Zoology Syllabus and Scheme of Examination

for

B.Sc. Certificate Course/ B.Sc. Diploma/B.Sc. Degree/ B.Sc. Hons. /Research Degree/M.Sc.

Under National Education Policy (NEP) System

DEPARTMENT OF ZOOLOGY
INDIRA GANDHI NATIONAL TRIBAL UNIVERSITY
(A Central University)
Amarkantak -484887(M.P.)
India

DEPARTMENT OF ZOOLOGY
INDIRA GANDHI NATIONAL TRIBAL UNIVERSITY, AMARKANTAK,
LALPUR, MADHAY PRADESH - 484887
(A Central University Established by an act of the Parliament)

Minutes of the Meeting of Board of Studies, Zoology Department

Date: 08/09/2022 Time: 11:00 am

Venue: Virtual/online meeting of Board of Studies (BoS)

As per the official notification Ref. number-IGNTU/2022/A&R/55 dated 08/08/2022 regarding to the Board of Studies of Department of Zoology, the following Members were present in Virtual meeting:

1. Dr Rekha Rani Head, Department of Zoology — Chairperson & Convenor
2. Prof. Poonam Sharma, Professor, Member — Member
Department of Zoology
3. Dr. Desh Deepak Chaudhary, Assistant Professor, Member — Member
Department of Zoology
4. Prof. Naveen Kumar Sharma, Professor — Member
Department of Botany
5. Prof. Bhumi Nath Tripathi, Head, Member — Member
Department ofBiotechnology,
6. Prof. Veena Batra Kushwaha, Head, Department of Member — Member
Zoology, Deen Dayal Upadhyaya Gorakhpur
University, Gorakhpur
7. Prof. Himendra Bharti, Former Head, Member — Member
Department of Zoology & Environmental Science,
Punjabi University, Patiala, Punjab

8/9/22
8/9/22

Agenda of the Meeting:

1. Finalization of UG&PG Syllabus asper National Educational Policy (NEP- 2020)
2. Inclusionof the Discipline Specific Elective -2 course work (DSE-2) with Paper name Fish and fisheries in PhD.

Agenda 1: Finalization of UG&PG Syllabus as per National Educational Policy (NEP-2020)

1. The syllabus of the values added course for the semester from Ist to VIth as per core course structure as circulated by the University is adopted.
2. Subject experts suggested that interdisciplinary major course may be adopted after the minor changes but as per the internal member's view, students of interdisciplinary major coursesmay opt the Zoology as core subject in future to pursuing research degree or the Ph.D.
3. First and Second semesters of UG syllabus as per NEP adopted; rest of the semester's syllabus adopted after minor changes if any.
4. Some minor corrections have made in the mentioned semesters as:

8/9/2022 08/9/2022
08.09.2022
08/09/2022

a. In seventh semester paper name Ecology and Toxicology replaced with paper title Ecology (ZOODMT-704) in which Unit-V now considered as pollution and acts.
b. In ninth semester Biosystematics and Quantitative Biology paper code ZOODMP-906 a laboratory exercise Shannon Winner index added.
c. In ninth semester, UNIT-V of major electivepaper Molecular Techniques (ZOODET-904), some doubling topics have removed (ELISA, FACS, South Western). Same accepted by the BoS members.

Agenda 2: Inclusion of the Discipline Specific Elective -2 course work (DSE-2) with Paper name Fish and fisheries in PhD.

5. One more Discipline Specific Elective -2 (DSE-2) course work with paper name Fish& Fisheriesand code PZRS-111 is included in the Ph.D. syllabus. The same approved by BoS.
6. The rest of the PhD course work syllabus for Zoology as discussed in earlier BoS meeting remain same. (That is DSE-2 course, Toxicology, Hormones and Diseases, Neurobiology, Genetics and Disease Biology, Behaviour Ecology and Insect Biocontrol, Aquatic Pollution).
7. The internalBoScommittee members shall be eligible to made up 20 % minor changes in the UG, PG & PhD syllabus. The same is accepted by the members.

BoS Members approved the agenda 1 &2 (From 1 to 7)and the same is submitted for the further approval of the Competent Authority.

The meeting ended with vote of thanks by the Chairman

08.09.2022 — Dr. Desh Deepak Chaudhary (Member)

08/09/2022 — Prof. Poonam Sharma (Member)

on leave — Prof. Bhumi Nath Tripathi (Member)

08/09/2022 — Prof. Naveen Kumar Sharma (Member)

8/9/22 — Prof. Himendra Bharti (Subject Expert)

8/9/22 — Prof. Veena Batra Kushwaha (Subject Expert)

08/9/2022 — Dr. Rekha Rani (Chairman)

Course Structure of UG, PG & PhD Programme as per National Education Policy (NEP 2020) & UGC
(Approved from Academic Council of IGNTU)

Course Structure of the academic program with multiple entry and exit and credit distribution as per UGC guideline (National Education Policy)

B.Sc. Semester	Disciplinary Major (40-56)	Minor (24)		Interdisciplinary Major (40-56)	Vocational (12)	Value added Course (Qualifying only) (University level course)	Total Credits	Entry/Exit Option
		Minor 1	**Minor 2**					
1st	4+2	2	2	4+2	2+2	English Communication	20	Bachelor Entry
2nd	4+2	2	2	4+2	2+2	Computer Studies	40	**Certificate Exit**
3rd	4+2	2	2	4+2	2+2	Environmental Studies	60	Bachelor Entry
4th	4+2	2	2	4+2	2+2	Disaster Management	80	**Diploma Exit**
5th	4+2 without internship Or 4+2+4 with Internship	2	2	4+2 without internship Or 4+2+4 with Internship	-	Creative Expression I (opt any one): Performing (Sport, Dance, Music, etc.)	100	Bachelor Entry
6th	4+4+2+2 Or 4	2	2	4+4+2+2 Or 4	-	Creative Expression II (opt any one): Painting, Craft etc.	120	**Bachelor Degree*** Exit
7th	4+4+2+2+2 Or 4+2	-	-	4+4+2+2+2 Or 4+2	-	-	140	Bachelor Entry/ PG Entry
8th	**Research/Dissertation/Project 20**						160	**Bachelor Hons/Res.** Degree** Exit
The four-year UG Programme should comprise 1 disciplinary majors (40-50 credits), 2. Multi/Interdisciplinary Majors (40-50 credits), 3. Disciplinary/Interdisciplinary Minors (20-28 credits), 4. Vocational (12-18) and field visit/Internship/Community Engagement & service (24-32 credits). Students will choose any one option for disciplinary/inter-disciplinary majors but not the same option for both.								
9th	**20** (4+4+4+4+2+2)						180	PG Continuing
10th	**20** (4+4+4+4+2+2)						**200**	**One Year/Two Years Masters**
	Doctoral Degree/PhD Programme					Minimum Credits as per Course work and thesis with publications		

Department of Zoology
Course Structure: B.Sc. & M.Sc. Zoology Program (National Education Policy)

Sem.	Value-Based	Disciplinary			Inter-Disciplinary			Vocational		Credits	Entry/Exit Options
		Major		Minor	Major		Minor				
		Theory (Credit-4)	Practical (Credit-2)	Theory (Credit-2)	Theory (Credit-4)	Practical (Credit-2)	Theory (Credit-2)	Theory (Credit-2)	Practical (Credit -2)		
1	English communication **ZOOVB-100**	Animal Diversity **ZOODMT-101**	Animal Diversity **ZOODMP-107**	Apiculture **ZOODMI-102**	Animal Diversity **ZOOIDMT-103**	Animal Diversity **ZOOIDMP-108**	Apiculture **ZOOIDMI-104**	Fish and Fisheries **Paper name** – Ichthyology **ZOOVOT-105**	Fish and Fisheries **Paper name** – Ichthyology **ZOOVOP-106**	20	Entry
2	Computer Studies **ZOOVB-200**	Comparative anatomy of Vertebrates and Developmental Biology **ZOODMT -201**	Comparative anatomy of Vertebrates and Developmental Biology **ZOODMP-207**	Integrated Pest Management **ZOODMI-202**	Comparative anatomy of Vertebrates and Developmental Biology **ZOOIDMT-203**	Comparative anatomy of Vertebrates and Developmental Biology **ZOOIDMP-208**	Integrated Pest Management **ZOOIDMI-204**	Fish and Fisheries **Paper name** – Pisciculture **ZOOVOT -205**	Fish and Fisheries **Paper name** – Pisciculture **ZOOVOP -206**	20	Exit (Certificate)
3	Environmental Studies **ZOOVB-300**	Physiology and Biochemistry **ZOODMT-301**	Physiology and Biochemistry **ZOODMP-307**	Food Nutrition and Health **ZOODMI-302**	Physiology and Biochemistry **ZOOIDMT-303**	Physiology and Biochemistry **ZOOIDMP-308**	Food Nutrition and Health **ZOO IDMI-304**	Fish and Fisheries **Paper name** – Maintenance of Fish Pond, Preservation Processing and Disease in Fish **ZOOVOT -305**	Fish and Fisheries **Paper name** – Maintenance of Fish Pond, Preservation Processing and Disease in Fish **ZOOVOP-306**	20	Entry
4	Disaster Management	Genetics and Evolutionary Biology	Genetics and Evolutionary Biology	Lac Culture	Genetics and Evolutionary Biology	Genetics and Evolutionary Biology	Lac Culture	Fish and Fisheries **Paper name** – Aquaculture Practices, Transportation	Fish and Fisheries **Paper name** – Aquaculture Practices, Transportation	20	Exit (Diploma)

	ZOOVB-400	**ZOODMT-401**	**ZOODMP-407**	**ZOODMI-402**	**ZOOIDMT-403**	**ZOOIDMP-408**	**ZOOIDMI-404**	Marketing and Specialized Organs in Fishes **ZOOVOT 405**	Marketing and Specialized Organs in Fishes **ZOOVOP 406**		
5	Creative Expression I (opt any one): (Performing arts e.g. Sports, Dance, Music) **ZOOVB-500**	Tools and Techniques of Biology **ZOODMT-501**	Tools and Techniques of Biology **ZOODMP-507**	Research Methodology **ZOODMI-502**	Tools and Techniques of Biology **ZOOIDMT-503**	Tools and Techniques of Biology **ZOOIDMP-508**	Research Methodology **ZOOIDMI-504**	-------	-------	20	Entry
		ZOOFV/I/CE-505 Field Visit/Internship/Community Engagement **(4)**			**ZOOFV/I/CE-506** Field Visit/Internship/Community Engagement **(4)**						
6	Creative Expression – II (opt any one): (Performing arts e.g. Sports, Dance, Music) **ZOOVB-600**	Molecular Biology **ZOODMT-601**	Molecular Biology **ZOODMP-607**	Medical Diagnostic **ZOODMI-602**	Molecular Biology **ZOOIDMT-604**	Molecular Biology **ZOOIDMP-608**	Medical Diagnostic **ZOOIDMI-605**	-------	--------	20	Exit (Degree)
		Epidemiology and Infectious Disease **ZOODMT-603**	Internship **ZOODMP-609**	----------							

Note: No interdisciplinary subject, Value-Based Paper will be taught after 6 semester

	Major Theory (Credit-4)	**Major Practical (Credit-2)**	**Major Theory (Credit-4)**	**Major Practical (Credit-2)**	**Major/Elective Theory (Credit-4)**	**Major/Elective Theory (Credit-4)**		
7	Immunology **ZOODMT-701**	Immunology **ZOODMP-705**	Cell Biology **ZOODMT-702**	Cell Biology **ZOODMP-706**	Animal Biotechnology **ZOODMT-703**	Ecology and Toxicology **ZOODMT-704**	20	Entry
8	Research Internship ZOOD-801 Dissertation (Four Components carrying 20 Credits)						20	Exit (Research

								Degree)
	ZOOD-801A: Lab Work/Field Work/Field Survey/Industrial Visit/Institutional Visit/Data Collection/Internship etc.						4	
	ZOOD-801B: Pre-Submission Presentation						4	
	ZOOD-801C: Report Writing/Write-up/Dissertation Report						8	
	ZOOD-801D: Viva Voce						4	
9	Non-Chordates **ZOODMT-901**	Non-Chordates+ Biosystematics and Quantitative Biology **ZOODMP-905**	Biosystematics and Quantitative Biology **ZOODMT-902**	Cell and Molecular Biology+ Molecular Techniques **ZOODMP-906**	Cell and Molecular Biology **ZOODET-903**	Molecular Techniques **ZOODET-904**	20	Entry
10	Chordates **ZOODMT-1001**	Chordates+ Microbiology and Immunology **ZOODMP-1005**	Microbiology and Immunology **ZOODMT-1002**	Biochemistry+ Molecular Endocrinology **ZOODMP-1006**	Biochemistry **ZOODET-1003**	Molecular Endocrinology **ZOODET-1004**	20	PG Exit
	Doctoral Degree/Ph.D. Programme						Minimum Credits as per Course work and thesis with publications	

B. Sc. Zoology (NEP)
FIRST SEMESTER
Course Structure

Paper Category	Title of the Paper	Credits	Contact Hrs./Week	Maximum Marks	Sessional Marks (40)		End Semester Examination Marks	Min. Pass Marks in End. Sem. Exam.
					10x2 Test Average	20 (10 Assignment +10 Attendance)		
Disciplinary Major	Animal Diversity **ZOODMT-101**	4	4 Hrs.	100	20	20	60	24
Disciplinary Minor	Apiculture **ZOODMI-102**	2	2 Hrs.	50	10	10	30	12
Interdisciplinary Major	Animal Diversity **ZOOIDMT-103**	4	4 Hrs.	100	20	20	60	24
Interdisciplinary Minor	Apiculture **ZOOIDMI-104**	2	2 Hrs.	50	10	10	30	12
Vocational	Fish and Fisheries **Paper name** – Ichthyology **ZOOVOT-105**	2	2 Hrs.	50	10	10	30	12
Laboratory Exercise Disciplinary Major	Animal Diversity **ZOODMP-107**	2	2 Hrs.	50	-	-	50	20
Laboratory Exercise Interdisciplinary Major	Animal Diversity **ZOOIDMP-108**	2	2 Hrs.	50	-	-	50	20
Laboratory Exercise Vocational	Fish and Fisheries **Paper name** – Ichthyology **ZOOVOP-106**	2	2 Hrs.	50	-	-	50	20
Value Added Course	English communication **ZOOVB-100**	-	2 Hrs.	50	-	-	50	20
Total		**20**	**-**	**550**	**140**		**410**	**164**

Entry

B. Sc. Zoology
FIRST SEMESTER

Semester I	Disciplinary Major ANIMAL DIVERSITY ZOODMT-101	Credit	4
		Marks	100 (60+40)

COURSE CONTENT/SYLLABUS

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

Unit-2 **Phylum Porifera:** General characters and classification up to classes; Canal Systemin *Sycon.*

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

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

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

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

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

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

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

Unit-10 **Protochordates:** General features and Phylogeny of Protochordata.

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

Unit-12 **Pisces:** General features and Classification up to orders; Osmoregulation.

Unit-13 **Amphibia:** General features and Classification up to orders; Parental care.

Unit-14 **Reptiles:** General features and Classification up to orders; Poisonous and non-poisonous snakes, Biting mechanism in snakes.

Unit-15 **Aves:** General features and Classification up to orders; Flight adaptations.

Unit-16 **Mammals:** Classification up to orders; Origin of mammals.

Note: *Classification of Unit 1-10 to be followed from "Barnes, R.D. (1982). Invertebrate Zoology, V Edition".*

SUGGESTED READINGS

1. Barnes, R.D. (1982). *Invertebrate Zoology*, V Edition. Holt Saunders International Edition.
2. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). *The Invertebrates: A New Synthesis*, III Edition, Blackwell Science
3. Barrington, E.J.W. (1979). *Invertebrate Structure and Functions*. II Edition, E.L.B.S. and Nelson
4. Young, J. Z. (2004). *The Life of Vertebrates*. III Edition. Oxford university press.
5. Pough H. *Vertebrate life,* VIII Edition, Pearson International.
6. Hall B.K. and Hallgrimsson B. (2008). *Strickberger's Evolution*. IV Edition. Jones and Bartlett Publishers Inc.

