

*(Revised syllabus based on CBCS and on the inputs from the Board of Studies and Departmental Committee)*

# **UNIVERSITY OF LUCKNOW**

## **MASTERS IN ZOOLOGY**



## **PROGRAMME BROCHURE**

Head, Department of Zoology  
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## **About the Department**

The Department of Zoology, University of Lucknow, shares its birth with that of the university itself, the year 1921. Zoology is one of the founding departments and main stays of the university and was formed as a result of the bifurcation of the Department of Biology, Canning College. The roots of the department were strengthened by the initial leadership of the officiating head, Dr. G.S. Thapar (Ph.D. London, 1925), and then by the first Head of Department, Dr. K.N. Bahl (D.Sc., D.Phil., Oxford, 1921) in 1923. He successfully nurtured the department till 1950 into an establishing ground and leading light for many Zoology departments of the country. He was succeeded by Prof. G.S. Thapar, who laid the foundation for Helminthology in the country. The next Head, Prof. M.B. Lal, added new heights to the field of Physiology and Experimental Zoology. Later the other faculty also joined the department and carried forward the tradition. The department has been identified as UGC-SAP (DRS-I & II), DST-FIST, DST-PURSE and Centre of Excellence (Dept. of Higher Education, Govt. UP) department.

Current faculty members are contributing in the areas of Protozoology, Parasitology, Environmental Toxicology, Entomology, Chronobiology, Endocrinology, Neurobiology, Fisheries, Human Genetics, Molecular Biology, Bone Biology and Wildlife.

## **Introduction to CBCS (Choice Based Credit System)**

The curriculum based on CBCS pattern provides an opportunity to the students to choose from a range of prescribed courses based on their interests. The CBCS course structure comprises of the core and elective/minor or skill-based content and the evaluation is based on the grading system, which is considered better than the conventional marks system. The grading system provides uniformity in evaluation and computation of the Cumulative Grade Point Average (CGPA) based on student's performance in examinations, which may help students to move across institutions of higher learning. The uniformity in evaluation system can be helpful to employers in assessing the performance of the candidates.

## **Definitions**

1. 'Academic Programme' means an entire course of study that comprises of its structure, course details, evaluation schemes etc. designed to be taught and evaluated in a teaching Department/Centre or jointly under more than one such Department/ Centre.
2. 'Course' is part of an Academic Programme.
3. 'Programme Structure' means a list of courses (Core, Freeze Elective, and Open Elective) that makes up an academic programme, describing the syllabus, credits, teaching hours, evaluation and examination schemes, minimum number of credits required for successful completion of the programme etc. prepared in conformity to University rules.
5. 'Core Course' is a particular programme in which the student is admitted to, and which must be successfully completed to receive the degree. The core course cannot be substituted by any other course.
6. 'Freeze Elective Course' is an optional intradepartmental course. Each Freeze elective has multiple papers within it, which cannot be substituted or changed. Once the student opts for a Freeze Elective, they would be required to study all the included papers across semesters.

‘Open Elective’ is an elective course with beginner level information on the topic, which is available for students of all programmes, including students of same and other departments also.

7. ‘Credit’ means the value assigned to a course which indicates the level of instruction; One hour lecture per week equals 1 credit, 2 hours practical class per week equals 1 credit. The credit for practical could be proposed as part of a course or as a separate practical course.

8. ‘SGPA’ means Semester Grade Point Average calculated for individual semester.

9. ‘CGPA’ is Cumulative Grade Points Average calculated for all courses completed by the students at any point of time. CGPA is calculated each year for both the semesters clubbed together.

10. ‘Grand CGPA’ is calculated in the last year of the course by clubbing together of CGPA of two years, i.e., four semesters. Grand CGPA is being given in Transcript form. To benefit the student a formula for conversation of Grand CGPA into %age is given in the Transcript.

### **M.Sc. Zoology Programme Details**

#### **Programme Objectives (POs)**

The Department of Zoology at University of Lucknow is known for the classical Zoology courses such as Taxonomy, Entomology, Parasitology and Physiology. In later times, modern courses such as Genetics, Cell and Molecular Biology, Chronobiology and Endocrinology were also introduced. Keeping in mind that tradition, the course has been designed in such a way to equip the students with both classical and modern aspects of Zoology. It aims to enable the students to study the animal diversity in Indian subcontinent and appreciate other areas of Zoology such as Aquaculture, Reproductive health, Behavior and Biological time keeping, Cancer Biology, Parasites, and their roles in health and diseases, Bioremediation of pollutants and pesticides, etc.

The free elective courses are divided into 4 groups specific to the department and the students will opt one of them. Besides these, there are (open) electives of interfaculty nature. The department also offers credit/ non value added courses of general importance for the students.

The dissertation in the courses provided will be allotted to the students in Semester III and will be evaluated in Semester IV.

#### **Programme Specific Outcomes (PSOs)**

It is expected that a student after successfully completing four semesters of M.Sc. in Zoology programme would be equipped to dwell deeper to generate, express and defend the knowledge as researcher, understand and extend the advances in zoological sciences and practice it at different educational levels.

#### **Programme Structure**

The M.Sc. in Zoology programme is a two-year course divided into four semesters, each semester is of six months duration. A student is required to complete 96 credits for the completion of course and the award of degree.

Year	Semester	Semester
First year	Semester I	Semester II
Second year	Semester III	Semester IV

### Course Credit Scheme

Semester	Core Course/ MOOCs**			Freeze Elective Course			Open Elective Course			Credit/ Non Credit Value added Courses			Total Credits
	No. of Papers	Credits (T+L)	Total Credits	No. of Papers	Credits (T+L)	Total Credits	No. of Papers	Credits (T)	Total Credits	No. of Papers	Credits (T)	Total Credits	
I	4	16T+8L	24	-	-	-	-	-	-	1	4	4	28
II	4	16T+8L	24	-	-	-	-	-	-	1	-	-	24
III	2	8T+2L+4F	14	1	4T+2L	6	1	4	4	-	-	-	24
IV	-	8D	8	2	8T	8	1	4	4	-	-	-	20
<b>Total Course Credits</b>													<b>96</b>

- For each Core and Freeze Elective Courses (4 credit each), there will be 4 hours of theory teaching per week. For lab (1 credit) there will be two hours of lab work every week. Therefore, for 8 credit lab, there will be 16 hours of lab work every week.
- Field Work will be of 4 credit and Dissertation of 8 credit.
- Open Electives will be of 4 credits.
- 1 Credit (4 credits) and 1 Non Credit Value added course is offered in each semester I and II respectively.
- **Codes:** T, L, F or D defines as Theory, Lab, Field Work or Dissertation, respectively.

### Distribution Scheme of Credits

SEMESTER	SEM I	SEM II	SEM III	SEM IV
CORE COURSES/ MOOCs				
CREDIT VALUE ADDED COURSE				
NON CREDIT VALUE ADDED COURSE				
FIELD WORK				
OPEN ELECTIVE				
FREEZE ELECTIVE				
DISSERTATION				

### Semester Details of M.Sc. Zoology Course

<b>Summary</b>						
<b>Semester</b>	<b>Code</b>	<b>Course</b>	<b>Credits</b>			
			<b>**Theory</b>	<b>Lab</b>	<b>Field</b>	<b>Total</b>
<b>I</b>	MZC101	Non Chordata	4		-	<b>28</b>
	MZC102	Animal Physiology*	4			
	MZC103	Genetics and Molecular Biology	4			
	MZC104	Biochemistry and Cell Biology	4			
	MZC105L	Lab based on MZC101		2		
	MZC106L	Lab based on MZC102-104		6		
	MZCV107	Credited Value Added	4			
<b>II</b>	MZC201	Chordata	4		-	<b>24</b>
	MZC202	Biosystematics, Evolutionary Biology and Biodiversity	4			
	MZC203	Quantitative biology and Bioinstrumentation	4			
	MZC204	Developmental Biology and Immunology*	4			
	MZC205L	Lab based on MZC201		2		
	MZC206L	Lab based on MZC202-204		6		
	MZNCV207	Non Credited Value Added	-			
<b>III</b>	MZC301	Animal Behaviour and Chronobiology	4		4	<b>24</b>
	MZC302	Environmental Biology, Wildlife and Toxicology	4			
	MZFE303 (A-D)	Freeze Elective I	4			
	MZC304L	Lab based on MZC301-302		2		
	MZFE305L (A-D)	Lab based on MZFE303 (A-D)		2		
	MZOE306 (A-D)	Open Elective	4	-		
<b>IV</b>	MZFE401 (A-D)	Freeze Elective II	4	-	-	<b>20</b>
	MZFE402 (A-D)	Freeze Elective III	4			
	MZC403	Dissertation	8			
	MZOE404 (A-D)	Open Elective	4	-		
<b>TOTAL</b>			<b>72</b>	<b>20</b>	<b>4</b>	<b>96</b>

\*Courses with MOOCs credit transfer

**\*\*Theory includes:** Lectures, Mentoring, Tutorials, Group Discussion, Assignments and Quiz.

## I. Freeze Electives

### A. Endocrinology and Reproductive Physiology

MZFE303A Principles of Endocrinology

MZFE401A Biology of Reproduction

MZFE402A Endocrine techniques, disorders and pathophysiologicals

### B. Entomology

MZFE303B Techniques on Insect Taxonomy, Morphology and Ecology

MZFE401B Insect Physiology

MZFE402B Applied Entomology and Pest Management

### C. Fish and Fisheries

MZFE303C Fish Biology and Genetic Resources

MZFE401C Fish Ecology, Aquaculture and Capture Fisheries

MZFE402C Tools and Techniques in Fish and Fisheries Science

### D. Parasitology

MZFE303D General parasitology

MZFE401D Biology of Parasites

MZFE402D Parasitological Techniques

## II. MOOCs

Some of the links for MOOCs are as follows:

<https://www.swayam.gov.in>

<https://www.edx.org/course/subject/biology-life-sciences>

<https://online-learning.harvard.edu/subject/biology>

<https://online.stanford.edu/courses>

<http://www.openculture.com/freeonlinecourses>

### **III. Dissertation**

MZC403A	Chronobiology
MZC403B	Endocrinology and Reproductive Physiology
MZC403C	Entomology
MZC403D	Evolutionary Biology
MZC403E	Fish and Fisheries
MZC403F	Human Genetics
MZC403G	Molecular Biology
MZC403H	Parasitology
MZC403I	Toxicology
MZC403J	Wild life and Biodiversity

Allotment and evaluation of dissertation will be done in Semester III and Semester IV, respectively.

The student will submit dissertation preferably supported by short publications.

The dissertation will be evaluated at the end of Semester IV in two stages.

Stage I: The Evaluation Committee will consist of supervisor, one senior faculty member and the Head of the Department. After evaluation, this three member committee will provide 'Grade' which will cover 70% of the total marks.

Stage II: The candidate will present his work to the external examiner appointed by the BOS and will cover 30% of the total marks.



#### IV: Value Added Course Scheme

Semester	Course	Credit Value Added Courses	Non Credit Value Added Courses	Credits	Total Lectures
I	MZCV107	Science Communication	-	4	60
II	MZNCV207	-	Physiology of Stress and Yoga	-	60
<b>TOTAL</b>				<b>4</b>	<b>120</b>

#### V: Open Electives

Semester	Course	TOPIC	Credits	Total Lectures
III	MZOE306A	Public Health	4	60
	MZOE306B	Fundamentals of Living System		
	MZOE306C	Insects in Human Life		
	MZOE306D	Molecular Diagnostics in Clinical Practice		
IV	MZOE404A	Clocks in the clinic	4	60
	MZOE404B	Biodiversity and Conservation		
	MZOE404C	Aquaculture Management and Entrepreneurship		
	MZOE404D	Human Parasitology		
<b>TOTAL</b>			<b>8</b>	<b>120</b>

### Semester wise Details of M.Sc. Zoology Course

<b>Paper Codes:</b> The first letter (M) in a paper code defines as M.Sc. course, the (Z) defines as a course of Zoology, and the last letter as C, FE, L, FW, D, OE, CV or NCV defines as Core, Freeze Elective, Lab, Field Work, Dissertation, Open Elective, Credit Value Added or Non Credit Value Added Courses respectively. The First numeral defines the semester and the remaining two numerals defines stream and the paper number. **Theory includes: Lectures, Mentoring, Tutorials, Group Discussion, Assignments and Quizzes.				
<b>Semester I</b>				
<b>Core courses</b>		<b>Credits</b>		
<b>Code</b>	<b>Course</b>	<b>**Theory</b>	<b>Lab</b>	<b>Total</b>
MZC101	Non–Chordata	4	-	4
MZC102	Animal Physiology	4	-	4
MZC103	Human Genetics and Molecular Biology	4	-	4
MZC104	Biochemistry and Cell Biology	4	-	4
MZC105L	Lab based on MZC101	-	2	2
MZC106L	Lab based on MZC102-104	-	6	4
<b>Core course 6 (total number)</b>		<b>16</b>	<b>08</b>	<b>24</b>
<b>Credit Value Added Course</b>		<b>Credits</b>		
MZCV107	Science Communication	4	-	4
<b>Total credits in Credit Value Added Course</b>		<b>4</b>		
<b>Total credits in Semester I (Core and Credit Value Added Courses) – 28</b>				
<b>Semester II</b>				
<b>Core courses</b>		<b>Credits</b>		
<b>Code</b>	<b>Course</b>	<b>**Theory</b>	<b>Lab</b>	<b>Total</b>
MZC201	Chordata	4	-	4
MZC202	Biosystematics, Evolutionary Biology and Biodiversity	4	-	4
MZC203	Quantitative biology and Bioinstrumentation	4	-	4
MZC204	Developmental Biology and Immunology	4	-	4
MZC205L	Lab based on MZC201	-	2	2
MZC206L	Lab based on MZC202-204	-	6	4
<b>Core course 6 (total number)</b>		<b>16</b>	<b>08</b>	<b>24</b>
<b>Non Credit Value Added Course</b>		<b>Credits</b>		
MZNVC207	Physiology of Stress and Yoga	-	-	-
<b>Total credits in Semester I (Core and Non Credit Value Added Courses) – 24</b>				
<b>Semester III</b>				
<b>Core + freeze courses</b>		<b>Credits</b>		
<b>Code</b>	<b>Course</b>	<b>**Theory</b>	<b>Lab</b>	<b>Total</b>
MZC301	Animal Behaviour and Chronobiology	4	-	4

MZC302	Environmental Biology, Wildlife and Toxicology	4	-	4
MZFE303 (A-D)	Freeze Elective I	4	-	4
MZC304L	Lab based on MZC301-302 Field Work (FW)	-	2 4	2 4
MZFE305L	Lab based on MZFE303-304	-	2	2
<b>Core course 6 (total number)</b>		<b>12</b>	<b>8</b>	<b>20</b>
<b>Total credits in Core + Freeze Elective courses</b>		<b>20</b>		
<b>Number of Open Elective courses</b> A student has to choose ONE open elective from the following		<b>Credits</b>		
MZOE306A	Public Health	4	-	4
MZOE306B	Fundamentals of Living System			
MZOE306C	Insects in Human Life			
MZOE306D	Molecular Diagnostics in Clinical Practice			
<b>Total credits in Open Elective</b>		<b>4</b>		
<b>Total credits in Semester III (Core, Free Elective and Open Elective) – 24</b>				
<b>Semester IV</b>				
<b>Core + freeze courses</b>		<b>Credits</b>		
<b>Code</b>	<b>Course</b>	<b>**Theory</b>	<b>Lab</b>	<b>Total</b>
MZC401 (A-D)	Freeze Elective II	4	-	4
MZC402 (A-D)	Freeze Elective III	4	-	4
MZFE403 (A-D)	Dissertation (D)	8	-	8
<b>Course 3 (total number)</b>		<b>16</b>	<b>-</b>	<b>16</b>
<b>Total credits in Core + Freeze Elective courses</b>		<b>16</b>		
<b>Number of Open Elective courses</b> A student has to choose ONE open elective from the following		<b>Credits</b>		
MZOE404A	Clocks in the Clinic	4	-	4
MZOE404B	Biodiversity and Conservation			
MZOE404C	Aquaculture Management and Entrepreneurship			
MZOE404D	Human Parasitology			
<b>Total credits in Open Elective</b>		<b>4</b>		
<b>Total credits in Semester IV (Free Elective, Dissertation and Open Elective) – 20</b>				

1. In the third and fourth semesters, a student has to choose one of the four freeze electives. Each freeze elective (**Freeze Elective – Endocrinology and Reproductive Physiology:** MZFE- 303A, 401A, 402A; **Entomology:** MZFE- 303B, 401B, 402B; **Fish and Fisheries:** MZFE- 303C, 401C, 402C; **Parasitology:** MZFE- 303D, 401D, 402D) has Three papers.
2. **Dissertation** – There is a list of available titles from which the student will make his preferred choices and accordingly, he may opt to do a dissertation in the research laboratory of the concerned Faculty members. This will be purely on mutual agreement between the student and the Faculty member. Upon successful completion of the dissertation (as certified by the concerned faculty member), the department would issue a certificate to the student.

