

NEHRU GRAM BHARATI (DEEMED TO BE UNIVERSITY)

**KOTWA- JAMUNIPUR- DUBAWAL
ALLAHABAD (UTTAR PRADESH)**



SYLLABUS

For the

M.Sc. – ZOOLOGY

(A Four Semester Course)

Based on

*Choice Based Credit System (CBCS)
as per UGC Guidelines*

[w.e.f. 2019-2020]

ABOUT NEHRU GRAM BHARATI

Nehru Gram Bharati (Deemed to be University) occupies an esteemed place among the rural universities of India for over decades now. Established on 27th June 2008, it is one of the promising institutes in the State of Uttar Pradesh situated at the bank of river Ganges. It was basically conceived by our Ist Prime Minister of India, Late Pt. Jawahar Lal Nehru, who laid the foundation stone of Nehru Gram Bharati on 26th July 1962 in the village of Rishi Durvasha Ashram, Kotwa-Jamunipur, Dubawal Complex of his phulpur constituency in Allahabad District. His dream was translated into reality by Sri J.N. Mishra, who had a clear vision and dedication to the cause of upliftment of rural masses through education.

As on date, the campus has emerged as a prominent establishment of professional, technical education and traditional education for meeting the aspirations of youth from rural as well as urban areas. To begin with Rajiv Gandhi Degree College was established in the year 1996 and upgraded to Rajiv Gandhi Post Graduate College from the academic session 2000-01 which subsequently merged into the Nehru Gram Bharati (Deemed to be University) in 2008-09 after University Grants Commission recommended to the Ministry of Human Resource & Development for granting it Deemed to be University Status. The MHRD notified vide its gazette Notification no. F.9-42/2005-43(A) dated as 27th June 2008 bestowing the Deemed to be University status to Nehru Gram Bharati

The Nehru Gram Bharati (Deemed to be University) is composed of six campuses encircling approximately 76 acres of land spread over within a radius of about 5 Kilometers. The campuses are as under :

Nehru Gram Bharati (Deemed to be University), Jamunipur Main Campus: The lush green campus has buildings for Administrative Office, Central Library, Faculty of Teacher Education, Arts, Science & Commerce. The Undergraduate Courses viz., Bachelor of Arts (in the subjects Ancient History, Pol. Science, Hindi, Geography, Education, Sanskrit, English, Sociology, Home Science, Economics, Music & Philosophy), Bachelor of Commerce, Bachelor of Science (In Physics, Chemistry, Zoology, Mathematics & Physics), Bachelor of Education(B.Ed.), Bachelor of Special Education (Hearing Impairment), Diploma in Special Education(D.Ed.Spl.Ed.[HI]), Bachelor of Elementary Education (B.El.Ed.), Diploma in Elementary Education (D.El.Ed.) are being offered in this campus. The Post Graduate Courses viz., Master of Arts (In Ancient History, Pol. Science, Hindi, Education, Sanskrit, English, Economics, Sociology, Home Science, Philosophy & Geography), Master of Commerce, Master of Science (In Physics, Chemistry, Zoology, Mathematics and Botany), Master in Education (M.Ed.), Master of Special Education in Hearing Impairment (M.Ed.Spl.Ed.[HI]) are being offered in the campus.

VISION

We aim to nurture and promote youth especially from rural area by providing high quality education and training in keeping with the promise of Late Pt. Jawahar Lal Nehru. Our dream is to build a role model Institution with state of art infrastructure providing right ambience for creativity and stimulation in thinking to generate new ideas for research and application of skill for developing technology for welfare of mankind.

MISSION

Our mission is to empower the nation through preparation of competent and trained human resource. University has plans to enhance capability of young talents for fulfillment of their aspirations through innovation, skill development and proper training. We endeavor to enhance employability through training and spirit of competitiveness. We emphasize inculcating initiative for entrepreneurship generating self employment and national wealth.

ABOUT DEPARTMENT

The Department of Zoology came into existence in 1996 for UG level teaching in Rajeev Gandhi Post Graduate College. It was upgraded as a PG and Research Department in 2008 after coming into existence of Nehru Gram Bharati (Deemed to be University). Now the Department runs semester based Under Graduate programme (B.Sc.) and Choice Based Credit System pattern Post Graduate programme (M.Sc.) with three specializations viz., Environmental Biology, Fishery Science and Cell Biology. In addition, the curriculum of M.Sc. Zoology includes general papers such as Biochemistry and Development Biology, Endocrinology, Molecular Biology, Biotechnology, Sericulture, Apiculture and Tools and Techniques in Biology which provides an ample knowledge in the domain of Life Sciences.

