2017

THE UNIVERSITY OF BURDWAN

SYLLABUS FOR THREE-YEAR DEGREE COURSE IN ZOOLOGY (HONS) UNDER CHOICE BASED CREDIT SYSTEM (CBCS)

(With effect from the session 2017-2018)

Contents

1. Introduction

The syllabus for Zoology at undergraduate level using the Choice Based Credit system has been framed incompliance with model syllabus given by UGC.

The main objective of framing this new syllabus is to give the students a holistic understanding of the subject giving substantial weightage to both the core content and techniques used in Zoology.

Keeping in mind and in tune with the changing nature of the subject, adequate emphasis has been given on new techniques and understanding of the subject.

The syllabus has also been framed in such a way that the basic skills of subject are taught to the students, and everyone might not need to go for higher studies and the scope of securing a job after graduation will increase.

There is wide deviation in the infrastructure, be it physical or in human resource, in the form of teachers' expertise and ability and aspiration of the students. Hence, University is free to choose the Electives as per their infrastructural strengths and offeratleast6 to7 electives. While the syllabus is in compliance with UGC model curriculum, it is necessary that Zoology students should learn "Immunology" as one of the core courses rather than as elective. Also, an important discipline specific elective on "Microbiology" has been added.

Project Work may be introduced instead of the 4th Elective with a credit of 6 split into 2+4, where 2credits will be for continuous evaluation and 4 credits reserved for the merit of the dissertation.

2. Scheme for CBCS Curriculum

2.1. Credit Distribution across Courses

Course Type	Number of Courses	Credits		
		Theory + Practical	Theory+ Practical	Total
Core Courses	14	14×4=56	14×2=28	84
Discipline Specific	04	4×4=16	4×2=8	24
Generic Elective	04	4×4=16	4×2=8	24
Language Courses & ENVS	02	4×1=4 2×1=2		6
Skill Enhancement Course	02	2×2=4		4
Total	26	94	44	142

2.2. Scheme for CBCS Curriculum

Semester	Course Name	Course Detail	Credits
I	Ability Enhancement Compulsory Course–I	English communication/Environmental Science	2
	Core course–I	Non-chordates I	4
	Core course–I Practical	Non-chordates I Lab	2
	Core course–II	Ecology	4
	Core course–II Practical	Ecology Lab	2
	Generic Elective–1*	Animal Diversity	4
	Generic Elective–1 Practical*	Animal Diversity Lab	2
II	Ability Enhancement Compulsory Course–II	English communication/Environmental Science	2
	Core course–III	Non- chordates II	4
	Core course–III Practical	Non- chordates II Lab	2
	Core course–IV	Cell Biology	4
	Core course–IV Practical	Cell Biology Lab	2
	Generic Elective–2*	Comparative Anatomy & Developmental Biology of Vertebrates	4
	Generic Elective–2 Practical*	Comparative Anatomy & Developmental Biology of Vertebrates Lab	2
III	Core course–V	Chordates	4
	Core course–V Practical	Chordates Lab	2
	Core course–VI	Animal Physiology: Controlling and Coordinating Systems	4
	Core course–VI Practical	Animal Physiology: Controlling and Coordinating Systems Lab	2
	Core course–VII	Fundamentals of Biochemistry	4
	Core course – VII Practical	Fundamentals of Biochemistry Lab	2
	Skill Enhancement Course–1	Apiculture or Sericulture	2
	Generic Elective–3*	Physiology and Biochemistry	4
	Generic Elective–3 Practical*	Physiology and Biochemistry Lab	2

IV	Core course–VIII	Comparative Anatomy of Vertebrates	4
	Core course–VIII Practical	Comparative Anatomy of Vertebrates Lab	2
	Core course–IX	Animal Physiology: Life Sustaining Systems	4
	Core course–IX Practical	Animal Physiology: Life Sustaining Systems Lab	2
	Core course–X	Immunology	4
	Core course–X Practical	Immunology Lab	2
	Skill Enhancement Course-2	Medical Diagnostics or Aquarium Fish Keeping	2
	Generic Elective–4*	Genetics and Evolutionary Biology	4
	Generic Elective–4 Practical*	Genetics and Evolutionary Biology Lab	2
V	Core course–XI	Molecular Biology	4
	Core course–XI Practical	Molecular Biology Lab	2
	Core course–XII	Genetics	4
	Core course–XII Practical	Genetics Lab	2
	Discipline Specific Elective–1	Animal Biotechnology or Microbiology	4
	Discipline Specific Elective–1 Practical	Animal Biotechnology or Microbiology	2
	Discipline Specific Elective–2	Parasitology or Biology of Insects	4
	Discipline Specific Elective–2 Practical	Parasitology or Biology of Insects	2
VI	Core course–XIII	Developmental Biology	4
	Core course–XIII Practical	Developmental Biology Lab	2
	Core course–XIV	Evolutionary Biology	4
	Core course–XIV Practical	Evolutionary Biology Lab	2
	Discipline Specific Elective–3	Animal Behaviour or Wild life Conservation	4
	Discipline Specific Elective–3 Practical	Animal Behaviour or Wild life Conservation	2
	Discipline Specific Elective–4	Endocrinology or Reproductive Biology	4
	Discipline Specific Elective–4 Practical	Endocrinology or Reproductive Biology	2
			140

*For other subjects. For Zoology Hons. students, Generic Electives will be any subject(s) other than Zoology.

2.3. Compulsory Core Courses

Core Courses			
Non-chordates I	Ecology	Non-chordates II	Cell Biology
Chordates	Physiology: Controlling and Coordinating Systems	Fundamentals of Biochemistry	Comparative Anatomy of Vertebrates
Physiology: Life Sustaining Systems	Immunology	Molecular Biology	Genetics
Developmental Biology	Evolutionary Biology		

2.4. Choices for Discipline Specific Electives

Discipline Specific Elective–1 to 4			
Animal Behaviour & Chronobiology	Animal Biotechnology	Biology of Insects	Endocrinology
Fish and Fisheries	Microbiology	Parasitology	Wildlife Conservation& Management
Reproductive Biology			

2.5. Choices for Skill Enhancement Courses

Skill Enhancement Course-1 & Skill Enhancement Course-2			
Apiculture	Aquarium Fish Keeping	Medical Diagnostic Techniques	Sericulture

2.6. Choices for Generic Elective Courses

Generic Elective Courses-1 to 4	
Animal Diversity	Comparative Anatomy & Developmental Biology of Vertebrates
Physiology and Biochemistry	Genetics and Evolutionary Biology

2.7. Scheme of CBCS distribution

SEMESTER	CORE COURSE (With Practical)	GENERAL ELECTIVE	DISCIPLINE SPECIFIC ELECTIVE	SKILL ENHANCE-MENT COURSE	ABILITY ENHANCE MENT COMPULSORY COURSE
I	i. Non-chordates ii. Ecology	Animal Diversity	_____	_____	
II	iii. Non-chordates iv. Cell Biology	Comparative Anatomy & Developmental Biology of Vertebrates	_____	_____	
III	v. Chordate vi. Animal Physiology vii. Biochemistry	Physiology and Biochemistry	_____	Apiculture or Sericulture	
IV	viii. Comparative Anatomy ix. Animal Physiology x. Immunology	Genetics and Evolutionary Biology	_____	Medical Diagnostics OR Aquarium Fish Keeping	
V	xi. Molecular Biology xii. Genetics	_____	Animal Biotechnology OR Microbiology Parasitology OR Biology of Insects	_____	
VI	xiii. Developmental Biology xiv. Evolution		Animal Behaviour OR Wild Life Endocrinology OR Reproductive Biology		

3. Core Subjects Syllabus

3.1. Core T1 –Non-Chordates I

Credits : 6

Lectures: 50

Non-Chordates I	4 Credits	Class
Unit 1: Basics of Animal Classification		
Definitions: Classification, Systematics and Taxonomy; Taxonomic Hierarchy, Taxonomic types. Codes of Zoological Nomenclature; Principle of priority; Synonymy and Homonymy; Five kingdom concept of classification (Whittaker)		**4**
Unit 2: Protista and Metazoa		**15**
Protozoa General characteristics and Classification up to phylum (according to Levine et. al., 1980) Locomotion in *Euglena*, *Paramoecium* and *Amoeba*; Conjugation in *Paramoecium*. Life cycle and pathogenicity of *Plasmodium vivax* and *Entamoeba histolytica* Metazoa Evolution of symmetry and segmentation of Metazoa		
Unit 3: Porifera		**6**
General characteristics and Classification up to orders (after Hyman, 1951); Canal system and spicules in sponges		
Unit 4: Cnidaria		**10**
General characteristics and Classification up to orders. Metagenesis in *Obelia* Polymorphism in Cnidaria Corals and coral reef diversity, function & conservation		
Unit 5: Ctenophora		**2**
General characteristics		
Unit 6: Platyhelminthes		**6**
General characteristics and Classification up to classes Lifecycle and pathogenicity and control measures of *Fasciola hepatica* and *Taenia solium*		
Unit 7:Nematoda		**7**
General characteristics and Classification up to classes Life cycle, and pathogenicity and control measures of *Ascaris lumbricoides* and *Wuchereria bancrofti*		

Suggested Readings:

1. Anderson, D. T. (Ed.) (2001). Invertebrate Zoology. 2nd Ed. Oxford University Press.
2. Barnes, R. D. & Ruppert, E. E., (1994). Invertebrate Zoology. 6thEd. Brooks Cole.
3. Barrington, E. J. W. (1981). Invertebrate Structure and function. 2nd Ed. ELBS & Nelson.
4. Blackwelder, R. E., (1967). Taxonomy- A text and reference book. John Wiley & Sons.
5. Brusca, R. C. & Brusca, G. J. (2002). Invertebrates. 4th Ed. Sinauer Associates...
6. Dhami P.S and J.K. Dhami – Invertebrate Zoology – S. Chand and Co.
7. Hickman, C.P. Jr., F.M. Hickuman and L.S. Roberts, 1984. Integrated Principles of Zoology, 7th Edition, Times Merror/Mosby College Publication. St. Louis. 1065pp.
8. Hyman, L. H. (1951). The Invertebrates (Vol-I). Mc.GrawHill Book Company.
9. Jordan, E. L. & Verma, P. S. (2006). Invertebrate Zoology. S. Chand & Company Ltd. New Delhi.
10. Kapoor, V. C. (2008). Theory and practice of animal taxonomy. 6th Ed. Oxford & IBH Pub
11. Kotpal, R.L., 1988 – 1992. (All Series) Protozoa, Porifera, Coelentereta, Annelida, Arthropoda, Mollusca, Echinodermata, – Rastogi Publications, Meerut – 250 002.
12. Mayr, E. (1969). Principles of Systematic Zoology. Tata McGraw-Hill.
13. Mayr, E. & Ashlock, P. D. (1991). Principles of Systematic Zoology. 2nd Ed., McGraw-Hill.
14. Meglitsch, P. A. & Schram, F. R. (1991). Invertebrate Zoology. Oxford University Press.

15. Parker, T. J. & Haswell, W. (1972). Text Book of Zoology, Volume I. Macmillan Press, London.
16. Pechenik, J. A. (1998). Biology of the Invertebrates, 4th Ed. McGraw Hill..
17. Ruppert E. E., Fox, R. & Barnes R. D. (2003). Invertebrate Zoology: a Functional Evolutionary Approach. 7th Ed. Brooks Cole.
18. Sinha, K. S., Adhikari, S., & Ganguly, B. B. Biology of Animals. Vol. I. New Central Book Agency. Kolkata.

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

3.2. Core P1–Non-Chordates I Lab

Non- Chordates I	**2 credits**
List of Practical	
1. Preparation of stained whole mount of *Euglena*, *Amoeba* and *Paramoecium* 2. Spot Identification of *Amoeba*, *Euglena*, *Entamoeba*, *Opalina, Paramecium*, *Plasmodium vivax* and *Plasmodium falciparum* (from the prepared slides) 3. Spot Identification of *Sycon*, Neptune's Cup, *Obelia*, *Physalia*, *Millepora* ,*Aurelia*, *Tubipora*,*Corallium*,*Alcyonium*,*Gorgonia*,*Metridium*,*Pennatula*,*Fungia*,*Meandrina*,*Madrepora* 4. Spot Identification and significance of adult *Fasciola hepatica*, *Taenia solium* and *Ascaris lumbricoides.* 5. Staining/mounting of any protozoa/helminth from gut of cockroach	
	Full Marks: 20
Examination Pattern: Staining and Mounting-/ Whole Mount (Item No.1) ---------- = 10 Spot identification (1 from Item 2, 2 from item 3) (3 X 2) = 06 Spot identification with significance (1 from item 4) = 02 Laboratory Note Book ---------- = 02 **Suggested Readings:** 1. Chatterjee and Chatterjee Practical Zoology 2. Ghosh, K.C. and Manna, B. (2015): Practical Zoology, New Central Book Agency, Kolkata 3. Sinha, J.K. , Chatterjee, A.K. and P. Chattopadhyay Advanced Practical Zoology	

3.3. Core T2–Ecology

Credits : 6

Lectures: 50

Ecology	**4 Credits**	**Class**
Unit 1:Introductionto Ecology		**4**
History of ecology, Autecology and synecology, Levels of organization, Laws of limiting factors, Study of Physical factors, The Biosphere.		
Unit 2: Population		**20**
Unitary and Modular populations Unique and group attributes of population: Demographic factors, life tables, fecundity tables, survivorship curves, dispersal and dispersion. Geometric, exponential and logistic growth, equation and patterns, and K strategies. Population regulation, density dependent and independent factors Population Interactions, Gause's Principle with laboratory and field examples, Lotka-Volterra equation for competition.		
Unit 3: Community		**11**
Community characteristics: species diversity, abundance, , dominance, richness, Vertical stratification, Ecotone and edge effect. succession with one example		
Unit 4: Ecosystem		**10**
Types of ecosystem with an example in detail, Food chain: Detritus and grazing food chains, Linear and Y-shaped food chains, Food web, Energy flow through the ecosystem, Ecological pyramids and Ecological efficiencies Nutrient and biogeochemical cycle with an example of Nitrogen cycle Human modified ecosystem		
Unit 5: Applied Ecology		**5**
Wildlife Conservation (in-situ and ex-situ conservation). Management strategies for tiger conservation; Wild life protection act (1972)		

Suggested readings:

1. Basu, R.N. (2004). A Compendium of Terms in Ecology and Environment. Naya Udyog.
2. Begon, M., Harper, J. L. & Townsend, C. R. (2006). Ecology: Individuals, Populations & communities. 4th Ed. Blackwell science.
3. Cain, Bowman &Hacker. Ecology. 3rdedition.Sinauerassociates
4. Chapman, R. L. and Reiss, M. J. (2000). Ecology - Principles & Application. Cambridge University Press.
5. Colinvaux, P. (1993). Ecology 2. John Wiley & Sons, Inc. New York.
6. Dash, M. C., (2001). Fundamental of Ecology. 2nd Ed. Tata McGraw-Hill Company.
7. Faurie, C., Ferra, C., Medori, P. & Devaux, J. (2001). Ecology-Science and Practice. Oxford & IBH Pub. Company.
8. Freedman, B. (1989). Environmental Ecology. Academic press, Inc.
9. Joshi, P.C. & Joshi, N. (2009). A Text Book of Ecology and Environment. Himalaya Publishing House.
10. Kormondy, E. J. (2002). Concepts of Ecology. 4th Indian Reprint, Pearson Education.
11. Krebs, C. J. (2001). Ecology. Benjamin Cummings.
12. Krebs, C.J. (2016).Ecology: The Experimental Analysis of Distribution and Abundance. Pearson Education Limited, Noida, India.
13. Molles, Jr. M.C. (2005). Ecology: Concepts and Applications. 3rd Ed. McGraw- Hill.
14. Odum, E. P. & Barret, G. W. (2005). Fundamentals of Ecology. 5th Ed. Thompson Brooks/Cole.
15. Ricklefs, R. E. & Miller, G. L. (2000). Ecology. 4th Ed. W. H. Freeman & Company.
16. Russel, P.J., Wolfe, L. S., Hertz, P.E. Starr, C. & McMillan, B. (2008). Ecology.
17. Brooks/Cole. Saharia, V. B. (1998). Wildlife in India. Natraj Publishers.
18. Smith, R. L. & Smith, T. M. (2001). Ecology and Field Biology. Benjamin Cummings Pearson Education.
19. Smith, T. M & Smith, R. L. (2006). Elements of Ecology. 6th Ed. Pearson Education.
20. Stiling, P. (2009). Ecology- Theories and Applications. 4th Ed. Prentice Hall of India.