### **Selection of Freeze Elective/Open Elective Courses:**

#### **1. Freeze Elective courses in Zoology:**

The number of seats in each elective would be limited and will be announced before the commencement of the course in each year. The Selection of Freeze elective papers in 3rd and 4th Semesters would be based on merit (performance in the First Semester Examination) and choice.

#### **2. Open Elective Course in Zoology:**

There shall be total of 50 seats in open elective in Zoology. This number is the maximum intake of students in M.Sc. Zoology. Students of Faculty of Science who have studied Biology at least at the level of +2 can opt for Open Elective in Zoology. The selection of students shall be based on the merit prepared based on their marks obtained in the M.Sc. First semester.

### **Teaching:**

There shall be 90 instructional days excluding examination in a semester.

The teaching methodology will include classroom lectures, seminars/ presentations, group discussions, mentoring, tutorials, field study/ report, case study, assignments, project writing, quiz, etc. and the theory should be at least 70% of the total workload.

**Assessment of Students' Performance and Scheme of Examinations:**

1. The medium of instruction and examination shall be English.
2. Assessment of students' performance shall consist of two components (i) Internal assessment (mid-semester) and (ii) end-semester examination. The timing shall be decided for these as per the Academic Calendar notified by the University of Lucknow.

A. The break-up of marks for credit course examinations will be:

<b>Assessment Type</b>	<b>Theory course (mark distribution) 4 credits</b>
<b>Internal Assessment</b>	
(a) Examinations	15
(b) Assignment/ Seminar/ Presentation	10
(c) Attendance	05
<b>External Assessment</b>	
(a) End semester Examination	70
<b>Total Marks</b>	<b>100</b>

- B. Each two and four credit lab course shall be evaluated at the end-semester examination for 50 and 100 marks respectively.
- C. Internal assessment will be broadly based on attendance in Theory and Lab (5 marks), assignments, seminars, presentations, quizzes and tests in the theory component (25 marks). These criteria are tentative and could be modified based on guidelines approved by the academic council.
- D. The question papers will be comprised of short, long and essay type questions.
- E. Examinations for courses shall be conducted only in the respective odd and even Semesters as per the Scheme of Examinations. Regular as well as Ex-students shall be permitted to appear/re-appear/improve in courses of Odd Semesters only at the end of Odd Semesters and courses of Even Semesters only at the end of Even Semesters.

**Pass Percentage & Promotion Criteria**

As per the rules of University of Lucknow.

**Part I to Part II Progression**

As per the rules of the University of Lucknow.

**Conversion of Marks into Grades**

As per the rules of the University of Lucknow.

**Grade Points**

Grade point table as per University Examination rule.

**CGPA Calculation**

As per University Examination rule.

**SGPA Calculation:**

As per University Examination rule.

**Grand SGPA Calculation:**

As per University Examination rule.

**Conversion of Grand CGPA into Marks**

As notified by competent authority the formula for conversion of Grand CGPA into marks is:

Final %age of marks = CGPA based on all four semesters  $\times$  9.5

**Division of Degree into Classes**

Post Graduate degree to be classified based on CGPA obtained into various classes as notified into Examination policy.

**Attendance Requirement**

No student shall be considered to have pursued a regular course of study unless he/she is certified by the Head of the Department of Zoology, University of Lucknow, to have attended 75% of the total number of theory and lab classes conducted in each semester, during his/her course of study.

**Span Period**

As per University rule.

**Guidelines for the Award of Internal Assessment Marks in M.Sc. Zoology Programme (Semester Wise)**

Internal assessment will be broadly based on attendance in Theory and Lab (5 marks), assignments, seminars, quizzes and tests in the theory component (25 marks). These criteria are tentative and could be modified based on guidelines approved by the academic council.

# Semester I

## MZC101: Non-Chordata

**Total Credits: 04**

**Teaching Hours: 60**

### **Course objectives**

- To create in the student an appreciation of non-chordate diversity
- To develop in the student an understanding of structural and functional diversity
- To develop in the student the understanding of evolutionary relationship amongst non-chordate groups

### **Unit I**

#### **Protozoa**

Ultrastructure	01
Osmoregulation	01
Locomotion	01
Nutrition	01
Reproduction	01

#### **Porifera**

Cell types	01
Skeleton	01
Reproduction	01

#### **Cnidaria**

Origin of metazoan	01
Polymorphism	01
Metagenesis	01
Corals	01
Pigments	01

### **Unit II**

#### **Platyhelminthes**

Origin and evolution of bilateria	02
Parasitic adaptations	01
General organization of Trematoda and Cestoda	04
Larval stages of Trematoda and Cestoda	02
Life cycle patterns in Platyhelminthes	02

#### **Aschelminthes**

General organization	02
Economic importance of nematodes in animals and plants	02

### **Unit III**

#### **Annelida**



Coelom & Metamerism	01
Adaptive radiation in Polychaeta	01
Segmental organs	01
Filter feeding	01
<b>Arthropoda</b>	
Organisation and affinities of Onychophora	02
Larval forms in Crustacea	01
Parasitism in Crustacea	01
Respiratory organs in Arthropods	01
General organization of Tardigrada	01
General organization of Pycnogonida	01
General organization of Trilobitomorpha	01
<b>Unit IV</b>	
<b>Mollusca</b>	
Foot and Radula	02
Respiration	01
Nervous system	01
Torsion in gastropods	02
Shell types	01
<b>Echinodermata</b>	
Origin of Deuterostomia	02
Water vascular system	01
Larval forms & affinities	02
<b>Unit V</b>	
<b>Minor phyla</b>	
General Organization and affinities of Rotifera	03
General Organization and affinities of Phoronida	02
General Organization and affinities of Ectoprocta	02
General Organization and affinities of Endoprocta	02
General Organization and affinities of Ctenophora	02

### **Student learning outcomes**

The student at the completion of the course will be able to:

- demonstrate comprehensive identification abilities of non-chordate diversity
- describe structural and functional diversity of non-chordate
- explain evolutionary relationship amongst non-chordate groups

### **Suggested readings**

1. Barnes et al (2009). The Invertebrates: A synthesis. Wiley Backwell

2. Hunter: Life of Invertebrates (1979, Collier Macmillan)
3. Marshall: Parker & Haswell Text Book of Zoology, Vol. I (7th ed 1972, Macmillan)
4. Moore: An Introduction to the Invertebrates (2001, Cambridge University Press)
5. Brusca and Brusca (2016) Invertebrates. Sinauer
6. Jan Pechenik (2014) Biology of the invertebrates. McGraw Hill
7. Neilsen (2012). Animal Evolution: Interrelationships amongst living Phyla. Oxford

## MZC102: Animal Physiology

**Total Credits: 04**

**Teaching Hours: 60**

### Course objectives

- To develop in the student an understanding of functioning of an organisms body
- To develop in the student an understanding of the various homeostatic systems of the body
- To develop in the student an understanding of regulation of function in the body

### Unit I

#### Physiology of Digestion

Digestion and absorption of proteins	01
Digestion and absorption of carbohydrates	01
Digestion and absorption of lipids	01
Digestion and absorption of nucleic acids	01
Regulation of digestion and absorption	01

#### Physiology of Excretion

Homeostasis	01
Ion regulation	01
Regulation of excretion	01
Physiological responses to salinity changes	01

#### Physiology of Thermoregulation

Thermoregulation	01
Thermoregulation based animal categories	02
Acute and chronic metabolic responses to temperature change	01
Thermal limits of individuals	
Mechanism of thermoregulation	

### Unit II

#### Physiology of respiration

External respiration	01
Internal respiration	02
Gaseous exchange in terrestrial and aquatic animals	02
Respiratory pigments	02
Mechanism and regulation of respiration	02

#### Physiology of circulation

Pattern of circulation among different animal groups	02
Haemodynamics	02
Regulation of circulation	01
Cardiac cycle	01
<b>Unit III</b>	
<b>Physiology of muscular system</b>	
Types, function and properties of muscle tissue	01
Molecular organization of sarcomere	01
Molecular mechanism of striated muscle contraction	01
Molecular mechanism of smooth muscle contraction	01
Muscle metabolism	01
Regulation of muscle contraction	01
<b>Neurophysiology</b>	
Neuronal tissue	01
Structural Organization of Nervous System	01
Functional Organization of Nervous System	01
Ionic and Physical Basis of Membrane Potential	01
Electrotonic and Action Potential Conduction	01
Molecular mechanism of Synaptic transmission, vesicle fusion and recycling	01
Neurotransmitters and Neuro Modulators	01
Synaptic Plasticity	01
<b>Unit IV</b>	
<b>Physiology of sense organs</b>	
Organization of Sensory System	01
Mechanoreception and Touch	01
Vestibular Organ and Hearing	01
Chemoreception and Taste	01
Olfaction	01
Vision	01
<b>Physiology of endocrine system</b>	
Overview of endocrine glands	02
Mechanism of action of hormones	02
Neuroendocrine feedback	02
<b>Unit V</b>	
<b>Physiology of stress</b>	
Mechanism of stress	01
Stress disorders	01
Secondary effects	01

## **Physiology of Aging**

Aging and Senescence	01
Physiological and Cellular Manifestations of Aging	03
Theories of Aging	03
Evolutionary Theories of Aging	
Programmed Theories of Aging	
Damage Theories of Aging	
Beyond Molecular Biology of Aging	
Molecular Mechanisms of Aging	02

## **Student learning outcomes**

The student at the completion of the course will be able to

- understand various functional components of an organism body
- analyse the complexities and interconnectedness of these functional components
- identify the mechanism underlying maintenance of homeostasis of the body
- infer the regulatory mechanisms for maintenance of function in the body

## **Suggested readings**

1. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hecourt Asia PTE Ltd. /W.B. Saunders Company.
2. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons
3. Christopher D. Moyes, Patricia M. Schulte 2016 Principles of Animal Physiology. 3rd Edition, Pearson Education
4. Hill, Richard W., et al. Animal physiology. Vol. 2. Sunderland, MA: Sinauer Associates, 2004.
5. Chatterjee C C (2016) Human Physiology Volume 1 & 2. 11th edition. CBS Publishers

## MZC103: Human Genetics and Molecular Biology

Total Credits: 04

Teaching Hours: 60

### Course objectives

- To describe the structure of gene and learn how the information contained within them gets transferred from one generation to another.
- To impart knowledge about the human chromosome constitution that would help in applying basic principles of chromosome behavior to disease context.
- To create awareness of genetic diseases
- To list the molecular diagnostic means for multiple diseases
- Overall, this course will highlight evolution of the concept of gene and its amalgamation with molecular biology and study

### Unit I

#### Genetic basis of human diseases

History of genetic diseases	01
Patterns of inheritance	02
Causes of complex diseases: Types and symptoms	02
Chromosome anomalies and diseases: (chronic myeloid leukemia, Burkitt's lymphoma, retinoblastoma and Wilms' tumor)	02
Oncogenes: tumor inducing retroviruses and viral oncogenes	01
Inborn errors of metabolism: Signs & Symptoms, diagnosis, treatment, epidemiology (eg. Phenylketonuria, Tay Sach's disease, Glycogen storage disease, G6PD deficiency, Alkaptonuria)	02
Human genome and mapping, identifying and confirming the disease gene	02

### Unit II

#### Genetic and molecular diagnostics

Molecular technique: Genotyping, Real time PCR, Biochemical tests, ELISA, DNA markers- RFLP, SNPs	03
Diagnosis: Quantitative measurement of amino acids in plasma and urine, specific diagnostic tests	03
Cancer screening and diagnosis: Physical exam, laboratory tests, Imaging test, Biopsy	02
Treatment of cancers: Surgery, Chemotherapy, Radiotherapy, Immunotherapy, Bone marrow transplant, Hormone therapy	02
Management of cancers: Molecular genotyping, Palliative care, Cure	02

### Unit III

#### DNA replication

DNA polymerases & Enzymes involved in replication	03
Origin of replication and formation of primosome	02

Unit of replication	01
Replication fork and replisome	02
Fidelity of replication	02
Termination of replication	02

## Unit IV

### Transcription & Translation

Fine structure of gene, transcription unit	02
Initiation, elongation and termination of transcription in prokaryotes and eukaryotes	02
RNA polymerases, Transcription factors and machinery	03
Formation of initiation complex	02
Initiation, elongation and termination of translation in prokaryotes and eukaryotes	04
Aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase	02

## Unit V

### Regulation of gene expression

Regulation at transcriptional level: Operon system, <i>lac</i> , <i>trp</i> , <i>arabinose</i> operons	03
Post-transcriptional modifications: Capping, Splicing, Polyadenylation, RNA editing	
Role of chromatin in gene expression	02
Regulation at translational level	02
Post- translational modifications: Protein folding, Intracellular protein degradation	
Gene silencing, RNAi	02

### Course Outcome

The course offers a detailed and conceptual understanding of molecular processes *viz.* Replication, transcription, translation *etc.* underlying survival and propagation of life at molecular level. It will help students to understand how genes are ultimately expressed as proteins which are responsible for the structure and function of all organisms. To learn how four sequences (3 letter codons) generate the transcripts of life and determine the phenotypes of organisms.

The student will have awareness about genetic diseases, their types and causes. Also the understanding of molecular techniques will provide improved diagnosis and management of these diseases.

<b>Reference Books</b>				
1.	Lewin	Genes VIII	Pearson	2004
2.	Lodish <i>et al</i>	Molecular Cell Biology	Freeman & Co, USA	2004
3.	Watson et al	Molecular Biology of the Gene	Pearson	2004
4.	Nelson & Cox	Lehninger Principles of Biochemistry	Freeman & Co, USA	2005
5.	Alberts et al	Molecular Biology of the Cell	Garland	2002
6.	Cooper	Cell: A Molecular Approach	ASM Press	2000
7.	Karp	Cell and Molecular Biology	Wiley	2002

8.	Pierce	Genetics	Freeman	2004
9.	Watson <i>et al</i>	Molecular Biology of the Gene	Pearson	2004
10.	George Patrinos <i>et al</i>	<i>Molecular Diagnostics</i> - 3rd	Academic Press	2016
11.	Carl A. Burtis, David E. Bruns	Tietz Fundamentals of Clinical Chemistry and Molecular Diagnostics	E-book	
12.	Sudbery	Human Molecular Genetics	Prentice-Hall	2002
13.	Wilson	Clinical Genetics-A Short Course	Wiley	2000
14.	Pasternak	An Introduction to Molecular Human Genetics	Fritzgerald	2000



## MZC104: Biochemistry and Cell Biology

**Total Credits: 04**

**Teaching Hours: 60**

**Objective:** To develop an understanding of biochemical basis of life, role of stabilizing interaction and biomolecular complexity and biochemical processes as the foundation of all physiological events occurring in animals.