The Department offers Ph.D. Programme in the field of aquatic ecology, Fisheries, Biochemistry and Biotechnology. The Department also offers two Post graduate Diploma in “Aquaculture Technology and Management” and “Environmental Impact Assessment (EIA)”. The main aim of the department is to impart training to students by which they can become self-employable and attain the heights of success in future. The Environmental Biology provides ample of jobs opportunities in the field of EIA and EMP sectors as environmental executives in Government and private institutions. In India, Fisheries has been developed as agro-based industries with a vast potential to the rural economy.

The department is credited for producing several post-graduate students and awarded many doctoral degrees. Its alumni are doing exceptionally well in the society. The academic training imparted to the department's M.Sc. students, equips them to enter doctoral programs of leading institutes in the country and abroad. These areas generate employment opportunities as given below:

1. Generation of employment and revenue through inland fish culture.
2. Generation of employment and revenue through Sericulture
3. Generation of employment and revenue through Apiculture
4. Direct employment through EIA as Environmental executive

Vision:

The holistic development of the student and make them able to contribute effectively for their welfare and society in this dynamic era.

Mission

- Provide inexpensive educational services, inspire to all the section of society to get expertise /skills at P.G. and above level in biological sciences.
- To develop research aptitude and a scientific advancement.
- Inculcate high values through a liberal education and also to provide platform to have non-formal educational services.
- To bring about an awareness regarding nature and biodiversity and help to solve different problems to establish sound and peaceful environment and life for community and society.
- Provide a broad range of Transform society through the empowerment of youth.
- Reinvent ourselves in response to the changing demands of society with high moral values as a good citizen.

PREAMBLE

The syllabus of M. Sc. Zoology based on 'Choice Based Credit System' (CBCS) semester with credit based pattern comprises of four semesters. Each paper with 3 credits ($3 \times 3 = 9$ credits), 1 elective papers of 3 credits each ($3 \times 1 = 3$ credits), 1 skill development paper of 2 credits for Departmental student ($2 \times 1 = 2$ credits), 1 laboratory course of 3 credits ($3 \times 1 = 3$ credits) and 1 interdisciplinary paper (for other Departmental students) of 3 credit ($3 \times 1 = 3$ credit). The fourth semester consists of 2 core papers for 4 credits and 8 credits (Dissertation/Project) and 1 elective papers of 3 credits and 1 skill development paper, each ($2 \times 1 = 2$ credits) and one interdisciplinary paper with 3 credit ($3 \times 1 = 3$ credit). Thus, each semester offers 20 credits ($4 \times 20 = 80$ credits). Each 3 credit theory paper is equivalent to 75 marks and the laboratory course consists of three modules (i.e. one module from each core paper). In the fourth semester Dissertation is available based on elective paper opted by candidates. The Examination in each theory paper and laboratory course shall be of three hours duration. The evaluation of the dissertation/Project work wills internal and external examination. The external exam will be based on open house power point presentation.

INTRODUCTION OF CBCS

The CBCS provides an opportunity for the students to choose courses from the prescribed courses comprising core, elective, skill-based courses and interdisciplinary courses (Inter Departmental course). 'Academic Programme' means an entire course of study comprising its programme 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

PROGRAMME INTRODUCTION

PROGRAMME OBJECTIVES (POs)

- The objective of the M.Sc. Zoology is to teach and learn the significance of fauna in and their biology related from animals of single cell to multicellular systems.
- To provide knowledge about biochemistry, biotechnology, immunology, Developmental Biology, and Molecular Genetics apart from classical subjects like invertebrates, chordates and their ecology and evolution.
- To understand the value of fauna and its relevance to the society and our environment
- To understand the impact of Climate change on fauna diversity and their survival etc.
- To equip ourselves to fit for entrepreneur with special attention on Aquaculture, Apiculture, Sericulture, medical lab technology etc.
- To give confidence to students from multiple disciplines to experience research in the field of fundamental and advanced Zoology.
- To provide knowledge to student for utilizing the research experience and create the new ideas and develop the new products from this field.
- To provide wide opportunity in research to address the societal needs