21. Van Dyke, F. (2008). Conservation Biology: Foundations, Concepts, Application. 2nd Ed. Springer Science and Business Media.

3.4. Core P2– Ecology Lab

Ecology **Credits 2**

List of Practical

1. Study of life tables and plotting of survivorship curves of different types from the hypothetical/real data provided
2. Determination of population density in a natural/hypothetical community by quadrate method and calculation of Shannon-Weiner diversity index for the same community
3. Study of an aquatic ecosystem: Phytoplankton and zooplankton, Measurement of area, temperature, determination of pH and free CO2
4. Report on a visit to National Park/Biodiversity Park/Wild life sanctuary/ Biodiversity Centre/ Any Museum/Sea shore

Full Marks: 20

Examination Pattern:

1 question (pH, free CO2 estimation)	(8 X 1) =	08
1 question From Item 1 and 2,	(8 X 1) =	08
Excursion Report	=	02
Laboratory Note Book	=	02

Suggested Readings:

1. Robert Desharnais, Jeffrey Bell, 'Ecology Student Lab Manual, Biology Labs'
2. Darrell S Vodopich, 'Ecology Lab Manual'

3.5. Core T3- Non-Chordates II

Credits : 6

Lectures: 50

Non- Chordates II	**4 Credits**	**Class**
Unit1:Introduction		2
Evolution of coelom and metamerism		
Unit2: Annelida		10
1. General characteristics and Classification up to order 2. Excretion in Annelida through nephridia. 3. Metamerism in Annelida.		
Unit3: Arthropoda		16
1. General characteristic sand Classification up to subclass 2. Vision in Insecta 3. Respiration in Arthropoda (Gills in prawn and trachea in cockroach) 4. Metamorphosis in Lepidopteran Insects. 5. Social life in termite		
Unit4: Onychophora		2
General characteristics and Evolutionary significance		
Unit5: Mollusca		10
1. General characteristics and Classification up to classes 2. Nervous system and torsion in Gastropoda 3. Feeding and respiration in *Pila* sp		
Unit6: Echinodermata		8
1. General characteristics and Classification up to orders 2. Water-vascular system in Asteroidea 3. Larval forms in Echinodermata 4. Affinities with Chordates		
Unit7: Hemichordata		2
General characteristics of phylum Hemichordata. Relationship with non-chordates and chordates		

Suggested Readings:

1. Anderson, D. T. (Ed.) (2001). Invertebrate Zoology. 2nd Ed. Oxford University Press.
2. Barnes, R. D. & Ruppert, E. E., (1994). Invertebrate Zoology. 6thEd. Brooks Cole.
3. Barrington, E. J. W. (1981). Invertebrate Structure and function. 2nd Ed. ELBS & Nelson.
4. Brusca, R. C. & Brusca, G. J. (2002). Invertebrates. 4th Ed. Sinauer Associates...
5. Dhami P.S and J.K. Dhami – Invertebrate Zoology – S. Chand and Co.
6. Hickman, C.P. Jr., F.M.Hickuman and L.S. Roberts, 1984. Integrated Principles of Zoology, 7th Edition, Times Merror/Mosby College Publication. St. Louis. 1065pp.
7. Hyman, L. H. (1951). The Invertebrates (Vol-I). Mc. GrawHill Book Company.
8. Jordan, E. L. & Verma, P. S. (2006). Invertebrate Zoology. S. Chand & Company Ltd. New Delhi.
9. Kotpal, R.L., 1988 – 1992. (All Series) Annelida, Arthropoda, Mollusca, Echinodermata, – Rastogi Publications, Meerut – 250 002.
10. Meglitsch, P. A. & Schram, F. R. (1991). Invertebrate Zoology. Oxford University Press.
11. Parker, T. J. & Haswell, W. (1972). Text Book of Zoology, Volume I. Macmillan Press, London.
12. Pechenik, J. A. (1998). Biology of the Invertebrates, 4th Ed. McGraw Hill.
13. Ruppert E. E., Fox, R. & Barnes R. D. (2003). Invertebrate Zoology: a Functional Evolutionary Approach. 7th Ed. Brooks Cole.

14. Sinha, K. S., Adhikari, S., & Ganguly, B. B. Biology of Animals. Vol. I. New Central Book Agency (p) Ltd. Kolkata.

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

3.6. Core P3–Non- Chordates II Lab

Non-Chordates II	**2 Credits**	

List of Practical

1. Spot identification of following specimens (based on specimen characters):
   a. Annelids-*Aphrodite, Nereis, Heteronereis, Sabella, Chaetopterus, Pheretima, Hirudinaria*
   b. Arthropods- *Carcinoscorpius, Palamnaeus, Palaemon, Daphnia, Balanus, Sacculina, Cancer, Eupagurus, Scolopendra, Julus, Bombyx, Periplaneta*, *Odontotermes and Apis*
   c. Onychophora- *Peripatus*
   d. Molluscs - *Chiton, Dentalium, Pila, Doris, Helix, Lamellidens, Ostrea, Pinctada, Sepia, Octopus, Nautilus*
   e. Echinoderms-*Pentaceros / Asterias, Ophiura, Clypeaster, Echinus, Cucumaria* and *Antedon*
   f. Hemichordates - *Balanoglossus*
2. Study of digestive system, septal nephridia and pharyngeal nephridia of earthworm using model and chart
3. T.S. through pharynx, gizzard, and intestine at typhlosolar region of earthworm
4. Mount of mouth parts and study of digestive system and nervous system of *Periplaneta*
5. To submit a Project Report on any related topic on larval forms (arthropods, mollusc and

Full Marks: 20

Examination Pattern:

Dissection (From item No. 2 and/or 4) any one	(8 ×1)	= 08
Spot identification (any four)	(2×4)	=08
Project Report		= 02
Laboratory Note Book		= 02

Suggested Readings:

Chatterjee and Chatterjee Practical Zoology
Ghosh, K.C. and Manna, B. (2015): Practical Zoology, New Central Book Agency, Kolkata
Sinha, J.K. , Chatterjee, A.K. and P. Chattopadhyay Advanced Practical Zoology

3.7. Core T4- Cell Biology

Credits : 6

Lectures: 50

Cell Biology	**Credits 4**	**Class**
Unit1: Overview of Cells		2
Basic structure of Prokaryotic and Eukaryotic cells, Viruses, Viroid, Prion and Mycoplasma		
Unit2:PlasmaMembrane		6
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		
Unit3:Cytoplasmic organelles I		5
1. Structure and Functions: Endoplasmic Reticulum, Golgi Apparatus, Lysosomes 2. Protein sorting and mechanisms of vesicular transport		
Unit4:Cytoplasmic organelles II		6
1. Mitochondria: Structure, Semi-autonomous nature, Endosymbiotic hypothesis Mitochondrial Respiratory Chain, Chemi- osmotic hypothesis. 2. Structure and Functions of Peroxisome and Centrosome		
Unit5:Cytoskeleton		5
1. Type, structure and functions of cytoskeleton 2. Accessory proteins of microfilament &microtubule 3. A brief idea about molecular motors		
Unit6:Nucleus		8
1. Structure of Nucleus: Nuclear envelope, nuclear pore complex, Nucleolus. 2. Chromatin: Euchromatin and Heterochromatin and packaging (nucleosome)		
Unit7:Cell Division		8
1. Cell cycle and its regulation, 2. Cancer (Concept of oncogenes and tumor suppressor genes with special referencetop53, Retinoblastoma and Ras and APC. 3. Mitosis and Meiosis: Basic process and their significance		
Unit8:Cell Signaling		8
1. Cell signalling transduction pathways; Types of signalling molecules and receptors 2. GPCR and Role of second messenger (cAMP) 3. Extracellular matrix 4. Cell interactions Apoptosis and Necrosis		

Suggested Readings:

1. Albert Bruce, 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.
2. Cooper, G.M. and Hausman, R.E. (2009). The Cell: AMolecularApproach.5thEdition. ASM Press and Sunderland, Washington, D.C.; Sinauer Associates, MA.
3. Hardin, J. Bertoni, G and Klein smith, J. L. (2012). Becker's World of the Cell. 8th Edn, Pearson Benjamin Cummings, San Francisco.
4. Harvey, L. (2004). Molecular Cell Biology. 5th Edn. W.H. Freeman
5. Karp, G. (2008). Cell and Molecular biology: Concepts and Application. 5th Edn, John Wiley.
6. Lodish, Berk, Matsudaira, Kaiser, Bretscher, Ploegh, Amon, and Martin (2016) Molecular Cell Biology. 8th Edn. W.H. Freeman
7. Pal, A. (2011). Textbook of Cell and Molecular Biology 3rd Edn, Bokks and Allied, Kolkata.
8. Plopper, G, D. Sharp, Siroski, E (2015) Lewin's Cell 3rdEdition—Johns & Bartlett Publishers

9. Pollard and Earnshaw (2007). Cell Biology. 2nd. Edn Saunders.
10. Reed, J.C. and Green, D.R. (2011). Apoptosis: Physiology and Pathology. Cambridge Univ. Press
11. Verma and Agarwal. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology. S. Chand Pub, Weinberg R.A. (2014). Biology of Cancer. 2ndedition. Garland Science, Taylor and Francis

3.8. Core P4–Cell Biology Lab

Cell Biology	**2 Credits**	

List of Practical

1. Preparation of temporary stained squash of onion root tip to study various stages of mitosis
2. Squash preparation of grasshopper testis and study of the various stages of meiosis.
3. Preparation of permanent slide to show the presence of Barr body in human female blood cells/cheek cells.
4. Study of cell viability by Trypan Blue staining from onion root tip/ blood cell.

Full Marks: 20

Examination Pattern:

1 question on squash preparation from Item No. 1 or 2	(6X 1)	= 06
Preparation of slide (From Item 3 or 4)	(4X 1)	= 04
Identification of stages of mitosis and meiosis	(2X4)	= 08
Laboratory Note Book		= 02

Suggested Readings:

Chatterjee and Chatterjee Practical Zoology
Ghosh, K.C. and Manna, B. (2015): Practical Zoology, New Central Book Agency, Kolkata
Sinha, J.K. , Chatterjee, A.K. and P. Chattopadhyay Advanced Practical Zoology

3.9. Core T5- Chordates

Credits : 6

Lectures: 50

Chordates	**4 Credits**	**Class**
Unit 1: Introduction to Chordates		**2**
General characteristics and outline classification of Phylum Chordata		
Unit 2: Protochordata		**6**
1. General characteristics and classification of sub-phylum Urochordata and Cephalochordate up to Classes. 2. Retrogressive metamorphosis in *Ascidia*. **3.** Chordate Features and Feeding in *Branchiostoma*		
Unit 3: Origin of Chordata		2
1. Dipleurula concept and the Echinoderm theory of origin of chordates **2.** Advanced features of vertebrates over Protochordata		
Unit 4: Agnatha		2
General characteristics and classification of cyclostomes up to order		
Unit 5: Pisces		6
1. General characteristics and classification of Chondrichthyes and Osteichthyes up to Subclasses 2. Accessory respiratory organ, migration and parental caring fishes **3.** Swim bladder in fishes.		
Unit 6: Amphibia		6
1. General characteristics and classification unto living Orders. **2.** Metamorphosis and parental care in Amphibia		
Unit 7: Reptilia		8
1. General characteristics and classification up to living Orders. **2.** Poison apparatus and Biting mechanism in Snake		
Unit 8: Aves		8
1. General characteristics and classification up to Sub-Classes 2. Exoskeleton and migration in Birds **3.** Principles and aerodynamics off flight		
Unit 9: Mammals		8
General characters and classification up to living orders Affinities of Prototheria Exoskeleton derivatives of mammals Adaptive radiation in mammals with reference to locomotory appendages Echolocation in Micro-chiropterans and Cetaceans		
Unit 10: Zoogeography Zoogeographical realms, Plate tectonic and Continental drift theory, distribution of birds and mammals in different realms		2

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).

Suggested Readings:

1. **Arora, M.P.** *Chordata I. Himalaya Pub House*
2. Darlington P.J. The Geographical Distribution of Animals, R.E. Krieger Pub Co.
3. HallB.K.andHallgrimssonB.(2008).Strickberger'sEvolution.IVEdition.Jonesand Bartlett
4. Jordan, E.L. & Verma, P.S. (2003).Chordate Zoology. S. Chand &Company Ltd. New Delhi.
5. Kardong, K.V. (2002).Vertebrates: Comparative anatomy, function evolution. Tata McGraw Hill.
6. Kent, G. C. &Carr, R.K. (2001).ComparativeanatomyoftheVertebrates.9thEd.McGrawHill.
7. Nelson, J.S. (2006): Fishes of the World, 4th Edn. Wiley.