### Unit I

#### Biomolecules

Introduction to biomolecules (carbohydrates, lipids, proteins, nucleic acids)	03
Stablizing interactions (van der waals, electrostatic, hydrogen bonding, hydrophobic interaction <i>etc.</i> )	01
Types and structure of amino acids	02
Secondary structure of Proteins ( $\alpha$ -helix, $\beta$ -sheet, motifs, folds, domains, Ramachandran plot)	02
Tertiary and quaternary structure	02
Nucleic acids: DNA structure, DNA supercoiling, forms of DNA, chromatin organization	
Types of RNA	02

### Unit II

#### Enzyme Kinetics and Bioenergetics

##### Enzymes

- Introduction to enzymes: Apoenzyme, holoenzyme, prosthetic group, cofactors, coenzymes, abzymes, ribozymes. 02
- Enzyme kinetics: Michaelis-Menten equation, LB Plots, enzyme inhibition, Related calculations 03
- Enzyme regulation: Allosteric regulation, covalent modification, zymogens, proenzymes, isozymes 03

##### Bioenergetics

- Thermodynamic principles: standard Free energy change, equilibrium constant, actual free energy change, Related calculations 04

### Unit III

#### Metabolism

- Carbohydrates: glycolysis, citric acid cycle, gluconeogenesis, glycogenesis, glycogenolysis, phosphate pentose pathway, oxidative phosphorylation, and their regulation 04
- Lipids --- Biosynthesis of saturated and unsaturated fatty acids  
Catabolism of fatty acids and ketone bodies 04
- Amino acids: Oxidation and production of urea 02
- Nucleic acids: Biosynthesis and degradation of pyrimidines and purines 02

### Unit IV

#### Structure and function of Membrane & Cytoskeleton

- Biomembranes and architecture: lipid bilayer and protein components 02
- Microfilaments: actin structures, myosin powered cell movements 01
- Intermediate filaments: Organization & function 01

- Microtubules: Organization and dynamics, Kinesin and dynein powered movements 01

### **Endomembrane system and intracellular trafficking**

- Compartmentalization in eukaryote cells 01
- Gated transport between nucleus & cytosol 01
- Structure of nuclear pore complex 01
- Signal sequences & sorting transporters 01
- Role of monomeric GTPases in protein sorting 01
- Protein sorting to ER and mitochondria. 01
- Vesicular trafficking, secretory pathways, receptor mediated endocytosis 01

### **Unit V**

#### **Cellular communication**

- General principles of cell communication 01
- Extracellular matrix and Cell adhesion 02

#### **Cell signaling**

- Signaling molecules and cell-surface receptors (G-protein coupled receptors, Ion-channel linked receptors, Enzyme linked receptors) 02
- Second messengers 01
- Regulation of signaling pathways, JAK-STAT pathway, MAP Kinase pathway 02

#### **Cell cycle and Cell division**

- Cell cycle overview and control 01
- Checkpoints in cell-cycle regulation 01
- Regulation of Mitosis and Meiosis 01
- Cancer and apoptosis 01

### **Student learning outcomes**

The course will lay down the foundation of biochemistry among students where they will develop a deep understanding of structure of biomolecules like proteins, lipids and carbohydrates and how simple molecules together form complex macromolecules. They will be able to understand the thermodynamics of enzyme catalyzed reactions and mechanisms of energy production at cellular and molecular levels. In addition, the application of Biochemistry in understanding disease and medicine will be appraised.

### **Suggested readings**

1.	Nelson & Cox	Lehninger's Principles of Biochemistry	McMillan	2000
2.	Zubay <i>et al</i>	Principles of Biochemistry	WCB	1995
3.	Voet & Voet	Biochemistry Vols 1 & 2	Wiley	2004
4.	Murray <i>et al</i>	Harper's Illustrated Biochemistry	McGraw Hill	2003
5.	Wilson and Walker	Practical Biochemistry – Principles and Techniques	Cambridge University Press	
6.	Elliott and Elliott	Biochemistry and Molecular Biology	Oxford University press	

#### IV: Value Added Course Scheme

<b>Semester</b>	<b>Course</b>	<b>Credit Value Added Courses</b>	<b>Non Credit Value Added Courses</b>	<b>Credits</b>	<b>Total Lectures</b>
I	MZCV107	Science Communication	-	4	60

## Science Communication

**Total Credits: 04**

**Teaching Hours: 60**

<b>Unit I: Communicating as a Scientist</b>	<b>12</b>
<ul style="list-style-type: none"><li>• Effective Communication</li><li>• Audience and Purpose</li><li>• Addressing Specific Audiences</li></ul>	
<b>Unit II: Papers</b>	<b>12</b>
<ul style="list-style-type: none"><li>• Scientific Papers</li><li>• Effective Writing</li><li>• Revision</li><li>• Advice for Specific Language Groups</li></ul>	
<b>Unit III: Classrooms and Presentations</b>	<b>12</b>
<ul style="list-style-type: none"><li>• Oral Presentation Structure</li><li>• Presentation Slides</li><li>• Effective Oral Presentations</li><li>• Answering Questions</li></ul>	
<b>Unit IV: Conferences</b>	<b>12</b>
<ul style="list-style-type: none"><li>• Poster Presentations</li><li>• Chairing Sessions</li><li>• Panel Discussions</li></ul>	
<b>Unit V: Correspondence</b>	<b>12</b>
<ul style="list-style-type: none"><li>• E-mail</li><li>• Memos and Progress Reports</li><li>• Formal Letters</li><li>• Résumés</li><li>• Thank You Letter</li><li>• <a href="https://www.nature.com/scitable/ebooks/english-communication-for-scientists-14053993/118520572/">https://www.nature.com/scitable/ebooks/english-communication-for-scientists-14053993/118520572/</a></li></ul>	

# **Semester II**

## MZC201: Chordata

**Total Credits: 04**

**Teaching Hours: 60**

### Course objectives

- To create in the student an appreciation of chordate diversity
- To develop in the student an understanding of structural and functional diversity
- To develop in the student the understanding of evolutionary relationship amongst chordates

### Unit I

#### Protochordates and Pisces

General organization and affinities of Hemichordata	01
General organization and affinities of Urochordata	01
General organization and affinities and Cephalochordata	01
General organization of fishes	03
General organization and affinities of Ostracoderms	02
General organization and affinities of Dipnoi and Holocephali	01
General organization and affinities of Coelacanthiformes	01

### Unit II

#### Amphibia

Origin of tetrapods	03
General organization of Anura	02
Neoteny	01
Peculiarities of Urodela	01
Peculiarities and affinities of Apoda	02
Adaptive Radiation	01
Extinct Amphibians	01

### Unit III

#### Reptilia

Origin and evolution	02
Adaptive radiation	02
Dinosaurs	02
General organization and affinities of <i>Chelonia</i>	02
<i>Crocodylia</i>	02
Squamata	02
<i>Rhynchocephalia</i>	02

### Unit IV

#### Aves

Origin and evolution	03
Flightless birds	02
Adaptations for flight	03

Adaptive radiation	02
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## Unit V

### Mammalia

Origin of mammals	03
Adaptive radiation of Mammalia	02
Structural peculiarities and phylogenetic relations of <i>Prototheria</i> and <i>Metatheria</i>	02
Dentition	02
Stomach	01
Uterus modifications	01
Aquatic mammals	02

### Student learning outcomes

The student at the completion of the course will be able to:

- demonstrate comprehensive identification abilities of chordate diversity
- explain structural and functional diversity of chordate
- explain evolutionary relationship amongst chordate

### Suggested readings

1. Harvey et al: The Vertebrate Life (2006)
2. Colbert et al: Colbert's Evolution of the Vertebrates: A history of the backboned animals through time (5th ed 2002, Wiley - Liss)
3. Hildebrand: Analysis of Vertebrate Structure (4th ed 1995, John Wiley)
4. Kenneth V. Kardong (2015) Vertebrates: Comparative Anatomy, Function, Evolution McGraw Hill
5. McFarland et al: Vertebrate Life(1979, Macmillan Publishing)
6. Parker and Haswell: TextBook of Zoology, Vol. II (1978, ELBS)
7. Romer and Parsons: The Vertebrate Body (6th ed 1986, CBS Publishing Japan)
8. Young: The life of vertebrates (3rd ed 2006, ELBS/Oxford)
9. Neilsen (2012). Animal Evolution: Interrelationships amongst living Phyla. Oxford

## MZC202: Biosystematics, Evolutionary Biology and Biodiversity

**Total Credit: 04**

**Teaching Hours: 60**

### Course objectives

- To provide the basic concepts, importance, status and interaction between organisms and environment

### Unit I

#### Taxonomy and classification

Concepts, terminology and types of taxonomy and classification	04
Principles of classification	04
Artificial and natural classification	04

### Unit II

Concept and preambles of ICZN	04
Law of priority	04
Proteins and nucleic acids in modern taxonomy	04

### Unit III

Concept and type of species	03
Endemic species	03
Mechanisms of speciation	03
Origin of life: Life's beginnings, evolution of eukaryotes	03

### Unit IV

Evolutionary theories	03
Natural selection	02
Molecular evolution	03
Adaptation (evolutionary analysis of form and function)	02
Phylogenetics: concept, phylogenetic gradualism and punctuated equilibrium	02

### Unit V

Biodiversity: concepts and hierarchical levels	02
Species diversity	02
Species richness and evenness	02
Genetic diversity	02
Ecosystem diversity and services	02
National laws of biodiversity	02

### Student learning outcome

The student at the completion of the course will be able to understand:

- basic concepts of biosystematics, evolutionary biology and biodiversity which will enable the students not only to understand the subjects but also to solve the biological problems related to the environment, and



- principles of taxonomy for identification, classification and naming the organisms scientifically.
- origin and modification of various life forms during various time scales.

### **Suggested readings**

1. Principles of Systematic Zoology by Ernst Mayr, McGraw Hill, New York
2. Principles of Animal Taxonomy by G.G.Simpson, Columbia University Press, Scientific Publisher.
3. Evolution: An Introduction by S.C.Stearns and R.F.Hoekstra, Oxford University Press, New York
4. Evolution by N. H. Barton, D.E.G. Briggs, J.A. Eisen, D. B. Goldstein and N.H. Patel, Cold Spring Harbor Laboratory Press, New York.
5. Ridley, M (2004) Evolution III Edition Blackwell publishing Hall, B.K. and Hallgrimson, B (2008). Evolution IV Edition. Jones and Barlett
6. What is biodiversity by James Maclaurin and Kim Sterelny, U.Chicago.Edu.
7. Schuh, R.T., and A.V.Z. Brower. 2009. Biological Systematics: Principles and Applications, 2nd Ed. Cornell University Press. 311+xi pp.
8. Wiley, E. O. and B. S. Lieberman. 2011. Phylogenetics: Theory and Practice of Phylogenetic Systematics, 2nd Ed. Wiley-Blackwell. 406+xvi pp.
9. Williams, D. M. and M. C. Ebach. 2010. Foundations of Systematics and Biodiversity. Springer. 309+xvii pp.
10. Biodiversity and Ecosystem Functioning by E.D. Shulze and H. A. Moonthy, Spriger Publication.
11. Methods and Practice in biodiversity Conservation by David Hawks worth, Springer publication
12. A Text Book of Biodiversity by K.V. Krishnamurthy, CBS Publication

## MZC 203: Quantitative Biology and Bioinstrumentation

**Total Credit: 04**

**Teaching Hours: 60**

### Course objectives

- To describe the basics and application of Biostatistics.
- To explain the principle and working of instruments in a biology laboratory.

### Unit I

#### Biological data

Data on a ratio scale	02
Data on an interval scale	02
Data on an ordinal scale	02
Data on a nominal scale	02
Types of statistics: inferential and descriptive	02
Parametric and non-parametric tests (concepts and applications)	02

### Unit II

#### Measures of central tendency (individual observations, discrete and continuous series)

Mean (simple and weighted)	02
Median	02
Mode (analysis using group table)	02

#### Measures of dispersion (individual observations, discrete and continuous series)

Range and mean deviation	02
Standard deviation	02
Kurtosis and skewness	02

### Unit III

#### Correlation and regression

Types and methods of studying correlation	02
Karl Pearson's coefficient of correlation and determination	02
Regression equation (X on Y and Y on X)	02
Regression lines	01

#### Tests of significance and their application

t-test	02
Chi-square test	01

#### Analysis of variance

One-way and two-way ANOVA	02
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### Unit IV

#### Bioinstruments

Basic principles of microscopy	01
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Phase contrast microscope	01
Electron microscope	02
Fluorescence microscope	02
Confocal microscopes	02
Centrifuge: principle, types of rotors, high speed and ultracentrifuge	02
pH Meter, Chromatography: Paper, Gel Filtration, Ion exchange, HPLC	02

## Unit V

### Advanced instrumentation

Colorimetry and spectrophotometry: Beer-lambert law, absorption coefficient	02
Biochemical Analysers, Lyophilizer	02
Water purification system, Laminar flow, Autoclave	02
PCR machine, Gel Documentation System, Gel Apparatus	03
Flow cytometer, DNA sequencer, Microarray, Microplate reader	03

### Student learning outcomes

The present course will enable the students to:

- solve the biological problems during data analysis using various statistical methods such as uni-variate analysis, bi variate analysis, correlation, regression and various tests of significance.
- learn the working of various equipments which will be useful in the final semester for their experimental work.

### Suggested readings

Biostatistical Analysis (Fourth Edition) by Jerrold H. Zarr, Pearson Education Inc., Delhi.

Statistical Methods (Eighth Edition) by G. W. Snedecor and W. G. Cochran, Willey Blackwell

Biostatistics (Tenth Edition) by W.W. Daniel and C. L. Cross, Wiley

Introductory Biological Statistics (Fourth Edition) by John E. Havel, Raymond E. Hampton and Scott J. Meiners

### Suggested readings

1.	Sambrook <i>et al</i>	Molecular Cloning vols I, II, III	CSHL	2001
2.	Primrose	Molecular Biotechnology	Panima	2001
3.	Clark & Switzer	Experimental Biochemistry	Freeman	2000
4.	Westhead <i>et al</i>	Bioinformatics: Instant Notes	Viva Books	2003

## MZC204: Developmental Biology and Immunology

**Total Credits: 04**

**Teaching Hours: 60**

### **Course objectives**

The objective of this course is to provide insight on:

- how the single cell formed at fertilisation forms an embryo and then a fully formed adult organism.
- integration of genetics, molecular biology, biochemistry, cell biology, anatomy and physiology during embryonic development, and
- the treatment of birth defects and infertility in humans.
- To develop basic understanding about Immunity, its organization and their mechanisms.
- To understand in detail the basic immune mechanism related to different Immunological diseases & disorders.
- To create and develop the ideology about different vaccines, immune treatment mechanisms, cancer immunotherapy and latest experimental immune system.