Laboratory Exercise **Disciplinary Major** **ANIMAL DIVERSITY** **ZOODMP-107**	**Credit – 2** **Marks – 50**

- **Kingdom Protista:** *Amoeba*, *Euglena, Plasmodium, Paramecium.*
- **Phylum Porifera:** *Sycon* (including T.S. and L.S.), *Hyalonema,* and *Euplectella.*
- **Phylum Cnidaria:** *Obelia, Physalia, Aurelia, Tubipora, Metridium.*
- **Phylum Platyhelminthes:** *Taenia solium* and Study of its life history stages.
- **Phylum Nemathelminthes:** Male and female *Ascaris lumbricoides.*
- **Phylum Annelida:** *Aphrodite, Nereis, Pheretima, Hirudinaria.*
- **Phylum Arthropoda:** *Palaemon, Cancer*, *Limulus*, *Palamnaeus, Scolopendra*, *Julus*, *Periplaneta*, *Apis.*
- **Phylum Mollusca:** *Chiton, Dentalium, Pila, Unio, Loligo, Sepia, Octopus.*
- **Phylum Echinodermata:** *Pentaceros, Ophiura, Echinus, Cucumaria* and *Antedon.*
- **Protochordata:** *Balanoglossus, Herdmania, Branchiostoma.*
- **Agnatha:** *Petromyzon.*
- **Pisces:** *Sphyrna, Pristis, Torpedo, Labeo, Exocoetus, Anguilla.*
- **Amphibia:** *Ichthyophis/Ureotyphlus, Salamandra, Bufo, Hyla.*
- **Reptilia:** *Chelone, Hemidactylus, Chamaeleon, Draco, Vipera, Naja, Crocodylus, Gavialis*Key for Identification of poisonous and non-poisonous snakes.
- **Aves:** Study of six common birds from different orders.
- **Mammalia:** *Sorex*, Bat, *Funambulus, Loris.*

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. These need not be repeated as drawings by the album maker.

Semester I	Disciplinary Minor APICULTURE ZOODMI-102	Credit	2
		Marks	50 (30+20)

COURSE CONTENT/SYLLABUS

Unit-1 Biology of Bee:

Introduction, history, classification and life cycle, social organization.

Unit-2 Rearing and Processing of Bee

Artificial bee rearing (Apiary), Bee hives: Newton and Langstroth, methods of extraction of honey, composition of honey, processing and preservation.

Unit-3 Diseases and Enemies of Honey Bee:

Bee diseases and natural enemies and its IPM**,** preventive measures.

Unit-4 Economic Importance

Apiculture industries, products and its uses, role in pollination, Carrier opportunities.

SUGGESTED READINGS

1. NPCS Board of Consultants & Engineers (2015). The complete book on Bee keeping and Honey Processing. (2nd Revised Edition).
2. Hepburn R. and Radroff Sarah E. (2011) Honeybees of Asia
3. Mishra R.C. (2013). Honeybees and their management in India.
4. Mc Huge T. (2017). How Honey is processed. Food technology magazine article.

Semester I	Interdisciplinary Major ANIMAL DIVERSITY ZOOIDMT-103	Credit	4
		Marks	100 (60+40)

COURSE CONTENT/SYLLABUS

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

Unit-2 **Phylum Porifera:** General characters and classification up to classes; Canal Systemin *Sycon.*

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

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

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

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

Unit-7 **Phylum Arthropoda:** General characters and classification up to classes; Vision in *Arthropoda*, Metamorphosis in insects.

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

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

Unit-10 **Protochordates:** General features and Phylogeny of *Protochordata.*

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

Unit-12 **Pisces:** General features and Classification up to orders; Osmoregulation.

Unit-13 **Amphibia:** General features and Classification up to orders; Parental care.

Unit-14 **Reptiles:** General features and Classification up to orders; Poisonous and non-poisonous snakes, Biting mechanism in snakes.

Unit-15 **Aves:** General features and Classification up to orders; Flight adaptations.

Unit-16 **Mammals:** Classification up to orders; Origin of mammals.

Note: *Classification of Unit 1-10 to be followed from "Barnes, R.D. (1982). Invertebrate Zoology, V Edition".*

SUGGESTED READINGS

1. Barnes, R. D. (1982). *Invertebrate Zoology*, V Edition. Holt Saunders International Edition.
2. Barnes, R. S. K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). *The Invertebrates: A New Synthesis*, III Edition, Blackwell Science
3. Barrington, E.J.W. (1979). *Invertebrate Structure and Functions*. II Edition, E.L.B.S. and Nelson
4. Young, J. Z. (2004). *The Life of Vertebrates*. III Edition. Oxford university press.
5. Pough H. *Vertebrate life,* VIII Edition, Pearson International.
6. Hall B.K. and Hallgrimsson B. (2008). *Strickberger's Evolution*. IV Edition. Jones and Bartlett Publishers Inc.

Laboratory Exercise **Interdisciplinary Major** **ANIMAL DIVERSITY** **ZOOIDMP-108**	**Credit - 2** **Marks - 50**

- **Kingdom Protista:** *Amoeba*, *Euglena, Plasmodium, Paramecium.*
- **Phylum Porifera:** *Sycon* (including T.S. and L.S.), *Hyalonema,* and *Euplectella.*
- **Phylum Cnidaria:** *Obelia, Physalia, Aurelia, Tubipora, Metridium.*
- **Phylum Platyhelminthes:** *Taenia solium* and Study of its life history stages.
- **Phylum Nemathelminthes:** Male and female *Ascaris lumbricoides.*
- **Phylum Annelida:** *Aphrodite, Nereis, Pheretima, Hirudinaria.*
- **Phylum Arthropoda:** *Palaemon, Cancer*, *Limulus*, *Palamnaeus, Scolopendra*, *Julus*, *Periplaneta*, *Apis.*
- **Phylum Mollusca:** *Chiton, Dentalium, Pila, Unio, Loligo, Sepia, Octopus.*
- **Phylum Echinodermata:** *Pentaceros, Ophiura, Echinus, Cucumaria* and *Antedon.*
- **Protochordata:** *Balanoglossus, Herdmania, Branchiostoma.*
- **Agnatha:** *Petromyzon.*
- **Pisces:** *Sphyrna, Pristis, Torpedo, Labeo, Exocoetus, Anguilla.*
- **Amphibia:** *Ichthyophis/Ureotyphlus, Salamandra, Bufo, Hyla.*
- **Reptilia:** *Chelone, Hemidactylus, Chamaeleon, Draco, Vipera, Naja, Crocodylus, Gavialis* Key for Identification of poisonous and non-poisonous snakes.
- **Aves:** Study of six common birds from different orders.
- **Mammalia:** *Sorex*, Bat, *Funambulus, Loris.*

*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. These need not be repeated as drawings by the album maker.*

Semester I	Interdisciplinary Minor APICULTURE ZOOIDMI-104	Credit	2
		Marks	50 (30+20)

COURSE CONTENT/SYLLABUS

Unit-1 Biology of Bee:

Introduction, history, classification and life cycle, social organization.

Unit-2 Rearing and Processing of Bee

Artificial bee rearing (Apiary), Bee hives: Newton and Langstroth, methods of extraction of honey, composition of honey, processing and preservation.

Unit-3 Diseases and Enemies of Honey Bee:

Bee diseases and natural enemies and its IPM**,** preventive measures.

Unit-4 Economic Importance

Apiculture industries, products and its uses, role in pollination, Carrier opportunities.

SUGGESTED READINGS

1. NPCS Board of Consultants & Engineers (2015). The complete book on Bee keeping and Honey Processing. (2nd Revised Edition).
2. Hepburn R. and Radroff Sarah E. (2011) Honeybees of Asia
3. Mishra R.C. (2013). Honeybees and their management in India.
4. Mc Huge T. (2017). How Honey is processed. Food technology magazine article.

Semester I	Vocational FISH AND FISHERIES Paper name - ICHTHYOLOGY ZOOVOT-105	Credit	2
		Marks	50 (30+20)

COURSE CONTENT/SYLLABUS

Unit-1 Introduction about fishes and Classification of bony Fishes as proposed by L. S. Berg.

Unit-2 Knowledge about indigenous and exotic major carps viz, *Labeo rohita, Catla catla*, *Cirrhinus mrigala*, Grass carp, Silver carp, and Common carp.

Unit-3 Food fishes of India and Economic importance of fishes.

Unit-4 Larvivorus fishes and their role in control a human diseases.

Unit-5 Common Aquarium fishes and their food preference (Goldfish, Zebrafish, Angelfish, Tiger barb, Dwarf gourami.

SUGGESTED READINGS

1. An Introduction to Fishes: S.S. Khanna.
2. Introduction of Aquaculture: Landua M.
3. Fish & Fisheries: K. Pandey and J.P. Shukla
4. Fish and Fisheries of India: Jhingran VG.
5. Pond Aquaculture Water Quality Management: Claude E. Boyd & C.S. Tucker.

Laboratory Exercise VOCATIONAL ZOOVOP-106	Credit - 2
	Marks - 50

- Identification of fishes and their diagnostic features - *Notopterus notopterus, Notopterus chitala, Hilisa ilisha, Labeo rohita, Labeo calbasu, Mystus (M.) menoda, Clarias batrachus, Channa punctatus, Channa marulius, Gross carp, Silver carp, Common carp.*
- Study of fins namely - Dorsal fin, Ventral fin, Pectoral fin, Anal fin, and Caudal fin for identification.
- A salient feature of Larvivorous fishes namely *Gambusia affinis, Colisa fasciatus, Esomus danricus, Chanda nama.*
- Study of Aquarium fishes namely *Goldfish, Zebrafish, Angelfish, Tiger barb, Colisa lalia.*

B.Sc. Zoology

SECOND SEMESTER (COURSE STRUCTURE) ** Exit option with Course Certificate

Paper Category	Title of the Paper	Credits	Contact Hrs./Week	Maximum Marks	Sessional Marks 40		End Semester Examination Marks	Min. Pass Marks in End. Sem. Exam.
					10x2 Test Average	20 (10 Assignment +10 Attendance)		
Disciplinary Major	Comparative anatomy of Vertebrates and Developmental Biology **ZOODMT-201**	4	4 Hrs.	100	20	20	60	24
Disciplinary Minor	Integrated Pest Management **ZOODMI-202**	2	2 Hrs.	50	10	10	30	12
Interdisciplinary Major	Comparative anatomy of Vertebrates and Developmental Biology **ZOOIDMT-203**	4	4 Hrs.	100	20	20	60	24
Interdisciplinary Minor	Integrated Pest Management **ZOOIDMI-204**	2	2 Hrs.	50	10	10	30	12
Vocational	Fish and Fisheries **Paper name** – Pisciculture **ZOOVOT-205**	2	2 Hrs.	50	10	10	30	12
Laboratory Exercise Disciplinary Major	Comparative anatomy of Vertebrates and Developmental Biology **ZOODMP-207**	2	2 Hrs.	50	-	-	50	20
Laboratory Exercise Interdisciplinary Major	Comparative anatomy of Vertebrates and Developmental Biology **ZOOIDMP-208**	2	2 Hrs.	50	-	-	50	20
Laboratory Exercise Vocational	Fish and Fisheries **Paper name** – Pisciculture **ZOOVOP206**	2	2 Hrs.	50	-	-	50	20
Value Added Course	Computer Studies **ZOOVB-200**	-	2 Hrs.	50	-	-	50	20
Total		**20**		**550**	**140**		**410**	**164**

**** Exit option with Course Certificate**

B.Sc. Zoology (NEP)
SECOND SEMESTER

Semester II	Disciplinary Major COMPARATIVE ANATOMY OF VERTEBRATES AND DEVELOPMENTAL BIOLOGY ZOODMT-201	Credit	4
		Marks	100 (60+40)

COURSE CONTENT/SYLLABUS

PART A - COMPARATIVE ANATOMY OF VERTEBRATES

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

Unit-2 **Skeletal System:** Evolution of visceral arches.

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

Unit-4 **Respiratory System:** Gills, lungs, air sacs and swim bladder.

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

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

Unit-7 **Nervous System:** Comparative account of brain.

Unit-8 **Sense Organs:** Types of receptors.

PART B – DEVELOPMENTAL BIOLOGY

Unit-1 **Early embryonic development:**

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

Unit-2 **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.

Unit-3 **Control of Development**

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

SUGGESTED READINGS

1. Kardong, K.V. (2005) Vertebrates' Comparative Anatomy, Function and Evolution. IV Edition. McGraw-Hill Higher Education.
2. Kent, G.C. and Carr R.K. (2000). Comparative Anatomy of the Vertebrates. IX Edition. The McGraw-Hill Companies.
3. Weichert C.K and William Presch (1970). Elements of Chordate Anatomy, Tata McGraw Hills
4. Hilderbr and, M and Gaslow G.E. Analysis of Vertebrate Structure, John Wiley and Sons.
5. Walter, H.E. and Sayles, L.P; Biology of Vertebrates, Khosla Publishing House.
6. Gilbert, S. F. (2006). Developmental Biology, VIII Edition, Sinauer Associates, Inc.,

Publishers, Sunderland, Massachusetts, USA.
7. Balinsky, B.I. (2008). An introduction to Embryology, International Thomson Computer Press.
8. Carlson, Bruce M (1996). Patten's Foundations of Embryology, McGraw Hill, Inc.

Laboratory Exercise **Disciplinary Major** **COMPARATIVE ANATOMY OF VERTEBRATES AND DEVELOPMENTAL BIOLOGY** **ZOODMP-207**	**Credit – 2** **Marks – 50**

A. COMPARATIVE ANATOMY:

- **Osteology:**
  a. Axial and Appendicular skeleton of Fowl and Varanus.
  b. Carapace and plastron of turtle /tortoise.
  c. Mammalian skulls-One herbivorous and one carnivorous animal.
- Dissection /demonstration of cranial nerves, afferent and efferent arteries in fish.
- Glycerine and Permanent preparation of placoid scales and study of permanent slides of different types of fish scales.
- Study of types of beak, feathers and feet of birds.
- Study of histology of various organs by prepared slides.

B. DEVELOPMENTAL BIOLOGY:

- **Frog** – Study of developmental stages – whole mounts and sections through permanent slides – cleavage stages, blastula, gastrula, neurula, tail bud stage, tadpole-external and internal gill stages.
- **Study of the different types of placentae**- histological sections through permanent slides or photomicrographs.
- **Study of placental development in humans by ultrasound scans.**
- **Examination of gametes** – frog/rat – sperm and ova through permanent slides orphotomicrographs.

Semester II	Disciplinary Minor INTEGRATED PEST MANAGEMENT ZOODMI-202	Credit	2
		Marks	50 (30+20)

COURSE CONTENT/SYLLABUS

Unit-1 Basics of insect, Pest and its categories:

Introduction of insect, diversity and nature, insect classification based on economic importance, insect as a pest, types of pests, methods of samplings and surveillance of pest.

Unit-2 IPM, concepts and ecological components:

Principle of pest management, definition, history, concept, Component of Integrated pest Management (IPM), ecological methods of pest management, legal approaches, Host plant resistance and biological components of IPM.

Unit-3 Pest management through botanicals, behavioural modification and radiation technology:

Pest management by modifying insect behaviour and development, insect growth regulator; repellents attractants and inhibitors, Sterile insect technique. Biological control; using predators, parasitoids and microbes and chemical control.

Unit-4 Pest management through innovative approaches:

Integration of different IPM tools and techniques; pros and cons. Adoption of IPM; Successful implementation of IPM in cereals (paddy), pulses and commercial crops (cotton and sugarcane) oilseed, vegetable crops and fruit crops.

SUGGESTED READINGS

1. Chapman RF. 1998. The Insects: Structure and Function. Cambridge Univ. Press, Cambridge.
2. David BV & Ananthkrishnan TN. 2004. General and Applied Entomology. Tata-McGraw Hill, New Delhi.
3. Duntson PA. 2004. The Insects: Structure, Function and Biodiversity. Kalyani Publ., New Delhi.
4. Richards OW & Davies RG. 1977. Imm's General Text Book of Entomology. 10th Ed. Chapman & Hall, London.
5. Koul O, Dhaliwal GS & Curperus GW. 2004. Integrated Pest Management Potential, Constraints and Challenges. CABI, London.
6. Larry P. Pedigo, Jack E Rechcigl, Nancy A Rechcigl Entomology and Pest Management.
7. Insect Pest Management: Techniques for Environmental Protection . CRC Press. Library Call Number: SB933.3.I53 2000
8. Gimme H Walter . Insect Pest Management and Ecological Research. - Cambridge University Press. Library Call Number: SB931.W25 2003
9. Dhaliwal GS & Arora R. 2003. Integrated Pest Management – Concepts and Approaches. Kalyani Publ., New Delhi.

Semester II	Interdisciplinary Major COMPARATIVE ANATOMY OF VERTEBRATES AND DEVELOPMENTAL BIOLOGY ZOOIDMT-203	Credit	4
		Marks	100 (60+40)

COURSE CONTENT/SYLLABUS

PART A – COMPARATIVE ANATOMY OF VERTEBRATES

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

Unit-2 **Skeletal System:** Evolution of visceral arches.

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

Unit-4 **Respiratory System:** Gills, lungs, air sacs and swim bladder.

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

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

Unit-7 **Nervous System:** Comparative account of brain.

Unit-8 **Sense Organs:** Types of receptors.

PART B – DEVELOPMENTAL BIOLOGY

Unit-1 **Early embryonic development:**

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

Unit-2 **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.

Unit-3 **Control of Development**

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

SUGGESTED READINGS

1. Kardong, K.V. (2005) Vertebrates' Comparative Anatomy, Function and Evolution. IV Edition. McGraw-Hill Higher Education.
2. Kent, G.C. and Carr R.K. (2000). Comparative Anatomy of the Vertebrates. IX Edition. The McGraw-Hill Companies.
3. Weichert C.K and William Presch (1970). Elements of Chordate Anatomy, Tata McGraw Hills
4. Hilderbr and, M and Gaslow G.E. Analysis of Vertebrate Structure, John Wiley and Sons.
5. Walter, H.E. and Sayles, L.P; Biology of Vertebrates, Khosla Publishing House.
6. Gilbert, S. F. (2006). Developmental Biology, VIII Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.
7. Balinsky, B.I. (2008). An introduction to Embryology, International Thomson Computer Press.
8. Carlson, Bruce M (1996). Patten's Foundations of Embryology, McGraw Hill, Inc.