8. Parker, T.J. &Haswell, W. (1972).Text Book of Zoology, Volume II: Marshall and Willam (Eds.) 7thEd.MacmillanPress, London.
9. Pough H. Christine M. J. and B. Haiser (2002). Vertebrate life, VIII Edition, Pearson Internatl.
10. Rastogi, V.B. Ecology and Animal Distribution. Rastogi Publication.
11. Romer, A. S. &Parsons, T.S. (1986).The vertebrate body. 6th Ed.Saunders College Pub.
12. Sinha, K. S, Adhikari, S. Ganguly B.B. & Bharati Goswami, B.D. (2001).Biology of Animals. Vol. II. New Central Book Agency (p) Ltd.
13. Young, J. Z. (2004).The Life of Vertebrates. III Edition. Oxford university press.

3.10. Core P5–Chordates Lab

Chordates	**2 Credits**

List of Practical

1. Spot identification of
   a. Protochordata : *Balanoglossus*, *Herdmania*, *Branchiostoma*
   b. Agnatha: *Petromyzon*, *Myxine*
   c. Fishes: *Scoliodon*,*Sphyrna*,*Pristis*, *Torpedo*, *Chimaera*, *Mystus*, *Heteropneustes*,*Labeo*, Catla, *Cirrhinus, Hypopthalmichthys, Cyprinus, Ctenopharyngodon, Exocoetus*, *Echeneis*, *Anguilla*, *Hippocampus*,*Tetrodon/ Diodon*,*Anabas*,*Clarias*
   d. Amphibia: *Necturus, Bufo, Hyla, Alytes, Axolotl* larva, *Tylototriton*
   e. Reptilia: *Chelone*, *Trionyx*, *Hemidactylus, Varanus, Uromastix, Mabuya, Draco, Bungarus, Vipera, Naja, Hydrophis*
   f. Mammalia: Bat (Insectivorous and Frugivorous), *Funambulus*
2. Key for Identification of poisonous and non-poisonous snake
3. Mounting of Pecten from Fowl head
4. Dissection of brain and pituitary of any major carp
5. Power point presentation on study of any two animals from two different classes by students (may be included if dissections not permitted). Power point submission & demonstration through laptop.

Full Marks: 20

Examination Pattern:

One question on Dissection (Item No. 4)	---------- (6X 1)	= 06
One question (From Item 2 or 3)	---------- (4 X 1)	= 04
Spot Identification of three Specimen	(2X3)	= 06
Power point Presentation		= 02
Laboratory Note Book ----------		= 02

Suggested Readings:

1. Chatterjee and Chatterjee Practical Zoology
2. Ghosh, K.C. and Manna, B. (2015): Practical Zoology, New Central Book Agency, Kolkata
3. Sinha, J.K. , Chatterjee, A.K. and P. Chattopadhyay Advanced Practical Zoology

3.11. Core T6 - Animal Physiology: Controlling &Coordinating Systems

Credits : 6

Lectures: 50

Animal Physiology: Controlling& Coordinating Systems	**4 Credits**	**Class**
Unit1:Tissues		4
Structure, location, classification and functions of epithelial tissue, connective tissue, muscular tissue and nervous tissue		
Unit2:Bone and Cartilage		4
Structure and types of bones and cartilages, Ossification		
Unit3:NervousSystem		10
1. Structure of neuron, resting membrane potential, Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers. 2. Types of synapse, Synaptic transmission and Neuro-muscular junction; 3. Reflex action and its types		
Unit4:Muscular system		10
1. Histology of different types of muscle; 2. Ultrastructure of skeletal muscle; 3. Molecular and chemical basis of muscle contraction; Characteristics of muscle fibre		
Unit5:ReproductiveSystem		6
1. Histology of testis and ovary 2. Physiology of Reproduction (Estrus and Menstrual cycle)		
Unit6:Endocrine System		16
1. Histology and function of pituitary, thyroid, pancreas and adrenal 2. Classification of hormones; 3. Mechanism of Hormone action: Signal transduction pathways for Steroidal and Nonsteroidal hormones 4. Hypothalamus (neuroendocrine gland) – principal nuclei involved in neuroendocrine control of anterior pituitary and endocrine system 5. Placental hormones		6.

Suggested Readings:

1. Cui, Naftel, Daley, Lynch, Haines, Yang and Fratkun (2011). Atlas of Histology with Functional and Clinical Correlations. Lippincoat, Williams and Wilkins.
2. Cormack, D.H (2003). PDQ Histology. B.C. Decker Ins., London
3. Gartner and Hiatt (2011). Concise Histology. Saunders Elsevier
4. Gunasegaran, JP (2010). A Text book of Histology and a Practical Guide. Elsevier
5. Junqueria and Cameiro (2005). Basic Histology: Text and Atlas.
6. Ross & Pawlina Histology: A Text and Atlas. Sixth Edition. Lippincott Williams &Wilkins.
7. Randall, D. and Warren Burggren. Eckert Animal Physiology 4th edition. W.H. Freeman.
8. Sembulingam and Sembulingam (2012) Essentials of Medical Physiology. 6th Edn. Jaypee Pub, New Delhi
9. Vasudeva and Mishra (2014). Inderbir Singh's Text book Of Human Histlogy 7th Edn Jaypee Publisher N. Delhi

3.12. Core P6–Animal Physiology: Controlling &Coordinating Systems Lab

Animal Physiology: Controlling &Coordinating Systems	**2 Credits**

List of Practical

1. Recording of simple muscle twitch with electrical stimulation(or Virtual)
2. Demonstration of the unconditioned reflex action(Deep tendon reflex such as knee jerk reflex)
3. Preparation of temporary mounts: Squamous epithelium, Striated muscle fibres
4. Identification of permanent slides of Mammalian Cartilage, Bone, Pituitary, Liver, Kidney, Intestine, Lung, Pancreas, Testis, Ovary, Adrenal, Thyroid
5. Microtomy: Preparation of permanent slide of any five mammalian(Goat/white rat)tissues

Full Marks: 20

Examination Pattern:

Preparation of stained temporary mount (Item No. 3)	----------	(6×1) = 06
One question (From Item 1, 2 or 5)	----------	(6×1) = 06
Spot Identification of three Specimen		(2×3) = 06
Laboratory Note Book ----------		= 02

Scudamore C.L. (2014). A Practical Guide to the Histology of Mouse. Wiley Blackwell.

3.13. Core T7- Fundamentals of Biochemistry

Credits : 6

Lectures: 50

Fundamentals of Biochemistry	**4 Credits**	**Class**
Unit1:Carbohydrates		8
1. Structure and Biological importance: Monosaccharides, Disaccharides, Polysaccharides; Derivatives of Monosachharides 2. Carbohydrate metabolism: Glycolysis, Citric acid cycle, Pentose phosphate pathway, Gluconeogenesis		
Unit2:Lipids		7
1. Structure and Significance: Physiologically important saturated and unsaturated fatty acids, Tri- acyl glycerols, Phospholipids, Sphingolipid, Glycolipids, Steroids, Eicosanoids and terpinoids. 2. Lipid metabolism: β-oxidation of fatty acids; Fatty acid biosynthesis		
Unit3:Proteins		10
1. Amino acids : Structure, Classification, General and Electrochemical properties of α-amino acids; Physiological importance of essential and non-essential amino acids 2. Proteins: Bonds stabilizing protein structure; Levels of organization 3. Protein metabolism: Transamination, Deamination, Urea cycle, Fate of C-skeleton of Glucogenic and Ketogenic amino acids		
Unit4:NucleicAcids		10
1. Structure: Purines and pyrimidines, Nucleosides, Nucleotides, Nucleic acids 2. Types of DNA and RNA, Complementarity of DNA, Hypo-Hyper chromaticity of DNA 3. Basic concept of nucleotide metabolism		
Unit5:Enzymes		13
1. Nomenclature and classification; Cofactors; Specificity of enzyme action; Isozymes 2. 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 Factors affecting rate of enzyme-catalyzed reactions; 3. Enzyme inhibition; Allosteric enzymes and their kinetics; Strategy of enzyme action- 4. Catalytic and Regulatory (Basic concept with one example each)		
Unit5:Oxidative Phosphorylation		
Redox systems; Review of mitochondrial respiratory chain, Inhibitors and un-couplers of Electron		

Suggested Readings:

1. Berg, J.M., Tymoczko, J.L.and Stryer, L (2007).Biochemistry, VI Edition, W.H.Freeman and Co., New York.
2. Campbell and Farrell (2012). Biochemistry. 7th Edn. Brooks and Cole.
3. Chatterjee, MN and Shinde, R (2012). A Textbook of Medical Biochemistry. 8th Edn. Jaypee Pub., N. Delhi
4. Cox, M.M and Nelson, D.L. (2008). Lehninger's Principles of Biochemistry, V Edition, W.H. Freeman and Co. New York.
5. Das, D. (200). Biochemistry. Central Book Agency, Kolkata
6. Hames, B.D. and Hooper, N.M. (2000).Instant Notes in Biochemistry, II Edition, BIOS Scientific Publishers Ltd., U.K.
7. Jain, J.L., Jain m S and N. Jain. Fundamentals of Biochemistry. S. Chand Pub. N. Delhi
8. Maheswari, N (2008). Clinical Biochemistry. Jaypee Pub., New Delhi
9. Metzler D.E. (2001). The chemical reactions of living cells –2nd edition, 2001, Academic Press.

10. Murray, R.K. ,Bender , D.A., Botham, K.M.,Kennelly ,P.J., Rodwell, V.W.andWell, P.A. (2009).Harper's Illustrated Biochemistry, XXVIII Edition, International Edition, The McGraw-Hill Companies Inc.
11. Sathyanarayana U. and Chakrapani, (2002). Biochemistry –Books & Allied (P) Ltd, Kolkata
12. Voet. D & Voet. J.G, (2004). Biochemistry –3rd edition, 2004, John Wiley & Sons, Inc.
13. Zubay G.L, (1998). Biochemistry –4th edition, Mc Graw-Hill.

3.14. Core P7–Fundamentals of Biochemistry Lab

Fundamentals of Biochemistry	**2 Credits**
List of Practical 1. Qualitative tests of functional groups in carbohydrates (Benedict's test), proteins (Biuret's test) and lipids (Saponification number). 2. Paper chromatography of amino acids. 3. Quantitative estimation of protein by Lowry Method 4. Demonstration of protein separation by SDS-PAGE. 5. To study the enzymatic activity of Salivary amylase and Catalase in *Cajanus cajan*.	
Full Marks: 20 **Examination Pattern:** One question from item 1 and 5 ---------- (6X 1) = 06 One question on quantitative test (From Item 3) ---------- (8X 1) = 08 One question from item no. 2 & 4 (4X1) = 04 Laboratory Note Book ---------- = 02	

3.15. Core T8-Comparative Anatomy of Vertebrates

Credits : 6

Lectures: 50

Comparative Anatomy of Vertebrates	**4 Credits**	**Class**
Unit1:Integumentary System		6
Structure, function and derivatives of integument in amphibian, birds and mammals		
Unit2:SkeletalSystem		6
Overview of axial and appendicular skeleton; Jaw suspension; Visceral arches.		
Unit3:DigestiveSystem		8
1. Comparative anatomy of stomach. 2. Dentition in mammals		
Unit4:Respiratory System		6
Respiratory organs in fish, amphibian, birds and mammals		
Unit5:CirculatorySystem		8
General plan of circulation, Comparative account of heart and aortic arches		
Unit6:UrinogenitalSystem		6
1. Succession of kidney, 2. Evolution of urinogenital ducts, 3. Types of mammalian uteri		
Unit7:NervousSystem		6
1. Comparative account of brain, 2. Cranial nerves in mammals		
Unit8:Sense Organs		4
1. Classification of receptors, 2. Brief account of auditory receptors invertebrate		

Suggestive Readings

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

3.16. Core P8–Comparative Anatomy of Vertebrates Lab

Comparative Anatomy of Vertebrates	**2 Credits**

List of Practical

1. Mounting of cycloid and ctenoid scales
2. Study of disarticulated skeleton of Toad, Pigeon and Guineapig
3. Demonstration of Carapace and plastron of turtle from model/chart
4. Identification of mammalian skulls:One herbivorous(Guineapig) and one carnivorous animal (Dog)
5. Study and Dissection of Afferent arterial system, brain, pituitary in Carp

Full Marks: 20

Examination Pattern:

One question on Dissection (Item No. 5) ---------- (8X 1) = 08
One question (From Item No. 1) ---------- (4 X 1) = 04
Spot Identification of three Specimen (from item 2,3,and 4) (2X3) = 06
Laboratory Note Book ---------- = 02

3.17. Core T9- Animal Physiology: Life Sustaining Systems

Credits : 6

Lectures: 50

Animal Physiology: Life Sustaining Systems **4 Credits**	**Class**
Unit1:Physiology of Digestion	8
1. Structural organization and functions of Gastrointestinal tract and Associated glands; 2. Mechanical and chemical digestion of food, 3. Absorption of Carbohydrates, Lipids, Proteins and Nucleic Acids; 4. Digestive enzymes	
Unit2:Physiology of Respiration	8
1. Mechanism of Respiration, 2. Respiratory volumes and capacities, 3. Transport of Oxygen and Carbon dioxide in blood ,Dissociation curves and the factors influencing it, 4. Respiratory pigments. 5. Carbon monoxide poisoning	
Unit3:Physiology of Circulation	12
1. Components of Blood and their functions ;Structure and functions of haemoglobin 2. Homeostasis; Blood clotting system, Fibrinolytic system 3. Haemopoiesis; Basic steps and its regulation 4. Blood groups; ABO and Rh factor	
Unit4:Physiology of Heart	8
1. Structure of mammalian heart, 2. Coronary Circulation, 3. Structure and working of conducting myocardial fibres, 4. Origin and conduction of cardiac impulses 5. Cardiac Cycle and cardiac output 6. Blood pressure and its regulation	
Unit5:Thermoregulation&Osmoregulation	6
1. Physiological classification based on thermal biology. 2. Thermal biology of endotherms 3. Osmoregulation in aquatic vertebrates 4. External osmoregulatory organs invertebrates	
Unit6:RenalPhysiology	8
1. Structure of Kidney and its functional unit, 2. Mechanism of urine formation, 3. Regulation of acid-base balance	

Suggested Readings:

1. Costanzo, L.S. BRS Phyiology.4th Edn. Lippincoat Williams and Wilkins.
1. Fox, S.I. (2011). Human Physiology. 12th Edn. Mc Graw Hill.
2. Gunstream, S.E. (2010). Anatomy and Physiology with integrated study guide. 4th Edn., Mc Graw Hill
3. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edn. Hercourt Asia PTE Ltd. W.B. Saunders Company.
4. Hill, Wyese and Anderson (2012). Animal Physiology. 3rd Edn. Sineuer Associaes.
5. Randall, Burggren and French Eckert Animal Physiology: Mechanisms and adaptations
6. Rastogi, S.C. (2007). Essentials of Animal Physiology4th Edn. New Age Pub., N. Delhi
7. Sembulingam and Sembulingam (2012) Essentials of Medical Physiology. 6th Edn. Jaypee Pub, New Delhi

8. Sherwood, L. (2013). Human Physiology from cells to systems. 8th Edn., Brooks & Cole
9. Tortora, G.J. & Grabowski, S. (2006).Principles of Anatomy & Physiology. XI Edition John Wiley & sons,
10. VictorP. Eroschenko. (2008). DiFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. &Wilkins.
11. Vander A, Sherman J.and Luciano D. (2014).Vander's Human Physiology: The Mechanism of Body Function. XIII Edition, McGraw Hills

3.18. Core P9–Animal Physiology: Life Sustaining Systems Lab

Animal Physiology: Life Sustaining Systems	**2 Credits**
List of Practical 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 haem in crystals 5. Recording of blood pressure using a sphygmomanometer	
Full Marks: 20 **Examination Pattern:** One Experiment from Item No. 3 or 4 ---------- (6X 1) = 06 One Experiment from Item No. 2 ---------- (7X 1) = 07 One experiment from Item No. 1 or 5 (1 X5) = 05 Laboratory Note Book ---------- = 02	

3.19. Core T10-Immunology

Credits : 6

Lectures: 50

Immunology	**4 Credits**	**Class**
Unit1: Overview of Immune System		2
1. Basic concepts of health and diseases, 2. Historical perspective of Immunology, 3. Cells and organs of the Immune system		
Unit2:Innate and Adaptive Immunity		8
1. Anatomical barriers, 2. Inflammation, 3. Cell and molecules involved in innate immunity, Adaptive immunity (Cell mediated and humoral).		
Unit3:Antigens		4
1. Antigenicity and immunogenicity, Immunogens, Adjuvants and haptens, 2. Factors influencing immunogenicity, 3. Band T-Cell epitopes		
Unit4:Immunoglobulins		8
1. Structure and functions of different classes of immunoglobulins, 2. Antigen- antibody interactions, 3. Immunoassays (ELISA and RIA), 4. Hybridoma technology, Monoclonal antibody production		
Unit5:MajorHistocompatibilityComplex		6
1. Structure and functions of MHC molecules. 2. Structure of Tcell Receptor and its signalling, 3. Tcell development &selection		
Unit6:Cytokines		2
Types, properties and functions of cytokines.		
Unit7:ComplementSystem		6
Components and pathways of complement activation.		
Unit8:Hypersensitivity Gell and Coombs' classification and brief description of various types of hypersensitivities		4
Unit9:Immunology of diseases		6
Malaria, Filariasis, Dengue and Tuberculosis		
Unit10:Vaccines		4
Various types of vaccines. Active & passive immunization (Artificial and natural).		

Suggested Readings:

1. Abbas, K.Abul and Lechtman H. Andrew (2003.) Cellular and Molecular Immunology. V Edition. Saunders Publication.
2. Abbas, K.Abul and Lechtman H. Andrew (2011.) Basic Immunology: Functions and Disorders of Immune System. Saunders Elsevier Publication.
3. Delves, Martin, Burton and Roitt (2006). Roitt's Essential Immunology. 11th Edn. Blackwell Pub.
4. Kindt, T.J., Goldsby, R.A., Osborne, B.A. and Kuby, J (2006). Immunology, VI Edition. W.H.Freeman and Company.

5. Mohanty, SK and Leela, KS (2014). Text book of Immunology. 2nd Edn. Jaypee Pub. N. Delhi
6. Parija, SC (2012). Text book of Microbiology and Immunology. 2nd Edn. Elsevier.
7. Playfair, JHL and Chain, BM (2001) Immunology at a glance. 7 th Edn. Blackwell Pub.
8. Shetty, N. (2005). Immunology: Introductory Textbook. 2nd Edn. , New Age Internatl. Pub. N. Delhi
9. Virella, G (2007). Medical Immunology 6th Edn. Informa Healthcare.

3.20. Core P10–Immunology Lab

Immunology	**2 Credits**
List of Practical	
1. Demonstration of lymphoid organs in human through model/ photograph. 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. Total count (TC) & Differential count (DC) of WBC 5. Demonstration of ELISA by available teaching kit	
	Full Marks: 20
Examination Pattern: One Experiment from Item No. 3 or 4 ---------- (10X 1) = 10 Identification of slides/ photographs/apparatus (item 1, 2, 5) (any two) (2 X4) = 08 Laboratory Note Book ---------- = 02	

3.21. Core T11- Molecular Biology

Credits : 6

Lectures: 50

Molecular Biology	**4 Credits**	**Class**
Unit1:Nucleic Acids		3
1. Salient features of DNA and RNA 2. Watson and Crick Model of DNA		
Unit2:DNA Replication		9
1. Mechanism of DNA Replication in Prokaryotes, Semi-conservative, bidirectional and discontinuous Replication, RNA priming, 2. Replication of telomeres		
Unit3:Transcription		7
Mechanism of Transcription in prokaryotes and eukaryotes, Transcription factors, Difference between prokaryotic and eukaryotic transcription.		
Unit4:Translation		6
1. Mechanism of protein synthesis in prokaryotes, 2. 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; 3. Genetic code, Degeneracy of the genetic code and Wobble Hypothesis; 4. Inhibitors of protein synthesis; 5. Difference between prokaryotic and eukaryotic translation		
Unit5:PostTranscriptionalModificationsandProcessingofEukaryoticRNA		8
1. Capping and Poly A tail formation in mRNA; 2. Split genes: concept of introns and exons, splicing mechanism, alternative splicing, Exon shuffling, and RNA editing, 3. Processing of tRNA		
Unit6:Gene Regulation		7
1. Regulation of Transcription in prokaryotes: *lac* operon and *trp* operon; 2. Regulation of Transcription in eukaryotes: Activators, enhancers, silencer, repressors, 3. miRNA mediated gene silencing, 4. Genetic imprinting		
Unit7:DNA Repair Mechanisms		4
Types of DNA repair mechanisms, RecBCD model in prokaryotes, nucleotide and base excision repair, SOS repair		
Unit8: Principles of Molecular Techniques		6
1. PCR 2. Western and Southern blot 3. Northern Blot & 4. Sanger DNA sequencing		

Suggested Readings:

- Albert Bruce, Bray Dennis, Levis Julian, Raff Martin, Roberts Keith and Watson James (2008). Molecular Biology of the Cell, V Edition, Garland publishing Inc., NY and London.
- Allison, L.A. (2007). Fundamental Molecular Biology. Blackwell Publishing.
- Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. 5th Edition.ASM Press and Sunderland, Washington, D.C.; Sinauer Associates, MA.
- Harvey, L. (2004). Molecular Cell Biology. 5th Edn. W.H. Freeman
- Karp, G. (2008). Cell and Molecular biology: Concepts and Application. 5th Edn, John Wiley.

- Lackie, J.M. (2013). Dictionary of Molecular Biology. 5th Edn. Academic Press.
- Lewin, B. (2008). Gene IX. Joned and Barlett.
- Lodish, Berk, Matsudaira, Kaiser, Bretscher, Ploegh, Amon, and Martin (2016) Molecular Cell Biology. 8th Edn. W.H. Freeman
- Pal, A. (2011). Textbook of Cell and Molecular Biology 3rd Edn, Bokks and Allied, Kolkata.
- Russel, P.J. (2010). i-Genetics: A Molecular Approach 3rd edition. Pearson Benjamin
- Turner, McLennan, Bales & White (2005). Instant Notes in Molecular Biology. Taylor Francis
- Twyman, Advanced Molecular Biology. Viva Publication.
- Verma & Agarwal. Cell Biology, Genetics, Molecular Biology, Evolution & Ecology. S. Chand
- Watson, Baker, Bell, Gann, Lewin, Losick (2014). Molecular Biology of the Gene. 7th Edn. Pearson.

3.22. Core P11–Molecular Biology Lab

Molecular Biology	**2 Credits**
List of Practical	
1. Preparation of polytene chromosome from Diptera (*Chironomus/ Drosophila/ Mosquito larva*) 2. Identification of polytene and lampbrush chromosome from photograph 3. Isolation and quantification of genomic DNA using spectrophotometer (A260 measurement) (demonstration only) 4. Demonstration of agarose gel electrophoresis for DNA 5. Study and interpretation of electron micrographs/ photographs showing a) DNA replication b) Transcription c) Split genes 6. Preparation of liquid and solid bacterial culture media, slant and stab 7. Demonstration of antibiotic sensitivity/ resistance of bacteria to antibiotic discs	
Full Marks: 20	
Examination Pattern: One Experiment from Item No. 1 ---------- (6 X 1) = 06 One experiment from Item No. 6 (4X1) = 04 Identification any four from Item No. 2 , 3, 4 , 5 & 7 (2 X 4) = 08 Laboratory Note Book ---------- = 02	

3.23. Core T12- Genetics

Credits : 6

Lectures: 50

Genetics	**4Credits**	**Clas**
Unit1: Mendelian Genetics and its Extension		10
1. Principles of inheritance, Incomplete dominance and co-dominance, Epistasis Multiple alleles, Lethal alleles, Pleiotropy 2. Sex-linked, sex-influenced and sex-limited inheritance, 3. Polygenic Inheritance.		
Unit2: Linkage, Crossing Over and Chromosomal Mapping		10
1. Linkage and Crossing Over, molecular basis of crossing over, 2. Measuring Recombination frequency and linkage intensity using three factor crosses, Interference and coincidence		
Unit3: Mutations		8
1. Types of gene mutations(Classification), 2. Types of chromosomal aberrations(Classification with one suitable example of each), 3. Non-disjunction and variation in chromosome number; 4. Molecular basis of mutations in relation to UV light and chemical mutagens		
Unit4: Sex Determination		8
1. Mechanisms of sex determination in *Drosophila* 2. Sex determination in mammals 3. Dosage compensation in *Drosophila* & Human		
Unit5: Extra-chromosomal Inheritance		4
1. Criteria for extra chromosomal inheritance, Antibiotic resistance in *Chlamyadomonas,* 2. Kappa particle in *Paramoecium* 3. Shell spiralling in snail		
Unit6: Recombination in Bacteria and Viruses		6
1. Conjugation, Transformation, Transduction, 2. Complementation test in Bacteriophage		
Unit7:TransposableGeneticElements		4
1. Transposons in bacteria, Ac-Ds elements in maize and P elements in *Drosophila,* 2. LINE, SINE, Alu elements in humans		

Suggested Readings:

1. Brooker, R.J. (2012). Genetics Analysis and Principles. 4th Edn. McGraw Hill.
2. Dale, J.W. and Park, S. F. (2004). Molecular Genetics of Bacteria. 4 th Edn. John Wiley.
3. Dudek, E.W. (2013). BRS Genetics. Lippincoat, Walker and Wilson
4. Jorde, Carey and Bamshad (2010). Medical Genetics. 4th Edn. Mosby.
5. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. (2010). Introduction to Genetic Analysis WH Freeman.
6. Hartl D.L. and Jones, E. W. (1998). Genetics: Principles and Analysis. 4th Edn. Jones and Barlett
7. Hartwell, Hood, Goldberg, Reynolls and Sikver (2011). Genetics: From Genes to Genome. 4th Edn. McGraw Hill.
8. Hyde, D. (2009). Introduction to Genetic Principle. McGraw Hill.
9. Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics. X Edition. Benjamin Cummings

10. Pierce, B.A. (2013). Genetics Essentials: Concepts abd Connections. 2nd Edn. Freeman W.H.
11. Russell, P.J. (2009).Genetics-A Molecular Approach. III Edition. Benjamin Cummings
12. Snustad,D.P.,Simmons,M.J.(2009).PrinciplesofGenetics.VEdition.JohnWileyandSonsInc
13. Tamarin, R.F (1998). Principles of Genetics. William C Brown Pub
14. Verma PS, Agarwal VK (2016). Genetics, 9th edition. S. Chand and Company Pvt. Ltd

3.24. Core P12–Genetics Lab

Genetics	**2 Credits**
List of Practical 1. Chi-square analyses 2. Problems of linkage maps on *Drosophila* 3. Identification of chromosomal aberration in Drosophila (inversion, ring chromosome, paracentric inversion) from photograph 4. Study of human karyotype, normal and abnormal (Down, Klinefelter, Turner's, Cri-du-Chat) from photograph 5. Pedigree analysis of some human inherited traits (X-linked dominant, X-linked recessive, autosomal dominant, autosomal recessive, Y-linked)	
Full Marks: 20 **Examination Pattern:** One question from Item No. 1 and 5 ---------- (6 X 1) = 06 One question from Item No. 2 ---------- (6X 1) = 06 Identification any three from Item No. 3 and 4 (2 X 3) = 06 Laboratory Note Book ---------- = 02	

3.25. Core T13- Developmental Biology

Credits : 6

Lectures: 50

Developmental Biology	**4 Credits**	**Class**
Unit1:Introduction		2
Basicconcepts:PhasesofDevelopment,Cellcellinteraction,Differentiationandgrowth,Differential gene expression		
Unit2:Early Embryonic Development		20
1. Gametogenesis, Spermatogenesis, Oogenesis; 2. Types of eggs, Egg membranes; 3. Fertilization(External and Internal): Changes in gametes, Blocks to polyspermy; 4. Planes and patterns of cleavage; 5. Types of Blastula; Fate maps(including Techniques); 6. Early development of frog and chick up to gastrulation; 7. Embryonic induction and organizers		
Unit3:Late Embryonic Development		8
1. Fate of Germ Layers; 2. Extra-embryonic membranes in birds; 3. Implantation of embryo in humans, 4. Placenta(Structure, types and functions of placenta)		
Unit4:PostEmbryonicDevelopment		12
1. Development of brain and Eye in Vertebrate 2. Regeneration: Modes of regeneration, epimorphosis, morphallaxis and compensatory regeneration (with one example each)		
Unit5:Implications of Developmental Biology		8
1. Teratogenesis:Teratogenicagentsandtheireffectsonembryonicdevelopment; 2. In vitro fertilization, 3. Stem cell(ESC), 4. Amniocentesis		