### **Unit I**

#### **Gamete fertilization and early development**

Structure and recognition of the gametes	02
Sperm capacitation and acrosomal reaction	02
Gamete binding and fusion, and the prevention of polyspermy	02
Cleavage patterns	02
Gastrulation	02
Neurulation	02

### **Unit II**

#### **Comparative account of underlying mechanisms in vertebrate development**

Morphogenesis and cell adhesion	02
Evidence for genomic equivalence	02
Differential gene expression	02
Cell-cell communication in development	02
Primary organizers, induction and competence	02
Early development of fish, birds, and mammals	02

### **Unit III**

#### **Later developmental processes**

The dynamics of organ development	03
Development of eye	
Development of kidney	
Development of limb	
Metamorphosis: the hormonal reactivation of development	03
Amphibian metamorphosis	

Metamorphosis in insects	
Regeneration	03
Epimorphic regeneration of salamander Limbs	
Compensatory regeneration in the mammalian Liver	
Morphallactic regeneration in hydras	
Aging: the biology of senescence	03

#### **Unit IV**

##### **Immune system & responses**

Types of Immunity (Innate, Adaptive, humoral, cell-mediated)	02
Cells of Immune system (B & T lymphocytes, Phagocytes, Granulocytic cells, Mast cells, NK Cells, Dendritic cells)	02
Organs of Immune system- (Primary and secondary lymphoid organs-Thymus, marrow, Bone lymph nodes, spleen, MAST)	02
Generation of B & T cell responses	06
Immunoglobulins (structure, Types/Classes & functions)	
Epitopes	
Maturation, differentiation and activation of BCR and TCR	
Monoclonal and polyclonal antibodies	
Antibody diversity	
Organization & Expression of Immunoglobulin genes	

#### **Unit V**

##### **Immune mechanisms**

Antigen antibody interactions (Agglutination Rns', Precipitation Rns', cross reactivity, Antibody affinity and avidity, immune fluorescence, flow cytometry, western blotting, immune electron microscopy, RIA, ELISA and its types)	03
Antigen: types, processing & presentation	02
Major Histocompatibility complex: classes, structure, expression, immune responsiveness, and disease susceptibility (HLA)	03
Complement system—classical, alternative, lectin pathways	02
Vaccine	02

##### **Student learning outcomes**

The student at the completion of the course will be able to understand:

- a variety of interacting processes, which generate an organism's heterogeneous shapes, size, and structural features,
- how a cell behaves in response to an autonomous determinant or an external signal, and
- the scientific reasoning exhibited in experimental life science.
- an in depth understanding about Immune System & its elaborate mechanisms.
- state of art information about recent trends in Immune therapy in case of several diseases like cancer, hepatitis etc

### **Suggested readings**

1. Developmental Biology: T. Subramaniam, (Reprint) 2013, Narosa Publishing House Pvt. Ltd., New Delhi
2. Essential Developmental Biology: Jonathan M. W. Slack, (3rd ed.) 2012, Wiley-Blackwell.
3. Developmental Biology: From a Cell to an Organism (Genetics & Evolution) eBook: Russ Hodge, 2009, Infobase Publishing.
4. Current Topics in Developmental Biology: Roger A. Pedersen, Gerald P. Schatten, 1998 Elsevier.
5. Developmental biology: Werner A. Müller, 2012, Springer Science & Business Media.
6. Human Embryology and Developmental Biology E-Book: [Bruce M. Carlson](#), 2018, Elsevier Health Sciences.
7. Developmental Biology: Michael J. F. Barresi, Scott F. Gilbert, 2019, Oxford University Press.
8. Thomas J. Kindt, Richard A. Goldsby, Barbara A. Osborne, Janis Kuby (2007) Kuby Immunology. W H Freeman
9. Delves Peter J., Martin Seamus J., Burton Dennis R., Roitt Ivan M. (2017). Roitt's Essential Immunology, 13th Edition. Wiley Blackwell
10. Immunology by Ian. R. Tizard Saunders college Publishing Chicago, New York.
11. Nandini Shetty (2005) Immunology Introductory Textbook. New Age International.

#### IV: Value Added Course Scheme

<b>Semester</b>	<b>Course</b>	<b>Credit Value Added Courses</b>	<b>Non Credit Value Added Courses</b>	<b>Credits</b>	<b>Total Lectures</b>
II	MZNCV207	-	Physiology of Stress and Yoga	-	60

## Physiology of Stress and Yoga

**Non Credit Course**

**Teaching Hours: 60**

<b>Unit I: Homeostasis and Its Disruption</b>	<b>12</b>
<ul style="list-style-type: none"><li>• Homeostasis: the maintenance of steady state</li><li>• Environmental disruptors of homeostasis</li><li>• Lifestyle disruptors of homeostasis</li></ul>	
<b>Unit II: Consequences of Homeostasis Disruption</b>	<b>12</b>
<ul style="list-style-type: none"><li>• General Adaptation Syndrome (GAS)</li><li>• Mechanism of stress</li><li>• Stress disorders</li><li>• Secondary effects</li></ul>	
<b>Unit III: Yoga: Stress Buster Mechanisms I</b>	<b>12</b>
<ul style="list-style-type: none"><li>• Pranayama</li><li>• Nadishuddhi</li><li>• Ujjayi</li><li>• Sitali/ Sitkari and Brahamari</li></ul>	
<b>Unit IV: Yoga: Stress Buster Mechanisms II</b>	<b>12</b>
<ul style="list-style-type: none"><li>• Meditation</li><li>• Breath Awareness</li><li>• Om chanting and meditation</li><li>• Yoga Nidra</li><li>• Kundalini Jagriti</li></ul>	
<b>Unit V: Yoga: Stress Buster Mechanisms III (Asanas)</b>	<b>12</b>
<ul style="list-style-type: none"><li>• Tadasana</li><li>• Katichakrasana</li><li>• Pavanamuktasana</li><li>• Sarvangasana</li><li>• Sarala Matsyasana</li><li>• Gomukhasana</li><li>• Vakrasana</li><li>• Ardhamatsyaendrasana</li><li>• Ushtrasana</li><li>• Makarasana</li><li>• Bhujangasana</li><li>• Dhanurasana</li><li>• Shavasana</li></ul>	



# **Semester III**

## MZC301: Animal Behaviour and Chronobiology

**Credits: 04**

**Teaching Hours: 60**

### Course objectives

The course is so designed that students will learn:

- animal behaviour in the context of evolutionary and ecological biology,
- historical background and theory for animal behaviour concepts,
- recent approaches in animal behaviour,
- techniques used to study animal behaviour in a variety of different organisms and identify potential research questions from discussions of current literature,
- how the rhythmic geophysical environment impacts the internal rhythms,
- how environmental cues are perceived by the organisms and modulate the circadian physiology at molecular, cellular and systems levels,
- diagnosis of clock disruption and related disorders, and
- time dependent treatment to different lifestyle disorders.

### Unit I

#### Behavioural evolution and regulation

History of behavioural studies	01
Regulation of behaviour	02
Proximate and ultimate causes of behavioural evolution	01

#### Learning and memory

Types of learning (non–associative and associative)	01
Social learning (cultural transmission)	01
Survival value of learning	
Molecular basis of learning	01
Molecular basis of memory	

#### Communication

Communication modes	02
Evolution of communication	
Deceit versus honest signalling	02
Game theory and communication	
Adaptive value of communication	

#### Sexual selection

Intra and intersexual selection	02
Pre–and post–copulatory sexual selection	
Sperm competition	
Cryptic female choice	
Evolutionary models of mate choice	01

## **Unit II**

### **Reproductive strategies**

Different mating systems	01
Ecology and evolution of mating systems	02
Neuroendocrine control of mating systems	

### **Parental care**

Parental investment	01
Origin and evolution of parental care	
Patterns of parental care	02
Parent–offspring conflict	
Sibling conflict	
Brood parasitism	

### **Territorial behaviour**

Aggression, dominance and territorial behaviour	01
Habitat choice	
Ideal free and despotic distribution	
Types of territories	
Economic defendability	02
Territory size determinants and defense measure	
Evolution of territoriality	
Adaptive value of territoriality	

### **Social behaviour and kin selection**

Levels of cooperation	02
Paths to cooperation (reciprocity, byproduct, mutualism, group selection)	
Types of social structure	
Adaptive value and evolution of sociality	01
Social symbioses	
Hamilton's rule for kin selection	01
Evolution of kin selection	

## **Unit III**

### **Clock, rhythms and calendar**

Introduction, milestones and scope of chronobiology	03
Geophysical environment seasons	01
Proximate and ultimate factors	
Biological clocks, types, constant conditions, model systems	03
Entrainment theory: masking, synchronization	02
Photoreception, phototransduction	03
Photoperiodic time measurement	

## Unit IV

### Clock, underlying events and misalignments

Anatomy and physiology of the time keeping system	03
Cellular and Molecular basis of circadian timekeeping in <i>Drosophila</i> and mammals	03
Seasonal migration	01
Sleep and neural relation	02
Clock misalignment; jet lag, shift work,	01
Lifestyle disorders: depression and sleep disorders, social jetlag	01
Clock repair, chronotherapy and chronomedicine	01

## Unit V

### Study and analysis of animal behavior

Evolution by natural selection	01
Genetics and inheritance	01
Comparative method	01
Tinbergen's four questions (proximate and ultimate causes)	02
Observational	
Experimental	
Comparative	

### Study and analysis of Chronobiology

Activity and rest calculations	01
Phase shift	01
Phase response curves (PRC) and Phase transition curves (PTC)	01
Questionnaires (sleep logs, chronotype, fatigue, RNAS)	02
Monitoring of physiological variables (temperatures, blood pressure, heart rate)	01

### Student learning outcomes

After successful completion of this course in animal behaviour and chronobiology the students should be capable of:

- Understanding and identify behaviours in a variety of taxa
- discussing the proximate and ultimate causes of various behaviours
- designing and implementing experiments to test hypotheses relating to animal behaviour
- understanding about the molecules, cells, and systems of biological timing systems
- conceptualizing how species profitably inhabit in the temporal environment and space out their activities at different times of the day and seasons.
- studying and analysing the scientific literature
- planning studies on biological rhythms in both human and non-human species
- interpreting the cause and effect of lifestyle disorders
- contributing to public understanding of biological timing

### Suggested readings

1. Alcock, J. 2013. *Animal Behavior: An Evolutionary Approach*. Tenth Edition. ISBN-13: 978-0878939664 2)
2. Sherman, P.W. and J. Alcock. 2013. *Exploring Animal Behavior: Readings from American Scientist*. Sixth Edition. ISBN-13: 978-1605351957
3. Dugatkin, L. A. (2013). *Principles of animal behavior: Third international student edition*. WW Norton & Company.
4. Breed, M. D., & Moore, J. (2015). *Animal behavior*. Academic Press.
5. Mellgren, R. L. (Ed.). (2000). *Animal cognition and behavior* (Vol. 13). Elsevier.
6. Bolhuis, J. J., Giraldeau, L. A. E. (2005). *The behavior of animals: Mechanisms, function, and evolution*. Blackwell Publishing.
7. Hazlett, B. (Ed.). (2012). *Quantitative methods in the study of animal behavior*. Elsevier.
8. *Chronobiology Biological Timekeeping*: Jay. C. Dunlap, Jennifer. J. Loros, Patricia J.
9. DeCoursey (ed). 2004, Sinauer Associates, Inc. Publishers, Sunderland, MA, USA
10. *The Physiological Clock* (3<sup>rd</sup> edition), Erwin Bunning, The English Universities Press Ltd. London, Springer- Verlag New York, Berlin Heidelberg
11. *Circadian Physiology*: Roberto Refinetti, CRC Press (3<sup>rd</sup>ed) 2016
12. *Introducing Biological Rhythms*: Willard L. Koukkari, Robert B. Sothorn, 2006, Springer
13. *Biological Timekeeping: Clock, Rhythms and Behaviour*, Vinod Kumar (ed. 2017) Springer India Pvt Limited.
14. *Insect Photoperiodism*: Stanley D. Beck, Academic Press, New York and London
15. Chapter 1, *The Clocks that Time Us*, Moore-Ede, MC, Sulzman, FM and Fuller, CA (1982) Harvard University Press, Cambridge.
16. C. S. Pittendrigh, S. Daan (1976c) A functional analysis of circadian pacemakers in nocturnal rodents. V. Pacemaker structure: a clock for all seasons. *J. Comp. Physiol. [A]*106:333-355.
17. M. Menaker (1968) Extraretinal light perception in the sparrow. I. Entrainment of the biological clock. *Proc. Natl. Acad. Sci.* 59:414-421.
18. J.C. Dunlap (1999) Molecular bases for circadian clocks. *Cell* 96:271-290.

## MZC302: Environmental Biology, Wildlife and Toxicology

**Total Credits: 04**

**Teaching Hours: 60**

### **Course objectives**

- To develop in the student an understanding of environmental structure and function
- To develop in the student an understanding of global environmental issues
- To develop in the student an understanding of significance and conservation of wild life
- To develop in the student an understanding of xenobiotics, their mode of action and damage caused

### **Unit I**

#### **Ecosystem**

Concept, production and decomposition	01
Biosphere and biomes	02
Biogeochemical cycles	02
Population ecology	02
Community ecology and ecological succession	03
Concept of habitat ecology and ecological niche	01
Island biogeography	02

### **Unit II**

#### **Global environmental problems**

Environmental pollution	04
Waste management	02
Environmental monitoring	02
Acid rain	01
Greenhouse effect and global warming	01
Depletion of ozone layer	01
Climate change	01

### **Unit III**

#### **Wildlife**

Basic concept of wildlife and biodiversity	02
Causes of wildlife depletion	02
Wildlife conservation strategies	02
Wildlife management tools and techniques	02
Conservation genetics	02
Legislative methods of biodiversity conservation	02

### **Unit IV**

#### **Exposure of toxicants**

Different routes/methods of exposure, frequency & duration of exposure

Human exposure	01
Dose-response relationship	01
Selective toxicity:	02
concept, significance	
Basic mechanisms of selective toxicity	
<b>Toxicity Tests</b>	
Bioassay	01
Acute toxicity tests for terrestrial and aquatic animals	02
Chronic toxicity tests	01
Concept of maximum acceptable toxicant concentration (MATC) and safe concentration	02
<b>Factors affecting toxicity</b>	
Factors related to the chemical exposure	01
Surrounding medium and the organisms	
<b>Unit V</b>	
<b>Toxic effects of Xenobiotics</b>	
Local and systemic effects	01
Immediate and delayed effects	
Reversible and irreversible effects	
Biochemical and physiological effects of xenobiotics	01
Nanotoxicology	01
Toxicogenomics	01
<b>Bioaccumulation of Xenobiotics</b>	
Concept of bioconcentration, bioaccumulation and biomagnifications;	
Bioconcentration factor	01
Process of bioaccumulation in the biological system	01
<b>Biotransformation of Xenobiotics</b>	
Concept of biotransformation and metabolism	01
Sites of biotransformation	01
Biotransformation enzymes and general biotransformation reactions	01
Factors affecting biotransformation	01
Safety evaluation of xenobiotics	01
Antidotal therapy	01
<b>Student learning outcomes</b>	
The student at the completion of the course will be able to explain:	
• complexities and interconnectedness of various environmental levels and their functioning	
• global environmental issues, their causes, consequences and amelioration	

- significance and conservation of wild life
- xenobiotics, their mode of action and damage caused

### **Suggested readings**

1. Ecology: Theories & Applications. Peter D. Stiling, 2001, Prentice Hall.
2. Ecological Modeling. 2008. Grant, W.E. and Swannack, T.M., Blackwell.
3. Ecology: The Experimental Analysis of Distribution and Abundance. Charles J. Krebs, 2016, Pearson Education Inc.
4. Elements of Ecology. T.M. Smith and R.L. Smith, 2014, Pearson Education Inc.
5. Environmental Chemistry. 2010. Stanley and Manahan, E. CRC, Taylor & Francis. London.
6. Environment. Raven, Berg, Johnson, 1993, Saunders College Publishing.
7. Essentials of Ecology. G.T. Miller, Jr. & Scott. E. Spoolman, 2014, Brooks/Cole, Cengage Learning.
8. Freshwater Ecology: A Scientific Introduction. 2004. Closs, G., Downes, B. and Boulton, A. Wiley-Blackwell publisher, Oxford.
9. Fundamental Processes in Ecology: An Earth system Approach. 2007. Wilkinson, D.M. Oxford University Press, UK.
10. Fundamentals of Ecology. E.P. Odum & Gray. W. Barrett, 1971, Saunders.
11. Principles of Terrestrial Ecosystem Ecology. 2011. Chaplin, F.S., Matson, P.A. & Vitousek, P.M. Springer.
12. Omkar and Pervez, A.(2017). Concepts of Toxicology. A Textbook for U.G. and P.G. students. Publ. by Vishal Publishing Co. Jalandhar.
13. Derelanko & Auletta. Handbook of Toxicology, 3rd Ed. CRC Press
14. Casarett & Doull's Toxicology: The Science of Poisons" 8th Ed. Edited by Curtis A. Klaassen & John B. Watkins III
15. Principles of Biochemical Toxicology" by J.A.Timbrell, 4th Ed. Informa Press
16. Mechanistic Toxicology", U.A.Boelsterli, 2nd Ed. CRC Press.
17. Caughley, G., and Sinclair, A.R.E. (1994). Wildlife Ecology and Management. Blackwell Science.
18. Pushpesh. J. Wildlife & Forest Conservation A Status Report. Swastik
19. Anderson Stanley.Managing Our Wildlife Resources. Prentice Hall, 3rd Edition
20. Martin Winter. Wildlife Biology. Syrawood Publishing House
21. Kasen Hurst. Wildlife Conservation & Management. Larsen & Keller
22. Martin Winter. Wildlife Conservation & Management .Syrawood Publishing House
23. Martin Winter. Wildlife Protection & Management. Callisto Reference
24. Kendall W.L . Wildlife Study Design . SJ
25. Andrew Wright. Forest Ecology. Black Prints
26. Rajesh Gopal. Fundamental of Wildlife Management. Natraj Publishers
27. Biodiversity and Ecosystem functioning. edited by Michel Lorean ,ShahidNaureen and Pablo Inchausti ( Oxford University Press.)
28. Biodiversity and Conservation in Forests. By Diana. F. Tomback. Publication MDPI-Multidisciplinary Digital Publishing Institute.



