimaera, Notopterus, Mystus, Heteropneustes, Labeo, Exocoetus, Echeneis, Anguilla, Tetrodon/ Diodon, Anabas, Flat fish
Dissection of Afferent branchial system of *Scoliodon*

4. Amphibia

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

5. Reptiles

Chelone, Trionyx, Hemidactylus, Varanus, Uromastix, Chamaeleon, Draco, Ophiosaurus, 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
Dissection of Brain of Pigeon/Fowl
Temporary mount of pecten of Pigeon/Fowl

7. Mammalia

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

ESSENTIAL 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.

SUGGESTED READING

- Hall B.K. and Hallgrimsson B. (2008). *Strickberger's Evolution*. IV Edition. Jones and Bartlett Publishers Inc.

PHYSIOLOGY: LIFE SUSTAINING SYSTEMS

DC - I: Paper 6

THEORY (48 Periods)

Unit 1: Physiology of Digestion (14)

Structural organization of gastrointestinal tract; Mechanical and chemical digestion of food; Absorption of carbohydrates, proteins, lipids, water, minerals and vitamins; Nervous and hormonal control of digestion

Unit 2: Physiology of Respiration (12)

Mechanism of breathing, Pulmonary ventilation, Respiratory volumes and capacities, External and internal respiration, Transport of oxygen and carbon dioxide in blood, Factors affecting transport of gases, 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: Cardiovascular physiology (14)

Blood: Composition, Haemostasis

Heart: Structure of mammalian heart, Origin and conduction of the cardiac impulse, Cardiac cycle, Cardiac output and its regulation, ECG.

PHYSIOLOGY: LIFE SUSTAINING SYSTEMS

DC - I: Paper 6

PRACTICAL

1. Preparation of haemin and haemochromogen crystals.
2. To enumerate the RBC and WBC count using haemocytometer.
3. Estimation of haemoglobin using Sahli's haemoglobinometer.
4. Effect of posture, exercise and stress on blood pressure.
5. Examination of permanent histological sections of mammalian oesophagus, stomach, duodenum, rectum, liver, kidney, lung, testis, ovary
6. Video demonstration of heart perfusion.
7. Calculation of the rate of heart beat from the recording provided.
8. Preparation of histological sections (Microtomy) – Any two tissues

ESSENTIAL 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). *Vander's Human 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.

SUGGESTED READINGS

- 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.

COMPARATIVE ANATOMY OF VERTEBRATES

DC-I: Paper 7

THEORY (48 Periods)

Unit 1: Integumentary System **(6)**

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 **(6)**

Alimentary canal and associated glands

Unit 4: Respiratory System **(6)**

Skin, gills, lungs and air sacs; Accessory respiratory organs

Unit 5: Circulatory System **(6)**

General plan of circulation, evolution of heart and aortic arches

Unit 6: Urinogenital System **(4)**

Succession of kidney, Evolution of urinogenital ducts, Types of mammalian uteri.

Unit 7: Nervous System **(7)**

Comparative account of brain

Autonomic nervous system, Spinal cord, Cranial nerves in mammals

Unit 8: Sense Organs **(5)**

Classification of receptors: Brief account of visual receptors, chemo-receptors and mechanoreceptors

COMPARATIVE ANATOMY OF VERTEBRATES
DC-I: Paper 7

PRACTICAL

Dissections:

1. Temporary mount of placoid, cycloid and ctenoid scales.
2. Weberian ossicles and air bladder of *Mystus*
3. V and VII cranial nerves of *Scoliodon*
4. IX and X cranial nerves of *Scoliodon*

Osteology:

1. Disarticulated skeleton of Frog, *Varanus,* Fowl, Rabbit
2. Carapace and plastron of turtle /tortoise
3. Mammalian skulls: One herbivorous and one carnivorous animal.

ESSENTIAL READINGS

- Kardong, K.V. (2005) *Vertebrates' Comparative Anatomy, Function and Evolution*. IV Edition. McGraw-Hill Higher Education.
- Kent, G.C. and Carr R.K. (2000). *Comparative Anatomy of the Vertebrates*. IX Edition. The McGraw-Hill Companies.
- Weichert C.K and William Presch (1970). *Elements of Chordate Anatomy*, Tata McGraw Hills

SUGGESTED READINGS

- 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.

FUNDAMENTALS OF BIOCHEMISTRY

DC-I: Paper 8

THEORY (48 Periods)

Unit 1: Carbohydrates (8)

Structures and biological importance of monosaccharides, disaccharides, polysaccharides and glycoconjugates; Structures and biological importance of selected derivatives.

Unit 2: Lipids (8)

Structures and significance of physiologically important saturated and unsaturated fatty acids; Tri-acylglycerols, Phospholipids, Glycolipids, Steroids.

Unit 3: Proteins (10)

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; General methods of protein purification (*in brief*)

Unit 4: Nucleic acids (6)

Structure of purines and pyrimidines; Nucleotides and nucleic acids; Phospho-diester bonds, Base pairing.

Unit 5: Enzymes (16)

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 Km and Vmax, Lineweaver-Burk plot; Multi-substrate reactions; Allosteric enzymes and their kinetics; Enzyme inhibition and associated changes in kinetics; Regulation of enzyme action.

FUNDAMENTALS OF BIOCHEMISTRY

DC-I: Paper 8

PRACTICAL

1. Colour tests of functional groups in carbohydrate solutions.
2. Colour tests of functional groups in protein solutions.
3. Paper chromatography of amino acids.
4. Action of salivary amylase under optimum conditions.
5. Effect of pH on the action of salivary amylase.
6. Effect of temperature on the action of salivary amylase.
7. Separation of proteins by SDS-PAGE.

ESSENTIAL READINGS

- 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.

SUGGESTED READINGS

- 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.

PRINCIPLES OF GENETICS

DC-I: Paper 9

THEORY (48 Periods)

Unit 1: Mendelian Genetics and its Extension (7)

Principles of inheritance, Incomplete dominance and co-dominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Sex-linked inheritance.

Unit 2: Linkage, Crossing Over and Chromosomal Mapping (9)

Linkage and crossing over, Cytological basis of crossing over, Molecular mechanisms of crossing over, Recombination frequency as a measure of linkage intensity, Two factor and three factor crosses, Interference and coincidence, Somatic cell hybridization.

Unit 3: Mutations (9)

Gene mutations, Chromosomal mutations: Deletion, duplication, inversion, translocation, aneuploidy and polyploidy; Induced versus spontaneous mutations; Backward and forward mutations; Suppressor mutations; Molecular basis of mutations in relation to UV light and chemical mutagens; Detection of mutations: CLB method, attached *X* method, DNA repair mechanisms

Unit 4: Sex Determination (4)

Chromosomal mechanisms of sex determination; Sex-linked, sex-influenced and sex-limited characters

Unit 5: Extra-chromosomal Inheritance (5)

Criteria for extra-chromosomal inheritance, Antibiotic resistance in *Chlamydomonas*, Mitochondrial mutations and Maternal effects.