Reference Books

1. Carlson, B.M. (2014). Human Embryology and Developmental Biology. 5th Edn. Elsvier.
2. Carlson, B.M. (2014). Patten's Embryology.
3. Dudek, R.W. And Fix, J.D. (2013). BRS Embryology. 3rd Edn. Lippincoat Williams Wilkins
4. De Jonge, C.J. and Barratt, C.L. R. (2006). The Sperma cell. Cambridge Univ Press.
5. Gilbert, S. F. (2010). Developmental Biology, IX Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts ,USA
6. Slack JMW (2006). Essential Developmental Biology. 2nd Edn. Blackwell Pub.
7. Schoenwolf, G.C., Bleyl, S.B., Brauer, P.R. and Francis-West, P.H. (2009). Ladesn's Human Embryology. 4th Edn. Elsvier
8. Verma and Agarwal. Developmental Biology. S. Chand Pub. New Delhi.
9. Wolpert, L. (2002). Principles of Development. 2nd Edn. Oxford Univ. Press

3.26. Core P13–Developmental Biology Lab

Developmental Biology	**2 Credits**
List of Practical	
1. Identification of whole mounts of developmental stages of chick through permanent slides: Primitive streak (13 to 18 hours), 21-33h, 36-48h and 72-96 hours of incubation (Hamilton and Hamburger stages) 2. Study of the developmental stages and lifecycle of *Drosophila* from stock culture 3. Study and identification of different sections of placenta (through photo micrograph/slides) 4. Project report on *Drosophila* culture/chick embryo development	
	Full Marks: 20
Examination Pattern: One question from Item No. 2 ---------- (6 X 1) = 06 Identification any four from Item No.1 and 3 (2 X 4) = 08 Project report ---------- = 04 Laboratory Note Book ---------- = 02	

3.27. Core T14–Evolutionary Biology

Credits : 6

Lectures: 50

Evolutionary Biology	**4 Credits**	**Class**
Unit1		**5**
Life's Beginnings: Chemogeny, RNA world, Biogeny, Origin of photosynthesis, Evolution of eukaryotes		
Unit2		5
Historical review of Evolutionary concepts, Lamarckism, Darwinism and Neo Darwinism		
Unit3		6
1. Geological time scale, 2. Fossil records of Hominids (from *Australopithecus* to *Homo sapiens*), evolution of horse 3. Neutral theory of molecular evolution, Molecular clock		
Unit4		5
Sources of variations: Heritable variations and the its role in evolution		
Unit5		12
1. Population genetics: Hardy-Weinberg Law (statement and derivation of equation, application of law to biallelic Population); 2. Evolutionary forces upsetting H-W equilibrium; Natural selection (concept of fitness, types of selection, selection coefficient, mode of selection heterozygous superiority). 3. Genetic Drift mechanism (founder's effect, bottleneck phenomenon) Role of Migration and Mutation in changing allele frequencies.		
Unit6		6
1. Species concept, 2. Isolating mechanisms, modes of speciation 3. Adaptive radiation/macroevolution (exemplified by Galapagos finches)		
Unit 7		**2**
Extinctions, Back ground and mass extinctions (causes and effects), detailed example of K–T extinction		
Unit8		**6**
Origin and Evolution of Man, Unique Hominin characteristics contrasted with primate characteristic Molecular analysis of human origin		
Unit9		**3**
Phylogenetic trees, Construction & interpretation of Phylogenetic tree using parsimony, Convergent& Divergent evolution.		

Suggested Reading

1. Barton, N.H., Birggs, D.E.G., Elsen, J.A. Goldstein, D.B. and Patel, N.H. (2007). Evolution. CSHL Press
2. Bergstorm, C.T. And Dujatkin, L.A. (2012). Evolution. 1st Edn. W.W. Norton and Co.
3. Dobzhansky T., Ayala, F.J., Stebbins, J.L. & Valentine, J.W. (1977). Evolution. Surajeet Pub., N.Delhi
4. Freeman, S., Herron, J. C. (2016). Evolutionary Analysis.Pearson Education Limited, Noida, India.
5. Futuyma, D.J. (1997).EvolutionaryBiology.3rd Edn. Sinauer Associates.
6. Futuyma, D.J. (2005).Evolution. Sinauer Associates.
7. Gillespie, J.H. (1998). Population Genetics: a Concise Guide. John Hopkins Univ Press.
8. Hall, B.K. and Hallgrimson, B. (2008). Stirckberger's Evolution. 4th Edn. Jones and Barlett.
9. Kardong, K. (2004). An Introduction to Biological Evolution. McGraw Hill.
10. Mitchell, T.N. (). Chemical Evolution and the Origin of Life. Springer.
11. Page, R.D.M. and Holmes E.C. (1998). Molecular Evolution: A Phylogenetic Approach. Blackwell Sc
12. Ridley, M. (1996). Evolution. 2nd Edn. Blackwell Science.
13. Scientific American Special Issue (2006). Becoming Human: Evolution and the rise of intelligence.

14. Smith, J.M. (1998). Evolutionary Genetics. 2nd Edn. Oxford Univ Press.
15. Volpe, E.P. and Rossenbaum, P.A. (1999). Evolution. McGraw Hill.

3.28. Core P14–Evolutionary Biology Lab

Evolutionary Biology	**2 Credits**
List of Practical	
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 100 humans in relation to the age and sex.	
	Full Marks: 20
Examination Pattern: One question from Item No. 3 ---------- (8 X 1) = 08 One question from Item No. 4 ---------- (6X 1) = 06 Identification any two from Item No. 1 and 2 (2 X 2) = 04 Laboratory Note Book ---------- = 02	

4. Department Specific Electives Subjects Syllabus

4.1. DSE T1- Animal Biotechnology

Credits : 6 **Lectures: 50**

Animal Biotechnology	**4 Credits**	**Class**
Unit1:Introduction		5
1. Organization of prokaryotic and eukaryotic genome, 2. Concept of genomics		
Unit2:MolecularTechniquesinGene manipulation		23
1. Cloning vectors: Plasmids, Cosmids, Phagemids, Lambda Bacteriophage, M13, BAC, YAC, MAC and Expression vectors (characteristics). 2. Restriction enzymes: Nomenclature, detailed study of Type II. 3. Transformation techniques: Calcium chloride method and electroporation. 4. Construction of genomic and cDNA libraries and screening by colony and plaque hybridization 5. Southern, Northern and Western blotting 6. DNA sequencing: Sanger method 7. Polymerase Chain Reaction, DNA Fingerprinting and DNA microarray		
Unit3:Genetically Modified Organisms		12
1. Production of cloned and transgenic animals: Nuclear Transplantation, Retroviral Method, DNA microinjection. 2. Applications of transgenic animals: Production of pharmaceuticals, production of donor organs, knockout mice.		
Unit4:CultureTechniquesand Applications		10
1. Animal cell culture, 2. Expressing cloned genes in mammalian cells, 3. Molecular diagnosis of genetic diseases(Cystic fibrosis, Sickle cell anaemia)		

Reference Books

1. Brown, T.A. (1998). Molecular Biology Lab fax II: Gene Cloning and DNA Analysis. II Edition, Academic Press, California, USA.
2. Butler, J.M. (2010). Fundamentals of Forensic DNA Typing. Academic Press.
3. Glick, B.R. and Pasternak, J.J. (2009). Molecular Biotechnology - Principles and Applications of Recombinant DNA. IV Edition, ASM press, Washington, USA.
4. Harisha, S. (2007). Biotechnology Procedures and Experiments Handbook. Infinity Science Press. New Delhi.
5. Mosier, N.S. And Ladisch, M.R. (2009). Modern Biotechnology. John Wiley.
6. Primrose, and Twyman. Principles of Gene Manipulation and Genomics. 7th Edn.
7. Singh, B.D. Biotechnology. Kalyani Pub. New Delhi.
8. Weaver.MolecularBiology.5thedition.

4.2. DSE P1 –Animal Biotechnology Lab

Animal Biotechnology	**2 Credits**

List of Practical

1. Construction of linear restriction map from the data provided.
2. Calculation of transformation efficiency from the data provided.
3. Study and identification of following techniques through photographs
    a. Southern Blotting
    b. Northern Blotting
    c. Western Blotting
    d. DNA Sequencing (Sanger's Method)
    e. PCR
    f. DNA fingerprinting
4. Project report on animal cell culture

Full Marks: 20

Examination Pattern:

One question from Item No. 1,	---------- (6 X 1)	= 06
One question from Item No. 2	---------- (6X 1)	= 06
Identification of two techniques	---------- (2 X 2)	= 04
Project Report	----------	= 02
Laboratory Note Book	----------	= 02

4.3. DSE T2 Microbiology

Credits : 6 **Lectures: 50**

Microbiology	**6 Credits**	**Class**
Unit1:Introduction to Microbiology		4
Historical perspective of Microbiology, Prokaryotic pathogens, Eukaryotic pathogens		
Unit2: **Bacterial taxonomy**		8
Principles and modern approaches of bacterial taxonomy. Basic idea about Hackel and Whittaker's kingdom concept and domain concept of Carl Woose		
Unit3:Morphology of Bacteria and Virus		14
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, gasvesicles, ribosome). Structural organization of viruses, Prions and viroids		
Unit4: Normal flora		4
Distribution of normal flora in the body: Skin, eye, mouth, intestinal tract, urino-genital tract, Beneficial functions of normal flora. Harmful effects of normal flora		
Unit5: Pathogenicity of Microorganisms		10
Bacterial pathogenesis: Entry to the host, Adherence to host cells, Invasiveness, Bacterial toxins: Exotoxins, Endotoxins, Antigenic switching. Viral Pathogenesis: Cellular level(Cell death, Transformation, Cell fusion, Cytopathic effect).Initial infections: Routes of entry and dissemination to secondary sites, Typical secondary sites of localization, Virus shedding and mode of transmission; Factors involved intermination of acute infection		
Unit6: Infection of pathogens to human populations		2
Communicable, Non-communicable, Endemic, Epidemic, Pandemic and Sporadic		
Unit7: Diagnostic Microbiology and Bacteria culture		4
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		
Unit8: Genetic recombination in bacteria		4
Transformation, Conjugation-F+, F-, Hfr & F' strain, Transduction, Generalized &specialized types.		
Unit9: Microbial Diseases		4
Name of pathogen, symptoms, pathogenesis, mode of action &preventive measures of following diseases: Bacterial (Polio, Typhoid, Staphylococcal Food Poisoning), Viral(Dengue, AIDS)		

Suggested Readings:

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

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

4.4. DSE P2- Microbiology Lab

Microbiology	**2 Credits**
List of Practical	
1. Simple staining and Gram's staining of bacteria. 2. Preparation of liquid media (broth) and solid media for routine cultivation of bacteria. 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), Sugar fermentation test 7. Submission of project report on water or soil bacteria	
Full Marks: 20 **Examination Pattern:** One question from Item No. 1,2,3 and 4 ---------- (6 X 1) = 06 One question from Item No. 5 ---------- (5X 1) = 05 One question from Item No. 6 ---------- (5X 1) = 05 Project Report ---------- = 02 Laboratory Note Book ---------- = 02	

4.5. DSE T3- Parasitology

Credits : 6

Lectures: 50

Parasitology	**4 Credits**	**Class**
Unit1: Introduction to Parasitology		2
1. Brief introduction of Parasitism, Parasite, Parasitoid and Vectors (mechanical and biological vector) 2. Host parasite relationship		
Unit2: Parasitic Protists		12

Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Giardia intestinalis*, *Trypanosoma gambiense*, *Leishmania donovani*	
Unit3: Parasitic Platyhelminthes	12
Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Schistosoma haematobium*, *Taenia sajinata*	
Unit4:ParasiticNematodes	12
1. Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Ascaris lumbricoides*, *Ancylostoma duodenale*, *Wuchereria bancrofti* and *Trichinella spiralis*, *Brugiamalayi*; 2. Nematode plant interaction ; Gall formation	
Unit5: Parasitic Arthropods	10
Biology, importance and control of ticks (Soft tick *Ornithodoros,* Hard tick *Ixodes*),mites (*Sarcoptes*), Lice (*Pediculus*),Flea (*Xenopsylla*) and Bug (*Cimex*)	
Unit5: Parasite Vertebrates	**2**
Brief account of Cookicutter Shark, Hood Mocking bird, Vampire bat	

Suggested Reading

1. Arora,D.RandArora,B.(2001)MedicalParasitology.IIEdition.CBSPublicationsandDistributors
2. Ahmed, N., Dawson, M., Smith, C.and Wood, Ed. (2007). Biology of Fish Disease. Taylor and Francis Group
3. Bogitsch, B.J., Carter, C. E. and Oeltmann T.N. (2013). Human Parasitology. 4th Edn. Elsevier.
4. Bose M (2017).Parasitoses and zoonoses. New Central Book Agency. 1:3-808
5. Chatterjee, K. D. (2009).Parasitology: Protozoology and Helminthology. XIII Edition, CBS Publishers & Distributors (P) Ltd.
6. Chakraborty P (2016). Textbook of Medical parasitology, 3rd edition. New Central Book Agency
7. Gunn, A. and Pitt, S.J. (2012). Parasitology: an Integrated Approach. Wiley Blackwell.
8. John, D.T. and W.A. Petri (2006). Markell and Voge's Medical Parasitology. 9th Edn. Elsevier.
9. Meyer, Olsen &Schmidt's Essentials of Parasitology, Murray, D. Dailey, W.C. Brown Publishers
10. Marr, J.J., Nilsen, T.W. and Komuniecki, R.W. (2003). Molecular Medical Parasiology. 2nd Edn. Academic Press
11. Muller, R. and Wakelin, D. (2002). Worms and Human Disease. 2nd Edn. CAB International Pub.
12. Noble, E. R. and G.A.Noble (1982) Parasitology: The biology of animal parasites. V th Edition, Lea &Febiger
13. Paniker, C.K.J., Ghosh, S. [Ed} (2013). Paniker's Text Book of Medical Parasitology. Jaypee, New Delhi.
14. Parija,S.C.Textbookofmedicalparasitology,protozoology&helminthology(Textand color Atlas),II Edition, All India Publishers & Distributers, Medical Books Publishers, Chennai, Delhi
15. RatanLalIchhpujaniandRajeshBhatia.MedicalParasitology,IIIEdition,JaypeeBrothersMedicalPublishers(P)Ltd.,NewDelhi
16. Roberts, L.S and Janovy, J. (2009). Smith & Robert's Foundation of Parasitology. 8th. Edn. McGraw Hill