29. Methods and Practice in Biodiversity Conservation by David Hawks-worber. (Springer Publication)
30. Recent Studies in Biodiversity and Traditional Knowledge in India. By Chandra Ghosh and A.P. Das (Publisher: Levant Books)
31. Biodiversity and Protected Areas by Beazley, Karen, Baldwin, Robert. (Publishers: MDPI)  
An Advanced Text book on Biodiversity (Principle and Practice) by K.V. Krishnamurthy. (Publication-CBS)
32. Biodiversity Hotspots edited by Vittore Rescigrio and SavarioMoletta. (Publishers: Nova Science Publishers)

## MZFE303A: Principles of Endocrinology

**Theory Credit: 04**

**Teaching Hours: 60**

### **Course objectives**

The course focuses on helping the students to understand the basics of endocrinology and impart knowledge about the endocrine regulation of different body functions. Besides, it aims to understand the integrative working of signaling system in maintaining homeostasis

### **Unit I**

#### **Fundamentals of Endocrinology**

Introduction and evolutionary perspective	03
Endocrine hypothalamus, structure and function SON, PVN, POA, Arcuate nucleus	04
Hypophysiotropic hormones	
Pituitary gland, structure and function (adenohypophysis, Neurohypophysis, pars intermedia)	05

### **Unit II**

#### **Hormones and metabolic regulation**

Thyroid gland	06
Biosynthesis and chemistry of thyroid hormones	
Mechanism of action	
Biological actions	
Endocrine Pancreas	03
Insulin, glucagon and other secretions	
Chemical regulation of feeding, digestion	03

### **Unit III**

#### **Endocrine regulatory molecules**

Hormones	07
Chemical classification of hormones	
Hormone receptors	
Mechanism of hormone action	
Neurotransmitters and neuropeptides	03
Regulatory pathways	02

### **Unit IV**

#### **Neuroendocrine integration**

Hypothalamo–hypophyseal axis	03
Feedback mechanisms	02
Adrenal gland, cellular organization	04
Catecholamines and General Adaptation Syndrome	03

## Unit V

### Endocrine regulation of homeostasis

Hormones and Homeostasis	06
Electrolytes and water balance (Renin-Angiotensin system)	
Energy homeostasis	
Parathyroid gland	06
Calcium homeostasis	
Endocrine regulation of bone	

### Student learning outcome

The course will enable the students:

- To develop an understanding of the basic endocrinology
- To study the endocrine regulatory molecules mediating physiology and behavior
- To study the neural and endocrine components of physiological function and neuroendocrine regulation
- To understand the role of hormones in metabolic regulation and maintaining homeostasis
- To understand the integrative working of signaling system

### Suggested readings

1. Vertebrate Endocrinology: David O. Norris, James A. Carr, 2013, 5<sup>th</sup> Edition, Academic Press
2. Williams Textbook of Endocrinology: H. M. Kronenberg, S. Melmed, K. S. Polonsky and P. R. Larsen, 2008, 11<sup>th</sup> Edition, Saunders, Elsevier
3. Comparative Vertebrate Endocrinology: P. J. Bentley, 3<sup>rd</sup> Edition, Cambridge University Press
4. Neuroendocrinology: Charles B. Nemeroff, CRC, US
5. An Introduction to Neuroendocrinology: Richard E. Brown, 2005, Cambridge University Press
6. Endocrinology: Mac E. Hadley, Jon E. Levine, 2009, 6<sup>th</sup> Edition, Pearson Education
7. Molecular Endocrinology: F. F. Bolander, 3<sup>rd</sup> Edition, 2004, Elsevier Academic Press
8. Essential Endocrinology: Darville Brook, C.G. & Marshall, Wiley Blackwell
9. Endocrinology at a Glance: Greenstein B, Wiley Blackwell
10. Evidence-Based Endocrinology: V. M. Montori (ed.), Humana Press
11. General And Comparative Endocrinology: John B. Allard, Cunming Duan, Intelliz Press LLC (2016)

## MZFE303B: Techniques on Insect Taxonomy, Morphology and Ecology

**Theory Credit: 04**

**Teaching Hours: 60**

### **Course objectives**

- To acquaint students with taxonomical and biological diversity of insects
- To acquaint students with biology and evolutionary history of the hexapod orders.
- To acquaint the students with general external morphology of insects
- To acquaint students with the role that insects play in the ecosystems and to study how the ecosystems influence the insects that live in them

### **Unit I**

#### **Insect taxonomy I**

Overview of insect classification	04
Identification of Entognathushexapodes	06
Protura	
Collembola	
Diplura	
Identification of apterygotes	02
Thysanura	

### **Unit II**

#### **Insect taxonomy II**

Identification of pterygote orders and their economically important superfamilies	04
Orthoptera	
Hemiptera	
Identification of orders and their economically important superfamilies	04
Coleoptera	
Hymenoptera	
Identification of order and their economically important superfamilies	04
Lepidoptera	
Diptera	

### **Unit III**

#### **Insect morphology**

General organization of the insect body	02
General Organization of insect head	04
Sutures and area of the cranium	
Tentorium	
Gnathal appendages (antenna and mouth parts)	
General Organization of insect thorax	04
Pterothorax	
Legs and their modification	
Wing types	

Wing venation	
General organization of insect abdomen	02

#### **Unit IV**

##### **Insect ecological techniques I**

Survey and sampling methods	03
Reproductive potential	02
Population growth and dynamics	03
Survivorship curves and life tables and their application to insect biology	04

#### **Unit V**

##### **Insect ecological techniques II**

Interspecific interactions	02
Prey-predator interactions	02
Functional and numerical response	01
Concept of predator satiation	01
Evolution of life history strategies	03
Insect–plant interactions	03

#### **Student learning outcomes**

Upon successfully completing this course students will be able to;

- demonstrate identification skills for all insect orders and some superfamilies
- demonstrate an understanding of the evolutionary history of hexapod orders
- explain and identify the external morphology of insects
- demonstrate understanding of the interactions between the insects and ecosystem.

#### **Suggested references**

1. Richards, O. W., & Davies, R. G. (1997). *Imms' General Textbook of Entomology, Volume I: Structure, Physiology and Development*. London, Chapman and Hall.
2. Imms, A. D., Richards, O. W., & Davies, R. G. (Eds.). (2012). *Imms' General Textbook of Entomology: Volume 2: Classification and Biology*. Springer Science & Business Media.
3. B. Danforth & C. Marshall. 2003. *Eickworth's Manual of Insect Morphology*. (Posted PDF files on Carmen.osu.edu.
4. Snodgrass, R.E. 1993 (originally 1935). *Principles of Insect Morphology* (with new forward by George Eickwort). Cornell University Press. 667pp.
5. Grimaldi, D.A. and M.S. Engel. 2005. *Evolution of the Insects*. Cambridge University Press. 755 pp.
6. Triplehorn, C.A. and N.F. Johnson. 2005. *Borror and DeLong's Introduction to the Study of Insects*, 7th edition. Thomson Brooks/Cole, Belmont, CA.
7. Schowalter, T.D. (2016). *Insect Ecology: An Ecosystem Approach*. Academic Press.
8. Price, P.W., Denno, R.F., Eubanks, M.D., Finke, D.L., and Kaplan, I. (2012). *Insect Ecology: Behavior, Populations, and Communities*. Cambridge University Press.

## MZFE303C: Fish Biology and Genetic Resources

**Total Credit: 04**

**Teaching Hours: 60**

### **Course objectives**

The aim is to provide students with the knowledge of:

- biology and physiology of fishes
- fish genetics resources and its use for fish productivity

### **Unit I**

#### **Fish morphology and anatomy**

Skin: structure, composition and function	01
Barbels in fishes	01
Scales: Types, structure and composition	02
Tail: structural modifications	01
Fins and locomotion	02
Air breathing organs and swim bladder: (structural modifications)	03
Weberian ossicles and sound producing organs	02

### **Unit II**

#### **Fish physiology**

Food, feeding habits and digestion	03
Excretion	01
Osmoregulation	01
Respiratory system: gills, physiology of respiration	02
Circulatory system	02
Nervous system	01
Sense organs: eyes, olfactory and gustatory	02

### **Unit III**

#### **Reproduction and development**

Gonads: male and female	02
Reproductive cycle and maturation	03
Spawning	01
Development in fishes	02
Parental care	02
Selective breeding and hybridization	02

### **Unit IV**

#### **Endocrinology and behaviour**

Endocrine glands: structure and functions	03
Fish behaviour (conditioned response and ethological analogies)	02
Fish migration	02
Pigments, colour changes and its significance	02
Electric organ	01

Luminescence organs in different fishes	02
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## **Unit V**

### **Fish genetic resources**

Fish Biodiversity	02
Stock (concept and structuring)	03
Fish chromosome and karyotyping	03
Chromosome Banding (C, G and NOR)	02
Chromosome Manipulation ( Gynogenesis, Androgenesis and Polyploidy)	02

### **Student learning outcomes**

The present course provides the basic concepts of fish biology and genetic resources, which will enable the students to:

- utilize the knowledge in fish biology researches,
- manage the fish under controlled conditions, and
- understand the status of fish biogenetic resources of India

### **Suggested readings**

1. Lagler KF, Bardach, JE, Miller, RR, Passino DRM. 1977. Freshwater Fishery Biology by Ichthyology, 2nd Ed. John Wiley & Sons, New York
2. Santosh Kumar and Manju Tembhre. 2011. Fish and Fisheries.
3. Moyle PB. 1982. Fishes: An introduction to ichthyology. Printice-Hall, Englewood cliffs.
- Jayaram KC. 2008. Fundamentals of Fish Taxonomy.
4. Gopal Ji Srivastava. 1995. Fishes of U.P. and Bihar.
5. Paul J.B. Hart and John D. Reynolds. 1979. Handbook of Fish Biology and Fisheries.
6. Brown ME. 1966. Physiology of fishes. Vol. I and II Academic Press. New York.
7. Hoar WS, Randall DJ and Donaldson EM. 1983. Fish Physiology. Vol. IX. Academic Press, New York

## MZFE303D: General Parasitology

**Credits: 04**

**Teaching Hours: 60**

### **Course objectives**

This course will acquaint the students with:

- adequate knowledge on parasites and parasitism with an emphasis on the physiology, biochemistry, ecology and evolution of parasites, and
- an understanding of the molecular taxonomy of parasites, and the interface of parasitism/immunity in the context of the host-parasite interactions.

### **Unit 1**

#### **Introduction to Parasitology** 12

General introduction; basic definitions and concepts; career in parasitology  
Animal associations (phoresy, symbiosis, mutualism, symbiosis, parasitism)  
Types of hosts and parasites; Host specificity; Parasitic adaptation  
Parasitology and human welfare

### **Unit 2** 12

#### **Taxonomy and diversity**

Basic definitions and concepts of taxonomy and systematics  
Morphological taxonomic characters of major parasite groups  
Kinds of taxonomic literature and databases and their uses  
Process of typification and different zoological types  
International code of Zoological Nomenclature (ICZN)  
Biodiversity of parasites at global and national level

### **Unit 3**

#### **Physiology and biochemistry** 12

Ultrastructure of the tegument  
Physiology of digestion, excretion and respiration  
Metabolism of protein, lipid and carbohydrate  
Physiology of reproduction and egg–shell formation

### **Unit 4**

#### **Ecology, evolution and immunology of parasites** 12

Mechanism of infection  
Dimensions and saturation of niches of parasites  
Parasite manipulation of host behaviour  
Host–parasite coevolution  
Host–parasite interactions (tissue damage, tissue changes, immunological adaptations of parasitism)



## Unit 5

### Molecular biology and bioinformatics

12

Extraction, preservation, and amplification of DNA  
Quantitative and qualitative analysis of nucleic acid (spectrophotometry and gel electrophoresis)  
DNA sequencing  
DNA barcoding  
Bio-molecular databases in bioinformatics  
Phylogenetic tree and its reconstruction (distance-based methods, maximum parsimony, maximum likelihood)

### Course learning outcomes

By the end of the semester, students will be able to:

- define variety of animal associations,
- demonstrate an understanding of the physiology, biochemistry, ecology, evolution, and molecular biology of parasites, and
- use the bioinformatics for molecular phylogenetic analysis.

### Suggested readings

1. *Animal Parasitology* by JD Smyth. Cambridge University Press.
2. *Essentials of Parasitology* by GD Schmidt. Brown Publishers
3. *Encyclopaedia of Bioinformatics and computational biology* by Shoba Ranganathan, Michael Gribskov, Kenta Nakai, Christian Schonbach.
4. *Evolutionary Parasitology: The Integrated Study of Infections, Immunology, Ecology, and Genetics* by Paul Schmid-Hempel. OUP Oxford.
5. *Foundation of Parasitology* by GD Schmidt LS Roberts. McGraw Hill Publishers.
6. *General Parasitology* by TC Cheng. Academic Press
7. *Helminths, Arthropods and Protozoa of domesticated animals* by E JL Soulsby. ELBS and Bailliere Tindall. London.
8. *Human Parasitology* by BJ Bogitsh, CE Carter, TN Oeltmann. Academic Press.
9. *Introduction to Parasitology* by AC Chandler & CP Read. John Wiley & Sons Inc.
10. *Parasite genomics protocols* by SE Melville. Humana Press.
11. *Parasitology* by Chaterjee K.D. Medical Pulisher Calcutta.
12. *Parasitology: The Biology of animal parasites* by ER Noble GA Noble
13. *Modern Parasitology* by FEG Cox. Blackwell Scientific Publications.
14. *Molecular Parasitology* by JE Hyde. Open University Press. London.