Unit 6: Quantitative Genetics (3)

Polygenic inheritance and Transgressive variation

Unit 7: Recombination in Bacteria (6)

Conjugation, Transformation, Transduction

Unit 8: Transposable genetic elements (5)

Transposons in bacteria, Ac-Ds elements in maize and P elements in *Drosophila*, Transposons in humans

PRINCIPLES OF GENETICS

DC-I: Paper 9

PRACTICAL

1. To study the Mendelian laws and gene interactions and their verification by Chi-square analyses using seeds/beads/*Drosophila*.
2. Identification of various mutants of *Drosophila*.
3. To calculate allelic frequencies by Hardy-Weinberg Law.
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.
7. Preparation of polytene chromosomes from *Chironomous*/*Drosophila* larva.
8. To study mutagenicity in *Salmonella/E. coli* by Ames test.

ESSENTIAL 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.

SUGGESTED READINGS

- 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.

BIOCHEMISTRY OF METABOLIC PROCESSES

DC-I: Paper 10

THEORY (48 Periods)

Unit 1: Overview of Metabolism (6)

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 (18)

Sequence of reactions and regulation of glycolysis, Citric acid cycle, Phosphate pentose pathway, Gluconeogenesis, Glycogenolysis and Glycogenesis

Unit 3: Lipid Metabolism (10)

β-oxidation of saturated fatty acids with even and odd number of carbon atoms; Biosynthesis of palmitic acid; Ketogenesis and its regulation

Unit 4: Protein Metabolism (8)

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

Unit 5: Oxidative Phosphorylation (6)

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

BIOCHEMISTRY OF METABOLIC PROCESSES

DC-I: Paper 10

PRACTICALS

1. Estimation of total protein in given solutions by Lowry's method.
2. Detection of SGOT/SGPT or GST and GSH in serum.
3. Lipolysis by lipase.
4. Proteolysis by trypsin.
5. Study of biological oxidation (SDH) [goat liver]
6. Acid/Alkaline phosphatase assay [Serum].
7. Dry Lab: To trace the labeled C atoms of Acetyl-CoA till they evolve as CO_2 in the TCA cycle.

.

ESSENTIAL 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,). *Harper's Illustrated Biochemistry*, XXVIII Edition, International Edition, The McGraw-Hill Companies Inc.

SUGGESTED READINGS

- Hames, B.D. and Hooper, N.M. (2000). *Instant Notes in Biochemistry*, II Edition, BIOS Scientific Publishers Ltd., U.K.

PHYSIOLOGY: CONTROLLING AND CO-ORDINATING SYSTEMS

DC-I: Paper 11

THEORY (48 periods)

Unit 1: Nerve and Sensory Physiology (13)

Organization of nervous tissue, Ionic basis of resting and action potentials, propagation of nerve impulse in myelinated and non-myelinated nerve fibres, Synaptic transmission, Physiology of vision and hearing

Unit 2: Muscle Physiology (10)

Ultrastructure of skeletal muscle, Mechanism of muscle contraction, Characteristics of muscle twitch: Summation, tetany and fatigue; Neuro-muscular junction; Motor unit

Unit 3: Endocrine Physiology (15)

Structure and function of pituitary, thyroid, parathyroid, pancreas and adrenals; Hypothalamic control of hormone secretion; Feed-back mechanisms; Mode of hormone action

Unit 4: Reproductive Physiology: **(10)**

Physiology of male reproduction: Hormonal control of spermatogenesis; Epididymal and accessory gland functions; Physiology of female reproduction: Hormonal control of oogenesis and menstrual cycle including ovarian and uterine changes

PHYSIOLOGY: CONTROLLING AND CO-ORDINATING SYSTEMS

DC-I: Paper 11

PRACTICAL

1. Preparation of temporary mounts: Neurons and Striated muscles
2. Demonstration of Knee jerk reflex
3. Optometry: Retinal examination, concept of Myopia, Hyperopia, Presbyopia, Blind spot.
4. Measurement of lowest audible sound (threshold): Each ear separately tested
5. Video demonstration of simple muscle twitch.
6. Calculate the different phases of a simple muscle twitch from the myograph provided.
7. Examination of permanent histological sections of mammalian pituitary, thyroid, parathyroid, pancreas, adrenal, spinal cord, ovary, testis

ESSENTIAL 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). *Vander's Human 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

SUGGESTED READINGS

- 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.

BIOINFORMATICS AND BIOSTATISTICS

DC-I: Paper 12

THEORY (48 Periods)

Part-A BIOINFORMATICS (24 Periods)

Unit 1: Introduction (2)

Importance, Goal, Scope; Limitations of Bioinformatics

Unit 2: Biological Databases and Data Retrieval (9)

Introduction to biological databases: Primary, secondary and composite databases; Types of biological databases: (Gene Bank, EMBL, DDBJ, 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: Basic Concepts of Sequence Alignment (8)

Similarity, identity and homology of sequences; Alignment: Local and global alignment, pair wise and multiple sequence alignments, Alignment algorithms (Dynamic and Heuristic, Scoring matrices)

Unit 4: Applications of Bioinformatics (5)

Structural Bioinformatics (3-D protein, PDB), Functional genomics, Drug discovery method (Basic concepts)

Part-B BIOSTATISTICS (24 Periods)

Unit 1: Introduction to Biostatistics: Aim and scope **(2)**

Unit 2: Measures of Central Tendency and Dispersion (7)

Mean, Median and Mode; Variance, Standard deviation, Standard error, Co-efficient of Variance

Unit 3: Distributions (4)

Normal, Binomial and Poisson; Skewness and Kurtosis

Unit 4: Testing of Hypothesis (3)

Type-I and Type-II errors; Confidence Intervals and Confidence Levels

Unit 5: Statistical Tests (6)

Chi-square tests, Z-test and t-test, F-test (ANOVA)

Unit 6: Introduction to statistical software tools and data analyses (SPSS) **(2)**

BIOINFORMATICS AND BIOSTATISTICS

DC-I: Paper 12

PRACTICAL

Part - A Bioinformatics

1. To learn about biological databases and their characteristics.
2. To retrieve nucleotide and protein sequences from the databases.
3. To perform pair-wise alignment of sequences (BLAST).
4. To predict the structure of protein.

Part - B Biostatistics

1. To compute Coefficient of Variance from samples provided.
2. To collect data on different parameters of animal samples and test significant difference between means (Z-test, t-test)
3. To compute 'test of independence' and test for 'goodness of fit' with samples/data provided.
4. To learn graphical representations of statistical data with the help of computers (e.g. MS Excel).