4.6. DSE P3 –Parasitology Lab

Parasitology	**2 Credits**
List of Practicals	

1. Identification of life stages of *Giardia lamblia* and *Leishmania donovani* through permanent slides/microphotographs
2. Identification of adult and life stages of *Schistosoma haematobium*, *Taeniasolium* through permanent slides/microphotographs
3. Identification of adult and life stages of *Ancylostoma duodenale*, *Wuchereria bancrofti* and *Trichinella spiralis* through permanent slides/microphotographs
4. Identification of plant parasitic root knot nematode, *Meloidogyne* from the soil sample
5. Identification of *Pediculus humanus*, *Xenopsyll acheopis* and *Cimex lectularius* through permanent slides/photographs
6. Isolation and fixation of nematode/cestode parasites from the intestine of hen[Intestine can be procured from poultry/market as a by-product]
7. Submission of a project report on any parasite of vertebrates

Full Marks: 20

Examination Pattern:

One question from Item No. 6 ---------- (8 X 1) = 08
Identification of four specimens from item no.1, 2 , 3 and 5---- (2 X 4) = 08
Project Report ---------- = 02
Laboratory Note Book ---------- = 02

4.7. DSE T4-Biology of Insects

Credits : 6

Lectures: 50

Biology of Insects	**4 Credits**	**Class**
Unit1:Introduction		2
1. General Features of Insects 2. Distribution and Success of Insects on the Earth		
Unit2:Insect Taxonomy		4
Basis of insect classification; Classification of insects up to orders (according to Brusca and Brusca, 2016)		
Unit3:General Morphology of Insects		6
1. External Features; Head–Eyes, Types of antennae, Mouth parts w.r.t .feeding habits 2. Thorax: Wings and wing articulation, Types of Legs adapted to diverse habitat 3. Abdominal appendages and genitalia		
Unit4:Physiology of Insects		20
1. Structure and physiology of Insect body systems - Integumentary, digestive, excretory, circulatory, respiratory, endocrine, reproductive, and nervous system 2. Photoreceptors: Types, Structure and Function 3. Metamorphosis: Types and Neuroendocrine control of metamorphosis		
Unit5:InsectSociety		6
1. Social insects with special reference to termites 2. Trophallaxis in social insects such as ants, termites and bees		
Unit6:Insect Plant Interaction		4
1. Theory of co-evolution, role of allelochemicals in host-plant mediation 2. Host-plant selection by phytophagous insects, 3. Major insect pests in paddy		
Unit7:Insects as Vectors		**8**
1. Insects as mechanical and biological vectors, 2. Brief discussion on houseflies and mosquitoes as important vectors		

Suggested Readings:

1. Bernays, E.A. and Chapman, R.F. (). Host Selection by Phytophagous insects. Chapman and Hall, New York, USA
2. Bigness, Roisin and Lo (2011). Biology of Termites: A Modern Synthesis. Springer.
3. Borror, D.J. Triplehorn, C.A. and Johmson N.F. Introduction to the Study of insects. Saunders College Publication, USA
4. Chandra, G. (2000). Mosquito. Sribhumi Pub. Co., Kolkata.
5. Chapman, R.F. The Insects: Structure and function. Cambridge University Press, UK
6. Gullan, P.J. and Cranston, P.S. (). The Insects: An Outline of Entomology. Wiley Blackwell.
7. Hati, A.K. (2010). Medical Entomology. Allied Book Agency, Kolkata.
8. Imms, A.D., A General TextBook of Entomology. Chapman & Hall, UK
9. Klowden, M.J. Physiological system in Insects. Academic Press, USA
10. Lehane, M.J. (2005). The Biology of Blood Sucking Insects. 2nd Edn. Cambridge Univ Press.
11. Nation, J.L. Insect Physiology and Biochemistry. CRC Press, USA
12. Snodgrass, R.E. Principles of Insect Morphology. Cornell Univ. Press, USA
13. Wilson, E.O. The Insect Societies. Harvard Univ. Press, UK

Note: Classification to be followed from Brusca and Brusca (20)

4.8. DSE P4 –Biology of Insects Lab

Biology of Insecta	**2 Credits**
List of Practical	
1. Study of life cycle of Mosquito 2. Mounting and identification of different kinds of antennae, legs and mouth parts of insects 3. Mounting of insect wings, spiracles and genitalia of any insects 4. Methodology of collection, preservation and identification of insects. 5. Morphological studies of various castes of *Apis*, *Camponotus, Odontotermes* 6. Identification of major insect pests of paddy and their damages (*Nilaparvata, Scirpophaga, Hispa*) 7. Identification of Mulberry silk moth as beneficial insect	
	Full Marks: 20

Examination Pattern:

One question from Item No. 2 ---------- (6X 1) = 06
One question from Item No. 3 ---------- (6X 1) = 06
Identification of two specimens from item no.5, 6 and 7 -------- (2 X 2) = 04
Submission of life cycle of mosquito ---------- = 02
Laboratory Note Book ---------- = 02

4.9. DSE T5– Animal Behaviour

Credits : 6

Lectures: 50

Animal Behaviour and Chronobiology	**4 Credits**	**Class**
Unit1:IntroductiontoAnimal Behaviour		5
1. Origin and history of Ethology, Brief profiles of Karl Von Frish, Ivan Pavlov, Konrad Lorenz, NikoTinbergen 2. Proximate and ultimate causes of behaviour, Methods and recording of a behaviour		
Unit2:Patterns of Behaviour		6
1. Stereotyped Behaviours (Orientation, Reflexes); 2. Individual Behavioural patterns; Instinct vs. Learnt Behaviour; 3. Associative learning, classical and operant conditioning, Habituation, Imprinting.		
Unit3: Social and Sexual Behaviour		15
1. Social Behaviour: Concept of Society; Communication and the senses 2. Altruism; Insects' society with Honeybee as example; Foraging in honeybee and advantages of the waggle dance. 3. Sexual Behaviour: Asymmetry of sex, Sexual dimorphism, Mate choice, Intra-sexual selection (male rivalry), Inter-sexual selection (female choice), Sexual conflict in parental care.		
Unit4:Introductionto Chronobiology		10
1. Historical developments in chronobiology; 2. Biological oscillation :the concept of Average, amplitude, phase and period 3. Adaptive significance of biological clocks		
Unit5: Biological Rhythm		14
1. Types and characteristics of biological rhythms :Short- and Long- term rhythms; Circadian rhythms; Tidal rhythms and Lunar rhythms; 2. Concept of synchronization and masking; Photic and non-photic zeitgebers; Circannual rhythms; 3. Photoperiod and regulation of seasonal reproduction of vertebrates; 4. Role of melatonin.		

Reference Books

1. Alcock, J. (2001). Animal Behaviour: An Evolutionary Approach. , Sinauer Associate Inc., USA.
2. Chattopadhyay, S. (2012). Life: Evolution, Adaptation, Ethology. 3rd Edn. Books and Allied, Kolkata.
3. Dujatkin, L.A. (2014). Principles of Animal Behaviour. 3rd Edn. W.W.Norton and Co.
4. Dunlap, J.C., Loros, J.J. and De Coursey, J.P. (2004). Chronobiology: Bioloigcal Time keeping. Sinauer Associates, Inc. Publishers, Sunderland, MA, USA
5. Kumar, V. (2002). Biological Rhythms. Narosa Publishing House, New Delhi.
6. Mandal, F. (2010). A Text Book of Animal Behaviour. Pentice Hall India.
7. Mathur, R. (2005). Animal Behaviour. Rastogi Pub. Meerut.
8. Refinetti, R. (2000). Circadian Physiology. CRC Press, Boca Raton.
9. Ruhela, A. and Sinha, M. (2010). Recent Trends in Animal Behaviour. Oxford Book Co. Jaipur.
10. Saunders, D. S. C. G. H. Steel, X., Afopoulou (ed.) R. D. Lewis. (2002). Insect Clocks. 3rd Ed Barens and Noble Inc. New York, USA
11. Sherman, P. W. and John Alcock, Exploring Animal Behaviour, Sinauer Associate Inc., Massachusetts, USA.

4.10. DSE P5 –Animal Behaviour Lab

Animal Behaviour and Chronobiology	**2 Credits**

List of Practical

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

Full Marks: 20

Examination Pattern:

One question from Item No. 1, 2, 3 and 4 ---------- (5X 1) = 05
One question from Item No. 6 ---------- (5X 1) = 05
One question from Item No. 7 ---------- (5X 1) = 05
Excursion Report ---------- = 03
Laboratory Note Book ---------- = 02

4.11. DSE T6–Wild Life Conservation

Credits : 6

Lectures: 50

Wild Life Conservation and Management	**4 Credits**	**Class**
Unit1:Introduction to Wild Life		6
Values of wildlife-positive and negative; Conservation ethics; Importance of conservation; Causes of depletion; World conservation strategies.		
Unit2:Evaluation and management of wildlife		8
Habitat analysis, Physical parameters: Topography, Geology, Soil and water Biological Parameters: food, cover, forage, browse and cover estimation Standard evaluation procedures: remote sensing and GIS.		
Unit3: Management of habitats		6
1. Setting back succession; Grazing logging; 2. Mechanical treatment; Advancing the successional process; Cover construction; Preservation of general genetic diversity 3. Restoration of degraded habitats		
Unit4: Population estimation		12
1. Population density, Natality, Birth-rate, Mortality, fertility schedules and sex ratio computation; 2. Faecal analysis of ungulates and carnivores; 3. Pug marks and census method.		
Unit5:Aimsandobjectivesofwildlifeconservation		6
1. Wild life conservation in India–through ages; different approaches of wildlife conservation; 2. Modes of conservation ;in- situ conservation and ex-situ conservation 3. Necessity for wildlife conservation		
Unit6:Managementplanningof wildlife in protected areas		5

5. Estimation of carrying capacity; 6. Eco tourism/ wild life tourism in forests; 7. Concept of climax persistence; 8. Ecology of perturbence.	
Unit7:Manand Wildlife	3
Causes and consequences of human-wildlife conflicts; mitigation of conflict – an overview; Management of excess population	
Unit8:Protected areas	4
1. National parks &sanctuaries, Community reserve; Important features of protected areas in India; 2. Tiger conservation- Tiger reserves in India; Management challenges in Tiger reserve.	

Suggested Readings:

1. Caughley, G., and Sinclair, A.R.E. (1994).Wildlife Ecology and Management. Blackwell Science.
2. Woodroffe R, Thirgood, S. and Rabinowitz, A. (2005). People and Wildlife, Conflictor Co-existence Cambridge University.
3. Bookhout, T. A. (1996).Research and Management Techniques for Wild life and Habitats, 5 th edition. The Wildlife Society, Allen Press.
4. Sutherland, W.J. (2000).The Conservation Handbook: Research, Management and Policy. Blackwell Sciences
5. Sodhi, N.S. and Ehlich, P.R. (2010). Conservation Biology for All. Oxford university Press

4.12. DSE P6–Wild Life Conservation Lab

Wild Life Conservation and Management2 Credits

List of Practical

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

Full Marks: 20

Examination Pattern:

One question from Item No. 5	----------	(7 X 1) = 07
One question from Item No. 6	----------	(7X 1) = 07
Identification of two specimens from item no. 3	--------	(2 X 2) = 04
Laboratory Note Book ----------		= 02

4.13. DSE T7-Endocrinology

Credits : 6

Lectures: 50

Endocrinology	**4 Credits**	**Class**
Unit1:Introductionto Endocrinology		4
1. General idea of Endocrine systems, Classification, Characteristics and Transport of Hormones, 2. Neurosecretions and Neurohormones		
Unit2:Epiphysis,Hypothalamo-hypophysial Axis		16
1. Structure of pineal gland, Secretions and their functions in biological rhythms and reproduction. 2. Structure and functions of hypothalamus and Hypothalamic nuclei, Regulation of neuroendocrine glands, Feedback mechanisms 3. Structure of pituitary gland, Hormones and their functions, Hypothalamo- hypophysial portal system, Disorders of pituitary gland.		
Unit3:Peripheral Endocrine Glands		16
1. Structure, Hormones, Functions and Regulation of Thyroid gland, Parathyroid, Adrenal, Pancreas, Ovary and Testis 2. Hormones in homeostasis 3. Disorders of endocrine glands		
Unit4:Regulation of Hormone Action		14
1. Mechanism of action of steroidal, non-steroidal hormones with receptors 2. Bioassays of hormones using RIA &ELISA 3. Estrous cycle in rat and menstrual cycle in human 4. Multifaceted role of Vasopressin &Oxytocin. 5. Hormonal regulation of parturition.		