### V: Open Electives

<b>Credit Elective Papers</b>				
<b>Semester</b>	<b>Course</b>	<b>TOPIC</b>	<b>Credits</b>	<b>Total Lectures</b>
III	MZOE306A	Public Health	4	60
	MZOE306B	Fundamentals of Living Systems		
	MZOE306C	Insects in Human Life		
	MZOE306D	Molecular Diagnostics in Clinical Practice		
	Total		4	60

## MZOE306A: Public Health

**Total Credits: 04**

**Teaching Hours: 60**

### **Course objectives**

- Provide conceptual knowledge of different diseases and their prevention
- Explain measures for healthy life
- Discuss Government's role in disease management
- Discuss epidemiology of diseases

### **Unit I**

#### **Human diseases**

Communicable/Vector borne diseases- Malaria, Sleeping sickness	04
Non-Communicable diseases- Cancer, AIDS	04
Metabolic diseases - Diabetes, BP, Thyroid	02
Genetics diseases- PKU, Sickle Cell Anaemia, Thalassaemia	02

### **Unit II**

#### **Disease prevention**

Tackling antimicrobial resistance	04
Measures for reduced maternal & child/infant mortality rate	04
Prevention of environmental pollution & its degradation	04

### **Unit III**

#### **Measures for healthy life**

Micronutrients, their role, deficiency & related problems	02
Improved nutrition for all age groups	02
Application of yoga & physical exercise for healthy life (their role)	02
Obesity, Non-alcoholic fatty liver	02
Hazards of tobacco chewing & smoking	02
Importance of personal & public hygiene & better sanitary habits	02

### **Unit IV**

#### **Government's role in public health**

Strong Government's accountability for enforcement of quality health measures	02
Regular immunization/vaccination programmes eg., pulse polio	04
Adequate measures for preventing spread of vector borne diseases	02
Government's role in propagation of family planning measures, AIDS awareness	04

### **Unit V**

#### **Epidemiological studies**

Epidemiology & statistical analysis of difference diseases	06
Population genetics	06

### **Student learning outcomes**

At the end of the course the student will have

- Enhanced awareness towards various human diseases, their control and prevention.
- Information on improvement of life style & health via quality health measures.

### **Suggested readings**

1. Public Health and Hygiene by Sorna Raj and KumaresanSaras Publication
2. Public Health Management: Principle and Practice by Sundar Lal, Vikas, CBS Publishers, 2018
3. A practical guide for PG course in Community medicine, Public Health and Health management by Sudip Bhattacharya and Sailesh Tripathi, 2018
4. Park's Textbook of Preventive and Social Medicine by K. Park 2017

## MZOE306B: Fundamentals of Living Systems

**Total Credits: 04**

**Teaching Hours: 60**

### Course Objectives

- To know about fundamentals of life, its basic organization
- To learn about the structural and functional diversity of organisms in terms of their complexity
- To study the seasonality of life processes
- To combat the biological challenges

### Unit I: Introduction to life

Living systems, their basic organization	<b>04</b>
Sensitivity to the environment	<b>04</b>
Adaptation with the environment	<b>04</b>

### Unit II: Properties of life: structural aspect

Interaction between abiotic and biotic components	<b>04</b>
Organization of living systems	<b>04</b>
Growth and development	<b>04</b>

### Unit III: Properties of life: functional aspect

Regulation of life processes	<b>04</b>
Homeostasis	<b>04</b>
Energy dynamics	<b>04</b>

### Unit IV: Seasonality in Life

Migration	<b>04</b>
Reproduction	<b>04</b>
Hibernation/ aestivation and diapauses	<b>04</b>

### Unit V: Challenges to life

Stress physiology	<b>04</b>
Life style disorders	<b>04</b>
Prevalence of various diseases	<b>04</b>

### Student Learning Outcomes

1. Major trends in the diversification of invertebrates and vertebrates through evolutionary history.
2. Characterize and differentiate the structural and functional characteristics of major animal phyla and how these have led to a natural, phylogenetic grouping of animal.
3. Adaptation in animals in time and space
4. Symmetry and its basis in body plans
5. Evolution of symmetry and its significance in animal life

### Suggested Reading

1. Lisa A. Urry, Michael L. Cain, Steven A. Wasserman, Peter V. Minorsky, Jane B. Reece, Campbell Biology, Pearson, (11<sup>th</sup> edition), 2016.
2. James Grier Miller, Living systems, Univ Pr of Colorado, 1995.

3. Christopher A. Wilson, Daniel Conway, *The fundamentals of life*, 2017, ISBN-10: 1521825645
4. Heisenberg C-P, Bellaïche Y. Forces in tissue morphogenesis and patterning. *Cell*. 2013;153:948–62.
5. Cummings FW. On the origin of pattern and form in early Metazoans. *Int J Dev Biol*. 2006;50:193–208.
6. Carroll SB. Chance and necessity: the evolution of morphological complexity and diversity. *Nature*. 2001;409:1102–9.

## MZOE306C Insects in Human Life

**Total Credits: 04**

**Teaching Hours: 60**

### Course Objectives

- To develop an appreciation of insect diversity, and structure
- To develop and appreciation for the beneficial role of insects

### Unit I

#### General Insect Biodiversity

What are Insects?	06
General life cycle of Insects	06

### Unit II

#### Insect Classification

General Insect Morphology & Anatomy	04
How to Identify Insects?	04
Wrongful Vilification of Insects	04

### Unit III

#### Beneficial Insects-I

Apiculture	04
Sericulture	04
Lac Culture	04

### Unit IV

#### Beneficial Insects-II

Biological Control Agents	04
Ecological Services of Insects	04
Edible Insects	04

### Unit V

#### Beneficial Insects-III

Entomotherapy	04
Insects in Music, Art, poetry	04
Insects in Culture	04

### Student Learning Outcomes

At the end of the course, the student will be able to

- Demonstrate the ability to observe and identify insects around them
- Exhibit an understanding of how insects are beneficial to humans
- Demonstrate the ability to communicate the benefits of insects effectively

### Suggested Reading

- Chapman, R. (2012). The Insects: Structure and Function (S. Simpson & A. Douglas, Eds.). Cambridge: Cambridge University Press
- Gullan, P. J., & Cranston, P. S. (2014). The insects: an outline of entomology. John Wiley & Sons.
- McGavin: Essential Entomology (2001, Oxford Univ Press)
- Srivastava: A Text Book of Applied Entomology (Vol. I & II, 2nd ed.) Kalyani Publ., 2001

- A Textbook of Applied Entomology Vol. I and II by Srivastava and Dhaliwal
- Van Huis, A. (2013). Potential of insects as food and feed in assuring food security. *Annual review of entomology*, 58, 563-583.
- Huis, A. V., Itterbeeck, J. V., Klunder, H., Mertens, E., Halloran, A., Muir, G., & Vantomme, P. (2013). Edible insects: future prospects for food and feed security. *FAO Forestry paper*, (171).
- van Huis, A., & Oonincx, D. G. (2017). The environmental sustainability of insects as food and feed. A review. *Agronomy for Sustainable Development*, 37(5), 43.
- EFSA Scientific Committee. (2015). Risk profile related to production and consumption of insects as food and feed. *EFSA journal*, 13(10), 4257.
- Dobermann, D., Swift, J. A., & Field, L. M. (2017). Opportunities and hurdles of edible insects for food and feed. *Nutrition Bulletin*, 42(4), 293-308.
- Anankware, P. J., Fening, K. O., Osekre, E., & Obeng-Ofori, D. (2015). Insects as food and feed: A review. *International Journal of Agricultural Research and Review*, 3(1), 143-151.
- Eilenberg, J., Vlak, J. M., Nielsen-LeRoux, C., Cappellozza, S., & Jensen, A. B. (2015). Diseases in insects produced for food and feed. *Journal of Insects as Food and Feed*, 1(2), 87-102.
- Costa-Neto, E. M. (2005). Entomotherapy, or the medicinal use of insects. *Journal of Ethnobiology*, 25(1), 93-114.
- Cherniack, E. P. (2010). Bugs as drugs, Part 1: Insects: the "new" alternative medicine for the 21st century. *Altern Med Rev*, 15(2), 124-135.



## MZOE306D: Molecular Diagnostics in Clinical Practice

**Total Credits: 04**

**Teaching Hours: 60**

### Course Objectives

- To create awareness of genetic diseases
- To learn molecular diagnostic means for multiple diseases

### Unit I

Chromosomal aberrations: Diagnosis, treatment, epidemiology	04
Karyotyping: Detection of human chromosomal abnormalities	03
Cytogenetic and Molecular approaches	03
Microscopy: phase-contrast microscopy, fluorescence microscopy	02

### Unit II

Monogenic disorders: DMD, Hemophilia, Mental retardation, SMA	02
Mutation detection technique: DNA Isolation, Polymerase Chain Reaction	04
Carrier analysis: PCR-RFLP, DNA sequencing	04
Management of genetic disorders: calculation of genetic risk, prenatal diagnosis and genetic counseling	02

### Unit III

Inborn errors of metabolism: Signs & Symptoms, diagnosis, treatment, epidemiology (eg. Phenylketonuria, Tay Sach's disease, Glycogen storage disease, G6PD deficiency, Alkaptonuria)	06
Diagnosis: Quantitative measurement of amino acids in plasma and urine, specific diagnostic tests	04
Genome imprinting syndromes & mitochondrial syndromes	02

### Unit IV

Polygenic diseases: Diabetes, pulmonary diseases etc.	02
Causes of complex diseases: Types and symptoms	02
Diagnosis of complex diseases: Family history, IDRS, Spirometry etc.	02
Molecular technique: Genotyping, Real time PCR, Biochemical tests, ELISA	06

### Unit V

Types of cancers and stages, Carcinoma, Sarcoma, Leukemia, Lymphoma etc.	04
Cancer screening and diagnosis: Physical exam, laboratory tests, Imaging test, Biopsy	04
Treatment of cancers: Surgery, Chemotherapy, Radiotherapy, Immunotherapy, Bone marrow transplant, Hormone therapy	02
Management of cancers: Molecular genotyping, Palliative care, Cure	02

### Student learning outcomes

After completion of the course, the student will have

- Awareness about genetic diseases, their types and causes.
- Understanding of molecular techniques have improved diagnosis and management of these diseases.
- Understanding of how via precautions the onset of these diseases can be prevented or delayed.

**Suggested readings**

1. *Molecular Diagnostics* - 3rd Edition. **Editors:** George Patrinos et al. Academic Press, 2016
2. Tietz Fundamentals of Clinical Chemistry and Molecular Diagnostics - E-Book By Carl A. Burtis, David E. Brun

# **Semester IV**

## MZFE401A: Biology of Reproduction

**Theory Credit: 04**

**Teaching Hours: 60**

### **Course objectives**

The main objective of this course is to study the physiology of male and female reproductive axis and reproductive cycles and develop understanding of endocrinology of pregnancy, parturition and lactation. It also emphasizes to understand the interrelationship between reproduction and immunity, and study the seasonality in reproduction.

### **Unit I**

#### **Physiology of male and female reproductive axis**

##### Reproductive system

Gonadal differentiation and theories	04
Differentiation of reproductive tract	04
Hormones of reproductive axis (GnRH/ GnIH; luteinizing hormone [LH] and follicle stimulating hormone [FSH]; sex steroids)	04

### **Unit II**

#### **Reproductive cycles and pregnancy**

Estrus cycle and menstrual cycle	04
Cellular details and hormonal regulation	
Pregnancy and its hormonal regulation	04
Implantation window, mechanism of implantation	
Trophoblast differentiation	
Placentation	04
Mechanism of placentation	
Placental transport function	

### **Unit III**

#### **Endocrinology of parturition and lactation**

Parturition and its control	03
Oxytocin and prolactin	
Lactation and its hormonal control	06
Anatomical changes in mammary glands	
Lactogenesis, Colostrum and its composition	
Cellular mechanism of milk secretion	
Metabolic homeostasis in human pregnancy and lactation	03

### **Unit IV**

#### **Reproduction and immunity**

Immunity during pregnancy	05
Suppression of immunity	
Role of hormones	

Immune tolerance	03
Autoimmune bases of infertility	04

## **Unit V**

### **Seasonality in reproduction**

Pineal gland	06
Melatonin biosynthesis	
Melatonin as clock and calendar	
Neuroendocrine regulation of seasonality in reproduction	06

### **Student learning outcome**

The course will enable the students:

- To study the physiology of male and female reproductive axis and reproductive cycles
- To develop understanding of endocrinology of pregnancy, parturition and lactation
- To understand the interrelationship between reproduction and immunity
- To study the seasonality in reproduction

### **Suggested readings**

1. Encyclopedia of Reproduction: Ernst Knobil and Jimmy D. Neill, Volumes 1-4, Academic Press
2. The biology of reproduction: Giuseppe Fusco and Alessandro Minelli, Cambridge University Press
3. Biology of reproduction: Peter J. Hogarth, Blackie
4. Williams Textbook of Endocrinology: H. M. Kronenberg, S. Melmed, K. S. Polonsky and P. R. Larsen, 2008, 11<sup>th</sup> Edition, Saunders, Elsevier

## MZFE401B: Insect Physiology

**Theory Credit: 04**

**Teaching Hours: 60**

### **Course objectives**

- To acquaint students with the physiological systems of insects
- To acquaint students with habitat dependent change in structure of physiological systems
- To acquaint students with habitat dependent change in physiological functions

### **Unit I**

#### **Digestive system**

06

Alimentary canal and its modification

Salivary glands

Nutritional requirements of insect

Physiology of digestion

Digestion of special food stuffs (wool, collagen, keratin, pollen, silk, wax)

Intermediary metabolism of carbohydrates, fats and protein, fat body

Ectosymbiotic fungi

Endosymbionts

#### **Circulatory system**

06

Structure of heart

Mechanism of circulation

Reversal of heart beat

Haemocytes

Type

Origin and longevity

Haemopoietic organs

Changes in haemocyte population

### **Unit II**

#### **Nervous system**

05

Structure of brain

Nerve chord

Neurotransmitters and neuromodulator system

Cholinergic systems

Biogenic amines

Amino acids

Neuropeptides

#### **Sense organs**

07

Mechanoreceptors

Chemoreceptors (Olfactory and gustatory)

Auditory organs & hearing;  
Sound and light producing organs  
Mechanism of sound and light production  
Visual organs and image formation

### **Unit III**

#### **Respiratory system**

06

General organization  
Types of spiracles  
Gaseous Exchange mechanisms and respiratory adaptations in terrestrial insects  
Gaseous Exchange mechanisms and respiratory adaptations in aquatic insects  
Respiratory adaptations in endoparasitic insects

#### **Excretory system**

06

Organs of excretion  
Nitrogenous excretion  
Excretory products  
Storage excretion  
Production of urine and its hormonal regulation  
    Terrestrial and salt water insects  
    Control of diuresis  
    Water regulation  
    Detoxification

### **Unit IV**

#### **Reproductive system**

06

Anatomy of reproductive organs  
Spermatogenesis and oogenesis  
Mating, insemination, oviposition  
Various modes of reproduction

#### **Insect Development**

06

Development up to three germ layers  
Physiological control of moulting and metamorphosis  
Various types of larvae and pupae

### **Unit V**

#### **Endocrine glands**

05

Historical perspective  
Endocrine glands and concept of neurosecretion  
Biosynthesis and degradation of hormones  
Function of JH and ecdysteroids  
Mechanism of action of JH and ecdysteroids  
Vertebrate hormones in insects

Eicosanoids and their functions

<b>Integument and cuticular sclerotization</b>	04
Structure of integument	
Structure of cuticle	
Components of sclerotized cuticle (structural proteins, chitin, catechols, enzymes)	
Dityrosine crosslinks	
Quinone tanning	
$\beta$ -sclerotization	
Differential mechanism of tanning	
Combined pathway and cross-linking mechanisms	
Free radical formation	

<b>Photoperiodism</b>	01
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<b>Diapause and its regulation in insects</b>	02
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### **Student learning outcomes**

At the end of the course the students will be able to demonstrate:

- an understanding of the various physiological systems of insects
- an understanding of structural differences in the physiological systems of insects from varied habitats
- an understanding of the functional differences in insect physiological systems