Laboratory Exercise **Interdisciplinary Major** **COMPARATIVE ANATOMY OF VERTEBRATES AND DEVELOPMENTAL BIOLOGY** **ZOOIDMP-208**	**Credit - 2** **Marks - 50**

A. COMPARATIVE ANATOMY:

- **Osteology:**
  a. Axial and Appendicular skeleton of Fowl and Varanus.
  b. Carapace and plastron of turtle /tortoise.
  c. Mammalian skulls-One herbivorous and one carnivorous animal.
- Dissection /demonstration of cranial nerves, afferent and efferent arteries in fish.
- Glycerine and Permanent preparation of placoid scales and study of permanent slides of different types of fish scales.
- Study of types of beak, feathers and feet of birds.
- Study of histology of various organs by prepared slides.

B. DEVELOPMENTAL BIOLOGY:

- **Frog** - Study of developmental stages - whole mounts and sections through permanent slides – cleavage stages, blastula, gastrula, neurula, tailbud stage, tadpole-external and internal gill stages.
- **Study of the different types of placentae**- histological sections through permanent slides or photomicrographs.
- **Study of placental development in humans by ultrasound scans.**
- **Examination of gametes** - frog/rat - sperm and ova through permanent slides orphotomicrographs.

Semester II	Disciplinary Minor INTEGRATED PEST MANAGEMENT ZOOIDMI-204	Credit	2
		Marks	50(30+20)

COURSE CONTENT/SYLLABUS

Unit-1 Basics of insect, Pest and its categories:

Introduction of insect, diversity and nature, insect classification based on economic importance, insect as a pest, types of pests, methods of samplings and surveillance of pest.

Unit-2 IPM, concepts and ecological components:

Principle of pest management, definition, history, concept, Component of Integrated pest Management (IPM), ecological methods of pest management, legal approaches, Host plant resistance and biological components of IPM.

Unit-3 Pest management through botanicals, behavioural modification and radiation technology:

Pest management by modifying insect behaviour and development, insect growth regulator; repellents attractants and inhibitors, Sterile insect technique. Biological control; using predators, parasitoids and microbes and chemical control.

Unit-4 Pest management through innovative approaches:

Integration of different IPM tools and techniques; pros and cons. Adoption of IPM; Successful implementation of IPM in cereals (paddy), pulses and commercial crops (cotton and sugarcane) oilseed, vegetable crops and fruit crops.

SUGGESTED READINGS

1. Chapman RF. 1998. The Insects: Structure and Function. Cambridge Univ. Press, Cambridge.
2. David BV & Ananthkrishnan TN. 2004. General and Applied Entomology. Tata-McGraw Hill, New Delhi.
3. Duntson PA. 2004. The Insects: Structure, Function and Biodiversity. Kalyani Publ., New Delhi.
4. Richards OW & Davies RG. 1977. Imm's General Text Book of Entomology. 10th Ed. Chapman & Hall, London.
5. Koul O, Dhaliwal GS & Curperus GW. 2004. Integrated Pest Management Potential, Constraints and Challenges. CABI, London.
6. Larry P. Pedigo, Jack E Rechcigl, Nancy A Rechcigl Entomology and Pest Management.
7. Insect Pest Management: Techniques for Environmental Protection . CRC Press. Library Call Number: SB933.3.I53 2000
8. Gimme H Walter . Insect Pest Management and Ecological Research. - Cambridge University Press. Library Call Number: SB931.W25 2003
9. Dhaliwal GS & Arora R. 2003. Integrated Pest Management – Concepts and Approaches. Kalyani Publ., New Delhi.

Semester II	Vocational FISH AND FISHERIES Paper name - PISCICULTURE ZOOVOT-205	Credit	2
		Marks	50(30+20)

COURSE CONTENT/SYLLABUS

Unit-1 Scope of Pisciculture, Monoculture, Composite fish culture and induced breeding in fishes.

Unit-2 Cage culture, Pen culture and Fish culture in sewage.

Unit-3 Integrated fish farming with special reference to- Fish cum paddy culture, Fish cum duck culture and fish cum Pig culture.

Unit-4 Food fishes in India (Fresh water and marine)

Unit-5 Importance and need of fish culture, Nature of Culturable food fishes and their nutrition with special reference to Herbivorous, Carnivorous and omnivorous fishes of fresh water.

SUGGESTED READINGS

1. An Introduction to Fishes: S.S. Khanna.
2. Introduction of Aquaculture: Landua M.
3. Fish & Fisheries: K. Pandey and J.P. Shukla
4. Fish and Fisheries of India: Jhingran VG.
5. Pond Aquaculture Water Quality Management: Claude E. Boyd & C.S. Tucker.

Laboratory Exercise VOCATIONAL FISH AND FISHERIES Paper name - PISCICULTURE ZOOVOP-206	Credit - 2
	Mark - 50

- Study of Hatchery system with special reference to breeding happa and hatching happa.
- Pituitary extraction for induced breeding.
- Models for integrated fish farming.
- Idea about culturable herbivorous and carnivorous fishes with special reference to indigenous major carps and murrels.
- Morphometric measurement for fish species identification.

B. Sc. Zoology
THIRD SEMESTER
Course Structure

Paper Category	Title of the Paper	Credits	Contact Hrs./Week	Maximum Marks	Sessional Marks (40)		End Semester Examination Marks	Min. Pass Marks in End. Sem. Exam.
					10x2 Test Average	20 (10 Assignment +10 Attendance)		
Disciplinary Major	Physiology and Biochemistry **ZOODMT-301**	4	4 Hrs.	100	20	20	60	24
Disciplinary Minor	Food Nutrition and Health **ZOODMI-302**	2	2 Hrs.	50	10	10	30	12
Interdisciplinary Major	Physiology and Biochemistry **ZOOIDMT-303**	4	4 Hrs.	100	20	20	60	24
Interdisciplinary Minor	Food Nutrition and Health **ZOOIDMI-304**	2	2 Hrs.	50	10	10	30	12
Vocational	Fish and Fisheries **Paper name** – Maintenance of Fish Pond, Preservation Processing and Disease in Fish **ZOOVOT-305**	2	2 Hrs.	50	10	10	30	12
Laboratory Exercise Disciplinary Major	Physiology and Biochemistry **ZOODMP-307**	2	2 Hrs.	50	-	-	50	20
Laboratory Exercise Interdisciplinary Major	Physiology and Biochemistry **ZOOIDMP-308**	2	2 Hrs.	50	-	-	50	20
Laboratory Exercise Vocational	Fish and Fisheries **Paper name** – Maintenance of Fish Pond, Preservation Processing and Disease in Fish **ZOOVOP-306**	2	2 Hrs.	50	-	-	50	20
Value Added Course	Environmental Studies **ZOOVB-300**	-	2 Hrs.	50	-	-	50	20
Total		**20**	**-**	**550**	**140**		**410**	**164**

Entry

Semester III	Disciplinary Major PHYSIOLOGY AND BIOCHEMISTRY ZOODMT-301	Credit	4
		Marks	100 (60+40)

COURSE CONTENT/SYLLABUS

PART A – PHYSIOLOGY

Unit-1 **Nerve and muscle:**

Structure of a neuron, Resting membrane potential, Graded potential, Origin of Action potential and its propagation in myelinated and non-myelinated nerve fibres, Ultrastructure of skeletal muscle, Molecular and chemical basis of muscle contraction.

Unit-2 **Digestion:**

Digestion in different segments of the alimentary canal; Absorption of carbohydrates, proteins, lipids.

Unit-3 **Respiration:**

Pulmonary ventilation, Respiratory volumes and capacities, Transport of Oxygen and carbondioxide in blood.

Unit-4 **Excretion:**

Structure of nephron, mechanism of Urine formation.

Unit-5 **Cardiovascular system:**

Blood: Composition, Hemostasis, Heart structure, Origin and conduction of the cardiacimpulse, cardiac cycle.

Unit-6 **Reproduction and Endocrine Glands:**

Physiology of male reproduction: hormonal control of spermatogenesis; Physiology of female reproduction: hormonal control of menstrual cycle; Structure and function of pituitary, thyroid, parathyroid, pancreas and adrenal.

PART B – BIOCHEMISTRY

Unit-1 **Carbohydrate Metabolism:**

Glycolysis, Krebs Cycle, Pentose phosphate pathway, Gluconeogenesis, Glycogen metabolism, Review of electron transport chain.

Unit-2 **Lipid Metabolism:**

Biosynthesis and β oxidation of palmitic acid.

Unit-3 **Protein metabolism:**

Transamination, Deamination and Urea Cycle.

Unit-4 **Enzymes:**

Introduction, Mechanism of action, Kinetics, Inhibition and Regulation.

SUGGESTED READINGS

1. Tortora, G.J.& Derrickson, B.H. (2009). Principles of Anatomy and Physiology, 12th Ed., John Wiley & Sons, Inc.
2. Widmaier, E.P., Raff, H. & Strang, K.T. (2008) Vander's Human Physiology, 11th Ed., McGraw Hill.
3. Guyton, A.C. & Hall, J.E. (2011) Textbook of Medical Physiology, 12th Ed., Harcourt Asia Pvt. Ltd/ W.B. Saunders Company.
4. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. 6th Edition. W.H. Freeman and Co.
5. Nelson, D. L., Cox, M. M. and Lehninger, A.L. (2009). Principles of Biochemistry. 4th

Edition. W.H Freeman and Co.
6. Murray, R. K., Granner, D. K., Mayes, P. A. and Rodwell, V. W. (2009). Harper's Illustrated Biochemistry. XXVIII Edition. Lange Medical Books/Mc Graw Hill.

Laboratory Exercise **Disciplinary Major** **PHYSIOLOGY AND BIOCHEMISTRY** **ZOODMP-307**	**Credit – 2** **Marks - 50**

PART A - PHYSIOLOGY:

- Preparation of hemin and hemochromogen crystals.
- Examination of permanent histological sections of mammalian pituitary, thyroid, parathyroid, pancreas, adrenal.
- Examination of permanent slides of spinal cord, duodenum, liver, lung, kidney, bone, cartilage.

Part B - BIOCHEMISTRY:

- Identification of unknown carbohydrates in given solutions (Starch, Sucrose, Lactose, Galactose, Glucose, Fructose).
- Colour reactions to identify functional group in the given solution of proteins.
- Study of activity of salivary amylase under optimum conditions.

Semester III	Disciplinary Minor FOOD NUTRITION AND HEALTH ZOODMI-302	Credit	2
		Marks	50(30+20)

COURSE CONTENT/SYLLABUS

Unit-1 Basic Concept of Food And Nutrition:

Food Components and food-nutrients. Concept of a balanced diet, nutrient needs and dietary pattern for various groups adults, pregnant and nursing mothers, infants, school children, adolescents and elderly

Unit-2 Nutritional Biochemistry

Carbohydrates, Lipids, Proteins- Definition, Classification, their dietary source and role, Vitamins- Fat-soluble and Water-soluble vitamins- their dietary source and importance, Minerals- Iron, calcium, phosphorus, iodine, selenium and zinc: their biological functions.

Unit-3 Health

Introduction to health- Definition and concept of health.

Major nutritional Deficiency diseases- Protein Energy Malnutrition (kwashiorkor and marasmus), Vitamin A deficiency disorders, Iron deficiency disorders, Iodine deficiency disorders- their causes, symptoms, treatment, prevention and government programmes, if any.

Life style related diseases- hypertension, diabetes mellitus, and obesity- their causes and prevention through dietary and lifestyle modifications.

Social health problems- smoking, alcoholism, drug dependence and Acquired Immuno Deficiency Syndrome (AIDS) - their causes, treatment and prevention Common ailments- cold, cough, and fevers, their causes and treatment.

Unit-4 Food Hygiene:

Potable water- sources and methods of purification at domestic level.

Food and Water borne infections:

Bacterial infection: Cholera, typhoid fever, dysentery;

Viral infection: Hepatitis, Poliomyelitis;

Protozoan infection: amoebiasis, giardiasis;

Parasitic infection: taeniasis and ascariasis their transmission, causative agent, sources of infection, symptoms and prevention;

Brief account of food spoilage: Causes of food spoilage and their preventive measures.

SUGGESTED READINGS

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

Semester III	Interdisciplinary Major PHYSIOLOGY AND BIOCHEMISTRY ZOOIDMT-303	Credit	4
		Marks	100 (60+40)

COURSE CONTENT/SYLLABUS

PART A – PHYSIOLOGY

Unit-1 **Nerve and muscle:**

Structure of a neuron, Resting membrane potential, Graded potential, Origin of Actionpotential and its propagation in myelinated and non-myelinated nerve fibres, Ultrastructure of skeletal muscle, Molecular and chemical basis of muscle contraction.

Unit-2 **Digestion:**

Digestion in different segments of the alimentary canal; Absorption of carbohydrates, proteins, lipids.

Unit-3 **Respiration:**

Pulmonary ventilation, Respiratory volumes and capacities, Transport of Oxygen and carbondioxide in blood.

Unit-4 **Excretion:**

Structure of nephron, mechanism of Urine formation.

Unit-5 **Cardiovascular system:**

Blood: Composition, Hemostasis, Heart structure, Origin and conduction of the cardiacimpulse, cardiac cycle.

Unit-6 **Reproduction and Endocrine Glands:**

Physiology of male reproduction: hormonal control of spermatogenesis; Physiology of female reproduction: hormonal control of menstrual cycle; Structure and function of pituitary, thyroid, parathyroid, pancreas and adrenal.

PART B – BIOCHEMISTRY

Unit-1 **Carbohydrate Metabolism:**

Glycolysis, Krebs Cycle, Pentose phosphate pathway, Gluconeogenesis, Glycogen metabolism, Review of electron transport chain.

Unit-2 **Lipid Metabolism:**

Biosynthesis and β oxidation of palmitic acid.

Unit-3 **Protein metabolism:**

Transamination, Deamination and Urea Cycle.

Unit-4 **Enzymes:**

Introduction, Mechanism of action, Kinetics, Inhibition and Regulation.

SUGGESTED READINGS

7. Tortora, G.J.& Derrickson, B.H. (2009). Principles of Anatomy and Physiology, 12th Ed., John Wiley & Sons, Inc.
8. Widmaier, E.P., Raff, H. & Strang, K.T. (2008) Vander's Human Physiology, 11th Ed., McGraw Hill.
9. Guyton, A.C. & Hall, J.E. (2011) Textbook of Medical Physiology, 12th Ed., Harcourt Asia Pvt. Ltd/ W.B. Saunders Company.
10. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. 6th Edition. W.H. Freeman and Co.
11. Nelson, D. L., Cox, M. M. and Lehninger, A.L. (2009). Principles of Biochemistry. 4th

Edition. W.H Freeman and Co.
12. Murray, R. K., Granner, D. K., Mayes, P. A. and Rodwell, V. W. (2009). Harper's Illustrated Biochemistry. XXVIII Edition. Lange Medical Books/Mc Graw Hill.

Laboratory Exercise **Interdisciplinary Major** **PHYSIOLOGY AND BIOCHEMISTRY** **ZOODMP-307**	**Credit – 2** **Marks – 50**

PART A - PHYSIOLOGY:

- Preparation of hemin and hemochromogen crystals.
- Examination of permanent histological sections of mammalian pituitary, thyroid, parathyroid, pancreas, adrenal.
- Examination of permanent slides of spinal cord, duodenum, liver, lung, kidney, bone, cartilage.

Part B - BIOCHEMISTRY:

- Identification of unknown carbohydrates in given solutions (Starch, Sucrose, Lactose, Galactose, Glucose, Fructose).
- Colour reactions to identify functional group in the given solution of proteins.
- Study of activity of salivary amylase under optimum conditions.

Semester III	Interdisciplinary Minor FOOD NUTRITION AND HEALTH ZOOIDMI-304	Credits-2 Marks 50(30+20)

COURSE CONTENT/SYLLABUS

Unit-1 Basic Concept of Food And Nutrition:

Food Components and food-nutrients. Concept of a balanced diet, nutrient needs and dietary pattern for various groups adults, pregnant and nursing mothers, infants, school children, adolescents and elderly

Unit-2 Nutritional Biochemistry

Carbohydrates, Lipids, Proteins- Definition, Classification, their dietary source and role, Vitamins- Fat-soluble and Water-soluble vitamins- their dietary source and importance, Minerals- Iron, calcium, phosphorus, iodine, selenium and zinc: their biological functions.

Unit-3 Health

Introduction to health- Definition and concept of health.

Major nutritional Deficiency diseases- Protein Energy Malnutrition (kwashiorkor and marasmus), Vitamin A deficiency disorders, Iron deficiency disorders, Iodine deficiency disorders- their causes, symptoms, treatment, prevention and government programmes, if any.