PROGRAMME SPECIFIC OUTCOMES (PSOs)

- The students pursuing this course would have to develop in depth understanding various aspects of the subject.
- The working principles, design guidelines and experimental skills associated with different fields of Zoology such as Genetics and Cell Biology, Ecology, Biochemistry, Molecular Biology, Biostatistics, Biodiversity, Physiology, Endocrinology, Developmental Biology, Biochemical Techniques, Animal tissue culture, Environmental Biology, Fishery Science, Cell Biology etc.
 - The course is especially designed for job oriented and self employment purpose because of having skill development & specialization papers. The syllabus covers almost all the advance knowledge along with basic knowledge

ORDINANCE AND REGULATIONS FOR M.Sc. (ZOOLOGY) DEGREE PROGRAMME

A. ORDINANCE

1. The Degree of Master of Science (Zoology)

The Nehru Gram Bharati (Deemed to University) may confer the Degree of Master's Programme in Zoology on Such candidates who, being eligible for admission to the Post Graduate Degree Programme, have received regular instruction in the prescribed course of study, passed successfully relevant examinations and being otherwise suitable by virtue of their character, have fulfilled such other condition as may be laid down from time to time by the appropriate authorities

A. Requirement for Admission

Registration:

- (i) Candidates of Master Degree shall first be admitted to the first semester upon the reopening of the University after summer vacation every year.
- (ii) Subsequent Registration

A candidate, who fails to clear a regular course of study during any of the second, third and fourth semesters may be registered in the appropriate term of any subsequent year to the semester concerned but within such time as enables him, to compete the study of all semester comprising Master Degree Programme within a maximum period of four years from the date of his/her registration for the first semester.

Minimum Qualification For Admission

- (i) Admission to the Master Degree Programme of study shall be open to those candidates who have passed the 3 Year Graduate Degree Examination of this University or such examination of any other University or Institution after Graduation under 10+2+3 pattern as recognized by the University. Admission shall be made according to merit subject to the fulfillment of eligibility requirement as determined by the University and availability of seats in the Master courses.

Conditions of Admission:

- (i) No application for registration to the First Semester shall be entertained unless it is accompanied by:
 - (a) A duly migration of scholastic record of the candidate, commencing from the graduation or equivalent examination.
 - (b) Original migration of a candidate who has been a regular student in any Institution at any time prior to making application for registration in the Faculty.
 - (c) Original migration certificate if the candidate is not enrolled in this University or if enrolled, his enrollment has been cancelled. Provided that if a candidate is unable to produce any of the documents other than the marks-sheet of the graduate examination at the time of seeking admission in the concerned Faculty before admission committee, he shall undertake to submit them within one month or within such further period as the University authorities may prescribed; and the admission, if any of such candidate shall until the submission of the aforesaid documents, be deemed to be provisional.
- (ii) Candidate shall give also a written undertaking to the effect that:
 - (a) He/She shall exclusively devote his/her time to the study of courses prescribed for Master Degree and in particular he/she shall not offer any other course leading to a degree of any description whatsoever, not shall he/she undertake any

remunerative work, though with the prior permission of the Faculty, he/she may join certificate of or diploma courses in any foreign language.

- (b) He/She shall abide by the provision of NGB (DU) Act, Statutes, Ordinances, Regulations and Rules that are framed or may be framed there under and the orders of Officers and authorities of the University and the concerned Faculty from time to time.

2. The Curriculum and Duration of Studies

(i) The Curriculum of study of the Master Degree shall comprise of courses set out in Annexure B.

(ii) The Departmental Committee shall prescribe the detailed content of various of study, if required before the beginning of each session. The Departmental Committee can make changes in the optional papers/subjects, subjects to the availability of teaching facility/ faculty.

3. Intake Capacity: 30 seats (As per NGB policy)

Specialisation: Environmental Biology, Fishery Science and Cell Biology

4. Reservation Policy: As per Govt. of India Policy

5. EVALUATION

The evaluation scheme of examination consists of two parts: Internal Assessment (IA), Mid Semester Exam (MSE) and End Semester Examination (ESE). Internal assessment includes Assignments, Presentations, Seminars, Quizzes, Case studies, Viva, Unit test, Group activities /Discussion, etc. The internal assessment will contribute 40% and the Semester and examination will contribute 60% to the total marks. This shall apply to both types of examination system i.e., Semester- wise and Choice based credit system (CBCS) based examination.