Reference Books

1. Fox, T. Brooks, A. And Baidya, B. (2015). Endocrinology. JP Medical, London.
2. Gardner, D.G. And Shoback, D. (2011). Greenspan's Basic and Clinical Endocrinology. 9th Edn. McGraw Hill Lange.
3. Goodman, H.M. (2000). Basic Medical Endocrinology. 4th Edn. Academic Press.
4. Jameson, J.L. (2010). Harrison's Endocrinology. 2nd Edn. McGraw Hill.
5. Melmed, S. And Conn, P.M. (2005). Endocrinology: Basic and Clinical Principles. 2nd Edn. Humana Press.
6. Melmed, Polonsky, Larsen and Kronenberg (2016). William's Text Book of Endocrinology. 13th Edn. Elsevier.
7. Molina, P.E. (2013). Endocrine Physiology. 4th Edn. McGraw Hill Lange.
8. Neal, J.M. (2000). Basic Endocrinology; An Interactive Approach. Blackwell Science.
9. Norris, D.O. (2007). Vertebrate Endocrinology. 4th Edn. Elsevier Academic Press.
10. Strauss, J.F. and Barbieri, R.L. (2014). Yen & Jaffe's Reproductive Endocrinology. Elsevier Saunders

4.14. DSE P7 –Endocrinology Lab

Endocrinology	**2 Credits**
List of Practical	
1. Dissect and display of Endocrine glands in laboratory bred rat. 2. Study of the permanent slides of all the endocrine glands (Thyroid, Adrenal, Pancreas, Testis and Ovary) 3. Tissue fixation, embedding in paraffin, microtomy and slide preparation of any endocrine gland 4. Demonstration of hormone assay through ELISA from available teaching kit	
	Full Marks: 20
Examination Pattern: One question from Item No. 3 ---------- (7 X 1) = 07 One question from Item No. 1 and 4 ---------- (5X 1) = 05 Identification of two specimens from item no.2 -------- (2 X 3) = 06 Laboratory Note Book ---------- = 02	

4.15. DSE T8-ReproductiveBiology

Credits : 6

Lectures: 50

Reproductive Biology	**4 Credits**	**Class**
Unit1:Reproductive Endocrinology		**10**
1. Mechanism of action of steroids and glycoprotein hormones. 2. Hypothalamo–hypophyseal–gonadal axis ,regulation of gonadotrophin secretion in human (male and female) 3. Reproductive system: Development and differentiation of gonads, genital ducts and external genitalia		
Unit2:Functional anatomy of male reproduction		14
1. Histo-architechture of testis in human; Spermatogenesis; Kinetics and hormonal regulation; 2. Androgen synthesis and metabolism; 3. Accessory glands functions		
Unit3:Functionalanatomy of female reproduction		18
1. Histoarchitechtureofovaryinhuman;Oogenesis;Kineticsandhormonalregulation;Steroidogenesis and secretion of ovarian hormones; 2. Reproductive cycles(human)and their regulation, fertilization; 3. Hormonal control of implantation; Hormonal regulation of gestation, 4. pregnancy diagnosis, foeto– maternal relationship; 5. Mechanism of parturition and its hormonal regulation; 6. Lactation and its regulation		
Unit4:ReproductiveHealth		8
1. Infertility in male and female: causes, diagnosis and management 2. Assisted Reproductive Technology: sex selection, sperm banks, frozen embryos, in vitro fertilization 3. Modern contraceptive technologies		

Suggested Reading

1. Jones, R.E. and Lopez, K.N. (2014). Human Reproductive Biology. 4 th Edn. Elsevier.
2. Hatcher, R.A.et al. The Essentials of Contraceptive Technology. Population Information Programme.
3. Khurana, I (2012). Medical Physiology for undergraduate students. Elsevier.
4. Lewis, V. (2007). Reproductive endocrinology and Infertility. Landes Bioscience, USA.
5. Plant, T.M. And Zelenik, A.J. [Ed} (2015). Knobil and Neill's Physiology of Reproduction. 4th. Edn. Vol I. Elsevier.
6. Rizzo, D.C. (2010). Fundamentals of Anaomy and Physiology. 3rd Edn. Delmer.
7. Sembulingam and Sembulingam (2012) Essentials of Medical Physiology. 6th Edn. Jaypee Pub, New Delhi
8. Sherwood, L. (2013). Human Physiology from cells to systems. 8th Edn., Brooks & Cole
9. Shoupe, D. and Kjos, S.L. (2006). The Handbook Of Contraception. Humana Press.
10. Strauss, J.F. and Barbieri, R.L. (). Yen and Jaffe's Reproductive Endocrinlogy. 7th Edn. Elsevier.
11. Tortora, G.J. & Grabowski, S. (2006).Principles of Anatomy & Physiology. XI Edition John Wiley& sons.

4.16. DSE P8–Reproductive Biology Lab

Reproductive Biology	**2 Credits**
List of Practical's	
1. Examination of vaginal smear from rats. 2. Tissue fixation, embedding in paraffin, microtomy and slide preparation of any endocrine gland 3. Examination of histological sections from photomicrographs/permanent slides of rat/human: testis, epididymis and accessory glands of male reproductive systems; Sections of ovary, fallopian tube,	
Full Marks: 20 **Examination Pattern:** One question from Item No. 1 ---------- (5 X 1) = 05 One question from Item No. 2 ---------- (7 X 1) = 07 Identification of two specimens from item no.4 -------- (3 X 2) = 06 Laboratory Note Book ---------- = 02	

5. Skill Enhancement Course

5.1. SEC T1 –Apiculture

Credits : 2

Lectures: 25

Apiculture	**2 Credits**	**Class**
Unit1:Biology of Bees		**2**
1. History, Classification and Biology of Honey Bees 2. Social Organization of Bee Colony		
Unit2:Rearing of Bees		10
1. Artificial Beer earing(Apiary),Beehives–Newton and Langstroth 2. Bee Pasturage 3. Selection of Bee Species for Apiculture 4. Bee Keeping Equipment 5. Methods of Extraction of Honey (Indigenous and Modern)		
Unit3:Diseases and Enemies		5
Bee Diseases and Enemies, Control and Preventive measures		
Unit4:Bee Economy		2
Products of Apiculture Industry and its Uses(Honey, Bees Wax, Propolis), Pollenetc		
Unit5:Entrepreneurshipin Apiculture		6
Bee Keeping Industry–Recent Efforts, Modern Methods in employing artificial Beehives for cross pollination in horticultural gardens		

Reference Books

1. Cramp, D. (2012). The Complete Step by Step Book of Beekeeping. Anness Publishing.
2. Prost, P.J. (1962).Apiculture. Oxford and IBH, New Delhi.
3. Bisht D.S, Apiculture, ICAR Publication.
4. SinghS. Beekeeping in India, Indian council of Agricultural Research, New Delhi.

5.2. SEC T2-Aquarium Fish Keeping

Credits : 2

Lectures: 25

Aquarium Fish Keeping	**2 Credits**	**Class**
Unit1: Introduction to Aquarium Fish Keeping		2
The potential scope of Aquarium Fish Industry as a Cottage Industry, Exotic and Endemic species of Aquarium Fishes		
Unit2: Biology of Aquarium Fishes		10
Common characters and sexual dimorphism of Freshwater and Marine Aquarium fishes such as Guppy, Molly, Swordtail, Goldfish, Angel fish ,Bluemorph, Anemone fish and Butterfly fish		
Unit3:Food and feeding of Aquarium fishes		7
1. Use of live fish feed organisms. 2. Preparation and composition of formulated fish feeds, 3. Aquarium fish as larval predator		
Unit 4: Fish Transportation		3
Live fish transport- Fish handling, packing and forwarding techniques.		
Unit5: Maintenance of Aquarium		3
General Aquarium maintenance – budget for setting up an Aquarium Fish Farm as a Cottage Industry		

Suggested Readings:

1. Axelrod, H.R. (1967). Breeding aquarium Fishes. TFH Pub.
2. Jayashree, K.V. Thara Devi, C.S. & Arumugam, N. Home Aquarium & Ornamental fish Culture. Saras Pub.
3. Mahapatra, B.K. (2015). Ornamental Fish Breeding, Culture& Trade. CIFE.
4. Saxena, A. (Ed). 2003. Aquarium Management. Daya Pub.

5.3. SEC T3- Medical Diagnostic techniques

Credits : 2

Lectures: 25

Medical Diagnostic Techniques	**2 Credits**	**Class**
Unit1:Introductionto Medical Diagnostics and its Importance		**2**
Unit2:DiagnosticsMethods Used for Analysis of Blood		7
1. Blood composition, 2. Preparation of blood smear and Differential Leucocyte Count (D.L.C) using Leishman's stain. 3. Platelet count using haemocytometer, 4. Erythrocyte Sedimentary Rate (E.S.R), 5. Packed Cell Volume (P.C.V.)		
Unit3:DiagnosticMethods Used for Urine Analysis		4
Urine Analysis: Physical characteristics; Abnormal constituents		
Unit4:Non-infectious Diseases		5
Causes, types, symptoms, complications ,diagnosis and prevention of Diabetes (Type I and Type II), Hypertension(Primaryandsecondary),TestingofbloodglucoseusingGlucometer/Kit		
Unit5:Infectious Diseases		3
1. Causes, types, symptoms, diagnosis and prevention of Tuberculosis and Hepatitis, Malarial parasite 2. Microscope based and ELISA based)		
Unit6: Clinical Biochemistry		1
1. LFT, 2. Lipid profiling		
Unit7:Clinical Microbiology		1
Antibiotic Sensitivity Test		
Unit8:Tumours		2
1. Types (Benign/Malignant), Detection and metastasis. 2. Medical imaging: X-Ray of Bone fracture, PET, MRI and CT scan (using photographs).		
Unit9: Visit to Pathological Laboratory and Submission of Project		

1. Prakash, G. (2012), Lab Manual on Blood Analysis and Medical Diagnostics, S. Chand and Co. Ltd.
2. Papadaki s, M.A., McPhee, S.J. and Rabow, M.W. ed. (2016). Current Medical Diagnosis and Treatment McGrw Hill.

5.4. SEC T4–Sericulture

Credits : 2

Lectures: 25

Sericulture	**2 Credits**	**Class**
Unit1:Introduction		2
1. Sericulture: Definition, history and present status; Silk route 2. Types of silkworms, Distribution and Races , Exotic and indigenous races Mulberry and non-mulberry Sericulture		
Unit2: Biology of Silkworm		4
1. Life cycle of *Bombyx mori* 2. Structure of silk gland and secretion of silk		
Unit3:Rearing of Silk worms		10
1. Selection of mulberry variety and establishment of mulberry garden 2. Rearing house and rearing appliances. Disinfectants: Formalin, bleaching powder, RKO 3. Silkworm rearing technology: Early age and Late age rearing 4. Types of mount ages 5. Spinning, harvesting and storage of cocoons		
Unit4:Pests and Diseases		7
1. Pests of silkworm :Uzifly, dermestid beetles and vertebrates 2. Pathogenesis of silkworm diseases: Protozoan, viral, fungal and bacterial 3. Control and prevention of pests and diseases		
Unit5:Entrepreneurshipin Sericulture		2
1. Prospectus of Sericulture in India: Sericulture industry in different states, employment, potential in mulberry and non-mulberry sericulture 2. Visit to various sericulture centers.		

Suggested Readings:

1. Manual on Sericulture; Food and Agriculture Organisation, Rome 1976
2. Handbook of Practical Sericulture: S.R. Ullal and M.N. Narasimhanna CSB, Bangalore
3. Silkworm Rearing and Disease of Silkworm, 1956, Ptd. By Director of Ptg., Stn. & Pub. Govt. Press, Bangalore
4. Appropriate Sericultural Techniques; Ed. M. S. Jolly, Director, CSR & TI, Mysore.
5. Handbook of Silkworm Rearing: Agriculture and Technical Manual-1, Fuzi Pub. Co. Ltd., Tokyo, Japan1972.
6. Manual of Silkworm Egg Production; M. N. Narasimhanna, CSB, Bangalore 1988.
7. Silkworm Rearing; Wupang—Chun and Chen Da-Chung, Pub. By FAO, Rome 1988.
8. A Guide for Bivoltine Sericulture; K. Sengupta, Director, CSR & TI, Mysore 1989.
9. Improved Method of Rearing Young age silkworm; S. Krishnaswamy, reprinted CSB, Bangalore, 1986.

6. General Elective [For Other Subject(s)]

6.1. GE T1 –Animal Diversity

Credits: 6

ANIMAL DIVERSITY (CREDITS 4)

THEORY		**CLASS**
Unit-1	Kingdom Protista General characters and classification up to classes; Locomotory Organelles and locomotion in Protozoa	4
Unit-2	Phylum Porifera General characters and classification up to classes; Canal System in *Sycon*	3
Unit-3	Phylum Cnidaria General characters and classification up to classes; Polymorphism in Hydrozoa	3
Unit-4	Phylum Platyhelminthes General characters and classification up to classes; Life history of *Taenia solium*	3
Unit-5	Phylum Nematoda General characters and classification up to classes; Life history of *Ascaris lumbricoides* and its parasitic adaptations	5
Unit-6	Phylum Annelida General characters and classification up to classes; Nephridia in Annelida	5
Unit 7	Phylum Arthropoda General characters and classification up to classes; Vision in Arthropoda, Metamorphosis in Insects	5
Unit-8	Phylum Mollusca General characters and classification up to classes; Respiration in *Pila*	4
Unit-9	Phylum Echinodermata General characters and classification up to classes; Water-vascular system in *Asterias*	4
Unit-10	Protochordates General features; Feeding in *Branchiostoma*	2
Unit-11	Agnatha General features of Agnatha and classification of cyclostomes up to classes	2
Unit-12	Pisces General features and Classification up to orders; Osmoregulation in Fishes	4
Unit-13	Amphibia General features and Classification up to orders; Metamorphosis in Toad	4
Unit-14	Reptiles General features and Classification up to orders; Poisonous and non-poisonous snakes, Biting mechanism in snakes	4
Unit-15	Aves General features and Classification up to orders; Flight adaptations in birds	5
Unit-17	Mammals Classification up to orders; Cranial nerves in *Cavia*	5

Note: Classification of Unit 1-9 to be followed from "Ruppert & Barnes, R.D. (1994), *Invertebrate Zoology*, VI Edition

Suggested Readings [Consult Latest Editions]

1. Arora, M.P.*Chordata I. Himalaya Pub House*
2. Barnes, R. D. & Ruppert, E. E., (1994). Invertebrate Zoology. 6thEd. Brooks Cole.
3. Brusca, R. C. & Brusca, G. J. (2002). Invertebrates. 4th Ed. Sinauer Associates.
4. Chatterjee, A & Chakraborty C.S. Approach to a Text Book of Zoology Nirmala Library, Kolkata.

5. Dhami P.S and J.K. Dhami – Invertebrate Zoology – S. Chand and Co.
6. Jordan, E. L. & Verma, P. S. (2006). Invertebrate Zoology & Chordate Zoology.. S. Chand & Company Ltd. New Delhi.
7. Kardong,K.V.(2002).Vertebrates:Comparativeanatomy,functionevolution.Tata McGrawHill.
8. Kent,G. C.&Carr,R.K.(2001).ComparativeanatomyoftheVertebrates.9thEd. McGrawHill.
9. Kotpal, R.L., 1988 – 1992. (All Series) Protozoa, Porifera, Coelentereta, Annelida, Arthropoda, Mollusca, Echinodermata, – Rastogi Publications, Meerut – 250 002.
10. Romer,A.S.&Parsons,T.S.(1986).Thevertebratebody.6thEd.SaundersCollege Pub.
11. Ruppert E. E., Fox, R. & Barnes R. D. (2003). Invertebrate Zoology: a Functional Evolutionary Approach. 7th Ed. Brooks Cole.
12. Saxena, R.A. & Saxena, S. Coperative Anatomy of Vertebrates. Viva Publication.
13. Sinha, K. S., Adhikari, S., & Ganguly, B. B. Biology of Animals. Vol. I, II. New Central Book Agency. Kolkata.
14. Young,J. Z.(2004).The Life of Vertebrates. III Edition. Oxford university press.