Life style related diseases- hypertension, diabetes mellitus, and obesity- their causes and prevention through dietary and lifestyle modifications.

Social health problems- smoking, alcoholism, drug dependence and Acquired Immuno Deficiency Syndrome (AIDS) - their causes, treatment and prevention Common ailments- cold, cough, and fevers, their causes and treatment.

Unit-4 Food Hygiene:

Potable water- sources and methods of purification at domestic level.

Food and Water borne infections:

Bacterial infection: Cholera, typhoid fever, dysentery;

Viral infection: Hepatitis, Poliomyelitis;

Protozoan infection: amoebiasis, giardiasis;

Parasitic infection: taeniasis and ascariasis their transmission, causative agent, sources of infection, symptoms and prevention;

Brief account of food spoilage: Causes of food spoilage and their preventive measures.

SUGGESTED READINGS

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

Semester III	Vocational FISH AND FISHERIES Paper name – MAINTENANCE OF FISH POND, PRESERVATION PROCESSING AND DISEASE IN FISH ZOOVOT-305	Credit	2
		Marks	50 (30+20)

COURSE CONTENT/SYLLABUS

Unit-1 Maintenance and physico–chemical factors of fish pond.

Unit-2 Fish diseases and their control with special reference to protozoan, fungal, bacterial and viral diseases

Unit-3 Water quality for fish culture, Fertilization in fish pond and Aquatic weeds and their control.

Unit-4 Age determination in fishes with special reference to Scale annuli.

Unit-5 Fish preservation and processing by drying, salting and freezing.

SUGGESTED READINGS

1. An Introduction to Fishes: S.S. Khanna.
2. Introduction of Aquaculture: Landua M.
3. Fish & Fisheries: K. Pandey and J.P. Shukla
4. Fish and Fisheries of India: Jhingran VG.
5. Pond Aquaculture Water Quality Management: Claude E. Boyd & C.S. Tucker.

Laboratory Exercise VOCATIONAL FISH AND FISHERIES Paper name – MAINTENANCE OF FISH POND, PRESERVATION PROCESSING AND DISEASE IN FISH ZOOVOP-306	Credit - 2 Mark - 50

- Identification of various disease symptoms in fishes namely fungal, protozoan and bacterial disease.
- Scale mounting for age determination in fishes.
- Pond water quality analysis- Temperature, pH, alkalinity, CO_2, and Dissolved Oxygen.

B. Sc. Zoology
FOURTH SEMESTER** Exit option with Diploma Certificate.
Course Structure

Paper Category	Title of the Paper	Credits	Contact Hrs./Week	Maximum Marks	Sessional Marks (40)		End Semester Examination Marks	Min. Pass Marks in End. Sem. Exam.
					10x2 Test Average	20 (10 Assignment +10 Attendance)		
Disciplinary Major	Genetics and Evolutionary Biology **ZOODMT-401**	4	4 Hrs.	100	20	20	60	24
Disciplinary Minor	Lac Culture **ZOODMI-402**	2	2 Hrs.	50	10	10	30	12
Interdisciplinary Major	Genetics and Evolutionary Biology **ZOOIDMT-403**	4	4 Hrs.	100	20	20	60	24
Interdisciplinary Minor	Lac Culture **ZOOIDMI-404**	2	2 Hrs.	50	10	10	30	12
Vocational	Fish and Fisheries **Paper name** – Aquaculture Practices, Transportation Marketing and Specialized Organs in Fishes **ZOOVOT-405**	2	2 Hrs.	50	10	10	30	12
Laboratory Exercise Disciplinary Major	Genetics and Evolutionary Biology **ZOODMP-407**	2	2 Hrs.	50	-	-	50	20
Laboratory Exercise Interdisciplinary Major	Genetics and Evolutionary Biology **ZOOIDMP-408**	2	2 Hrs.	50	-	-	50	20
Laboratory Exercise Vocational	Fish and Fisheries **Paper name** – Aquaculture Practices, Transportation Marketing and Specialized Organs in Fishes **ZOOVOP-406**	2	2 Hrs.	50	-	-	50	20
Value Added Course	Disaster Management **ZOOVB-400**	-	2 Hrs.	50	-	-	50	20
Total		**20**	**-**	**550**	**140**		**410**	**164**

**** Exit option with Diploma Certificate.**

Semester IV	Disciplinary Major GENETICS AND EVOLUTIONARY BIOLOGY ZOODMT-401	Credit	4
		Marks	100 (60+40)

COURSE CONTENT/SYLLABUS

PART A – GENETICS

Unit-1 **Mendelian Genetics and its Extension:**

Mendel's work on transmission of traits, Mendel's Laws of heredity, Test cross, Incomplete dominance and codominance, Interaction of genes or Epistasis, Multiple alleles, Lethal alleles, Pleiotropy, expressivity, Pedigree analysis.

Unit-2 **Extra nuclear inheritance:**

Maternal effects in snail shell coiling, Kappa particles in paramecium, Plastid characters in plants, Insertion sequences, Transposable elements.

Unit-3 **Sex Determination:**

Environmental effects on phenotypic expression, Genetic basis of Sex determination: Concepts of allosomes and autosomes, Sex chromosome systems (XX-XY, XX-XO, ZW-ZZ, ZO-ZZ types), sex linked inheritance, dosage compensation.

Unit-4 **Linkage, Crossing Over and Chromosomal Mapping:**

Types, Characteristics and significance of Linkage, Recombination frequency as a measure of linkage intensity, crossing over, Cytological basis of crossing over, Molecular mechanism of crossing over, two factor and three factor crosses, Interference and coincidence, Tetrad Analysis in *Neurospora*, Chromosome mapping.

Unit-5 **Mutations:**

Types of mutation: Deletion, Duplication, Inversion, Translocation, Aneuploidy and Polyploidy; Gene mutations: Induced versus Spontaneous Mutations, Back versus Suppressor Mutations, Silent Mutation, Mis-sense Mutation, Molecular basis of Mutations, Chemical Mutation.

Unit-6 **Chromosomal Aberration:**

Structural and Numerical Abnormalities, Autosomal abnormalities and sex chromosomal abnormalities or syndromes.

PART B - EVOLUTIONARY BIOLOGY

Unit-1 **History of Life**:

Major Events in History of Life.

Unit-2 **Introduction to Evolutionary Theories**:

Lamarckism, Darwinism, Neo-Darwinism.

Unit-3 **Direct Evidences of Evolution:**

Types of fossils, Incompleteness of fossil record, Dating of fossils, Phylogeny of horse.

Unit-4 **Processes of Evolutionary Change:**

Organic variations; Isolating Mechanisms; Natural selection (Example: Industrial melanism); Types of natural selection (Directional, Stabilizing, Disruptive), Artificial selection.

Unit-5 **Species Concept:**

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

Unit-6 Evolution above species level:

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

Unit-7 Extinction:

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

SUGGESTED READINGS

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). Principles of Genetics. VIII Edition. Wiley India.
2. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics. X Edition. Benjamin Cummings.
4. Russell, P. J. (2009). Genetics- A Molecular Approach. III Edition. Benjamin Cummings.
5. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. Introduction to Genetic Analysis. IX Edition. W. H. Freeman and Co.
6. Ridley, M. (2004). Evolution. III Edition. Blackwell Publishing
7. Barton, N. H., Briggs, D. E. G., Eisen, J. A., Goldstein, D. B. and Patel, N. H.(2007). Evolution. Cold Spring, Harbour Laboratory Press.
8. Hall, B. K. and Hallgrimsson, B. (2008). Evolution. IV Edition. Jones and Bartlett Publishers
9. Campbell, N. A. and Reece J. B. (2011). Biology. IX Edition, Pearson, Benjamin, Cummings.
10. Douglas, J. Futuyma (1997). Evolutionary Biology. Sinauer Associates.
11. Minkoff, E. (1983). Evolutionary Biology. Addison-Wesley.

Laboratory Exercise **Disciplinary Major** **GENETICS AND EVOLUTIONARY BIOLOGY** **ZOODMP-407**	**Credit - 2** **Marks - 50**

PART A - GENETICS

- Study of Mendelian Inheritance and gene interactions (Non-Mendelian Inheritance) using suitable examples. Verify the results using Chi-square test.
- Study of Linkage, recombination, gene mapping using the data.
- Study of Human Karyotypes (normal and abnormal).

PART B - EVOLUTIONARY BIOLOGY

- Study of fossil evidences from plaster cast models and pictures.
- Study of homology and analogy from suitable specimens/pictures.
- Charts:
  - Phylogeny of horse with diagrams/ cut outs of limbs and teeth of horse ancestors.
  - Darwin's Finches with diagrams/cut outs of beaks of different species.
- Visit Natural History Museum, submission of the report.

Semester IV	Disciplinary Minor LAC CULTURE ZOODMI-402	Credit	2
		Marks	50 (30+20)

COURSE CONTENT/SYLLABUS

Unit-1 Biology of Lac Insects:

Introduction, history, systematic position and life cycle.

Unit-2 Host, Cultural Techniques and Processing:

Lac insects host, cultural techniques of lac insects, forms of lac and its processing.

Unit-3 Diseases and Natural Enemies:

Lac diseases, natural enemies and its IPM and preventative measures.

Unit-4 Economic Importance:

Management of lac culture, lac industries, lac products and its economic values, marketing of lac products and career opportunities in lac culture.

SUGGESTED READINGS

1. Arumugam, N., S. Murugan, J. Johnson Rajeshwar, & R. Ramprabhu, 2005. Applied Zoology. Saras publication, Nagercoil.
2. Ravindranathan, K.R. 2005. A text book of economic zoology. Dominant publishers and distributers, New Delhi.
3. Shukla, G. S. & V.B. Upadhyay. 2011. Economic Zoology. Rastogi Publications, Meerut, New Delhi.
4. Vasantharaj David, B. & T. Kumaraswamy, 1996. Elements of Economic Entomology. Popular book depot, Chennai.
5. Tomer, B. S. 2011. Economic Zoology. Emkay publications, Delhi.
6. Ahsan, J. & S. P. Sinha, 2009. A Handbook on Economic Zoology, S. Chand & Company Ltd, New Delhi.

Semester IV	Interdisciplinary Major GENETICS AND EVOLUTIONARY BIOLOGY ZOOIDMT-403	Credit	4
		Marks	100 (60+40)

COURSE CONTENT/SYLLABUS

PART A – GENETICS

Unit-1 **Mendelian Genetics and its Extension:**

Mendel's work on transmission of traits, Mendel's Laws of heredity, Test cross, Incomplete dominance and codominance, Interaction of genes or Epistasis, Multiple alleles, Lethal alleles, Pleiotropy, expressivity, Pedigree analysis.

Unit-2 **Extra nuclear inheritance:**

Maternal effects in snail shell coiling, Kappa particles in paramecium, Plastid characters in plants, Insertion sequences, Transposable elements.

Unit-3 **Sex Determination:**

Environmental effects on phenotypic expression, Genetic basis of Sex determination: Concepts of allosomes and autosomes, Sex chromosome systems (XX-XY, XX-XO, ZW-ZZ, ZO-ZZ types), sex linked inheritance, dosage compensation.

Unit-4 **Linkage, Crossing Over and Chromosomal Mapping:**

Types, Characteristics and significance of Linkage, Recombination frequency as a measure of linkage intensity, crossing over, Cytological basis of crossing over, Molecular mechanism of crossing over, two factor and three factor crosses, Interference and coincidence, Tetrad Analysis in *Neurospora*, Chromosome mapping.

Unit-5 **Mutations:**

Types of mutation: Deletion, Duplication, Inversion, Translocation, Aneuploidy and Polyploidy; Gene mutations: Induced versus Spontaneous mutations, Back versus Suppressor mutations, Silent Mutation, Mis-sense Mutation, Molecular Basis of Mutations, Chemical Mutation.

Unit-6 **Chromosomal Aberration:**

Structural and Numerical Abnormalities, Autosomal abnormalities and sex chromosomal abnormalities or syndromes.

PART B - EVOLUTIONARY BIOLOGY

Unit-1 **History of Life**:

Major Events in History of Life.

Unit-2 **Introduction to Evolutionary Theories**:

Lamarckism, Darwinism, Neo-Darwinism.

Unit-3 **Direct Evidences of Evolution:**

Types of fossils, Incompleteness of fossil record, Dating of fossils, Phylogeny of horse.

Unit-4 **Processes of Evolutionary Change:**

Organic variations; Isolating Mechanisms; Natural selection (Example: Industrial melanism); Types of natural selection (Directional, Stabilizing, Disruptive), Artificial selection

Unit-5 Species Concept:

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

Unit-6 Evolution above species level:

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

Unit-7 Extinction:

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

SUGGESTED READINGS

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). Principles of Genetics. VIII Edition. Wiley India.
2. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics. X Edition. Benjamin Cummings.
4. Russell, P. J. (2009). Genetics- A Molecular Approach. III Edition. Benjamin Cummings.
5. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. Introduction to Genetic Analysis. IX Edition. W. H. Freeman and Co.
6. Ridley, M. (2004). Evolution. III Edition. Blackwell Publishing
7. Barton, N. H., Briggs, D. E. G., Eisen, J. A., Goldstein, D. B. and Patel, N. H.(2007). Evolution. Cold Spring, Harbour Laboratory Press.
8. Hall, B. K. and Hallgrimsson, B. (2008). Evolution. IV Edition. Jones and Bartlett Publishers
9. Campbell, N. A. and Reece J. B. (2011). Biology. IX Edition, Pearson, Benjamin, Cummings.
10. Douglas, J. Futuyma (1997). Evolutionary Biology. Sinauer Associates.
11. Minkoff, E. (1983). Evolutionary Biology. Addison-Wesley.

Laboratory Exercise **Interdisciplinary Major** **GENETICS AND EVOLUTIONARY BIOLOGY** **ZOOIDMP-408**	**Credit - 2** **Marks - 50**

PART A - GENETICS

- Study of Mendelian Inheritance and gene interactions (Non-Mendelian Inheritance) using suitable examples. Verify the results using Chi-square test.
- Study of Linkage, recombination, gene mapping using the data.
- Study of Human Karyotypes (normal and abnormal).

PART B - EVOLUTIONARY BIOLOGY

- Study of fossil evidences from plaster cast models and pictures.
- Study of homology and analogy from suitable specimens/pictures.
- Charts:
  - Phylogeny of horse with diagrams/ cut outs of limbs and teeth of horseancestors.
  - Darwin's Finches with diagrams/ cut outs of beaks of different species.
- Visit to Natural History Museum, submission of report.

Semester IV	Interdisciplinary Minor LAC CULTURE ZOOIDMI-404	Credit	2
		Marks	50 (30+20)

COURSE CONTENT/SYLLABUS

Unit-1 Biology of Lac Insects:

Introduction, history, systematic position and life cycle.

Unit-2 Host, Cultural Techniques and Processing:

Lac insects host, cultural techniques of lac insects, forms of lac and its processing.

Unit-3 Diseases and Natural Enemies:

Lac diseases, natural enemies and its IPM and preventative measures.

Unit-4 Economic Importance:

Management of lac culture, lac industries, lac products and its economic values, marketing of lac products and career opportunities in lac culture.

SUGGESTED READINGS

1. Arumugam, N., S. Murugan, J. Johnson Rajeshwar, & R. Ramprabhu, 2005. Applied Zoology. Saras publication, Nagercoil.
2. Ravindranathan, K.R. 2005. A text book of economic zoology. Dominant publishers and distributers, New Delhi.
3. Shukla, G. S. & V.B. Upadhyay. 2011. Economic Zoology. Rastogi Publications, Meerut, New Delhi.
4. Vasantharaj David, B. & T. Kumaraswamy, 1996. Elements of Economic Entomology. Popular book depot, Chennai.
5. Tomer, B. S. 2011. Economic Zoology. Emkay publications, Delhi.
6. Ahsan, J. & S. P. Sinha, 2009. A Handbook on Economic Zoology, S. Chand & Company Ltd, New Delhi.

Semester IV	**Vocational** **FISH AND FISHERIES** **Paper name – AQUACULTURE PRACTICES, TRANSPORTATION MARKETING AND SPECIALIZED ORGANS IN FISHES** **ZOOVOT-405**	**Credit**	**2**
		Marks	**50(30+20)**

COURSE CONTENT/SYLLABUS

Unit-1 Specialized organs and their biological significance in fish life -Venomous tissue fishes, Sound producing organs and Luminous organs.

Unit-2 Fresh water species of prawn culture and Shrimp culture.

Unit-3 By-products of fish industry and Frog fishery.

Unit-4 Fish catching device, transportation and marketing of fishes.

Unit-5 Development of fisheries in India and Fisheries Research Institutes and their contribution.

SUGGESTED READINGS

1. An Introduction to Fishes: S.S. Khanna.
2. Introduction of Aquaculture: Landua M.
3. Fish & Fisheries: K. Pandey and J.P. Shukla
4. Fish and Fisheries of India: Jhingran VG.
5. Pond Aquaculture Water Quality Management: Claude E. Boyd & C.S. Tucker.