ESSENTIAL READINGS

- Ghosh Z and Mallick B. (2008). Bioinformatics: *Principles and Applications*, Oxford University Press.
- Pevsner J. (2009). *Bioinformatics and Functional Genomic*s, II Edition, Wiley Blackwell.
- Zar, Jerrold H. (1999). *Biostatistical Analysis*, IV Edition, Pearson Education Inc and Dorling Kindersley Publishing Inc. USA

SUGGESTED READINGS

- Zvelebil, Marketa and Baum O. Jeremy (2008. *Understanding Bioinformatics*, Garland Science, Taylor and Francis Group, 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

MOLECULAR BIOLOGY

DC-I: Paper 13

THEORY (48 Periods)

Unit 1: Nucleic Acids (6)

Salient features of DNA double helix: Watson and Crick model of DNA, DNA denaturation and renaturation; DNA topology - linking number and DNA topo-isomerases, C_Ot curves

Unit 2: DNA Replication (9)

Mechanism of DNA replication: Enzyme involved in DNA replication - DNA polymerases, DNA ligase, primase, topoisomerase, telomerase and other accessory proteins; Semi-conservative, bidirectional and semi-discontinuous replication, RNA priming, Replication of circular and linear *ds*-DNA, Replication of the 5′end of linear chromosome

Unit 3: Transcription (5)

RNA polymerase and transcription unit, Transcription in prokaryotes and eukaryotes

Unit 4: Translation (10)

Structure of tRNA, 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 (4)

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 *lac* operon and *trp* operon; Transcription regulation in eukaryotes: Activators, repressors, enhancers, silencers elements; Gene silencing, Genetic imprinting

Unit 7: Regulatory RNAs (4)

Ribo-switches, RNA interference, miRNA, siRNA

MOLECULAR BIOLOGY

DC-I: Paper 13

PRACTICAL

1. Preparation of liquid culture medium (LB) and raise culture of *E. coli*.
2. Estimation of the growth kinetics of *E. coli* by turbidity method.
3. Preparation of solid culture medium (LB) and growth of *E. coli* by spreading and streaking.
4. Demonstration of antibiotic sensitivity/resistance of *E. coli* to antibiotic pressure and interpretation of results.
5. To understand the structure of the *lac* operon and its working in the presence/absence of glucose.
6. Quantitative estimation of salmon sperm/calf thymus DNA using colorimeter (Diphenylamine reagent) or spectrophotometer (A260 measurement).

ESSENTIAL 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.

SUGGESTED READINGS

- 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

ANIMAL BEHAVIOUR

DC – I: Paper 14

THEORY (48 Periods)

Unit 1: Introduction (5)

Origin and history of ethology, Brief profiles of Karl Von Frish, Ivan Pavlov, Konrad Lorenz, Niko Tinbergen, Asking questions about behaviour- proximate and ultimate, Objective of behaviour, Behaviour as a basis of evolution, Behaviour as a discipline of science

Unit 2: Mechanisms of Behaviour (5)

Innate behaviour, Instinct, Stimulus filtering, Sign stimuli, Code breakers

Unit 3: Patterns of Behaviour (14)

Reflexes: Types of reflexes, reflex path, characteristics of reflexes (latency, after discharge, summation, fatigue, inhibition) and its comparison with complex behaviour

Orientation: Primary and secondary orientation; kinesis-orthokinesis, klinokinesis; taxis-tropotaxis and klinotaxis, menotaxis (light compass orientation)

Learning: Associative learning, classical and operant conditioning, Habituation, Imprinting

Unit 4: Social Behaviour (6)

Insects' society; Honey bee: Society organization, polyethism, foraging, round dance, waggle dance, Experiments to prove distance and direction component of dance, learning ability in honey bee, formation of new hive/queen

Unit 5: Altruism (4)

Reciprocal altruism, Hamilton's rule and inclusive fitness with suitable examples

Unit 6: Sexual Behaviour (8)

Asymmetry of sex, Sexual dimorphism mate choice, Intra-sexual selection (male rivalry), Inter-sexual selection (female choice), Infanticide, Consequences of mate choice for female fitness, Sexual conflict for male verses female parental care, Courtship behavior in 3-spine stickleback

Unit 7: Biological Clocks (6)

Circadian rhythms, Tidal rhythms, Lunar rhythms, Advantages of biological clocks, Jet lag, Entrainment

ANIMAL BEHAVIOUR
DC-I: Paper 14

PRACTICAL

1. To study different types of animal behaviour such as habituation, social life, courtship behaviour in insects, and parental care from short videos/movies and prepare a short report.
2. To study nests and nesting habits of the birds and social insects.
3. To study the behavioural responses of wood lice to dry condition.
4. To study behaviour responses of wood lice in response to humid condition.
5. To study geotaxis behaviour in earthworm.
6. To study the phototaxis behaviour in insect larvae.
7. Visit to Forest/ Wild life Sanctuary/Biodiversity Park/Zoological Park to study behavioural activities of animals and prepare a short report.

ESSENTIAL 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.

SUGGESTED READING

- Paul W. Sherman and John Alcock, *Exploring Animal Behaviour,* Sinauer Associate Inc., Massachusetts, USA.

CONCEPTS AND MECHANISMS OF EVOLUTION

DC - I: Paper 15

THEORY (48 Periods)

Unit 1: Introduction to Evolutionary Theories (4)
Lamarckism, Darwinism, Neo-Darwinism

Unit 2: History of Life (3)
Overview, Biogeny

Unit 3: Evidences of Evolution (6)
Fossils as direct evidences, Types of fossils, Incompleteness of fossil record, Phylogeny of horse as an example, Molecular evidences (Globin gene families and Molecular clock concept)

Unit 4: Sources and Processes of Evolutionary Change (15)
Causes of organic variations: An overview, Role of variations in evolution; Natural selection (Examples; Industrial melanism, Pesticide/Antibiotic resistance); Types of natural selection (Directional, Stabilizing, Disruptive); Principles of population genetics: Concept of gene pool, Gene frequencies – equilibrium frequency (Hardy-Weinberg equilibrium), Shift in gene frequency - Genetic drift, Mutation pressures and Gene flow

Unit 5: Products of Evolutionary Change (8)
Biological species concept (Advantages and Limitations); Sibling species, Polymorphic species, Polytypic species, Ring species; Isolating mechanisms; Modes of speciation (Allopatric, Sympatric); Macro-evolutionary Principles (example: Darwin's Finches); Convergence, Divergence, Parallelism

Unit 6: Extinction (6)
Background extinction, Mass extinction (Causes, Names of five major extinctions, K-T extinction in detail), Role of extinction in evolution

Unit 7: Origin and Evolution of Man (6)
Palaentological evidences; Note on molecular evidences

CONCEPTS AND MECHANISMS OF EVOLUTION
DC - I: Paper 15

PRACTICAL

1. Study of fossil evidences from plaster cast models and pictures.
2. Study of homology, analogy and homoplasy from suitable specimens.
3. Study of natural selection under different conditions, using simulation exercise.
4. Demonstration of role of natural selection and genetic drift in changing allele frequencies.
5. Construction of cladograms based on morphological characteristics.
6. Construction of phylogenetic tree with the bioinformatics tools (Clustal X and Phylip) and its interpretation.