### **Suggested readings**

1. Chapman, R. (2012). *The Insects: Structure and Function* (S. Simpson & A. Douglas, Eds.). Cambridge: Cambridge University Press
2. Gullan, P. J., & Cranston, P. S. (2014). *The insects: an outline of entomology*. John Wiley & Sons.
3. Marshall, S. A. (2006). *Insects: their natural history and diversity: with a photographic guide to insects of eastern North America*. Richmond Hill, Ont.: Firefly Books.
4. Nation, J.L. *Insect Physiology and Biochemistry* 3rd edition. CRC press
5. Klowden: *Physiological Systems in Insects* (2002, Academic Press)
6. McGavin: *Essential Entomology* (2001, Oxford Univ Press)
7. Wigglesworth: *Principles of Insect Physiology* (1972, ELBS)



## MZFE401C: Fish Ecology, Aquaculture and Capture Fisheries

**Total Credit:04**

**Teaching Hours: 60**

### **Course objectives**

#### **Unit I**

##### **Ecology of teleostean fishes**

Water quality requirements	02
Temperature, salinity, osmotic pressure, pH, dissolved oxygen, carbon dioxide, nitrogen, alkalinity and turbidity	03
Toxic substances and their effects	02
International water code for responsible fisheries	02
Aquatic weeds and their control	02
Exclusive economic zone	01

#### **Unit II**

##### **Fish pond management**

Construction and lay-out of different types of ponds (nursery, rearing, and stocking)	02
Formulation and operation of different types of hatcheries	02
Productivity of the pond (planktons and Live food organism)	02

##### **Pond management and stocking materials**

Stocking materials (spawn, fry and fingerlings) and their culture	02
Manuring, liming, eradication of predatory and weed fishes, predatory aquatic insects and their control	03
Fish poison	01

#### **Unit III**

##### **Capture fisheries**

Freshwater fisheries (River, Lakes, and Reservoir)	02
Cold water fisheries and Hill stream adaptation	02
Brackish water fisheries	02
Marine fish resources of India	01
Problems and prospects of Mariculture	01
Capture fisheries of India with reference to Elasmobranchs	02
Bombay duck, Catfishes, Eels, Thread fish, Therapon, Mackerel and Pomfrets, Crustacean and Molluscan Fisheries	02

#### **Unit IV**

##### **Aquaculture**

Problems and prospects of aquaculture	02
Breeding habits of carps: Induced breeding and Bundh Breeding (Indigenous and Exotic)	02

Polyculture and Monoculture	02
Integrated fish farming and their management	02
Nets, Gears and Boats used for Fishing	02
Aquarium fish and their maintenance	02

## **Unit V**

### **Fish products and fish diseases**

Fish preservation and processing (traditional and advanced methods)	02
Fish by-products	02
Fish marketing and trade	02
Fish pathology: prevention, prophylaxis and treatment of Fungal, Bacterial, Viral and Protozoan Diseases	04
Fisheries Cooperative Societies of India	01
Fish in relation to Man and Human Welfare	01

### **Course learning outcome**

The present course will prepare the students for:

- the self-employment, and
- the jobs related to the fish and fisheries.

### **Suggested readings**

1. Jhingran VG. 1991. Fish and Fisheries of India, Hindustan Publishing Corporation.
2. A Hatchery Manual for the Common, Chinese and Indian Major Carps by V.G. Jhingran and R.S.V. Pullin, Asian Development Bank, ICLARM, Manila, Philippines
3. Reid GR.1961. Ecology and Inland waters and Estuaries. Rein Hold Corp., New York.
4. Pilley, TVR and Dill, WMA. 1979. Advances in Aquaculture. Fishing News Books, Ltd. England. 11.
5. Pillay TVR and Kutty MN. 2005. Aquaculture- Principles and Practices. Blackwell.
6. Nikolsky GV. 1963. Ecology of Fishes, Academic Press.
7. Norman JR and Greenwood PH. 1975. A History of Fishes, Halsted Press.
8. Potts GW and Wootten RJ. 1984. Fish Reproduction: Strategies and Tactics, Academic Press.
9. De Silva SS & Anderson TA. 1995. Fish Nutrition in Aquaculture. Chapman & Hall Aquaculture Series.
10. Ojha JS. 2005. Aquaculture Nutrition and Biochemistry. Daya Publ.
11. Rath RK. 2000. Freshwater Aquaculture. Scientific Publ.
12. Landau M. 1992. Introduction to Aquaculture. John Wiley & Sons.

## MZFE401D: Biology of parasites (Protozoa, Helminths, Arthropoda)

**Credits: 04**

**Teaching Hours: 60**

### Course objectives

The course will enable the students with the knowledge on:

- parasites of medical importance in humans, livestock, and fish, and
- general morphology, biology, life-cycle, pathogenicity and control of parasites.

### Unit I

#### Protozoa 12

General morphology, biology, life-cycle, *pathogenicity* and control of:

Visceral rhizopods and flagellates: *Entamoeba histolytica* and *Giardia lamblia*

Haemoflagellates: *Trypanosoma brucei rhodesiense*, *Leishmania donovani*

Haemosporina: *Plasmodium vivax*

### Unit II

#### Monogenea 10

General morphology, biology, life-cycle, *pathogenicity* and control of:

*Polystoma*

*Diplozoon*

*Gyrodactylus*

### Unit III

#### Trematoda and Cestoda 18

General morphology, biology, life-cycle (including larval forms), pathogenicity and control of:

Visceral flukes (*Fasciolopsis buski*, *Schistosomo* sp.)

Lung flukes (*Paragonimus westermani*)

General morphology, biology, life-cycle (including larval forms), pathogenicity and control of:

Intestinal tapeworms (*Taenia solium*, *Diphyllobothrium latum*)

Extraintestinal tapeworms: Human cysticercosis, Human hydatidosis

### Unit IV

#### Nematoda and Acanthocephala 12

General morphology, biology, life-cycle (including larval forms), pathogenicity and control of:

Intestinal nematodes: *Ancylostoma duodenale*, *Trichiura trichiura*

Blood and tissue nematodes: *Wuchereria bancrofti*, *Dracunculus medinensis*

General morphology, biology, life-cycle (including larval forms), pathogenicity and control of:

*Pallisentis* sp.

## Unit V

### Arthropoda

8

Significance of Arthropods as vectors of human pathogens:

- Biting dipterans (mosquitoes, tsetse flies)
- Non-biting dipterana (common house fly)
- Acarians (ticks and mites)
- Other insects (fleas, lice)

### Course learning outcomes

By the end of the semester, students will be able to:

- recognize significant morphological characteristics for identification of each of the major parasite group,
- value the diversity of parasites,
- describe the basic biology, morphology and life history of selected parasites, and
- apply the knowledge to generate novel ideas for the management of diseases.

### Suggested readings

1. *Animal Parasitology* by JD Smyth. Cambridge University Press.
2. *Essentials of Parasitology* by GD Schmidt. Brown Publishers
3. *Foundation of Parasitology* by GD Schmidt LS Roberts. McGraw Hill Publishers.
4. *General Parasitology* by TC Cheng. Academic Press
5. *Helminths, Arthropods and Protozoa of domesticated animals* by E.J.L Soulsby. ELBS and Bailliere Tindall. London.
6. *Human Parasitology* by BJ Bogitsh, CE Carter, TN Oeltmann. Academic Press.
7. *Introduction to Parasitology* by AC Chandler & CP Read. John Wiley & Sons Inc.
8. *Parasite genomics protocols* by SE Melville. Humana Press.
9. *Parasitology* by Chaterjee K.D. Medical Pulisher Calcutta.
10. *Parasitology. The Biology of animal Parasites* by ER Noble GA Noble
11. *Modern Parasitology* by FEG Cox. Blackwell Scientific Publications.
12. *Molecular Parasitology* by JE Hyde. Open University Press. London.

## MZFE402A: Endocrine Techniques, Disorders and Pathophysiologies

**Theory Credit: 04**

**Teaching Hours: 60**

### **Course objectives**

- To study the endocrine techniques used in endocrine researches
- To understand the endocrine disorders and pathophysiologies
- To study various reproductive technologies in treating infertility
- To understand current state of Endocrinology and Reproductive Biology
- To provide students understanding of conditions resulted from abnormal hormone secretion and the laboratory tests that are used to diagnose these conditions.

### **Unit I**

#### **Classical endocrine techniques** 12

Organ/ Tissue manipulation  
Histological methods  
Surgeries  
Tissue dissection and serum collection  
Subcutaneous injections  
HRT  
Hormone assays  
RIA, ELISA, HPLC  
Hormone pellet construction  
Hormone content extraction

### **Unit II**

#### **Modern endocrine techniques** 12

RNA extraction  
RT PCR  
qPCR  
Hormone localization  
Northern Blot  
ICC, ISH

### **Unit III**

#### **Endocrine disorders and pathophysiologies** 12

Disorders of major glands  
Pituitary Disorders  
Thyroid disorders  
Adrenal disorders  
Other disorders  
Osteoporosis  
Polycystic Ovary Syndrome  
Polyendocrine disorders

## Oligospermia

### Unit IV

#### **Infertility and reproductive technologies** 12

Primary and secondary infertility

implantation failure, recurrent abortions, preeclampsia

Reproductive techniques

Invitro fertilization, Embryo transfer

GIFT, ZIFT, Cryopreservation of gametes and embryos

Contraceptives, HRT

### Unit V

#### **Current state of endocrinology and reproductive biology** 12

Disease patterns across India

Endocrine diseases (Diabetes, PCOD, Thyroid hormones related)

Endocrinology of diseases

Breakthrough researches

Indian contribution in the field

### **Student learning outcome**

The present course has been designed to:

1. provide students the knowledge and understanding of the concepts and theories related to endocrine disorders.
2. carry out the researches related to the basic and modern aspects of endocrinology.

### **Suggested readings**

1. Vertebrate Endocrinology: David O. Norris, James A. Carr, 2013, 5<sup>th</sup> Edition, Academic Press
2. Williams Textbook of Endocrinology: H. M. Kronenberg, S. Melmed, K. S. Polonsky and P. R. Larsen, 2008, 11<sup>th</sup> Edition, Saunders, Elsevier
3. Comparative Vertebrate Endocrinology: P. J. Bentley, 3<sup>rd</sup> Edition, Cambridge University Press
4. Neuroendocrinology: Charles B. Nemeroff, xxxx, CRC, US
5. An Introduction to Neuroendocrinology: Richard E. Brown, 2005, Cambridge University Press
6. Endocrinology: Mac E. Hadley, Jon E. Levine, 2009, 6<sup>th</sup> Edition, Pearson Education
7. Molecular Endocrinology: F. F. Bolander, 3<sup>rd</sup> Edition, 2004, Elsevier Academic Press
8. Essential Endocrinology: Darville Brook, C.G. & Marshall, Wiley Blackwell
9. Endocrinology at a Glance: Greenstein B, Wiley Blackwell
10. Evidence-Based Endocrinology: V. M. Montori (ed.), Humana Press
11. Encyclopedia of Reproduction: Ernst Knobil and Jimmy D. Neill, Volumes 1-4, Academic Press

## MZFE402B: Applied Entomology and Pest Management

**Theory Credit: 04**

**Teaching Hours: 60**

### **Course objectives**

- an understanding of what is a pest
- an understanding of how insects negatively affect human life
- an understanding of mode of damage by insects
- an understanding of control measures used to manage harmful insect pest populations

### **Unit I**

#### **Agricultural and horticultural pests–1**

Characteristic features, biology, nature of damage and management measures of:

Important insect pests of cotton	03
Important insect pests of sugarcane	03
Important insect pests of vegetables	03
Important insect pests of oil seeds	03

### **Unit-II**

#### **Agricultural and horticultural pests–2**

Characteristic features, biology, nature of damage and management measures of:

Important insect pests of fruit crops, especially mango	02
Important insect pests of cereals and pulses	03
Important insect pests of stored grains	02
Polyphagous insects	02
Structural Pests	03

### **Unit III**

#### **Urban entomology**

Medical Entomology	04
Veterinary Entomology	04
Forensic Entomology	04

### **Unit IV**

#### **Industrial entomology**

Apiculture	04
Sericulture	04
Lac-culture	04

### **Unit V**

#### **Pest management**

Components of Insect Pest Management including Mechanical, Physical, Cultural, Chemical, Legal, Ecological, Biological, Microbial, Recent trends	06
Concept and Procedure of Integrated Pest Management	02

Mode of action of organochlorine, organophosphorous and carbamate pesticides	02
Pyrethroids and neem products	02

### **Student learning outcomes**

At the end of the course the students will be able to:

- identify insect pests
- understand pest population dynamics
- understand pest management measures

### **Suggested readings**

1. Alford: A textbook of Agricultural Entomology, Blackwell 1999
2. Atwal and Dhaliwal: Agricultural pests of India and South-East Asia, Kalyani Publishers, Byrd and Castner: Forensic Entomology, CRC Press, 2001
3. Dhaliwal and Arora: Principles of Insect pest management, National Agricultural Technology Information Centre, Ludhiana, 1996
4. Dhaliwal and Arora: Trends in Agricultural Insect pest Management, Commonwealth Publ., 1994
5. Hill: Pest of stored foodstuffs and their control, Springer, 2002
6. Metcalf and Flint: Destructive and useful insects and their control, McGraw Hill, 1962
7. Mullen and Durden: Medical and Veterinary Entomology, Academic Press, 2002
8. Norris et al: Concepts in Integrated Pest Management, Prentice-Hall, 2002
9. Pedigo: Entomology and Pest Management (4th ed.), Prentice Hall, 2002
10. Pruthi: A Text Book of Agricultural Entomology, ICAR, New Delhi, 1969
11. Purohit: Agricultural Biotechnology (2nd ed.) Agrobios (India), 2003
12. Racheigl and Racheigl: Biological and biotechnological control of insect pests, CRC Press, 1998
13. Schoonhoven et al.: Insect-plant Biology- from physiology to evolution (1st ed.) Chapman & Hall, 1998
14. Srivastava: A Text Book of Applied Entomology (Vol. I & II, 2nd ed.) Kalyani Publ., 2001
15. A Textbook of Applied Entomology Vol. I and II by Srivastava and Dhaliwal
16. Agricultural Pests Of South Asia And Their Management by Atwal and Dhaliwal
17. Industrial Entomology by Omkar. Springer Nature
18. Ecofriendly Pest Management for Food Security by Omkar, Academic Press
19. Introduction to General and Applied Entomology by Awasthi
20. Handbook of Agricultural Entomology by van Emden
21. Pests and Their Management by Omkar, Springer Nature



## MZFE402C: Tools and Techniques in Fish and Fisheries Science

**Total Credit:04**

**Teaching Hours: 60**

### **Course objectives**

#### **Unit I**

##### **Fish biology**

Study of morphometric and meristic characteristics	02
Study of length-weight and length-length relationship	02
Determination of age and growth using scale, otolith and operculum	02
Estimation of absolute and relative fecundity	02
Artificial breeding of Indian major carp	02

#### **Unit II**

##### **Fish ecology**

Physicochemical analysis of pond water	02
Estimation of DO	02
Estimation of hardness	02
Estimation of alkalinity	02
Estimation of pH	02
Estimation of temperature	02

#### **Unit III**

##### **Fish biodiversity assessment**

Biodiversity: concepts, patterns and measurement	02
Relative abundance	02
Measurement and estimation of species richness and evenness	03
Species diversity indices	03
Phenotypic Plasticity and Genetic Differentiation in Traits	02

#### **Unit IV**

##### **Fish taxonomy and biosystematics**

Fish collection and preservation	03
Identification of ichthyo-fauna through keys	07
Fish fin formula	02

#### **Unit V**

##### **Chromosome manipulation and genotoxicity assessment**

DNA isolation of fish	02
Karyotyping of selected fish	02
DNA polymorphism through RAPD	02
Micronuclei test (MNT)	03
Chromosomal aberration test (CAT)	03

**Course learning outcome**

The present course has been designed to provide students the knowledge of tools and techniques:

to carry out the researches related to the basic and modern aspects of fish and fisheries.