Laboratory Exercise **Vocational** **FISH AND FISHERIES** **Paper name – AQUACULTURE PRACTICES, TRANSPORTATION MARKETING AND SPECIALIZED ORGANS IN FISHES** **ZOOVOP-406**	**Credit - 2**
	Mark - 50

- Study of fishing crafts, gears and fishing accessories.
- Transport devices of fishes
- Study of various species of fresh water and estuarine Prawns.
- Collection of fishes.

B. Sc. Zoology
FIFTH SEMESTER
Course Structure

Paper Category	Title of the Paper	Credits	Contact Hrs./Week	Maximum Marks	Sessional Marks (40)		End Semester Examination Marks	Min. Pass Marks in End. Sem. Exam.
					10x2 Test Average	20 (10 Assignment +10 Attendance)		
Disciplinary Major	Tools and Techniques of Biology **ZOODMT-501**	4	4 Hrs.	100	20	20	60	24
Disciplinary Minor	Research Methodology **ZOODMI-502**	2	2 Hrs.	50	10	10	30	12
Interdisciplinary Major	Tools and Techniques of Biology **ZOOIDMT-503**	4	4 Hrs.	100	20	20	60	24
Interdisciplinary Minor	Research Methodology **ZOOIDMI-504**	2	2 Hrs.	50	10	10	30	12
Laboratory Exercise Disciplinary Major	Tools and Techniques of Biology **ZOODMP-507**	2	2 Hrs.	50	-	-	50	20
Laboratory Exercise Interdisciplinary Major	Tools and Techniques of Biology **ZOOIDMP-508**	2	2 Hrs.	50	-	-	50	20
Value Added Course	Creative Expression – I (opt any one): (Performing arts e.g. Sports, Dance, Music) **ZOOVB500**	-	2 Hrs.	50	-	-	50	20
Either								
Disciplinary Internship	Field Visit/Internship/Community Engagement **ZOOFV/I/CE/505**	4	4 Hrs.	100	-	-	-	40
Or								
Interdisciplinary Internship	Field Visit/Internship/Community Engagement **ZOOFV/I/CE/506**	4	4 Hrs.	100	-	-	-	40
Total		**20**		**550**	**120**		**330**	172

Entry

B.Sc. Zoology (NEP)
FIFTH SEMESTER
Course Structure

Semester V	Disciplinary Major TOOLS AND TECHNIQUES OF BIOLOGY ZOODMT-501	Credit	4
		Marks	100 (60+40)

COURSE CONTENT/SYLLABUS

Unit-1 Microscopy:

Microscope: Numerical aperture, limit of resolution, types of objectives, ocular and stage micrometers. Basic principle, working and application of Light Microscope, Phase Contrast Microscopy, Fluorescence Microscopy, Electron Microscopy (SEM and TEM).

Unit-2 Histological Techniques:

Fixation, Dehydration, Cleaning, Embedding, Cutting, Staining.

Unit-3 Centrifugation:

Basic principles of centrifugation, Types of rotor, Clinical, High speed and Ultracentrifuge.

Unit-4 Spectroscopy:

Basic principle, working and application of Colorimeter, UV-VIS Spectrophotometry, Spectrofluorometory.

Unit-5 Chromatography:

Column chromatography, Paper and Thin Layer Chromatography, HPLC, Gas Chromatography.

Unit-6 Electrophoresis:

Principle, working and application of Agarose gel electrophoresis, SDS-PAGE, 2-D electrophoresis.

Unit-7 Molecular Techniques:

Principle, working and application of PCR, Recombinant techniques, Restriction enzymes.

SUGGESTED READINGS

1. Principles and techniques of Biochemistry and Molecular Biology, 7th Ed: K. Wilson, J. Walker, Cambridge Univ. Press. UK
2. An Introduction to Practical Biochemistry, 3rd Ed. : D. T. Plummer, Tata-McGraw Hill
3. Modern Experimental Biochemistry and Molecular Biology 2nd Ed.: R. Boyer Benjamin/Cumin
4. Physical Biochemistry, 2nd Ed: D.M. Freifelder, Freeman Press.
5. Analytical Biochemistry, 3rd Ed. D. Holme, J. Peck, Tata McGraw Hill.
6. Experimental Biochemistry, 3rd Ed: R. L. Switzer, L.F. Garrity, Freeman Press.

LABORATORY EXERCISE **Disciplinary Major** **TOOLS AND TECHNIQUES OF BIOLOGY** **ZOODMP-507**	**Credit - 2** **Marks - 50**

- Identify the pH of given water samples.
- Separation of Serum from blood sample using centrifuge technique.
- Separation of Chlorophyll from leaf extract by Column Chromatography/Paper Chromatography.
- Separation of different amino-acids by Thin Layer Chromatography technique.
- Isolation and quantification of DNA from onion/bacterial sample.
- Visualization and separation of DNA through Agarose Gel Electrophoresis.
- Quantitative estimation of protein in a given sample by Lowry's method.
- Separation of Protein sample by SDS-PAGE technique.
- Prepare the permanent slides of different samples.

Semester V	Disciplinary Minor RESEARCH METHODOLOGY ZOODMI-502	Credit	2
		Marks	50 (30+20)

COURSE CONTENT/SYLLABUS

Unit-1 Foundations of Research:

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

Unit-2 Research Design:

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

Unit-3 Data Collection, Analysis and Report Writing:

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

Unit-4 Ethical Issues

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

SUGGESTED READINGS

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

Semester V	Interdisciplinary Major TOOLS AND TECHNIQUES OF BIOLOGY ZOOIDMT-503	Credit	4
		Marks	100 (60+40)

COURSE CONTENT/SYLLABUS

Unit-1 **Microscopy:** Microscope: Numerical aperture, limit of resolution, types of objectives, ocular and stage micrometers. Basic principle, working and application of Light Microscope, Phase Contrast Microscopy, Fluorescence Microscopy, Electron Microscopy (SEM and TEM).

Unit-2 **Histological Techniques:** Fixation, Dehydration, Cleaning, Embedding, Cutting, Staining.

Unit-3 **Centrifugation:** Basic principles of centrifugation, Types of rotor, Clinical, high speed and ultracentrifuge.

Unit-4 **Spectroscopy:** Basic principle, working and application of Colorimeter, UV-VIS Spectrophotometry, Spectrofluorometory.

Unit-5 **Chromatography:** Column chromatography, Paper and thin layer chromatography, HPLC, Gas Chromatography.

Unit-6 **Electrophoresis:** Principle, working and application of Agarose gel electrophoresis, SDS-PAGE, 2-D electrophoresis.

Unit-7 **Molecular Techniques:** Principle, working and application of PCR, Recombinant techniques, Restriction enzymes.

SUGGESTED READINGS

7. Principles and techniques of Biochemistry and Molecular Biology, 7th Ed: K. Wilson, J. Walker, Cambridge Univ. Press. UK
8. An Introduction to Practical Biochemistry, 3rd Ed. : D. T. Plummer, Tata-McGraw Hill
9. Modern Experimental Biochemistry and Molecular Biology 2nd Ed: R. Boyer Benjamin/Cumin
10. Physical Biochemistry, 2nd Ed: D.M. Freifelder, Freeman Press.
11. Analytical Biochemistry, 3rd Ed. D. Holme, J. Peck, Tata McGraw Hill.
12. Experimental Biochemistry, 3rd Ed: R. L. Switzer, L.F. Garrity, Freeman Press.

Laboratory Exercise Interdisciplinary Major TOOLS AND TECHNIQUES OF BIOLOGY ZOOIDMP-508	Credit - 2 Marks - 50

- Identify the pH of given water samples.
- Separation of Serum from blood sample using centrifuge technique.
- Separation of Chlorophyll from leaf extract by Column Chromatography/Paper Chromatography.
- Separation of different amino-acids by Thin Layer Chromatography technique.
- Isolation and quantification of DNA from onion/bacterial sample.
- Visualization and separation of DNA through Agarose Gel Electrophoresis.
- Quantitative estimation of protein in a given sample by Lowry's method.
- Separation of Protein sample by SDS-PAGE technique.
- Prepare the permanent slides of different samples.

Semester V	Interdisciplinary Minor RESEARCH METHODOLOGY ZOOIDMI-504	Credit	2
		Marks	50 (30+20)

COURSE CONTENT/SYLLABUS

Unit-1 Foundations of Research:

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

Unit-2 Research Design:

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

Unit-3 Data Collection, Analysis and Report Writing:

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

Unit-4 Ethical Issues

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

SUGGESTED READINGS

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

Semester V	Disciplinary Field Visit/Internship/Community Engagement /Project ZOOFV/I/CE-505	Credit	4
		Marks	100

- The student has to prepare a research proposal for his/her internship work and should submit the internship proposal along with the power-point presentation.
- The internship supervisor gives the final marks to the candidate based on his/her performance during the Internship.

Semester V	Interdisciplinary Field Visit/Internship/Community Engagement/Project ZOOFV/I/CE-506	Credit	4
		Marks	100

- The student has to prepare a research proposal for his/her internship work and should submit the internship proposal along with the power-point presentation.
- The internship supervisor gives the final marks to the candidate based on his/her performance during the Internship.

B. Sc. Zoology
SIXTH SEMESTER#
Course Structure #Exit option with Bachelor Degree Certificate.

Paper Category	Title of the Paper	Credits	Contact Hrs./Week	Maximum Marks	Sessional Marks (40)		End Semester Examination Marks	Min. Pass Marks in End. Sem. Exam.
					10x2 Test Average	20 (10 Assignment +10 Attendance)		
Disciplinary Major	Molecular Biology **ZOODMT-601**	4	4 Hrs.	100	20	20	60	24
Disciplinary Major	Epidemiology and Infectious Disease **ZOODMT-603**	4	4 Hrs.	100	20	20	60	24
Disciplinary Minor	Medical Diagnostic **ZOODMI-602**	2	2 Hrs.	50	10	10	30	12
Interdisciplinary Major	Molecular Biology **ZOOIDMT-604**	4	4 Hrs.	100	20	20	60	24
Interdisciplinary Minor	Medical Diagnostic **ZOOIDMI-605**	2	2 Hrs.	50	10	10	30	12
Laboratory Exercise Disciplinary Major	Molecular Biology **ZOODMP-607**	2	2 Hrs.	50	-	-	50	20
Disciplinary Major	**Internship ZOODMP-609**	2	2 Hrs.	50	-	-	50	20
Value Added Course	Creative Expression – II (opt any one): (Performing arts e.g., Sports, Dance, Music) **ZOOVB-600**	-	2 Hrs.	50	-	-	50	20
Total		**20**	**-**	**550**	**160**		**390**	**156**

#Exit option with Bachelor Degree Certificate.

B.Sc. ZOOLOGY
SIXTH SEMESTER
Course Structure

Semester VI	Disciplinary Major MOLECULAR BIOLOGY ZOODMT-601	Credit	4
		Marks	100 (60+40)

COURSE CONTENT/SYLLABUS

Unit-1 **DNA Replication:**

DNA Replication in prokaryotes and eukaryotes: mechanism of DNA, replication, Semi- conservative, bidirectional and semi-discontinuous replication, RNA priming, Replication of circular and linear *ds*-DNA.

Transcription:

RNA polymerase and transcription Unit, mechanism of transcription in prokaryotes and eukaryotes, synthesis of rRNA and mRNA, transcription factors.

Unit-2 **Translation:**

Genetic code, Degeneracy of the genetic code and Wobble Hypothesis; Process of protein synthesis in prokaryotes: Ribosome structure and assembly in prokaryotes, fidelity of protein synthesis, aminoacyl tRNA synthetases and charging of tRNA; Proteins involved in initiation, elongation and termination of polypeptide chain; Inhibitors of protein synthesis; Difference between prokaryotic and eukaryotic translation.

Unit-3 **Post Transcriptional Modifications and Processing of Eukaryotic RNA:**

Structure of globin mRNA; Split genes: concept of introns and exons, splicing mechanism, alternative splicing, exon shuffling, and RNA editing, Processing of tRNA.

Unit-4 **Introduction of Recombinant Technology:**

Concept and scope of biotechnology, Restriction enzymes: Nomenclature, detailed study of Type II Restriction Enzymes.

Unit-5 **Techniques in Gene Manipulation:**

Cloning vectors: Plasmids, Cosmids, Phagemids, Lambda Bacteriophage and Expression vectors (characteristics). Transformation techniques: Calcium chloride method and electroporation Construction of genomic and cDNA libraries and screening by colony and plaque hybridization.

SUGGESTED READINGS

1. Brown, T.A. (1998). Molecular Biology Labfax II: Gene Cloning and DNA Analysis. 2nd Edition, Academic Press, California, USA.
2. Glick, B.R. and Pasternak, J.J. (2009). Molecular Biotechnology - Principles and Applications of Recombinant DNA. 4th Edition, ASM press, Washington, USA.
3. Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M.(2009). An Introduction to Genetic Analysis. 9th Edition. Freeman and Co., N.Y.,USA.
4. Snustad, D.P. and Simmons, M.J. (2009). Principles of Genetics. 5th Edition, John, Wiley and Sons Inc.
5. Watson, J.D., Myers, R.M., Caudy, A. and Witkowski, J.K. (2007). Recombinant DNA-Genes and Genomes- A Short Course. 3rd Edition, Freeman and Co., N.Y.,USA.
6. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. 7th Edition. Pearson Benjamin Cummings Publishing, San Francisco.
7. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter: Molecular Biology of the Cell, 4th Edition.

8. Cooper G. M. and Robert E. Hausman R. E. The Cell: A Molecular Approach, 5th Edition, ASM Press and Sinauer Associates.
9. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. 8th Edition. Lippincott Williams and Wilkins, Philadelphia.
10. Karp, G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley and Sons. Inc.
11. Lewin B. (2008). Gene XI, Jones and Bartlett.
12. McLennan A., Bates A., Turner, P. and White M. (2015). Molecular Biology 4th Edition. GS, Taylor and Francis Group, New York.

Laboratory Exercise **Disciplinary Major** **MOLECULAR BIOLOGY** **ZOODMP-607**	**Credit - 2** **Marks - 50**

- Study of Polytene chromosomes from Chironomous / Drosophila larvae
- Preparation of liquid culture medium (LB) and raise culture of *E. coli*.
- Estimation of the growth kinetics of *E. coli* by turbidity method.
- Preparation of solid culture medium (LB) and growth of *E. coli* by spreading and streaking.
- Demonstration of antibiotic sensitivity/resistance of *E. coli* to antibiotic pressure and interpretation of results.
- Genomic DNA isolation from *E. coli.*
- Plasmid DNA isolation (pUC 18/19) from *E. coli*.
- Restriction digestion of plasmid DNA.
- Construction of circular and linear restriction map from the data provided.
- Calculation of transformation efficiency from the data provided

Semester VI	Disciplinary Major EPIDEMIOLOGY AND INFECTIOUS DISEASES ZOODMT-603	Credit	4
		Marks	100 (60+40)

COURSE CONTENT/SYLLABUS

Unit-1 **Basic epidemiology:**

Historical aspects, definition, aim and uses, Descriptive epidemiology, Determinants of disease, Natural history of disease, Epidemiological principles in prevention and control disease, Risk measurement.

Unit-2 **Measurement of morbidity and mortality:**

Incidence, Prevalence, Age-adjustment and survival analysis, use of morbidity and mortality Epidemiological study designs-Bias, confounding and interaction, Causal association, Nutritional surveillance.

Unit-3 **Introduction to Microbial Pathogenesis:**

Structure of prokaryotic cell -Pathogenic modifications–Mechanisms of breaching host, defences -Mechanisms of production of disease, Anti-microbial agents, mode of action, drug resistance.

Unit-4 **Epidemiology and Control of Infectious Diseases:**

General overview of infectious diseases and their impact in developing countries. Biology, pathogenesis and pathology, clinical presentation of common infections (a) Vaccine preventable diseases: TB, polio, diphtheria, tetanus, and measles;

(b) Respiratory: Tuberculosis, leprosy, ARI's.

Unit-5 Biology, pathogenesis and pathology, clinical presentation, of common infections.

Intestinal: Diarrhoea, typhoid, and worm infestations.

Contact: STDs and AIDS.

Vector borne: Plague, rabies, malaria and filaria, JE, dengue, leptospirosis.

SUGGESTED READINGS

1. Class handouts.
2. Oxford textbook of Public Health Ed. Roger Detels, James Mcewen, Robert Beaglehole, and Heizo Tanaka Oxford University Press (OUP) 4th Edition: 2002.
3. Public Health at the Crossroads – Achievements and Prospects. Robert Beaglehole and Ruth Bonita 2nd Edition Cambridge University Press
4. Maxcy-Rosenau-Last Public Health & Preventive Medicine, Fourteenth Edition Ed Robert Wallace, MD, et al.
5. Epidemiology and Management for Health Care: Sathe , P.V. Sathe, A.P., Popular Prakashan, Mumbai, 1991.
6. International Public Health: Diseases, Programs, Systems, and Policies by Michael Merson, Robert E Black, Anne J Mills - Jones and Bartlett Publishers.
7. Preventive and Social Medicine, K Park, Bansaridas Bhanot Publishing House.