ESSENTIAL READINGS

- Ridley, M. (2004). *Evolution*. III Edition. Blackwell Publishing
- Barton, N. H., Briggs, D. E. G., Eisen, J. A., Goldstein, D. B. and Patel, N. H. (2007). *Evolution*. Cold Spring, Harbour Laboratory Press.
- Hall, B. K. and Hallgrimsson, B. (2008). *Evolution*. IV Edition. Jones and Bartlett Publishers

SUGGESTED READINGS

- Pevsner, J. (2009). *Bioinformatics and Functional Genomics*. II Edition. Wiley-Blackwell.
- Campbell, N. A. and Reece J. B. (2011). *Biology*. IX Edition, Pearson, Benjamin, Cummings.
- Douglas, J. Futuyma (1997). *Evolutionary Biology*. Sinauer Associates.
- Minkoff, E. (1983). *Evolutionary Biology*. Addison-Wesley.

IMMUNOLOGY

DC - I: Paper 16

THEORY (48 Periods)

Unit 1: Overview of Immune System (9)

Historical perspective of Immunology, Early theories of Immunology, Haematopoiesis, Cells and organs of the Immune system

Unit 2: Innate and Adaptive Immunity (6)

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.

Unit 3: Antigens (5)

Antigenicity and immunogenicity, Immunogens, Adjuvants and haptens, Factors influencing immunogenicity, B and T-Cell epitopes

Unit 4: Immunoglobulins (11)

Structure and functions of different classes of immunoglobulins, Antigen-antibody interactions, Immunoassays, Polyclonal sera, Monoclonal antibodies, Hybridoma technology

Unit 5: Major Histocompatibility Complex (4)

Structure and functions of endogenous and exogenous pathway of antigen presentation

Unit 6: Cytokines (3)

Properties and functions, Cytokine-based therapies

Unit 7: Complement System (3)

Components and pathways of complement activation.

Unit 8: Hypersensitivity (3)

Gell and Coombs' classification and Brief description of various types of hypersensitivitie s

Unit 9: Vaccines (4)

Types of vaccines: Recombinant vaccines and DNA vaccines.

IMMUNOLOGY
DC - I: Paper 16

PRACTICAL

1. Demonstration of lymphoid organs.
2. Ouchterlony's double immuno-diffusion method.
3. ABO blood group determination.
4. Preparation of single cell suspension of splenocytes, cell counting and viability test.
5. To assess the phagocytic activity of macrophages.
6. Principles, experimental set up and applications of immuno-electrophoresis, ELISA, RIA, FACS (Dry lab).

ESSENTIAL 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.

SUGGESTED READING

- Lydyard, P., Whelan A. and Fanger M.W. (2004.) *Instant Notes in Immunology,* II Edition, BIOS Scientific Publishers

RESEARCH METHODOLOGY

DC-I: Paper 17

THEORY (48 Periods)

Research methods are a variety of techniques that people use when studying a given phenomenon. Research methods are well thought out and planned, scientific based and value neutral. This means that in order to have good research methods, a researcher must design the research in a way that maximizes the accuracy of the results. Research methodology is the framework used to study and compare different approaches of individual methods.

Unit 1: The Nature of Research (2)

Definition of Research, Significance of research, Objectives of research, Components of research problem, Steps in scientific research.

Unit 2: Literature Survey (2)

Sources of scientific literature: Print and Digital

Unit 3: Types of Research (4)

Descriptive *vs* Analytical; Applied *vs* Basic; Qualitative *vs* Quantitative; Conceptual *vs* Empirical; Survey *vs* Experimental.

Unit 4: Tools and Techniques in Research (16)

Model organisms; Principles and applications of Microscopy, Histochemical and Cytochemical techniques, Chromatography, Electrophoresis, Spectroscopy, ELISA, PCR and Animal Tissue Culture

Unit 5: Research Process (12)

Formulation of research problem; Inductive reasoning; Hypothesis; Preparing the research design; Sample design – deliberate, random, systematic, stratified, quota, cluster, area, multi-stage, sequential; Data collection – observation, interview, questionnaires, schedules; Categorization and summarization of data, Presentation of data – tabulation, graphical presentation – Bar, Line, Pie; Analysis of data -Statistical methods, Software; Recording of data through photographs; Hypothesis testing; Generalisations, Interpretation

Unit 6: Preparation of Report (4)

Scientific presentation, abbreviations, nomenclature used and reference writing

Unit 7: Publication of Report **(2)**

Finding a suitable journal – Open access, Publication charges; Writing scientific research papers

Unit 8: Bio-safety **(2)**

Awareness about handling of toxic laboratory chemicals, Use of pathogenic micro-organisms, Radioactive hazards, Safe disposal of animals and chemicals

Unit 9: Ethical Aspects of Biological Research **(4)**

Ethical principles and government regulations governing use of live animals as objects of research; Copyright and plagiarism; Patents; Peer review; Conflict of interest; IPR issues

ESSENTIAL READINGS

- Walliman, N. (2011). *Research Methods-The Basics.* Taylor and Francis, London and New York.
- Kothari, C. R. *Research Methodologies-Methods and Techniques.* New Age Publishers.
- Dawson, C. (2002). *Practical Research Methods.* UBS Publishers, New Delhi

SUGGESTED READINGS

- Booth, W.C., Colomb, G.G. and Williams, J.M. (2003). *The Craft of Research,* II Edition, University of Chicago Press.
- Monamy, V. (2009). *Animal Experimentation-A Guide to the Issues*, II edition. Cambridge University Press.

BIOTECHNOLOGY: MICROBES TO ANIMALS

DC - I: Paper 18

THEORY (48 Periods)

Unit 1: Introduction (3)

Concept and scope of Biotechnology

Unit 2: Techniques in Gene Manipulation (15)

Restriction and modifying enzymes, Cloning vectors and Expression vectors, Transformation techniques, Identification of recombinants, Construction and screening of DNA libraries; Molecular analysis of DNA, RNA and proteins (*i.e.* Southern, Northern and Western blotting), DNA sequencing (Sanger's method and automation), Polymerase Chain Reaction, Microarrays, DNA fingerprinting: RAPD

Unit 3: Microbes in Biotechnology (10)

Growth kinetics of microbes, Applications of microbes in industry (Concept of primary and secondary metabolites, Fermentation/Bioreactors, Downstream processing), Bioremediation and Biosensing

Unit 4: Transgenic Animal (10)

Production of transgenic animals: Retroviral method, DNA microinjection method, embryonic stem cell method, nuclear transplantation; Applications of transgenic animals; Knockout mice; Transgenic livestock; Transgenic fish.