**Suggested readings**

1. William RD and Matthew G. 1984. *Multivariate Analysis, Methods and Applications*. John Wiley & Sons.
2. Biradar RS. 2002. *Course Manual on Fisheries Statistics*. 2nd Ed. CIFE, Mumbai.
3. Welch PS. 2003. *Limnological Methods*. Narendra Publ. House.
4. Nelson JS. 2006. *Fishes of the World*, John Wiley and Sons, Inc., New Jersey.

## MZFE402D: Parasitological Techniques

**Credits: 04**

**Teaching Hours: 60**

### **Course objectives**

The course will enable the students to:

- learn and perform technical procedures such as collection of host and parasite specimens and preparation of reagent,
- process parasites using a variety of standardized techniques,
- performs microscopic examinations of processed specimens, and
- detect and identify parasites stages using both morphological and molecular taxonomy.

### **Unit I**

#### **Sampling and processing of vertebrate hosts (with special reference to fish) 12**

Types, preparation and applications of reagents used in parasitology laboratory  
Survey and collection of hosts  
Humane killing of hosts  
Necropsy and examination of hosts for recovery of parasites  
Faecal examination

### **Unit II**

#### **Sampling and processing of parasites 12**

Collection, fixation and preservation of ectoparasites  
Collection, fixation and preservation of endoparasites  
Staining protocols  
Preparation of temporary and permanent 'whole mounts'  
Histological techniques

### **Unit III**

#### **Morphological characterization 12**

Microscopic examination  
Introduction to optics  
Principles of image formation  
Principle, components, and applications of Light microscopy, Phase-contrast microscopy, Fluorescence microscopy, Confocal microscopy, and Electron microscopy (SEM, TEM and STEM)  
Morphometric analysis  
Measurements  
Drawing of parasites to scale  
Digital image analysis

### **Unit II**

#### **Molecular characterization 12**

Isolation of DNA

PCR Thermocycler: amplification of DNA  
Gel electrophoretic apparatus: qualitative analysis of DNA  
Spectrophotometer: quantitative analysis of DNA  
Centrifuge: collection of DNA precipitate  
DNA Sequencer: automation of DNA sequencing

## **Unit V**

### **Ecological, behavioural and immunological techniques**

12

Analysis of microhabitat distribution of ectoparasites  
Analyses of parasite communities–biodiversity indices  
Collection and analysis of water quality parameters for fish parasites  
Analysis of behaviour of cercariae  
Detection of antibodies by basic indirect ELISA

### **Course learning outcomes**

By the end of the course, students should be able to:

- examine and identify grossly parasites and their stages and parasitic lesions in different organs,
- examine and identify the microscopic morphology of parasites and their larval stages of medical importance in fixed stained smears, and
- use different kinds of microscopes and modern equipments used in Parasitology.

### **Suggested literature**

1. *Animal Parasitology* by JD Smyth. Cambridge University Press.
2. *Essentials of Parasitology* by GD Schmidt. Brown Publishers
3. *Foundation of Parasitology* by GD Schmidt LS Roberts. McGraw Hill Publishers.
4. *General Parasitology* by TC Cheng. Academic Press
5. *Helminths, Arthropods and Protozoa of domesticated animals* by E.J.L Soulsby. ELBS and Bailliere Tindall. London.
6. *Human Parasitology* by BJ Bogitsh, CE Carter, TN Oeltmann. Academic Press.
7. *Introduction to Parasitology* by AC Chandler & CP Read. John Wiley & Sons Inc.
8. *Parasite genomics protocols* by SE Melville. Humana Press.
9. *Parasitology* by Chaterjee K.D. Medical Publisher Calcutta.
10. *Parasitology. The Biology of animal Parasites* by ER Noble GA Noble
11. *Modern Parasitology* by FEG Cox. Blackwell Scientific Publications.
12. *Molecular Parasitology* by JE Hyde. Open University Press. London.

## **MZFE403: Dissertation (Project/ Assignment/ Case report/ Literature review)**

**Credits: 04**

**Contact Hours: 60**

### **Course objectives**

It will be a unique opportunity for the students to study intensively a biological question of their interest. They will have to make a choice from the available titles from which the preferred choices will be made and then work on it in the guidance of a teacher.

### **Aims**

- Literature searching to research a specific scientific topic.
- Interpretation and analysis of scientific literature.
- Scientific writing to enable production of a comprehensive literature review.
- Allow students to explore in depth a topic that is of interest to them.

### **Learning outcomes**

Students will be able to-

- understand in depth a scientific area of interest
- critically appraise research papers
- develop literature searching and scientific writing skills
- develop lay writing skills (abstract)
- develop organizational and time management skills
- develop oral presentation skills (in tutorials)
- develop written and oral communication skills

### V: Open Electives

<b>Credit Elective Papers</b>				
<b>Semester</b>	<b>Course</b>	<b>TOPIC</b>	<b>Credits</b>	<b>Total Lectures</b>
IV	MZOE404A	Clocks in the clinic	4	60
	MZOE404B	Biodiversity and Conservation		
	MZOE404C	Aquaculture Management and Entrepreneurship		
	MZOE404D	Human Parasitology		
<b>TOTAL</b>			<b>8</b>	<b>120</b>

## MZCE404A: Clocks in the clinic

**Total Credits: 04**

**Teaching Hours: 60**

**Course objective:** Biological clocks help the animals to adapt to the rhythmic environment and have emerged as key factors in health and well-being. The course will focus on clock disruption and related disorders.

### **Unit I: Life in a rhythmic world**

- Rhythmic geophysical environment 02
- Light, temperature, food and social cues 02
- Daily behaviours, locomotion, foraging and sleep 02
- Entrainment, masking, mis-alignment 04
- Photoperiodism 02

### **Unit II: Circadian physiology**

- Circadian photoreception, opsins 04
- Clock machines in action 04
- Sleep, its neural regulation 04
- Clocks and immunity 02

### **Unit III: Circadian rhythms and psychiatric disorders**

- Seasonal affective disorders (SAD) 02
- Mood disorders, depression and anxiety 02
  
- Sleep disorders 04
- Cognitive impairment 02

### **Unit IV: Understanding clock disruption**

- Factors causing clock disruption 02
- Shift-Work and Jet-lag syndrome 04
- Social jetlag 02
- Clock, fatigue and daytime sleepiness 04

### **Unit V: Circadian rhythms and metabolic health**

- Lifestyle, diabetes and obesity 02
- Clocks and Hypertension 02
- Cardiac health and clock function 02
- Clock disruption and cancer prevalence 04
- Chronotherapeutics 02

### **Student learning outcomes**

Students will learn the following:

- Adaptation of living system in a rhythmic environment
- Clock alignment and misalignment with the environment and its consequences
- Identification of different chronotypes
- Sleep and related disorders

- Major depressive disorders, mood disorders
- Effect of social jetlag (SJL) and chronotype on metabolic health.
- Time dependent treatment interventions to prevent and treat metabolic diseases.

### **Suggested readings**

1. Roenneberg T, Allebrandt KV, Merrow M, *et al.* Social jetlag and obesity. *Curr Biol* 2012;22(10):939–43.
2. Panda S. Circadian physiology of metabolism. *Sci* 2016;354:1008–15.
3. Koopman AD, Rauh SP, van ‘t Riet E, *et al.* The association between social jetlag, the metabolic syndrome, and type 2 diabetes mellitus in the general population: the new Hoorn study. *J Biol Rhythms* 2017;32(4):359–68.
4. Lyall LM, Wyse CA, Graham N, *et al.* Association of disrupted circadian rhythmicity with mood disorders, subjective wellbeing, and cognitive function: a cross-sectional study of 91105 participants from the UK Biobank. *Lancet Psychiatry* 2018;5(6):507–14.
5. Parsons MJ, Moffitt TE, Gregory AM, *et al.* Social jetlag, obesity and metabolic disorder: investigation in a cohort study *Int J Obes* 2015;39(5):842–48.



## MZOE404B: Biodiversity and Conservation

**Total Credits: 04**

**Teaching Hours: 60**

### Course Objectives

- To gain knowledge of biodiversity, its threats and conservation.
- To provide skills for identifying common biodiversity in their courtyard.
- To provide knowledge about government bodies & policies related to biodiversity.

### Unit I

#### Biodiversity

What is Biodiversity	02
Biodiversity Types: (a) Species, Ecosystem level, Genetic Level (b) Alpha, Beta, Gamma level	02
Indian Biodiversity & Its Distribution	02
Importance/Significance	02
Biodiversity Hotspots/Parks	02
Keystone species, Indicator Species	02

### Unit II

#### Classification and Diversity

General Classification & Diversity of Lepidopterans and Arachnids with common examples	06
General Classification & Diversity of Amphibians	06

### Unit III

#### Tools/Techniques

Binoculars	02
Cameras- Digital & DSLR	02
GPS, Sound Recorder, Some Common Wildlife Softwares	04
Methods of Census & Biodiversity, Census Technique	02
Biodiversity indices	02

### Unit 4

#### Threats

Major Threats to Biodiversity	02
Natural Threats: Climate Change, Natural Calamity, Desertification	04
Anthropogenic Threats: Pollution, Habitat Fragmentation Degradation, Hunting/Killing/Poaching, Agricultural Practices, Urbanization	06

### Unit 5

#### Conservation Strategies

Wild Life Protection 1972, Biodiversity Act 2000, IUCN Categories, Red Data List, Biodiversity Conservation	02
Govt. Agencies- IWB, MoEF, WII etc., NGO'S – BNHS, ATREE etc.	02
Ex situ, In situ Conservation	02
Tribes and Tradition Societies in Conservator – BISHNOI'S, etc	02

Andolans :- Chipko Movement, Panipanchayat, etc.	02
Biodiversity Register, Sacred Grooves, Traditional Knowledge	02

### **Student learning outcomes**

The student at the end of the course will be able to

- Appreciate biodiversity, its threats and conservation.
- Identify common biodiversity in their courtyard.
- Comprehend and communicate details of various Government Bodies & Policies related to biodiversity.

### **Suggested readings**

1. Biodiversity and Ecosystem functioning. edited by Michel Loreau, Shahid Naureen and Pablo Inchausti ( Oxford University Press.)
2. Biodiversity and Conservation in Forests. By Diana. F. Tomback. Publication MDPI-Multidisciplinary Digital Publishing Institute.
3. Methods and Practice in Biodiversity Conservation by David Hawksworber. (Springer Publication)
4. Recent Studies in Biodiversity and Traditional Knowledge in India. By Chandra Ghosh and A.P. Das (Publisher: Levant Books)
5. Biodiversity and Protected Areas by Beazley, Karen, Baldwin, Robert. (Publishers: MDPI)
6. An Advanced Text book on Biodiversity (Principle and Practice) by K.V. Krishnamurthy. (Publication-CBS)
7. Biodiversity Hotspots edited by Vittore Rescigno and Savario Moletta. (Publishers: Nova Science Publishers)

## MZOOE404C: Aquaculture Management and Entrepreneurship

**Total Credits: 04**

**Teaching Hours: 60**

### Course objectives

- To acquaint the students with aquaculture, its techniques, products and management

### Unit I

#### Aquaculture and Fish Farming Management

Introduction to Aquaculture as an Economic Enterprise	04
Fish Farm Management	04
Polyculture as an Enterprise	04

### Unit II

#### Fish Trading

Aquarium Fish and their Management	06
Women in Aquaculture	02
Fish Seed Production and their Trade	04

### Unit III

#### Fish and Human Health

Fish and Human Health	04
Fish as a Food	04
Happa Breeding	02
Hatchery Breeding	02

### Unit IV

#### Post Harvest Technology

Post-harvest techniques	03
Fish By-products and their economic importance	09
Fish Oils, Fish Proteins, Isinglass, Fish Manure, Fish Flour, Fish Leather, Fish Glue	

### Unit V

#### Fish Preservation and Processing

Traditional Methods(drying, salting, smoking)	06
Modern Methods (deep freezing and canning)	06

### Student learning outcomes

The student at the end of the course will be able to

- Comprehend the scope and processes of aquaculture
- Demonstrate and understanding of aquaculture management

### Suggested readings

1. Jhingran VG. 1991. Fish and Fisheries of India, Hindustan Publishing Corporation.
2. A Hatchery Manual for the Common, Chinese and Indian Major Carps by V.G. Jhingran and R.S.V. Pullin, Asian Development Bank, ICLARM, Manila, Philippines

3. Pilley, TVR and Dill, WMA. 1979. Advances in Aquaculture. Fishing News Books, Ltd. England. 11.
4. Pillay TVR and Kutty MN. 2005. Aquaculture- Principles and Practices. Blackwell.
5. De Silva SS & Anderson TA. 1995. Fish Nutrition in Aquaculture. Chapman & Hall Aquaculture Series.
6. Rath RK. 2000. Freshwater Aquaculture. Scientific Publ.
7. Landau M. 1992. Introduction to Aquaculture. John Wiley & Sons.

## MZOE404D: Human Parasitology

**Total Credits: 04**

**Teaching Hours: 60**

### Course objectives

The objective of this course is to:

- promote the understanding of the theoretical and practical aspects of parasitic diseases of humans with particular reference to protozoan and metazoan infections.

### Unit I

#### Introduction to parasitology

12

General introduction; basic definitions; career opportunities and scope in parasitology  
Animal associations (phoresy, symbiosis, mutualism, symbiosis, parasitism)  
Types of parasites and hosts  
Host parasite relationship

### Unit II

#### Parasitic protozoans

12

General account, morphology, life-cycle, pathogenicity and control of:  
*Entamoeba histolytica*  
*Plasmodium vivax*  
*Trypanosoma sp.*

### Unit III

#### Parasitic Platyhelminths

12

General account, morphology, life-cycle, pathogenicity and control of:  
Trematode parasites: *Fasciola hepatica*, *Schistosoma haematobium*  
Cestode parasites: *Taenia solium*, *Diphyllobothrium latum*

### Unit IV

#### Parasitic nematodes

12

General account, morphology, life-cycle, pathogenicity and control of:  
*Ascaris lumbricoides*  
*Ancylostoma duodenale*  
*Wuchereria bancrofti*

### Unit V

#### Parasitic arthropods

12

Significance of arthropods as vectors of human pathogens:  
mosquitoes  
common house fly  
lice

### Student learning outcomes

By the end of the semester, students will be able to

- identify each of the major parasite group of humans,
- appreciate the diversity of parasites, and
- describe the basic biology, morphology and life history of selected parasites

### **Suggested readings**

1. Animal Parasitology by JD Smyth. Cambridge University Press.
2. Essentials of Parasitology by GD Schmidt. Brown Publishers
3. Foundation of Parasitology by GD Schmidt LS Roberts. McGraw Hill Publishers.
4. General Parasitology by TC Cheng. Academic Press
5. Helminths, Arthropods and Protozoa of domesticated animals by E.J.L. Soulsby. ELBS and Bailliere Tindall. London.
6. Human Parasitology by BJ Bogitsh, CE Carter, TN Oeltmann. Academic Press.
7. Introduction to Parasitology by AC Chandler & CP Read. John Wiley & Sons Inc.
8. Parasite genomics protocols by SE Melville. Humana Press.
9. Parasitology by Chaterjee K.D. Medical Pulisher Calcutta.
10. Parasitology. The Biology of animal Parasites by ER Noble GA Noble
11. Modern Parasitology by FEG Cox. Blackwell Scientific Publications.
12. Molecular Parasitology by JE Hyde. Open University Press. London.