Laboratory Exercise **Disciplinary Major II** **EPIDEMIOLOGY AND INFECTIOUS DISEASES** **ZOODMP-609**	**Credit - 2** **Marks - 50**

- Study of Polytene chromosomes from Chironomous / Drosophila larvae
- Preparation of liquid culture medium (LB) and raise culture of *E. coli*.
- Estimation of the growth kinetics of *E. coli* by turbidity method.
- Preparation of solid culture medium (LB) and growth of *E. coli* by spreading and streaking.
- Demonstration of antibiotic sensitivity/resistance of *E. coli* to antibiotic pressure and interpretation of results.
- Genomic DNA isolation from *E. coli.*
- Plasmid DNA isolation (pUC 18/19) from *E. coli*.
- Restriction digestion of plasmid DNA.
- Construction of circular and linear restriction map from the data provided.
- Calculation of transformation efficiency from the data provided

Semester VI	Disciplinary Minor MEDICAL DIAGNOSTIC ZOODMI-602	Credit	2
		Marks	50 (30+20)

COURSE CONTENT/SYLLABUS

Unit-1 Diagnostics Methods Used for Analysis of Blood:

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

Unit-2 Diagnostic Methods Used for Urine Analysis:

Urine Analysis: Physical characteristics; Abnormal constituents.

Unit-3 Non-infectious Diseases:

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

Unit-4 Infectious Diseases:

Causes, types, symptoms, diagnosis and prevention of Tuberculosis and Hpatitis.

Unit-5 Tumours:

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

SUGGESTED READINGS

1. Park, K. (2007), Preventive and Social Medicine, B.B. Publishers.
2. Godkar P.B. and Godkar D.P. Textbook of Medical Laboratory Technology, 2nd Edition, Bhalani Publishing House.
3. Cheesbrough M., A Laboratory Manual for Rural Tropical Hospitals, A Basis for Training Courses.
4. Guyton A.C. and Hall J.E. Textbook of Medical Physiology, Saunders.
5. Robbins and Cortan, Pathologic Basis of Disease, 8th Edition, Saunders.
6. Prakash, G. (2012), Lab Manual on Blood Analysis and Medical Diagnostics, S. Chand and Co. Ltd.

Semester VI	Interdisciplinary Major MOLECULAR BIOLOGY ZOOIDMT-604	Credit	4
		Marks	100 (60+40)

COURSE CONTENT/SYLLABUS

Unit-1 **DNA Replication:**

DNA Replication in prokaryotes and eukaryotes: mechanism of DNA, replication, Semi- conservative, bidirectional and semi-discontinuous replication, RNA priming, Replication of circular and linear *ds*-DNA.

Transcription:

RNA polymerase and transcription Unit, mechanism of transcription in prokaryotes and eukaryotes, synthesis of rRNA and mRNA, transcription factors.

Unit-2 **Translation:**

Genetic code, Degeneracy of the genetic code and Wobble Hypothesis; Process of protein synthesis in prokaryotes: Ribosome structure and assembly in prokaryotes, fidelity of protein synthesis, aminoacyl tRNA synthetases and charging of tRNA; Proteins involved in initiation, elongation and termination of polypeptide chain; Inhibitors of protein synthesis; Difference between prokaryotic and eukaryotic translation.

Unit-3 **Post Transcriptional Modifications and Processing of Eukaryotic RNA:**

Structure of globin mRNA; Split genes: concept of introns and exons, splicing mechanism, alternative splicing, exon shuffling, and RNA editing, Processing of tRNA.

Unit-4 **Introduction of Recombinant Technology:**

Concept and scope of biotechnology, Restriction enzymes: Nomenclature, detailed study of Type II Restriction Enzymes.

Unit-5 **Techniques in Gene Manipulation:**

Cloning vectors: Plasmids, Cosmids, Phagemids, Lambda Bacteriophage and Expression vectors (characteristics). Transformation techniques: Calcium chloride method and electroporation Construction of genomic and cDNA libraries and screening by colony and plaque hybridization.

SUGGESTED READINGS

1. Brown, T.A. (1998). Molecular Biology Labfax II: Gene Cloning and DNA Analysis. II Edition, Academic Press, California, USA.
2. Glick, B.R. and Pasternak, J.J. (2009). Molecular Biotechnology - Principles and Applications of Recombinant DNA. 4th Edition, ASM press, Washington, USA.
3. Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M. (2009). An Introduction to Genetic Analysis. 9th Edition. Freeman and Co., N.Y.,USA.
4. Snustad, D.P. and Simmons, M.J. (2009). Principles of Genetics. 5th Edition, John,Wiley and Sons Inc.
5. Watson, J.D., Myers, R.M., Caudy, A. and Witkowski, J.K. (2007). Recombinant DNA-Genes and Genomes- A Short Course. 3rd Edition, Freeman and Co., N.Y.,USA.
6. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. 7th Edition. Pearson Benjamin Cummings Publishing, San Francisco.
7. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter: Molecular Biology of the Cell, 4th Edition.
8. Cooper G. M. and Robert E. Hausman R. E. The Cell: A Molecular Approach, 5th Edition, ASM Press and Sinauer Associates.

9. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
10. Karp, G. (2010) Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley and Sons. Inc.
11. Lewin B. (2008). Gene XI, Jones and Bartlett.
12. McLennan A., Bates A., Turner, P. and White M. (2015). Molecular Biology IV Edition. GS, Taylor and Francis Group, New York.

Laboratory Exercise **Interdisciplinary Major** **MOLECULAR BIOLOGY** **ZOOIDMP-608**	**Credit - 2** **Marks - 50**

- Study of Polytene chromosomes from Chironomous / Drosophila larvae
- Preparation of liquid culture medium (LB) and raise culture of *E. coli*.
- Estimation of the growth kinetics of *E. coli* by turbidity method.
- Preparation of solid culture medium (LB) and growth of *E. coli* by spreading and streaking.
- Demonstration of antibiotic sensitivity/resistance of *E. coli* to antibiotic pressure and interpretation of results.
- Genomic DNA isolation from *E. coli.*
- Plasmid DNA isolation (pUC 18/19) from *E. coli*.
- Restriction digestion of plasmid DNA.
- Construction of circular and linear restriction map from the data provided.
- Calculation of transformation efficiency from the data provided

Semester VI	Interdisciplinary Minor MEDICAL DIAGNOSTIC ZOOIDMI-605	Credit	2
		Marks	50 (30+20)

COURSE CONTENT/SYLLABUS

Unit-1 Diagnostics Methods Used for Analysis of Blood:

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

Unit-2 Diagnostic Methods Used for Urine Analysis:

Urine Analysis: Physical characteristics; Abnormal constituents.

Unit-3 Non-infectious Diseases:

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

Unit-4 Infectious Diseases:

Causes, types, symptoms, diagnosis and prevention of Tuberculosis and Hpatitis.

Unit-5 Tumours:

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

SUGGESTED READINGS

1. Park, K. (2007), Preventive and Social Medicine, B.B. Publishers
2. Godkar P.B. and Godkar D.P. Textbook of Medical Laboratory Technology, 2nd Edition, Bhalani Publishing House
3. Cheesbrough M., A Laboratory Manual for Rural Tropical Hospitals, A Basis for Training Courses
4. Guyton A.C. and Hall J.E. Textbook of Medical Physiology, Saunders
5. Robbins and Cortan, Pathologic Basis of Disease, 8th Edition, Saunders
6. Prakash, G. (2012), Lab Manual on Blood Analysis and Medical Diagnostics, S. Chand and Co. Ltd.

B. Sc. Zoology (Hons'./Research Degree)
SEVENTH SEMESTER
Course Structure

Paper Category	Title of the Paper	Credits	Contact Hrs./Week	Maximum Marks	Sessional Marks (40)		End Semester Examination Marks	Min. Pass Marks in End. Sem. Exam.
					10x2 Test Average	20 (10 Assignment +10 Attendance)		
Disciplinary Major-I	Immunology **ZOODMT-701**	4	4 Hrs.	100	20	20	60	24
Disciplinary Major -II	Cell Biology **ZOODMT-702**	4	4 Hrs.	100	20	20	60	24
Disciplinary Major/Elective	Animal Biotechnology **ZOODMT-703**	4	4 Hrs.	100	20	20	60	24
Disciplinary Major/Elective	Ecology **ZOODMT-704**	4	4 Hrs.	100	20	20	60	24
Laboratory Exercise Disciplinary Major-I	Immunology **ZOODMP-705**	2	2 Hrs.	50	-	-	50	20
Laboratory Exercise Disciplinary Major-II	Cell Biology **ZOODMP-706**	2	2 Hrs.	50	-	-	50	20
Total		**20**	**-**	**500**	**160**		**340**	**136**

Entry

B.Sc. ZOOLOGY (Hons.'/Research Degree)
SEVENTH SEMESTER
COURSE SYLLABUS

Semester VII	Disciplinary Major – I IMMUNOLOGY ZOODMT-701	Credit	4
		Marks	100 (60+40)

COURSE CONTENT/SYLLABUS

Unit-1 Overview of the immune system- Introduction to basic concepts in immunology, components of immune system, principles of innate and adaptive immune system.

Unit-2 Cells and organs of the immune system- Haematopoiesis, cells of immune system and organs (primary and secondary lymphoid organs) of the immune system.

Unit-3 Antigens- Basic properties of antigens, B and T cell epitopes, Haptens and Adjuvants.

Unit-4 Antibodies- Structure, classes and function of antibodies, Monoclonal Antibodies, Antigen-Antibody Interactions as tools for research and diagnosis.

Unit-5 Working of the immune system I- Structure and functions of MHC, Exogenous and Endogenous pathways of Antigen Presentation and Processing.

Unit-6 Working of immune system II- Basic properties and functions of Cytokines, types and functions of Complement System.

Unit-7 Immune system in Health and Disease I - Hypersensitivity: types and functions, Introduction to concepts of Autoimmunity and Immunodeficiency.

Unit-8 Immune system in health and disease II - Infectious agents and how they cause diseases, course of adaptive response to infection, general introduction to vaccines.

SUGGESTED READINGS

1. Kindt, T. J., Goldsby, R. A., Osborne, B. A., Kuby, J. (2006). VI Edition. Immunology. W.H. Freeman and Company.
2. Delves, P. J., Martin, S. J., Burton, D. R., Roitt, I.M. (2006). XI Edition. Roitt's Essential Immunology, Blackwell Publishing.

Laboratory Exercise Disciplinary Major (DM) IMMUNOLOGY ZOODMP-705	Credit - 2 Marks - 50

- Study of lymphoid organs (by slides or micrographs).
- ABO blood group determination.
- Ouchterlony's Double Diffusion assay.
- Preparation, cell count and percentage viability of spleenocytes.
- Enzyme linked immunosorbent assay (DOT-ELISA).
- Demonstration of immune-electrophoresis.

Semester VII	Disciplinary Major – II CELL BIOLOGY ZOODMT-702	Credit	4
		Marks	100 (60+40)

COURSE CONTENT/SYLLABUS

Unit-1 Introduction

Comparison of Prokaryotic and Eukaryotic cells, Structure and functions of cell organelles: Endoplasmic Reticulum, Golgi complex, Mitochondria, Ribosomes, Lysosomes, Peroxisomes.

Unit-2 Cell Organelles

Nucleus: Nuclear envelope with nuclear pore complex, nucleolus, nucleoplasm, and chromatin.

Cytoskeleton: Structure, Organization and functions, Microtubules, Microfilaments and Intermediate filaments.

Unit-3 Chromosome: Structure and Organization

Discovery, morphology and structural organization, centromere, secondary constriction, telomere, chromonema, euchromatin and heterochromatin, chemical composition and karyotype of chromosomes, Single stranded hypotheses, Folded-fibre hypotheses and nucleosome models, Special types of chromosomes: Salivary gland and Lambrush chromosomes.

Unit-4 Protein Transport and Translocation

Membrane transport, Principles of membrane transport, Channel proteins, carrier proteins, Passive and active transport, Intracellular transport and protein sorting, Signal peptides and protein targeting, Entry and passage of proteins through endoplasmic reticulum, Processing and sorting of proteins in Golgi Apparatus, Endosomes and lysosomes, Nuclear transport.

Unit-5 Cellular Communication

Cell junctions, Cell adhesion and extracellular matrix, General principles of cell signaling, Cell Division, Cell cycle, mitosis and meiosis, Events in different phases of cell cycle, Genetic regulation of cell proliferation, Cell transformation and malignancy.

SUGGESTED READINGS

1. Cell and Molecular Biology: P.K. Gupta, Rastogi Publications.
2. Cell and Molecular Biology: G. Karp, John Wiley & Sons.
3. Cell and Molecular Biology: De Robertis & De Robertis, B.I. Waverly Pvt. Ltd.
4. The Cell: A Molecular approach: Cooper and Hausman, Sinauer.

Laboratory Exercise Disciplinary Major CELL BIOLOGY ZOODMP-706	Credit – 2
	Marks – 50

- Preparation of temporary stained squash of onion root tip to study various stages of mitosis.
- Study of various stages of meiosis.
- Preparation of permanent slide to show the presence of Barr body in human female blood cells/cheek cells.
- Preparation of permanent slide to demonstrate:
  a) DNA by Feulgen reaction
  b) DNA and RNA by MGP
  c) Mucopolysaccharides by PAS reaction
  d) Protein by Mercurobromophenol blue/ Fast Green
- To study permanent slides of different stages of cell cycle.

Semester VII	Disciplinary Major – III ANIMAL BIOTECHNOLOGY ZOODMT-703	Credit	4
		Marks	100 (60+40)

COURSE CONTENT/SYLLABUS

Unit-1 **Introduction:**

Concept and scope of biotechnology, Restriction enzymes: Nomenclature, detailed study of Type II.

Unit-2 **Techniques in Gene Manipulation:**

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

Transformation techniques:

Calcium chloride method and electroporation.

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

Unit-3 **Molecular Techniques:**

Southern, Northern and Western blotting, DNA sequencing: Sanger method, Polymerase Chain Reaction, DNA Finger Printing and DNA micro array.

Unit-4 **Genetically Modified Organisms:**

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

Applications of transgenic animals:

Production of pharmaceuticals, production of donor organs, knock out mice.

Unit-5 **Culture Techniques and Applications:**

Animal cell culture, Expressing cloned genes in mammalian cells

Recombinant DNA in medicines:

Recombinant insulin and human growth hormone, Gene therapy.

SUGGESTED READINGS

1. Brown, T. A. (1998). Molecular Biology Labfax II: Gene Cloning and DNA Analysis. 2nd Edition, Academic Press, California, USA.
2. Glick, B.R. and Pasternak, J.J. (2009). Molecular Biotechnology - Principles and Applications of Recombinant DNA. 4th Edition, ASM press, Washington, USA.
3. Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M. (2009). An Introduction to Genetic Analysis. 9th Edition. Freeman and Co., N.Y.,USA.
4. Snustad, D.P. and Simmons, M.J. (2009). Principles of Genetics. 5th Edition, John Wiley and Sons Inc.
5. Watson, J.D., Myers, R.M., Caudy, A. and Witkowski, J.K. (2007). Recombinant DNA-Genes and Genomes- A Short Course. 3rd Edition, Freeman and Co., N.Y.,USA.

Semester VII	Disciplinary Major – IV Ecology ZOODMT-704	Credit	4
		Marks	100 (60+40)

COURSE CONTENT/SYLLABUS

Unit-1 Basic Ecology

Introduction to Ecology, Principles and Scope of Ecology, Structure and Functions of Ecosystems, Abiotic and Biotic components, Flow of energy and cycling of materials; water, carbon, nitrogen and phosphorus, Trophic pyramids and food webs, Ecosystems Types and Diversity

Unit-2 Population and community Ecology

Population characteristics, Population growth, Population regulation, Biotic community, Biotic characteristics, Diversity index, Nature and structure of community, Ecological interactions, Prey-predator interactions, Lotka-Volterra model, Succession, Types and mechanisms of succession

Unit-3 Behavioral Ecology

Proximate and ultimate causes of behavior, Learning, Communication, Patterns of communication, social organization, Pheromone and behaviour, Biological rhythms and clocks, Sexual selection and mating system, Aggressive and territorial behaviour

Unit-4 Biodiversity and its conservation

Biodiversity & its principles. level of biodiversity: alpha, beta, gamma diversity, National Parks and Sanctuaries, Reserve Designs and restoration of degrade habitats, Important conservation projects undertaken in India: Project Tiger, Project Elephant, Rhino reintroduction and Tiger-reintroduction Program.

Unit-5 Pollution & Acts

Pollution & its Types, Global warming, green house effects, ozone layer depletion, acid rain, impact and control measures, concept of sustainable development, Toxicants, Exposure, Bioindicators, biomagnification, control and prevention Acts of pollution

SUGGESTED READINGS

1.Animal Behaviour: An evolutionary approach By John Alcock
2.Fundamentals of Ecology By Eugene P. Odum and Gray W. Barrett
3.Environmental Pollution and Control, 4th ed. by J. Jeffrey Peirce, P. Aarne Vesilind, Ruth F. Weiner
4.Environment Biology and Ecology, J.P.Shukla, Amit Pandey, Kamleshwar Pandey, Narendra Publishing House Delhi
5.Fundamentals of Toxicology, K P Pandey, J.P. Shukla & S. P. Trivedi, New Central Book Agency, Kolkata
6.Fundamentals of Aquatic Toxicology, Rand GM & Petrocelli SR. Hemisphere Publ. Corp.
7.Toxicology, The Basic Science of Poison, Casarett and Doull's, eighth edition, McGraw-Hill Education

B. Sc. Zoology RESEARCH DEGREE

EIGHTH SEMESTER

Course Structure * Exit option with B.Sc. Bachelor Hons./ Research Degree in Zoology.