Unit 5: Biotechnology and Human Welfare (10)

Animal cell technology: Concept of expressing cloned genes in mammalian cells, Recombinant DNA in health (Recombinant insulin and human growth hormone), Production of recombinant vaccines, Gene therapy: *in vitro, in-vivo* and *ex-vivo*. Ethical issues concerning: Transgenesis, Biosafety and Intellectual Property Rights

BIOTECHNOLOGY: MICROBES TO ANIMALS

DC - I: Paper 18

PRACTICAL

1. Isolation of genomic DNA from *E. coli* and analyze it using agarose gel electrophoresis
2. Isolation of plasmid DNA (pUC 18/19) and analyse it using agarose gel electrophoresis.
3. Transformation of *E. coli* (pUC 18//19) and calculation of transformation efficiency.
4. Restriction digestion of lambda (λ) DNA using *EcoR*1 and *Hind* III.
5. DNA ligation (lambda DNA *EcoR*1/*Hind* III digested).
6. Construction of restriction digestion maps from data provided.
7. Study of Southern blot hybridization and PCR; Analysis of DNA fingerprinting (Dry Lab)

   * Project on Animal Cell Culture

ESSENTIAL READINGS

- Brown, T.A. (1998). *Molecular Biology Labfax II: Gene Cloning and DNA Analysis*. II Edition, Academic Press, California, USA.
- Klug, W.S., Cummings, M.R. and Spencer, C.A. (2009) *Concepts of Genetics*. IX Edition, Benjamin Cummings.
- Glick, B.R. and Pasternak, J.J. (2009). *Molecular Biotechnology - Principles and Applications of Recombinant DNA*. IV Edition, ASM press, Washington, USA.

SUGGESTED READINGS

- 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.
- Sreekrishna, V. (2001). *Bioethics and Biosafety in Biotechnology.* I Edition, New Age International (P) Ltd.

DEVELOPMENTAL BIOLOGY

DC - I: Paper 19

THEORY (48 Periods)

Unit 1: Introduction (**5**)

History and basic concepts: Epigenesis, preformation, Mosaic and regulative development; Discovery of induction, Cell-Cell interaction, Pattern formation, Differentiation and growth, Differential gene expression, Cytoplasmic determinants and asymmetric cell division, Reliability of development: Redundancy and negative feed-back.

Unit 2: Early Embryonic Development **(20)**

Gametogenesis, Spermatogenesis, Oogenesis; Types of eggs, Egg membranes; Fertilization: Changes in gametes, monospermy and polyspermy; Planes and patterns of cleavage; Early development of frog and chick up to gastrulation; Fate maps; 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 **(8)**

Metamorphosis: Changes, hormonal regulations in amphibians; Regeneration: Modes of regeneration, epimorphosis, morphallaxis and compensatory regeneration (with one example each); Ageing: Concepts and models

Unit 5: Implications of Developmental Biology **(7)**

Teratogenesis: Teratogenic agents and their effects on embryonic development; *In vitro* fertilization, Stem cell culture, Amniocentesis.

DEVELOPMENTAL BIOLOGY

DC - I: Paper 19

PRACTICAL

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 developmental stages (above mentioned) by raising chick embryo in the laboratory.
4. Study of the developmental stages and life cycle of *Drosophila* from stock culture
5. Study of different types of placenta
6. Project report on *Drosophila* culture/chick embryo development

ESSENTIAL 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.
- Kalthoff (2008). *Analysis of Biological Development*, II Edition, McGraw-Hill Publishers.

SUGGESTED READING

- Lewis Wolpert (2002). *Principles of Development*. II Edition, Oxford University Press.

Four Year Undergraduate Program
in
Zoology

Discipline Courses - II

BIOLOGY OF NON-CHORDATA

DC – II: Paper 1

THEORY (48 Periods)

Unit 1: Kingdom Protista **(7)**
General characteristics and classification up to classes
Reproduction in Protista

Unit 2: Phylum Porifera **(4)**
General characteristics and classification up to classes
Canal system in sponges

Unit 3: Phylum Cnidaria **(6)**
General characteristics and classification up to classes
Corals and coral reefs

Unit 4: Phylum Platyhelminthes **(4)**
General characteristics and classification up to classes
Life cycle, pathogenicity, prophylaxis and parasitic adaptations of *Taenia solium*

Unit 5: Phylum Nemathelminthes **(4)**
General characteristics and classification up to classes
Life cycle, pathogenicity, prophylaxis and parasitic adaptations of *Ascaris lumbricoides*

Unit 6: Phylum Annelida **(4)**
General characteristics and classification up to classes
Excretion in Annelida

Unit 7: Phylum Arthropoda **(9)**
General characteristics and classification up to classes
Vision in Arthropoda; Social life in honey bees

Unit 8: Phylum Mollusca **(5)**
General characteristics and classification up to classes
Shell in Mollusca, Pearl formation

Unit 9: Phylum Echinodermata **(5)**
General characteristics and classification up to classes
Water-vascular system in Asteriodea

Note: Classification to be followed from "Barnes, R.D. (1982), *Invertebrate Zoology,* VI Edition, Holt Saunders International Edition"

FYUP - DC-II
BIOLOGY OF NON-CHORDATA

PRACTICAL

Kingdom Protista

1. Study of *Amoeba*, *Euglena*, *Paramecium*, Binary fission and conjugation in *Paramecium*

Phylum Porifera

2. Study of *Sycon* (including T.S. and L.S.), *Hyalonema* and *Euplectella*

Phylum Cnidaria

3. Study of *Obelia, Physalia, Millepora, Aurelia, Tubipora, Alcyonium, Gorgonia, Metridium*

Phylum Platyhelminthes

4. Study of Adult *Taenia solium* and its life stages (Slides/micro-photographs)

Phylum Nemathelminthes

5. Study of Adult *Ascaris lumbricoides* and its life stages (Slides/micro-photographs)

Phylum Annelida

6. Dissection of digestive system; and temporary mount of pharyngeal and septal nephridia of earthworm
7. Study of *Aphrodite, Nereis, Heteronereis, Chaetopterus, Hirudinaria*

Phylum Arthropoda

8. Dissection of digestive system and temporary mount of mouth parts of cockroach
9. Study of *Palamnaeus, Palaemon, Cancer*, *Scolopendra*, *Julus*, termite, honeybee

Phylum Mollusca

10. Study of *Chiton, Dentalium, Pila, Unio, Loligo, Sepia,* and *Octopus*

Phylum Echinodermata

11. Study of *Pentaceros/Asterias, Ophiura, Echinus, Cucumaria* and *Antedon*

Note: Classification to be followed from "Barnes, R.D. (1982). *Invertebrate Zoology*, VI Edition, Holt Saunders International Edition"

ESSENTIAL READINGS

- Barnes, R.D. (1982) *Invertebrate Zoology*, VI Edition. Holt Saunders International Edition.
- Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and J.I., Spicer (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.

SUGGESTED READING

- Boradale, L.A. and Potts, E.A. (1961). *Invertebrates: A Manual for the use of Students.* Asia Publishing Home.