****Note: The ratio of internal assessment and semester and examination will be the same as determined by the University.**

There shall be continuous assessment of the student in each course. The course instructor shall hold a maximum of three and minimum of one internal test /assignment /presentation, etc. The distribution of marks in Internal assessment will be in two parts; 20% (Mid Sem. Exam) and 20% (Assignments/Presentations/Group Discussion etc.) Minimum marks for passing the examination in each semester shall be 36% in each paper and 40% in aggregate of a semester. The minimum overall credit is 2.5 for the promotion to the candidate in the next semester. If a candidate fails to obtain minimum credit i.e. 2.5, he/she will be considering as back paper examination. The back paper exam will be held with junior batch of the same semester. A candidate can be allowed 2 times back paper exam only in all the papers. If candidate fails to clear his/her semester after 2 attempt of back paper, his/her earlier registration will be cancelled and the candidate will only be allowed for examination after re-registration.

(a) In case of semester examination, there shall be no binding on the number of external paper setters/examiners, though in case of CBCS//CBSS system, generally the course instructor shall be the paper setter and examiner. However, the Core courses comprising “**Dissertation and Viva-Voce**” and “**Project Work and Viva-Voce**” respectively will be evaluated / examined by Board/s consisting of one external examiner and one internal examiner who shall be the Chairman of the Board. The Dissertation / Project Work and Viva-Voce shall equal weightage and would be

judged separately. The remuneration for these courses would be at par with such courses been run in other Department of the University.

(b) The duration of the End Semester Examination (ESE) of each course will be 3 Hours.

6. FEE:

The students pursuing Master Degree Programme of study shall have to pay fee as may be prescribed by the University from time to time.

7. REGULATIONS:

(a) Master Degree Programme has been divided in four semesters in two years, this is a full time course study. The odd semester would run between July to December and even semester between January to June. Two consecutive (one odd + one even) semester constitute one academic year.

(b) There will be minimum 18 and maximum 24 papers /courses in all in the whole programme. Besides, there would also be one course on **Dissertation and Viva-Voce**.

(c) The course has 4 components: Core courses, Elective course, Skill Development and Inter-disciplinary course.

(d) Each Core course has equal weightage. Each core course will have 100 marks or 4 credits. Elective and Inter-disciplinary course will have 3 credits, where as Skill Developments course will have 2 credits.

(e) The core courses are compulsory to all students in all four semesters. The fourth (Elective course) paper and fifth (Skill Development course) paper will be opted by the students of same Department. However, the sixth (Inter-disciplinary course / University elective course) paper of each semester will be opted by the students of other Departments only.

(f) In the beginning of the Semester I, the Department would announce the available specialization group/ course in the Elective Group to the students for the current session. The choice of elective group/course in the semester will be limited to those announced by the Department. Because of infrastructural and Faculty limitations, the Department may put a cap on the number of students in an elective group/course.

(g) Each semester shall have minimum 90 teaching days, exclusion of holidays, admission and examinations.

Pattern of theory papers & allocation of marks

M.Sc. - SEM I to SEM IV (Four papers)

1. THEORY:

Total Marks: 100/Paper: Internal Assessment (40% Marks) + End Semester Exam (60 % Marks)

Internal Assessment (IA):

Mid Term Test (CT) – Sessional	20% Marks
Assignment /Seminar	20% Marks
Total	40%

End-Semester Exam (ESE) – 60 %Marks

- Divided into 3 parts, **Total no. of questions – 9**
- **Part 1:** Question 1(Compulsory) – **10 marks** (10 Objective / Very short answer questions)
- **Part 2:** Section A – **Five Questions from Unit 1, 2 & 3** (Question 2 - 6)
(Students have to **attempt any three**), Each question Carries **7 Marks**
(**Contains Short answer as well as long answer questions**)
- **Part 3:** Section B - **Three Questions from Unit 4 & 5** (Question 7 - 9)
(Students have to **attempt any two**), Each question Carries **7 Marks**
(**Contains Short answer as well as long answer questions**)

2. PRACTICAL:

The practical mark in each semester is 100, in which 40% marks will be given internally while 80% marks will be given external by external examiner.

a. M.Sc. - SEM I (ZOO107)