Paper Category	Title of the Paper	Credits	Contact Hrs./Week	Maximum Marks	Four components carrying 20 Credits				End Semester Examination Marks	Min. Pass Marks in End. Sem. Exam.
					Lab Work/Field Work/Field Survey/Industrial Visit/Institutional Visit/ Data Collection/ Internship etc. ZOOD-801-A	Pre-Submission Presentation ZOOD-801-B	Report Writing/Write-up/Dissertation Report ZOOD-801-C	Viva Voce ZOOD-801-D		
Disciplinary Major	Dissertation **ZOOD-801**	20	Hrs.	500	4	4	8	4	-	200
Total		**20**	**-**	**500**					**-**	**200**

*** Exit option with B.Sc. Bachelor Hons./Research Degree in Zoology.**

Semester VIII	DISSERTATION ZOOD-801	Credit	20
		Marks	500

- The student has to prepare a research proposal for his/her internship work and should submit the internship proposal along with the power-point presentation.
- The internship supervisor gives the final marks to the candidate based on his/her performance during the Internship.

B.Sc. & M. Sc. Zoology
NINTH SEMESTER
Course Structure

Paper Category	Title of the Paper	Credits	Contact Hrs./Week	Maximum Marks	Sessional Marks (40)		End Semester Examination Marks	Min. Pass Marks in End. Sem. Exam.
					10x2 Test Average	20 (10 Assignment +10 Attendance)		
Disciplinary Major – I	Non-Chordates **ZOODMT-901**	4	4 Hrs.	100	20	20	60	24
Disciplinary Major – II	Biosystematics and Quantitative Biology **ZOODMT-902**	4	4 Hrs.	100	20	20	60	24
Disciplinary Major – III	Cell and Molecular Biology **ZOODET-903**	4	4 Hrs.	100	20	20	60	24
Disciplinary Major – IV	Molecular Techniques **ZOODET-904**	4	4 Hrs.	100	20	20	60	24
Laboratory Exercise – I	Non-Chordates **+** Biosystematics and Quantitative Biology **ZOODMP-905**	2	2 Hrs.	50	-	-	50	20
Laboratory Exercise – II	Cell and Molecular Biology+ Molecular Techniques **ZOODMP-906**	2	2 Hrs.	50	-	-	50	20
Total		**20**	**-**	**500**	**160**		**340**	**136**

Semester IX	Disciplinary Major NON-CHORDATES ZOODMT-901	Credit	4
		Marks	100 (60+40)

COURSE CONTENT/SYLLABUS

Unit-1 Grades of Organization, Types of Coeloms

Protozoa: Nutrition, Osmoregulation, reproduction; evolution of sex, Protozoan parasites and diseases and host immune evasion.

Unit-2 **Metazoa**: Organization & polarity

Porifera: Skeleton, canal system and reproduction, sponge industry

Unit-3 **Coelenterate (Cnidaria):** Polymorphism, defensive structures and their mechanism; coral reefs and their formation; metagenesis.

Ctenophora: General Characters.

Helminthes: Evolution of parasitism and parasitic adaptation, pathogenic symptoms and human diseases.

Unit-4 **Annelida:** Coelom and metamerism; modes of life in polychaetes; Adaptive radiation, Parasitic Adaptation.

Arthropoda: Biological Success, Larval forms and parasitism in Crustacea; respiration in arthropods, modification of mouth parts in insects, metamorphosis in insects and its hormonal regulation, social behaviour, pest control.

Unit-5 **Mollusca:** Formation of shell, Feeding, respiration, locomotion, Molluscan Larvae, torsion and detorsion in gastropods. Significance of Neopilina in Molluscan phylogeny, Economic Importance of Mollusca.

Echinodermata: Symmetry, larval forms; Water vascular System, Autonomy and regeneration.

SUGGESTED READINGS

1. Barnes, RSK., Calow P, Olive PJW., Golding DW. & Spicer JI., (2002): The Invertebrates : A New Synthesis, 3rd Edition, Blackwell Science.
2. Barrington EJW (1979): Invertebrates Structure and Function. II Edition Oxford University Press.
3. Marshall, AJ Williams WD (1972): The text book of zoology invertebrates, seventh edition. The Macmillan Publishers Limited .

Semester IX	Disciplinary Major BIOSYSTEMATICS AND QUANTITATIVE BIOLOGY ZOODMT-902	Credit	4
		Marks	100 (60+40)

COURSE CONTENT/SYLLABUS

Unit-1 **Basic concepts:**

Taxonomy, Systematics and Biosystematics, Stages in Taxonomic Procedure, Importance and applications of Biosystematics.

Trends in Biosystematics:

Chemotaxonomy, Molecular taxonomy and Cytotaxonomy

Unit-2 **Identification Keys in Taxonomy and Taxonomic Classification**

Biodiversity Indices: Shannon-Weinner index, Dominance index, Similarity and dissimilarity index, Association index.

Unit-3 **Nature and scope of Biostatistics:**

Primary and secondary data, Methods of data representation (Tabulation and Graphics), Frequency distribution, Central tendency, Dispersion, Hypothesis testing (t-test, Chi-square test), R x C Contingency table.

Unit-4 **Bivariate Data:**

Central and raw moments up to fourth order, Skewness, Kurtosis and their measures, Analysis of variance (ANOVA) - One way and two way, Post hoc test, Correlation, regression

Unit-5 **Probability:**

Concept, Classical and statistical definition of probability, Additive and multiplicative theorems of probability, Conditional probability and Baye's theorem, Binomial, Poisson and normal distributions with their properties and applications

Non-parametric statistics: Mann-Whitney U, Wilcoxon matched-pairs test, Kruskal- Wallis test

SUGGESTED READINGS

1. Principle of Animal Taxonomy: G. G. Simpson, Oxford IBH Publishing Company.
2. The Diversity of Life: E. O. Wilson, WW Northem and Company.
3. Biodiversity: E. Mayer, Academic Press, London.
4. Statistical methods 8th Ed: GW Snedecor and WG Cochran, East-west press.
5. Biomtery, 3rd Ed.: RR Sokal, and FJ Rohlf, Freeman.
6. Biostatistical Analysis, 5th Ed.: JH Jarr, Pearson.
7. Computational book of statistics, 2nd Ed.: J.L Bruning and, B.L. Scot Kintz, Foresman and company.
8. Medical Statistics at a Glance: A Petrie, and C. Sabin, Blackwell Science.
9. Statistics, 4th Ed.: DH Freedman R Pisani, R Purves, WW Norton and Company.

Semester IX	Disciplinary Major CELL AND MOLECULAR BIOLOGY ZOODET-903	Credit	4
		Marks	100 (60+40)

COURSE CONTENT/SYLLABUS

Unit-1 **Biomembranes and Transport:**

Structural and functional aspects of plasma membrane, Active and passive membrane transport, sodium pump, Endocytosis and exocytosis, Role of coated vesicles in transport..

Unit-2 **Cellular Receptors and Signaling:**

Cell surface receptors, Signaling via G-Protein Linked receptors, cAMP, IP_3, Diacylglycerol as second messengers, adenylate cyclase system, inositol phosphate pathway, role of Ca^{2+} ions in signaling process; Signal transduction via enzyme-linked surface receptors, receptor tyrosine kinases, Steroid receptors.

Unit-3 **Transcription:**

Mechanism of transcription in prokaryotes and eukaryotes, RNA polymerase, Promotors, Transcription factors, Concept of anti-termination.

RNA Processing:

Post-transcriptional processing of rRNA, tRNA and hnRNA among eukaryotes, Discovery of introns and role of spliceosomes in introns removal.

Unit-4 **Translation:**

Genetic code; Mechanism of translation in prokaryotes and eukaryotes, Post-translational modifications.

Protein Targeting and Sorting:

Concept of signal peptide, Signal recognition particle (SRP), SRP receptor, transport of soluble and membrane bound proteins in Endoplasmic reticulum.

Unit-5 **Organization and functions of eukaryotic cell organelles:**

Mitochondria: Membrane structure, Genome organization, Transport of proteins.

Chloroplasts: Genome organization, Transport of proteins.

Golgi apparatus: Role in protein glycosylation and transport.

Lysosomes: Intracellular digestion, sorting of lysosomal enzymes.

SUGGESTED READINGS

1. Becker's World of the Cell, 8th Ed.: J.Hardin, G.P. Bartoni, Pearson Education.
2. Molecular Cell Biology, 7th Ed.: Lodish, Baltimore, W. H. Freeman and Co.
3. Molecular Biology of the Cell, 5th Ed.: Bruce Albert, Garland Publication, NY.
4. iGenetics: A Molecular Approach, 3rd Ed.: P.J. Russel, Pearson Education.
5. Principles of Genetics, 8th Ed.: Gardner, Simmons and Snustad, John Wiley.
6. Cell and Molecular Biology: P.K. Gupta, Rastogi Publications.
7. Cell and Molecular Biology: De Robertis and De Robertis, B.I. Waverly Pvt. Ltd.

Semester IX	Disciplinary Major Molecular Techniques ZOODET-904	Credit	4
		Marks	100 (60+40)

COURSE CONTENT/SYLLABUS

Unit-1 **Centrifugation:** Basic principle, Types of rotors, Clinical, High speed and ultracentrifuge.

Electrophoresis: Agarose and Polyacrylamide Gel, Two-dimensional, Iso-electro focussing.

Microbiological Techniques: Culture of bacterial cells, recombinant techniques, Transformation, Restriction, ligation and cloning.

Unit-2 **Spectroscopy:** Beer-Lambert's law, Molar extinction coefficient and calculation, Absorption spectrum, Colorimeter and UV-Vis Spectrophotometer, NMR, Spectrofluorometry.

Unit-3 **Chromatography:** Paper and thin layer chromatography, Column chromatography, Gel filtration, Ion-exchange, HPLC, FPLC, MALDI (TOF), Affinity purification.

Unit-4 **Bioinformatics and Molecular Biology Techniques:**

Introduction and scope of Bioinformatics, Data bases Nucleic acid sequences Genomes, Protein sequence and structures, Access to molecular biology data bases Entrez Sequence retrieval system (SRS) Protein identification resource (PIR) , Sequence alignments and phylogenetic trees.

Unit-5 Southern and northern blotting, Western blotting, ELISA, PCR, FACS, *In situ* hybridization, FISH, RISH, immunostaining, Microarray, DNA protein Interaction methods, EMSA, Protein-protein interaction methods, Pull down assay, Far western Blot, FRET-FREM, Yeast two hybrid system.

SUGGESTED READINGS

1. Principles and techniques of Biochemistry and Molecular Biology, 7th Ed: K. Wilson, J. Walker, Cambridge Univ. Press. UK
2. An Introduction to Practical Biochemistry, 3rd Ed : D. T. Plummer, Tata-McGraw Hill
3. Modern Experimental Biochemistry and Molecular Biology 2nd Ed: R. Boyer Benjamin/Cumin
4. Physical Biochemistry, 2nd Ed: D.M. Freifelder, Freeman Press.
5. Analytical Biochemistry, 3rd Ed. D. Holme, J. Peck, Tata McGraw Hill.
6. Experimental Biochemistry, 3rd Ed: R. L. Switzer, L.F. Garrity, Freeman Press.

Laboratory Exercise – Part I NON-CHORDATES ZOODMP-905	Credit – 2 Marks – 50

- Study of prepared slides and specimens of different animals from different following phyla of invertebrates (Spotting)
  - **Protozoan Parasites**- *Entamoeba coli, Entamoeba gingivalis, Plasmodium, Balantidium, Trypanosoma, Leishmania.*
  - **Porifera** – *Euplectella, Spongilla, Euspongia, Gemmule formation , Amphiblastula Larva*
  - **Coelenterata** - *Physalia, Corallium, Admasia,, Scyphistoma Larva , Ephrya Larva*
  - **Platyhelminthes** - *Schistosoma, Diphyllobothrium, Echinococcus, Larvae of Faciola hepatica, Scolex of Taenia solium Cysticercus Larva*
  - **Aschelminthes** - *Enterobius, Dracunculus, Wuchereria, TS of Male and female Ascaris*
  - **Annelida** - *Acanthobdella Hirudo medicinalis, Bonellia, Heteroneries, Parapodium of Nereis*
  - **Arthropoda** - *Cypris, Sacculina, Eupagurus, Scolopendra, Lepisma, Schistocerca,Pediculus, odentotermes, Dragon fly, Cimex, Papilio demoleus, Apis, Xenopsylla, Limulus, Ixodes, Arthropods Larvae, Types of Mouth parts, Sting of Apis*
  - **Mollusca** - *Pinctada, Teredo, Nautilus, TS of Unio gill, Glochidium Larva*
  - **Echinodermata** - *Echinus, Ophiothrix, Pedicellaria, Larva of Asterias – Bipinneria and Brachiolaria.*
- Demonstration of nervous system of Cockroach (*Periplaneta americana*) (Major Dissection).
- Demonstration of nerve ring of Earthworm (*Pheretima posthuma*) (Minor Dissection).
- Dissect out the head and different mouth parts of insect and prepare the permanent slides.
- Demonstration of *Loligo nervous system.*
- Dissect out the hind legs (Pollen basket) and sting apparatus of Honey Bees and prepare the permanent slides.
- Insect collection and preservation in insect box.

Laboratory Exercise – Part II
BIOSYSTEMATICS AND QUANTITATIVE BIOLOGY

- To Calculate Shannon-Winner Index
- To draw a line diagram.
- To draw a Bar diagram.
- To find the Arithmetic Mean.
- To Calculate the probability.
- To find the median.
- To calculate Standard Deviation.
- To calculate Standard Deviation of Two Groups.
- To study the problem related to t-test for mean.
- To study the problem related to Chi-squared test of goodness of fit.
- To study the problem related to test of proportion using Z-test.
- To study the problem related to One way ANOVA.

Laboratory Exercise – Part -I CELL AND MOLECULAR BIOLOGY ZOODMP-906	Credit - 2 Marks - 50

- Preparation of Lampbrush chromosome for grasshopper testis and to study meiosis in it.
- Preparation of Polytene Chromosomes from Drosophila Larvae and to study polytene chromosome in it.
- Quantitative estimation of protein by Lowry's Method.
- Quantitative estimation of protein by Bradford method.
- Immunohistochemistry.
- Electrophoretic Separation of Proteins: Sodium Dodecyl Sulfate- Polyacrylamide Gel Electrophoresis (SDS-PAGE).
- Demonstration of Western Blotting.
- Agarose Gel Electrophoresis for the Separation of DNA Fragments.
- Demonstration of Enzyme-linked immunosorbent assay (ELISA).
- Media Preparation and Bacteriological Tools.

Laboratory Exercise – Part II
Molecular Techniques

- Temporary slide preparation from fish scales.
- Preparation of different fraction of homogenate using centrifuge.
- Preparation of block for sectioning using microtome.
- Preparation of competent cell.
- Transformation of bacterial using calcium chloride.
- Retrieval of amino-acid sequence and structure of protein from NCBI.
- RNA isolation from tissue samples.
- cDNA synthesis using PCR.
- Microarray Analysis for gene expression.
- Real-Time PCR Analysis for quantitative gene expression.
- *In-situ* Hybridization for identifying mRNA expression.
- 2D-Gel Electrophoresis to separate proteins.
- MALDI for identifying proteins.
- Checking of expression of a protein using immunoblotting.
- Immunofluorescence for localization of proteins.

B.Sc. & M. Sc. Zoology

TENTH SEMESTER*
Course Structure

Paper Category	Title of the Paper	Credits	Contact Hrs./Week	Maximum Marks	Sessional Marks (40)		End Semester Examination Marks	Min. Pass Marks in End. Sem. Exam.
					10x2 Test Average	20 (10 Assignment +10 Attendance)		
Disciplinary Major – I	Chordates **ZOODMT-1001**	4	4 Hrs.	100	20	20	60	24
Disciplinary Major – II	Microbiology and Immunology **ZOODMT-1002**	4	4 Hrs.	100	20	20	60	24
Disciplinary Major – III	Biochemistry **ZOODET-1003**	4	4 Hrs.	100	20	20	60	24
Disciplinary Major – IV	Molecular Endocrinology **ZOODET-1004**	4	4 Hrs.	100	20	20	60	24
Laboratory Exercise – I	Chordates+ Microbiology and Immunology **ZOODMP-1005**	2	2 Hrs.	50	-	-	50	20
Laboratory Exercise - II	Biochemistry+ Molecular Endocrinology **ZOODMP-1006**	2	2 Hrs.	50	-	-	50	20
Total		**20**	**-**	**500**	**160**		**340**	**136**

***Exit option with One Year/Two Year Master Degree.**

Semester X	Disciplinary Major CHORDATES ZOODMT-1001	Credit	4
		Marks	100 (60+40)

COURSE CONTENT/SYLLABUS

Unit-1 **Protochordate:**

Comparison of three protochordates subphyla (Hemichordates Urochordates, Cephalochordates), Significance of protochordates, Ciliary feeding, Neural complex, Retrogressive metamorphosis.