6.2. GE P1–Animal Diversity Lab

ANIMAL DIVERSITY
PRACTICAL (CREDITS 2)

1. **Spot identification of the following specimens:**

Amoeba, *Euglena, Plasmodium, Paramecium, Sycon*, *Euspongia,, Obelia, Physalia, Aurelia, Tubipora, Metridium, Taenia solium,* Male and female *Ascaris lumbricoides, Aphrodite, Nereis, Pheretima, Hirudinaria, Palaemon, Cancer*, *Limulus*, *Palamnaeus, Scolopendra*, *Julus*, *Periplaneta, Apis, Chiton, Dentalium, Pila, Unio, Loligo, Sepia, Octopus, Pentaceros, Ophiura, Echinus, Cucumaria* and *Antedon, Balanoglossus, Herdmania, Branchiostoma, Petromyzon, Sphyrna, Pristis, Torpedo, Labeo, Exocoetus, Anguilla, Ichthyophis/Ureotyphlus, Salamandra, Bufo, Hyla, Chelone, Hemidactylus, Chamaeleon, Draco, Vipera, Naja, Crocodylus, Gavialis, Passer, Psittacula, Alcedo*, *Sorex*, *Pteropus*, *Funambulus, Suncus*

2. **Study of the following permanent slides: Transverse section of male and female *Ascaris***
3. **Identification of poisonous and non-poisonous snakes**
4. **An "animal album" containing photographs, cut outs, with appropriate write up about the above mentioned taxa. Different taxa/ topics may be given to different sets of students for this purpose.**

Examination Pattern:

Full Marks: 20

Spot identification (6 from Item 1, 3 each from non-chordate & chordate) (6 × 2)	= 12
Spot identification (1 each from item 2 & 3) (2 × 2)	= 04
Laboratory Note Book ----------	= 02
Animal Album ----------	= 02

Suggested Readings:

1. Chatterjee and Chatterjee: Practical Zoology
2. Ghosh, K.C. and Manna, B. (2015): Practical Zoology, New Central Book Agency, Kolkata

6.3. GE T2-Comparative Anatomy & Developmental Biology of Vertebrates

(CREDITS 4)

THEORY		**CLASS**
Unit-1	**Integumentary System** Derivatives of integument with reference to glands and digital tips	4
Unit-2	**Skeletal System** Evolution of visceral arches	3
Unit-3	**Digestive System** Brief account of alimentary canal and digestive glands	4
Unit-4	**Respiratory System** Brief account of gills, lungs, air sacs and swim bladder	5
Unit-5	**Circulatory System** Evolution of heart and aortic arches	4
Unit-6	**Urinogenital System** Evolution of kidney and urinogenital ducts	4
Unit 7	**Nervous System** Comparative account of brain	3
Unit-8	**Sense Organs** Classification of receptors, Brief account of auditory receptors in vertebrate	3
Unit-9	**Early Embryonic Development** Gametogenesis: Spermatogenesis and oogenesis with reference to mammals, vitellogenesis in birds; Fertilization: external (amphibians), internal (mammals), blocks to polyspermy; Early development of frog and chick (structure of mature egg and its membranes, patterns of cleavage, fate map, up to formation of gastrula); types of morphogenetic movements; Fate of germ layers; Neurulation in frog embryo.	12
Unit-10	**Late Embryonic Development** Implantation of embryo in humans, Formation of human placenta and functions, other types of placenta on the basis of histology; Metamorphic events in frog life cycle and its hormonal regulation.	10
Unit-11	**Control of Development** Fundamental processes in development (brief idea) – Gene activation, determination, induction, differentiation, morphogenesis, intercellular communication, cell movements and cell death	8

Suggested Readings:

1. Carlson, Bruce M (1996). Patten's Foundations of Embryology, McGraw Hill, Inc.
2. Gilbert, S. F. (2006). Developmental Biology, VIII Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.
3. Hilderbrand, M and Gaslow G.E. *Analysis of Vertebrate Structure*, John Wiley and Sons.
4. Jordon & Verma . Chordate Emcryp;gy. S. Chand Pub. New Delhi.
5. Kardong, K.V. (2005) *Vertebrates' Comparative Anatomy, Function and Evolution*. IV Edition. McGraw-Hill Higher Education.
6. Kent, G.C. and Carr R.K. (2000). *Comparative Anatomy of the Vertebrates*. IX Edition. The McGraw-Hill Companies.
7. Saxena, R.A. & Saxena, S. Coperative Anatomy of Vertebrates. Viva Publication.
8. Walter, H.E. and Sayles, L.P; *Biology of Vertebrates*, Khosla Publishing House.

6.4. GE P2– Comparative Anatomy & Developmental Biology of Vertebrates Lab

COMPARATIVE ANATOMY AND DEVELOPMENTAL BIOLOGY OF VERTEBRATES
PRACTICAL (CREDITS 2)

1. **Osteology:**
a) Identification of limb bones and girdles of *Columba* and *Cavia*
b) Mammalian skulls: *Cavia* and *Canis*.
2. Frog - Study of developmental stages - whole mounts and sections through permanent slides or photomicrographs – cleavage stages, blastula, gastrula, neurula, tail bud stage, tadpole external and internal gill stages.
3. Study of the different types of placenta- histological sections through permanent slides or photomicrographs.
4. Examination of gametes - frog/rat - sperm and ova through permanent slides or photomicrographs.

Examination Pattern:

Full Marks: 20

Spot identification (4 from Item from item 1)	(4 × 2)	= 8
Spot identification (5 from item 2, 3 &4)	(5 × 2)	= 10
Laboratory Note Book ----------		= 2

Suggested Readings:

1. Chatterjee and Chatterjee: Practical Zoology
2. Ghosh, K.C. and Manna, B. (2015): Practical Zoology, New Central Book Agency, Kolkata

6.5. GE T3 –Physiology and Biochemistry

Credits: 6

PHYSIOLOGY AND BIOCHEMISTRY
(CREDITS 4)

THEORY		**CLASS**
Unit-1	**Nerve and muscle** **1.** Structure of a neuron, Resting membrane potential, Graded potential, Origin of Action potential and its propagation in myelinated and non-myelinated nerve fibres. **2.** Ultra-structure of skeletal muscle, Molecular and chemical basis of muscle contraction.	8
Unit-2	**Digestion** Physiology of digestion in the alimentary canal; Absorption of carbohydrates, proteins, lipids	5
Unit-3	**Respiration** Pulmonary ventilation, Respiratory volumes and capacities, Transport of Oxygen and carbon dioxide in blood	5
Unit-4	**Excretion** Structure of nephron, Mechanism of Urine formation, Counter-current Mechanism	5
Unit-5	**Cardiovascular system** Composition of blood, Homeostasis, Structure of Heart, Origin and conduction of the cardiac impulse, Cardiac cycle	6
Unit-6	**Reproduction and Endocrine Glands** Physiology of male reproduction: hormonal control of spermatogenesis;	7

	Physiology of female reproduction: hormonal control of menstrual cycle. Structure and function of pituitary, thyroid, pancreas and adrenal	
Unit 7	**Carbohydrate: Structure and Metabolism**	8
	Introduction to Carbohydrates, Structure & Types of Carbohydrates, Isomerism, Introduction to Intermediary metabolism: Glycolysis, Krebs cycle, Pentose phosphate pathway, Gluconeogenesis, Electron transport chain	
Unit-8	**Lipid: Structure and Metabolism**	5
	Introduction to Lipids: Definitions; fats and oils; classes of lipids; Lipoproteins; Biosynthesis and β oxidation of palmitic acid	
Unit-9	**Protein: Structure and metabolism**	5
	Proteins and their biological functions, functions of amino acids, physicochemical properties of amino acids. Peptides – structure and properties; primary structure of protein, secondary, tertiary and quaternary structures. Transamination, Deamination and Urea Cycle.	
Unit-10	**Enzymes**	4
	Introduction, Classification of Enzymes, Mechanism of action, Enzyme Kinetics, Inhibition and Regulation	

SUGGESTED READINGS

1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). *Biochemistry*. VI Edn. W.H Freeman & Co.
2. Chatterjea, MN and Shinde, R (2012
3.) . A Textbook of Medical Biochemistry. 8th Edn. Jaypee Pub., N.Delhi
4. Das, D. (200). Biochemistry. Central Book Agency, Kolkata
5. Deb, A.C.
6. Guyton, A.C. and Hall, J.E. (2011). T*extbook of Medical Physiology*, XII Edition, Harcourt Asia Pvt. Ltd/ W.B. Saunders Company
7. Murray, R.K., Granner, D.K., Mayes, P.A. and Rodwell, V.W. (2009). *Harper'sIllustrated Biochemistry*. XXVIII Edition. Lange Medical Books/Mc Graw3Hill.
8. Nelson, D. L., Cox, M. M. and Lehninger, A.L. (2009). *Principles of Biochemistry*. IV Edition. W.H. Freeman and Co.
9. Sathyanarayana U. and Chakrapani, (2002). Biochemistry –Books & Allied (P) Ltd, Kolkata
10. Sembulingam and Sembulingam (2012) Essentials of Medical Physiology. 6th Edn. Jaypee Pub, New Delhi
11. Sherwood, L. (2013). Human Physiology from cells to systems. 8th Edn., Brooks & Cole
12. Tortora, G.J. and Derrickson, B.H. (2009). *Principles of Anatomy and Physiology*, XII Edition, John Wiley & Sons, Inc.
13. Widmaier, E.P., Raff, H. and Strang, K.T. (2008) *Vander's Human Physiology*, XI Edition., McGraw Hill

6.6. GE P3– Physiology and Biochemistry Lab

PHYSIOLOGY AND BIOCHEMISTRY
PRACTICAL (CREDITS 2)

1. Preparation of hemin crystals
2. Identification of permanent histological sections of mammalian pituitary, thyroid, pancreas, adrenal gland, small intestine, liver, lung, kidney
3. Qualitative tests to identify functional groups of carbohydrates in given solutions: Glucose (Benedict's test),Sucrose (Iodine test)
4. Quantitative estimation of total protein in given solutions by Lowry's method.
5. Study of activity of salivary amylase under optimum conditions

Examination Pattern:

Full Marks: 20

One question	(Item No. 1) ----------	(5×1) = 05
One question on qualitative test (From Item 3)	----------	(4×1) = 03
One question from quantitative test item no. 4		(6×1) = 06
Identification of histological section (From Item No. 2) any two		(2×2) = 04
Laboratory Note Book	----------	= 02

6.7. GE T4 –Genetics and Evolutionary Biology

Credits: 6

GENETICS AND EVOLUTIONARY BIOLOGY(CREDITS 4)

THEORY		**CLASS**
Unit-1	**Introduction to Genetics** Mendel's work on transmission of traits, Genetic Variation, Molecular basis of Genetic Information	3
Unit-2	**Mendelian Genetics and its Extension** Principles of Inheritance, Chromosome theory of inheritance, Incomplete dominance and co-dominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Sex-linked inheritance, Extra-chromosomal inheritance	8
Unit-3	**Linkage, Crossing Over and Chromosomal Mapping** Linkage and crossing over, Recombination frequency as a measure of linkage intensity, two factor and three factor crosses, Interference and coincidence, Somatic cell genetics - an alternative approach to gene mapping	9
Unit-4	**Mutations** Chromosomal Mutations: Deletion, Duplication, Inversion, Translocation, Aneuploidy and Polyploidy; Gene mutations: Induced versus Spontaneous mutations	7
Unit-5	**Sex Determination** Chromosomal mechanisms of sex determination; dosage compensation (human)	4
Unit-6	**History of Life** Origin of Life	2
Unit 7	**Introduction to Evolutionary Theories** Lamarckism, Darwinism, Neo-Darwinism	5
Unit-8	**Direct Evidences of Evolution** Types of fossils, Incompleteness of fossil record, Dating of fossils, Phylogeny of horse	5
Unit-9	**Processes of Evolutionary Change** Organic variations; Isolating Mechanisms; Natural selection (Example: Industrial melanism); Types of natural selection (Directional, Stabilizing, Disruptive), Artificial selection	9
Unit-10	**Species Concept** Biological species concept (Advantages and Limitations); Modes of speciation (Allopatric, Sympatric)	6
Unit-11	**Macro-evolution** Macro-evolutionary principles (example: Darwin's Finches)	5
Unit-12	**Extinction** Mass extinction (Causes, Names of five major extinctions, K-T extinction in detail), Role of extinction in evolution	6

SUGGESTED READINGS

1. Barton, N. H., Briggs, D. E. G., Eisen, J. A., Goldstein, D. B. and Patel, N. H. (2007). *Evolution*. Cold Spring, Harbour Laboratory Press.

2. Brooker, R.J. (2012). GeneticsL Analysis and Principles. 4th Edn. McGraw Hill.
3. Chattopadhyay, S. (2012). Life: Evolution, Adaptation, Ethology. 3rd Edn. Books and Allied, Kolkata.
4. Futuyma, D. J. (1997). *Evolutionary Biology*. Sinauer Associates.
5. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). *Principles of Genetics*. VIII Ed. Wiley India.
6. Griffiths,A.J.F.,Wessler,S.R.,Lewontin,R.C.andCarroll,S.B. (2010). Introduction to Genetic Analysis WH Freeman.
7. Hall, B. K. and Hallgrimsson, B. (2008). *Evolution*. IV Edition. Jones and Bartlett Publishers
8. Hyde, D. (2009). Introduction to Genetic Principle. McGraw Hill.
9. Kardong, K. (2004). An Introduction to Biological Evolution. McGraw Hill.
10. Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). *Concepts of Genetics*. X Edition. Benjamin Cummings.
11. Pierce, B.A. (2013). Genetics Essebtials: Concepts abd Connections. 2nd Edn. Freeman W.H.
12. Ridley, M. (2004). *Evolution*. III Edition. Blackwell Publishing
13. Russel, P. J. (2009). *Genetics- A Molecular Approach.* III Edition. Benjamin Cummings.
14. Snustad, D.P., Simmons,M.J. (2009). *Principles of Genetics*. V Edition. John Wiley and Sons Inc.

6.8. GE P4–Genetics and Evolutionary Biology Lab

GENETICS AND EVOLUTIONARY BIOLOGY

PRACTICAL (CREDITS 2)

1. Study of Mendelian Inheritance and gene interactions using suitable examples. Verify the results using Chi-square test.
2. Study of Linkage, recombination, gene mapping using the data.
3. Study of Human Karyotypes; normal and abnormal (Turner's, Down's and Klinefelter syndrome) from photographs.
4. Study of fossil evidences from plaster cast models /pictures
5. Study of homology and analogy from suitable specimens/ pictures
6. Charts:

a) Phylogeny of horse with diagrams/ cut outs of limbs and teeth of horse ancestors
b) Darwin's Finches with diagrams/ cut outs of beaks of different species

7. Visit to any Zoological Museum and submission of report

Examination Pattern:

Full Marks: 20

One question from Item No. 1	----------	(5 × 1) = 05
One question from Item No. 2	----------	(5× 1) = 05
Identification any two from Item No. 3, 4, 5 & 6		(3 × 2) = 06
Excursion Report	_____	= 02
Laboratory Note Book ----------		= 02