BIOLOGY OF CHORDATA

DC – II: Paper 2

THEORY (48 Periods)

Unit 1: Outline classification of Chordates **(2)**

Unit 2: Protochordata **(4)**
General characters of Hemichordata, Urochordata and Cephalochordata

Unit 3: Vertebrata **(1)**
Advanced features over Protochordata.

Unit 4: Agnatha **(1)**
General characters and classification up to classes

Unit 5: Pisces **(8)**
General characters of *Chondrichthyes* and *Osteichthyes*
Classification up to order, Migration in fishes, Osmoregulation, Parental care

Unit 6: Amphibia **(6)**
General characters and classification up to order
Parental care in Amphibia

Unit 7: Reptilia **(6)**
General characters and classification up to order
Biting mechanism in snakes, Difference between poisonous and non-poisonous snakes

Unit 8: Aves **(10)**
General characters and classification up to order
Types of feathers, Types of flights, Flight adaptations, Migration in birds

Unit 9: Mammals **(10)**
General characters and classification up to order
Integument in mammals; Dentition and modification of stomach

BIOLOGY OF CHORDATA

DC – II: Paper 2

PRACTICAL

1. General Characteristics and Classification of Chordates

Agnatha up to classes; Pisces, Amphibia, Reptilia, Aves and Mammalia up to orders (classification to be followed from Young)

2. Protochordates

Balanoglossus, Branchiostoma, Herdmamia

3. Agnatha

Petromyzon

4. Pisces

Sphyrna, Pristis, Torpedo, Notopterus, Labeo, Exocoetus, Echeneis, Anabas.

Dissection of afferent branchial system of *Scoliodon;* Temporary mount of placoid scales

5. Amphibia

Uraeotyphlus, Necturus, Salamandra, Bufo, Hyla.

6. Reptilia

Chelone, Testudo, Hemidactylus, Chamaeleon, Draco, Ophiosaurus, Bungarus, Vipera, Naja, Hydrophis, Crocodylus.

7. Aves

Study of six common birds of different orders

Dissection of brain of fowl/pigeon; Mount of pecten of pigeon

8. Mammalia

Bat (frugivorous and insectivorous), *Sorex, Funambulus*, *Hemiechenis*

Study of disarticulated skeleton of rabbit

ESSENTIAL READINGS

- Young, J. Z. (2004). *The life of Vertebrates*. III Edition. Oxford university press.
- Pough H. *Vertebrate Life*, VIII Edition, Pearson International.
- Hilderbrand, M and Gaslow G.E. *Analysis of Vertebrate Structure*, John Wiley and Sons.

SUGGESTED READING

- Walter, H.E. and Sayles, L.P; *Biology of Vertebrates*, Khosla Publishing House.

FOUNDATIONS OF DEVELOPMENTAL BIOLOGY

DC – II: Paper 3

THEORY (48 Periods)

Unit 1: Historical Background of Developmental Biology (4)

Chief events in animal development, Epigenesis, Preformation, Experimental embryology, Induction, Differentiation, Growth and differential gene expression

Unit 2: Early Growth and Development of the Embryo (20)

Formation of gametes: Spermatogenesis, Oogenesis

Egg types, Egg envelopes, Fertilization: Sperm egg interaction, egg activation, prevention of polyspermy, fusion of male and female pronuclei, post-fertilization metabolic changes

Cleavage: Different planes and patterns; morula and blastula; Development of frog and chick up to gastrulation; Fate maps; Embryonic induction

Unit 3: Post Gastrulation Development (9)

Fate of germ layers, Embryonic adaptations: Extra-embryonic membranes in birds, placenta in mammals (Structure, types and functions of placenta)

Unit 4: Later Part of Ontogenesis (9)

Amphibian metamorphosis: Metamorphic changes and hormonal regulation; Regeneration: Types of regeneration, epimorphosis, morphallaxis and compensatory regeneration (with one example each)

Unit 5: Medical Implications of Development (6)

Teratogenesis: Effect of teratogens on development of embryo, stem cells and potential therapies

FOUNDATIONS OF DEVELOPMENTAL BIOLOGY

DC – II: Paper 3

PRACTICAL

1. Study of whole mounts and sections of developmental stages of frog through permanent slides: Cleavage stages, blastula, gastrula, neurula, tail buds stage, tadpole (external and internal gill stages)
2. Study of whole mounts of developmental stages of chick through permanent slides: Primitive streak (18 h), 24, 33, 48, 72 and 96 hours of incubation (Hamilton and Hamburger stage.
3. Study the developmental stages and the life cycle of *Drosophila* from the stock culture.
4. Study of different types of placenta

*** Project Report on *Drosophila* culture**

ESSENTIAL 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.
- Kalthoff, (2008). *Analysis of Biological Development*, II Edition, McGraw-Hill Professional.

SUGGESTED READINGS

- Wolpert L. (2002). *Principles of Development*. II Edition, Oxford University Press.

EVOLUTIONARY BIOLOGY

DC – II: Paper 4

THEORY (48 Periods)

Unit 1: Introduction to Evolutionary Theories (4)
Lamarckism, Darwinism, Neo-Darwinism

Unit 2: History of Life (4)

Unit 3: Evidences of Evolution (6)
Fossils as direct evidences, Types of fossils, Reasons for incompleteness of fossil record, (phylogeny of horse as an example), Molecular evidences (Globin genes).

Unit 4: Processes of Evolutionary Change (13)
Causes of organic variations; Role of variations in evolution (with one example); Hardy-Weinberg equilibrium and Genetic drift; Natural selection: Concept and example (Industrial melanism)

Unit 5: Products of Evolutionary Change (8)
Biological species concept (Advantages and limitations); Isolating mechanisms, Modes of speciation (Allopatric, Sympatric)

Unit 6: Mass Extinction (5)
(K-T Extinction)

Unit 7: Origin and Evolution of Man (8)

EVOLUTIONARY BIOLOGY
DC – II: Paper 4

PRACTICAL

1. Study of fossils from plaster cast models and pictures.
2. Study of homology, analogy and homoplasy from suitable specimens.
3. Study of natural selection under different conditions using simulation exercise.
4. Demonstration of role of natural selection and genetic drift in changing allele frequencies.

ESSENTIAL READINGS

- Ridley, M. (2004). *Evolution*. III Edition. Blackwell Publishing.
- Hall, B. K. and Hallgrimsson, B. (2008). *Evolution*. IV Edition. Jones and Bartlett Publishers.
- Campbell, N. A. and Reece, J. B. (2011). *Biology*. IX Edition, Pearson, Benjamin, Cummings

SUGGESTED READINGS

- Moody, P. A. (1962). *Introduction to Evolution*. New York Harper.
- Savage, J. M. (1963). *Evolution*. Holy, Rinehart and Winston.