Phylogenetic status of cyclostomata, Phylogeny and evolution of vertebrates, Endostyle structure and function in higher chordates, First jaws vertebrates.

Unit-2 **Pisces:**

Dipnoi, Scales, Respiration, Lateral line system, Locomotion and Migration, Parental Care, Flying fish.

Amphibia:

Origin of tetrapods, Skelton system, Limbless amphibians, Metamorphosis, parental care, Neoteny paedomorphosis. Flying frog.

Unit-3 **Reptilia:**

Origin of reptiles, Evolution and adaptive radiation, Skeleton and skull types, status of Sphenodon and crocodiles, Flying lizard.

Poisonous and non-poisonous snake, Locomotion, Hearing, Poison apparatus and biting mechanism, Venom and antivenom with first aid.

Unit-4 **Aves:**

Origin of birds, Skeleton and beak types, Flightless and flight birds and its distribution, origin of flight, Flight mechanism, flight adaptation, Acoustic Communication, migration, Archeopteryx as Connecting link.

Unit-5 **Mammalia:** Origin of mammals; dentition; general features of egg laying mammals, pouched-mammals, Placental Mammals, Toothless mammals, aquatic mammals and flying Mammals, primates, dentition, mammary gland, Uterus modification.

SUGGESTED READINGS

1. Barrington EJW, Oliver and Boyd: Biology of hemichordates and Protochordates.
2. Romer AS, Parsons T, Saunders-The vertebrate Body VIth Edition
3. Walter HE, Sayles LP: Biology of the vertebrates, Macmillan
4. Colbert EH,: Evolution of vertebrates, John willey & Sons Inc.
5. Young, J. Z. . The Life of Vertebrates. 3rd Edition. Oxford university press.
6. Pough H. Vertebrate life, VIIIth Edition, Pearson International.
7. Darlington P.J. The Geographical Distribution of Animals, R.E. Krieger Pub Co.

Semester X	Disciplinary Major MICROBIOLOGY AND IMMUNOLOGY ZOODMT-1002	Credit	4
		Marks	100 (60+40)

COURSE CONTENT/SYLLABUS

Unit-1 **Introduction of Microbes:**

Diversity of microbes, Systematics, Phylogeny, Major groups, bacteria, virus, bacteriophages, bacterial reproduction, antimicrobial agents, significance of microbes in the industry.

Unit-2 **Genome and gene regulation in bacteria:**

Organization of bacterial genome, Regulation of gene expression in bacteria, The lac Operon, Catabolic repression, The trp operon, Bacterial expression system.

Viruses:

Structure, Replication, Infection, Culture and growth, viral assay.

Bacteriophages:

Phage life cycle, T4 Lytic pathway, λ Lysogenic pathway, M13 Phage.

Unit-3 **Introduction of immune system:**

Infection and its consequences, Microbe habitat and immune defence, Pathogen protective mechanism, Damage caused by pathogens. Innate and adaptive immunity, Immune cells; type and production, immune tolerance, concept of clonal selection, complement system.

Unit-4 **Immunity to Bacteria and Viruses:**

Humoral Immunity, Antigen and Haptens, Primary and Secondary Response, Cell mediated immunity, T-cell receptors, MHC complexes.

Antibody: types, structure, function, production and diversity.

Antigen: processing and presentation, T helper cell and lymphocyte activation, Role of cytotoxic T-cell.

Unit-5 **Immune system failure, disease and Immunological techniques:** Immunodeficiency diseases, Hybridoma and monoclonal antibody, Interferon, Immunotoxins Role in autoimmune disorders, Polyclonal activation by microbial antigens, Modification of cell surface by microbes, Pathogen defence strategies, Defence mechanism, Evasion of immune response.

Vaccination:

Antigen preparation, Adjuvant, Bacterial and viral vaccines, DNA vaccines, Recombinant vaccines, Cytokines, Antiviral chemotherapy.

SUGGESTED READINGS

1. The Prokaryotes: A Handbook on the Biology of Bacteria, 3rd Ed : M. Dworkin, Springer
2. The Physiology and Biochemistry of Prokaryotes, 4th Ed : D. White, J. Drummond, C. Fuqua, Oxford University Press, USA.
3. Microbiology, 7th Ed: L. Prescott, J.P. Harley, D.A. Klein, McGraw Hill.
4. Microbiology, An Introduction, 10th Ed: G.J. Tortora, B.R. Funke, C.L. Case, Benjamin-Cummings.
5. Principles of Molecular Virology, 4th Ed: A.J. Cann, Academic Press, London.
6. Basic Virology, 2nd Ed.: E. Wagner, M.J. Hewlett, Blackwell Scientific, Oxford.
7. Immunology, 8th ED. Richard A Goldsby, Thomas J. Kindt, Barbara A Osborne & Janis Kuby W.H. Freeman and Company, New York.

Semester X	Disciplinary Major **BIOCHEMISTRY** ZOODET-1003	Credit	4
		Marks	100 (60+40)

COURSE CONTENT/SYLLABUS

Unit-1 **Bioenergetics:**

Basic Principles of thermodynamics free energy, Enthalpy and Entropy, Redox Potential and electron transport, ATP- Production (Chemiosmotic model), high energy phosphates, Coupled reactions.

Water:

Hydrogen bonding and structure of water molecule, Ionization of water, Concept of pH and pOH, Colligative properties.

Unit-2 **Biomolecules –**

1. Carbohydrates:

Classification and structure, Monosaccharides, Disaccharides and Polysaccharides, Glycosaminoglycans and Proteoglycans.

2. Proteins:

Classification and structure, Amino acids classification and general characters, Zwitter ionic properties and titration curves, Peptide bonds, Various levels of structural organization of proteins, disulphide and other types of cross-links, α-helix and other helices, Helix-coil transition, parallel and anti-parallel β-pleated sheets, Ramachandran plot and its significance.

Unit-3 **Biomolecules -**

3. Lipids:

Simple and complex lipids, Glycerophospholipids, Sphingolipids, Gangliosides, Eicosanoids and prostaglandins.

4. Nucleic acids and Nucleotides:

Biosynthesis of purines and pyrimidines, *de novo* and Salvage pathway, Various confirmations of nucleotides, Glycosidic bond rotation, Base-stacking.

Unit-4 **Enzymes:**

Nomenclature and classification of enzymes, Vitamins as co-enzymes, Enzyme Kinetics Michales-Menten equation, Determination of V_{max} and K_m, Factors affecting the enzyme activity, Enzyme inhibition - Competitive & non-competitive, Mechanism of enzyme action, active sites, Chymotrypsin as a model, Regulation of enzyme activity, allosteric enzymes, PFK, ATC (Phosphofructokinase /Aspartate trans-carbamylase.

Unit-5 **Metabolism:**

1. Carbohydrate Metabolism:

Glycolysis, Krebs cycle, pentose Phosphate pathway, Glycogenesis, Glycogenolysis, Gluconeogenesis, hexomonophosphate shunt.

2. Protein metabolism:

Transamination and deamination, incorporation of amino acids into TCA cycle, integration between urea cycle and TCA cycle.

3. Lipid metabolism:

Fatty acid oxidation and biosynthesis of cholesterol, ketone bodies.

4. Metabolic defects of carbohydrate, amino acid and fat metabolism.

SUGGESTED READINGS

1. Lehninger's Principles of Biochemistry 6th Ed.: Nelson and Cox, McMillan Worth Publishers.
2. Biochemistry 4th Ed.: Voet and Voet, John Wiley and Sons, Inc. USA.
3. Biophysical Chemistry Vol. I, II and III: Cantor and Schimmel, Freeman.
4. Biochemistry: Zubey, WCB.
5. Harper's Illustrated Biochemistry 29th Ed.: R.K. Murray et al., Prentice-Hall International Inc.
6. Biochemistry 4th Ed.: Christopher K. Mathews, Pearson Education.

Semester X	Disciplinary Major MOLECULAR ENDOCRINOLOGY ZOODET-1004	Credit	4
		Marks	100 (60+40)

COURSE CONTENT/SYLLABUS

Unit-1 **Chemistry of Hormones**

Chemical nature of hormones, Hormone secretions (apocrine, holocrine, and merocrine), Hormone delivery, Hormonal feedback in homeostasis, hormones in sexual behaviour, reproductive pheromones.

Unit-2 **Hypothalamus : Anatomy and physiology**

Anatomy and physiology of endocrine hypothalamus: Hypothalamic nuclei, Hypophysiotropic hormones (TRH, GnRH, CRH, Somatostatin, Nitric oxide, Monoamines, Endorphin).

Pituitary gland:

Adenohypophysial hormones: Chemistry and physiological roles of Somatotropin and Prolacin, Glycoprotein hormones (FSH, LH and TSH), Pro-opiomelanocortin (ACTH, MSH, β-LPH & β-endorphin).

Pineal gland:

Melatonin synthesis, rhythms and photoperiodic measurement. Pineal and biological clock.

Unit-3 **Mechanism of hormone action:**

Structure and function of Plasma membrane receptors, Kinase cascade receptors, G-protein, Second messengers of hormones, cyclic AMP – protein kinase A, PLC-protein kinase C, Tyronine kinase and Nitric oxide signaling pathway, Eicosanoids and hormone action

Intracellular receptors:

Thyroid hormone receptors, Calmodulin, Steroid hormones signaling (genomic and nongenomic pathways)

Pathophysiology of hormone receptors and hormone analogues as drugs.

Unit-4 **Thyroid Gland:**

Biosynthesis of thyroid hormones, Control of secretion, Physiological roles
Role of parathormone, Calcitonin and Vitamin D in calcium homeostasis

Endocrine Pancreas:

Biosynthesis and physiological actions of Insulin and Glucagon.

Unit-5 **Steroid hormone biosynthesis and pathways**

Testis: Organization, Control of secretion and Physiological roles of androgens, Inhibin.

Ovary: Organization and Physiological roles of Estrogen, Progesterone and Relaxin and inhibin.

Adrenal Cortex: Control and Physiological roles of mineralocorticoid and glucocorticoid secretions.

Adrenal Medulla: Catecholamine biosynthesis, release and its physiological roles.

SUGGESTED READINGS

1. General Endocrinology C. Donnell Turner Pub- Saunders Toppan.
2. Endocrinology: An Integrated Approach; Stephen Nussey and Saffron Whitehead. Oxford: BIOS Scientific Publishers; 2001.
3. Hadley, M.E. and Levine J.E. 2007. Endocrinology, 6th Edition.

Laboratory Exercise – Part I CHORDATES ZOODMP-1005	Credit – 2 Marks – 50

- **Protochordate**: Doliolum, Oikopleura Amphioxus, Petromyzon
- **Pisces:** *Torpedo, Chimaera, Notopterus, Labeo rohita, Anabas, Exocoetus, Hippocampus,* Lung Fishes - *Protopterus, Lepidosiren paradoxa, Neoceratodus porsteri*
- **Amphibia** - *Ichthyophis, Necturus, Ambystoma maculatum, Axolotl Larva, Alytes, Hyla, Rhacophorus.*
- **Reptilia** - *Phrynosoma, Draco, Chamaeleon,Varanus, Typhlops, Python,Vipera Naja naja,Crocodylus, Alligator, Gavialis* Extinct Reptiles (Dinosaurs) Models - *Rhamphorhynchus*
- **Aves** - *Gyps bengalensis, Pavo cristatus, Psittacula euparia, Corvus splendens, Archaeopteryx lithographica*, Types of Beaks in Birds, Types of Feet or Claws in Birds, Types of feathers.
- **Mammalia** - *Ornithorhynchus, Echidna(Tachyglossus)*, Macropus. *Pteropus, Dasypus, Manis, Funambulus, Rattus rattus, Hystrix, Herpestes, Felis leo, Platanista gangeticus, Equus, Rhinoceros, Sus scrofa , Giraffa camelo paradalis, Moschus moschiferous.*

Laboratory Exercise – Part II
MICROBIOLOGY AND IMMUNOLOGY

- Handling and maintenance of bright field microscopy.
- **Micrometry** -Measurement of microorganisms.
- **Staining** -Simple, Gram's, Acid -fast, Spore, Capsule.
- **Pure culture techniques**: Streak plate, pour plate, spread plate.
- **Growth curve** -Non-visual method; Turbidity method-Spectrophotometer.
- Effect of various factors on growth of bacteria - Temperature, pH
- Biochemical tests for identification of bacteria.
- Antibiotic sensitivity test- Kirby-Bauer & Stoke's methods.
- Isolation of genomic DNA from bacteria.
- Isolation of plasmid DNA.
- **ABO Blood grouping** -Rh typing and cross matching.
- Agglutination tests.
- WIDAL-slide and tube test.
- RA test, ASO test, CRP test, TPHA test.
- Precipitation reaction
  - Ouchterlony's Double Immunodiffusion test (ODD).
  - Counter immunoelectrophoresis (CIE).
- Rapid plasma reagin test - VDRL test.
- COVID-19 Rapid Antigen Test.
- Analysis of serum proteins by electrophoresis.

SUGGESTED READINGS

1. The Prokaryotes: A Handbook on the Biology of Bacteria, 3rd Ed: M. Dworkin, Springer.
2. The Physiology and Biochemistry of Prokaryotes, 4th Ed : D. White, J. Drummond, C. Fuqua, Oxford University Press, USA.
3. Microbiology, 7th Ed: L. Prescott, J.P. Harley, D.A. Klein, McGraw Hill.
4. Microbiology, An Introduction, 10th Ed: G.J. Tortora, B.R. Funke, C.L. Case, Benjamin-

Cummings.
5. Principles of Molecular Virology, 4th Ed: A.J. Cann, Academic Press, London.
6. Basic Virology, 2nd Ed.: E. Wagner, M.J. Hewlett, Blackwell Scientific, Oxford.
7. Microbiology: A Laboratory manual; 6th Edition, James G Cappuccino & Natalie Sherman (2004). Published by Pearson Education.
8. Immunology, 8th Edition. Richard A Goldsby, Thomas J. Kindt, Barbara A Osborne & Janis Kuby W.H. Freeman and Company, New York.
9. Immunology, Ivan Roitt, Jonathan Brostolf & David Male (2004). 6th Edition, reprinted, Mosby Publications, Edinburgh.
10. Myer's and Koshi's Manual of Diagnostic Procedures in Medical Microbiology and Immunology / Serology (2001). Published by Department of Clinical Microbiology, CMC and Hospital, Vellore, Tamil Nadu.

Laboratory Exercise – Part I BIOCHEMISTRY ZOODMP-1006	Credit – 2 Marks - 50

- Estimation of muscle and liver glycogen.
- Estimation of protein by Biuret and Lowry methods.
- Estimation of amino acid by Ninhydrin method.
- Estimation of DNA and RNA.
- Estimation of serum total cholesterol.
- Estimation of vitamin - C by 2,6- dichlorophenol indophenols method.
- Estimation of Ammonia (Nesslerisation method) and uric acid.
- The effect of pH and temperature on enzyme activity.
- The effect of concentration of enzyme activity.

SUGGESTED READINGS

1. Principles and techniques of Biochemistry and Molecular Biology, 7th Ed: K. Wilson, J. Walker, Cambridge Univ. Press. UK.
2. An Introduction to Practical Biochemistry, 3rd Ed: D. T. Plummer, Tata-McGraw Hill.
3. Modern Experimental Biochemistry and Molecular Biology 2nd Ed: R. Boyer, Benjamin/Cumin
4. Physical Biochemistry, 2nd Ed: D.M. Freifelder, Freeman Press.
5. Analytical Biochemistry, 3rd Ed. D. Holme, J. Peck, Tata McGraw Hill.
6. Experimental Biochemistry, 3rd Ed: R. L. Switzer, L.F. Garrity, Freeman Press.

Laboratory Exercise
MOLECULAR ENDOCRINOLOGY

- Surgical sterilization of male and female rats/mouse.
- To perform adrenalectomy in rats/mouse.
- Spectrophotometric method for detection of Nitrate and Nitrite.
- Estimation of plasma level of steroid hormone using ELISA.
- Immunohistochemistry/Immunocytochemistry.

SUGGESTED READINGS

1. Hadley, M.E. and Levine, J.E. 2007.Endocrinology.
2. Katrina M. Miranda,1 Michael G. Espey, and David A. Wink. A Rapid, Simple Spectrophotometric Method for Simultaneous Detection of Nitrate and Nitrite. NITRIC OXIDE: Biology and Chemistry Vol. 5, No. 1, pp. 62–71 (2001).
3. Immunohistochemistry vs Immunocytochemistry, Thermo Fisher Scientific.

Doctoral Degree/PhD Programme- Minimum Credits as per Course Work and thesis with publications