➤ **Total Marks** -75
Practical (Based on core Paper I, II&III) : 75 Marks

b. M.Sc. - SEM II (ZOO207)

➤ **Total Marks** - 75
Practical (Based on core Paper I, II&III) : 75 Marks

c. M.Sc. - SEM III (ZOO307)

➤ **Total Marks** - 75
General Practical (Paper I, II&III) : 75 Marks

Semester Wise Breakup Structure

Semester –I								
Paper Type	Paper No.	Code	Paper Title	Credit	Lecture L+T+P	IA	ESE	Total Marks
Core Course	Paper I	ZOO101	Non- Chordata	3	2+1+0	30	45	75
Core Course	Paper II	ZOO102	Evolution & Biostatistics	3	2+1+0	30	45	75
Core Course	Paper III	ZOO103	Ecology	3	2+1+0	30	45	75
Elective Course	Paper IV	ZOO104 BW/ ZOO104I M/ ZOO104 AZ	Biodiversity & Wildlife/ Immunology/ Applied Zoology	3	3+0+0	30	45	75
Skill Development Course	Paper V	ZOO105	Aquaculture	2	2+0+0	20	30	50
Interdisciplinary Course	Paper VI	ZOO106	Public Health & Hygiene	3	3+0+0	30	45	75
Laboratory Practical	-	ZOO107		3	0+0+3	30	45	75
Total				20				500
Semester –II								
Paper Type	Paper No.	Code	Paper Title	Credit	Lecture L+T+P	IA	ESE	Total Marks
Core Course	Paper I	ZOO201	Chordata	3	2+1+0	30	45	75
Core Course	Paper II	ZOO202	Animal Physiology & Instrumentation	3	2+1+0	30	45	75
Core Course	Paper III	ZOO203	Developmental Biology & Animal Behavior	3	2+1+0	30	45	75
Elective Course	Paper IV	ZOO204 EN/ ZOO204 RB/ ZOO204 GE	Endocrinology /Reproductive Biology/ Genetics	3	3+0+0	30	45	75
Skill Development Course	Paper V	ZOO205	Vermiculture	2	2+0+0	20	30	50
Interdisciplinary Course	Paper VI	ZOO206	Ornamental Fishery	3	3+0+0	30	45	75
Laboratory Course	-	ZOO207		3	0+0+3	30	45	75
Total				20				500

Semester –III								
Paper Type	Paper No.	Code	Paper Title	Credit	Lecture L+T+P	IA	ESE	Total Marks
Core Course	Paper I	ZOO 301	Biotechnology	3	2+1+0	30	45	75
Core Course	Paper II	ZOO 302	Molecular Biology	3	2+1+0	30	45	75
Core Course	Paper III	ZOO 303	Natural resources and conservations	3	2+1+0	30	45	75
Elective Course	Paper IV	ZOO 303EB/ ZOO 303FS/ ZOO 303CB	Environmental Biology-I/ Fishery Science-I/Cell Biology -I	3	3+0+0	30	45	75
Skill Development Course	Paper V	ZOO 305	Bioinformatics	2	2+0+0	20	30	50
Interdisciplinary Course	Paper VI	ZOO 306	Apiculture	3	3+0+0	30	45	75
Laboratory Course	-	ZOO 307		3	3+0+0	30	45	75
Total				20				500

Semester –IV								
Paper Type	Paper No.	Code	Paper Title	Credit	Lecture L+T+P	IA	ESE	Total Marks
Core Course	Paper I	ZOO 401	Bio-chemistry	4	2+1+0	40	60	100
Core Course	Dissertation & Viva – Voce (Paper II+ Paper III)	ZOO 402+ ZOO 403	Dissertation & Viva –Voce	8	1+0+7		100+ 100	200
Elective Course	Paper IV	ZOO 404EB/ ZOO 404FS/ ZOO 404CB	Environmental Biology- II/ Fishery Science-II/Cell Biology-II	3	3+0+0	30	45	75
Skill Development Course	Paper V	ZOO 405	Sericulture	2	2+0+0	20	30	50
Interdisciplinary Course	Paper VI	ZOO 406	River System	3	3+0+0	30	45	75
Total				20				500

Abbreviations: L+T+P = Lecture+ Tutorials+ Practical
IA = Internal Assessment
ESE = End Semester Exam