HUMAN PHYSIOLOGY
DC – II: Paper 5

THEORY (48 Periods)

Unit 1: Digestion and Absorption of Food (10)
Structure and function of digestive glands; Digestion and absorption of carbohydrates, fats and proteins; Nervous and hormonal control of digestion (*in brief*)

Unit 2: Functioning of Excitable Tissue (Nerve and Muscle) (9)
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

Unit 3: Respiratory Physiology (4)
Ventilation, External and internal Respiration, Transport of oxygen and carbon dioxide in blood, Factors affecting transport of gases.

Unit 4: Renal Physiology (6)
Functional anatomy of kidney, Mechanism and regulation of urine formation,

Unit 5: Cardiovascular Physiology (7)
Structure of heart, Coordination of heartbeat, Cardiac cycle, ECG

Unit 6: Endocrine and Reproductive Physiology (12)
Structure and function of endocrine glands (pituitary, thyroid, parathyroid, pancreas, adrenal, ovaries, and testes), Brief account of spermatogenesis and oogenesis, Menstrual cycle

HUMAN PHYSIOLOGY
DC – II: Paper 5

PRACTICAL

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.

ESSENTIAL 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). *Vander's Human 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.

SUGGESTED READINGS

- 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.

APPLIED ZOOLOGY

DC – II: Paper 6

(ANY TWO SECTIONS)

SECTION A: INTRODUCTION TO MEDICAL ZOOLOGY

THEORY (24 Periods)

Unit 1: Introduction to Host-parasite Relationship (4)

Host, Definitive host, Intermediate host, Parasitism, Symbiosis, Commensalism, Reservoir, Zoonosis

Unit 2: Epidemiology of Diseases (8)

Transmission, Prevention and control of diseases: Amoebiasis, dengue, malaria, and plague

Unit 3: Rickettsia and Spirochaetes (4)

Brief account of *Rickettsia prowazeki, Borrelia recurrentis* and *Treponema pallidum*

Unit 4: Parasitic Helminthes (6)

Life history and pathogenicity of *Schistosoma haematobium*, *Enterobius vermicularis* and *Wuchereria bancrofti*

Unit 5: Liver Cirrhosis (2)

Alcoholic cirrhosis (Early, intermediate and late stage)

PRACTICAL

1. Study of permanent slides/photomicrographs and specimens of *Plasmodium*, *Entamoeba histolytica, Schistosoma haematobium, Enterobius vermicularis* and *Wuchereria bancrofti*
2. Study of arthropod vectors associated with human diseases: *Pediculus, Culex, Anopheles, Aedes* and *Xenopsylla.*
3. Study of photomicrographs of Liver cirrhosis: Alcoholic cirrhosis.

ESSENTIAL READINGS

- Park, K. (2007). *Preventive and Social Medicine*. XVI Edition. B.B Publishers.
- Arora, D. R and Arora, B. (2001). *Medical Parasitology*. II Edition. CBS Publications and Distributors.
- Kumar and Corton. *Pathological Basis of Diseases*.

SUGGESTED READING

- Service, *A Guide to Medical Entomology*.

SECTION B: APPLIED ENTOMOLOGY

THEORY (24 Periods)

Unit 1: Introduction to Pest Management (6)

Definitions of pest; Monophagous, oligophagous and polyphagous pests; Economic injury level, Economic threshold level, Pest resurgence, Secondary pest outbreak; Classification of insects up to order (Special emphasis on Lepidoptera, Hymenoptera, Coleoptera and Hemiptera).

Unit 2: Insect Control (10)

IPM, Cultural, Chemical, Genetic and Biological control

Unit 3: Morphology of Insect Mouthparts (4)

Biting-chewing type and Piercing-sucking type: Morphology, plant damage; Effective control strategy of damage caused.

Unit 4: Phytophagous Pests (2)

Biology, damage and control of *Helicoverpa* (*Heliothis*) *armigera* and *Papilio demoleus*

Unit 5: Stored Grain Pests (2)

Biology, damage and control of *Callosobruchus chinensis* and *Corcyra cephalonica*

PRACTICAL

1. Study of mouthparts of insects
2. Study of insect damage to different plant parts/stored grains through damaged products/photographs.
3. Identifying feature and economic importance of *Helicoverpa* (*Heliothis*) *armigera*, *Papilio demoleus*, *Leptocorisa acuta* and *Earias vitella*.
4. Economic importance and life cycle of *Callosobruchus chinensis* and *Tribolium castaneum*.

ESSENTIAL READINGS

- Atwal, A.S. (1986). *Agricultural Pests of India and South East Asia*, Kalyani Publishers.
- Dennis, H. (2009). *Agricultural Entomology.* Timber Press (OR).
- Pradhan, S. (1969). *Insect Pests of Crops.* National Book Trust, India Book House.

SUGGESTED READING

- Pedigo, L.P. (2002). *Entomology and Pest Management*, Prentice Hall.

SECTION C: REPRODUCTIVE HEALTH AND HUMAN WELFARE

THEORY (24 Periods)

Unit 1: Reproductive System (4)

Anatomy of male and female reproductive tracts of human and rat; Structure of ovary and testis; Detailed structure of ovum and sperm (mammalian).

Unit 2: Infertility (4)

Infertility in male and female: Causes and diagnosis.

Unit 3: Assisted Reproductive Technology (6)

Brief account of sex selection; *In vitro* fertilization and ET, IFT, IUT (IUI), ZIFT, GIFT, ICSI, PROST

Unit 4: Modern Contraceptive Techniques: A Brief Review (4)

Unit 5: Introduction to Animal Husbandry (6)

Need and usefulness of artificial insemination in cattle, Induction of early puberty and Synchronization of estrus in cattle, Egg production in poultry

PRACTICAL

1. Study of T.S. of ovary and testis of rat.
2. Study of menstrual and estrus cycles from photomicrographs.
3. Study of modern contraceptives: IUDs, chemical methods and barrier methods.
4. Visit to any center of study involved in the field of Reproductive biology and Animal husbandry; PowerPoint presentation of the same in the class and submission of project report.

ESSENTIAL READINGS

- Chaudhary, S. K. (1996). *Practice of Fertility Control, A Comprehensive Textbook*. B. I. Churchill Livingstone Pvt. Ltd. India.
- Hafez, E. S. E. (1962). *Reproduction in Farm Animals*.
- Hafez, E. S. E. and Evans, T. N. (1973). *Human Reproduction: Contraception and Conception*. Harper and Row, New York.

SUGGESTED READINGS

- Knobil, E. and Neill, J. D. (2006). *The Physiology of Reproduction*. Vol. 2. Elsevier Publishers.

Four Year Undergraduate Program
in
Zoology

Applied Courses

APPLIED COURSE

MEDICAL DIAGNOSTICS
AC – Paper 1

THEORY (30 Periods)

Unit 1: Introduction to Medical Diagnostics and its Importance (2)

Unit 2: Diagnostics Methods Used for Analysis of Blood (10)
Blood composition, Preparation of blood smear and identification of various types of cells using Leishman's stain, Platelet count using haemocytometer, Differential Leucocyte Count (D.L.C), 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 (6)
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 (3)
Causes, types, symptoms, diagnosis and prevention of Tuberculosis and Hepatitis

Unit 6: Tumours (3)
Types (Benign/Malignant), Detection and metastasis; Medical imaging: X-Ray of Bone fracture, PET, MRI and CT Scan (using photographs).

ESSENTIAL 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
- Guyton A.C. and Hall J.E. T*extbook of Medical Physiology*, Saunders

SUGGESTED READINGS

- Cheesbrough M., *A Laboratory Manual for Rural Tropical Hospitals, A Basis for Training Courses*
- 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.

APPLIED COURSE

HEALTH AND LIFE STYLE

AC – Paper 2

(30 Periods)

Unit 1: Basic Concepts of Nutrition **(6)**

Components of nutrients: Macro-nutrients, micro-nutrients and their biochemical role; Food groups; Concept of a balanced diet; Preparation of balanced diet chart for age groups: 18-22 years, 30-50 years, 60 years onwards; Preparation of their own diet chart (of a week) by students and comparison with the balanced diet chart of their age group.

Food adulteration and detection of common adulterants

Unit 2: Nutritional Sources and Deficiencies **(12)**

Food sources and deficiency diseases of: Carbohydrates, Lipids, Proteins, Vitamins (Fat-soluble and water-soluble), Minerals (Iron, Calcium, Phosphorous, Iodine)

Identification of nutrient-rich food sources; Ascorbic acid and calcium estimation

Unit 3: Health and Life Style **(12)**

Introduction to health: Definition and concept

Life style-related diseases: Hypertension, diabetes mellitus, obesity; Causes and prevention of diseases through life style modifications, Project work/Survey on any Life style-related disease

Social health problems: Smoking, alcoholism, drug dependence, AIDS

ESSENTIAL READINGS

- Mudambi, S. R. and Rajagopal, M. V. (2010), *Fundamentals of Foods, Nutrition and Diet Therapy*, V Edition, New Age International (P) Limited.
- Bamji, M. S., Krishnaswamy K. and Brahmam, G.N.V. (2010). *Text Book of Human Nutrition*, III Edition.
- *Wardlow's Perspective in Nutrition* (2007). VIII Edition, McGraw Hill Higher Education.

SUGGESTED READINGS

- Srilakshmi B. (2010). *Nutrition Science,* III Edition, New Age International (P) Limited.
- Lakra, P. and Singh, M. D. (2008). *Text Book of Nutrition and Health*, I Edition, Academic Excellence.

APPLIED COURSE

ECONOMIC ZOOLOGY

AC – Paper 3

(30 Periods)

Unit 1: Bee-keeping and Bee Economy (Apiculture) (8)

Varieties of honey bees and Bee pasturage; Setting up an apiary: Langstroth's/Newton's hive, bee veil, brood and storage chambers, iron frames and comb sheets, drone excluder, rearing equipments, handling of bees, artificial diet; Diseases of honey bee, American and European Foulbrood, and their management; Honey extraction techniques; Physico-chemical analysis of honey; Other beneficial products from bee; Visit to an Apiculture Institute and honey processing units

Unit 2: Silk and Silk Production (Sericulture) (8)

Different types of silk and silkworms in India; Rearing of *Bombyx mori* – Rearing racks and trays, disinfectants, rearing appliances, black boxing, Chawki rearing, bed cleaning, mountages, harvesting of cocoons; Silkworm diseases: Pebrine, Flacherie, Grasserie, Muscardine and Aspergillosis, and their management; Silkworm pests and parasites: Uzi fly, Dermestid beetles, and their management; Silk reeling techniques; Quality assessment of silk fibre

Unit 3: Aquaculture (8)

Brood stock management; Induced breeding of fish and prawn; Management of hatchery of fish; Management of nursery, rearing and stocking ponds; 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 4: Dairy/Poultry Farming (6)

Introduction; Indigenous and exotic breeds; Rearing, housing, feed and rationing; Commercial importance of dairy and poultry farming; Varietal improvement techniques; Diseases and their management; Dairy/poultry farm management and business plan; Visit to any Dairy farm/Poultry farm

* Submission of report on anyone field visits mentioned above

ESSENTIAL READINGS

- Prost, P. J. (1962). *Apiculture*. Oxford and IBH, New Delhi.
- Sericulture, *FAO Manual of Sericulture.*
- Hafez, E. S. E. (1962). *Reproduction in Farm Animals*, Lea and Fabiger Publishers.
- Srivastava, C. B. L. (1999). *Fishery Science and Indian Fisheries*. Kitab Mahal publications, India.

SUGGESTED READINGS

- Sardar Singh, *Beekeeping in India*, Indian council of Agricultural Research, New Delhi.
- Dhyan Singh Bisht, *Apiculture*, ICAR Publication.
- Knobil, E. and Neill, J. D. (2006). *The Physiology of Reproduction*, Vol. 2, Elsevier Publishers.
- Dunham R. A. (2004). *Aquaculture and Fisheries Biotechnology - Genetic Approaches.* CABI publications, U.K.

AGRO-CHEMICALS AND PEST MANAGEMENT

AC – Paper 4

(30 Periods)

Unit 1: Fundamentals of Pest Management (5)

Pest: Definition, pest resurgence, secondary pest outbreak, Economic injury level, Economic threshold; Types of pests according to damage (sub economic, occasional, perennial)

Unit 2: Practical Approach to Pest Management (15)

General morphological features of different groups of insects; Study of biting and chewing, and piercing and sucking type of mouth parts

Integrated Pest Management: Cultural, biological, chemical, genetic control

Agrochemicals: Pesticides, brief history, nomenclature, mode of action of insecticides, tools and techniques for pesticide application, environmental issues.

Measurement of insecticide toxicity by estimation of LD_{50} value of any one insect pest

Unit 3: Study of Pest in Laboratory and Field (10)

Visit to agricultural field to study biology, damage and management practices of pests of agricultural crops (*Papilio demoleus*, *Helicoverpa armigera*, *Leptocorisa acuta, Leucinodes orbonalis, Epilachna vigintioctopunctata)*

Rearing of any two important pests; one each from stored grain and agricultural crop in the laboratory and study their different stages.

ESSENTIAL READINGS

- Atwal, A.S. (1986). *Agricultural Pest of South Asia and Their Management*. Kalyani Publishers, New Delhi.
- Pradhan, S. (1969). *Insect Pests of Crops*. National Book Trust, India Book House.
- Dennis S. Hill. *Agricultural Insect Pests of the Tropics and Their Control*.

SUGGESTED READINGS

- Pedigo L. P. (2002). *Entomology and Pest Management,* Prentice Hall Publication
- Robert F. Norris, Edward P. Caswell-Chen and Marcos Kogan, *Concepts of Integrated Pest Management*, Prentice Hall of India.