**M.Sc.[Zoology]
PROGRAMME OUTCOME (POS)**

PO1	The objective of the M.Sc. Zoology is to teach and learn the significance of fauna in and their biology related from animals of single cell to multi-cellular systems.
PO2	To provide knowledge about biochemistry, biotechnology, immunology, Developmental Biology and Molecular Genetics apart from classical subjects like invertebrates, chordates and their ecology and evolution.
PO3	To understand the value of fauna, impact of climate change and its relevance to the society and our environment
PO4	To give confidence to students from multiple disciplines and equip for entrepreneur with special attention on Aquaculture, Apiculture, Sericulture, medical lab technology and for research in the field of fundamental and advanced Zoology
PO5	To provide knowledge to the students for utilizing the research experience and create the new ideas and develop the new products from this filed to address the society needs
Programme Specific Outcome (PSOs)	
PSO1	The students will be able to know about working principles, design guidelines and experimental skills of different fields of Zoology such as Genetics and Cell Biology, Ecology, Biochemistry.
PSO2	The students will be able to know about working principles, design guidelines and experimental skills of many zoological fields Molecular Biology, Biostatistics, Biodiversity, Physiology, Endocrinology, Developmental Biology, Environmental Biology, Fishery Science, Cell etc.
PSO3	The programme is especially designed for job oriented and self employment purpose.
PSO4	The programme is having skill development & specialization papers and syllabus covers almost all the advance and basic knowledge

**Course Outcome-M.Sc. [Zoology]
Semester-I**

Paper-I (Zoo101) Non-Chordates	CO.1 Understand about the primitive as well as higher non-chordates animals.
	CO.2 Understand about the host-parasite relationship
	CO.3 Understand the specialized systems for high in Annelida and Mollusca
	CO.4 Understand the specialized systems for high in Arthropoda
	CO.5 Knowledge about features and characters of some minor phyla
Paper-II (Zoo102) Evolution & Biostatistics	CO.1 Exploring the basic and advance knowledge about animal origin
	CO.2 Understand the evolutionary trends of the animals
	CO.3 Biostatistics helps to understand the nature of variability
	CO.4 Derive general laws from small samples by biostatistics
	CO. 5 Understand about the correlations and test
Paper-III (Zoo103) Ecology	CO.1 Understand the ecological concept
	CO.2 Understand the various ecosystem freshwater and marine
	CO.3 Use of biomarkers and remote sensing to better understanding of nature

	CO.4 Understand the population ecology, statistical ecology and molecular ecology
	CO.5 Improve our environment, manage our natural resources, and protect human health
Paper-IV (ZOO104BW) Biodiversity & Wildlife	CO.1 Know the nature's balance ecosystems with healthy populations
	CO.2 Know about biodiversity and its mathematical expression
	CO.3 Understand the ecological importance, economic importance, investigatory importance, conservation of biological diversities.
	CO.4 Become nature expert and wildlife expert
	CO.5 Find job opportunity as of EIA, EMP expert
Elective Paper Paper-IV (ZOO104 IM) Immunology	CO. 1 Know about immunity and types of immunity
	CO. 2 Understand the antigens-antibodies relation and their properties
	CO. 3 Know about vaccines, vaccination and diseases
	CO. 4 Get scientific research post and technical post
	CO. 5 Relation with Immune system and health disease
Paper-IV (ZOO104AZ) Applied Zoology	CO.1 Know about human health related disease
	CO.2 Understand various kind of epidemic disease and their prevention and control
	CO.3 Understand with various parasitic protozoan and their impacts.
	CO.4 Get self employment jobs like dairy industry and its role
	CO.5 Get self employment jobs like poultry industry and role in society
Skill Development Paper-V (Zoo105) Aquaculture	CO.1 Know about globally important culture like prawn and pearl culture
	CO.2 Get self employment like fish, prawn and pearl culture
	CO.3 Learn composite fish culture as a popular practice specially in rural people
Interdisciplinary Paper Paper-VI (Zoo106) Public Health & Hygiene	(Not for Zoology Students)
	CO.1 Impart knowledge about advance concepts of Public health and hygiene
	CO.2 Know about composition of food and balance diet
	CO.3 Gain knowledge about some common diseases their causes
	CO.4 Know about prevention and treatment of the disease
CO.5 Understand the communicable and non-communicable disease	
Practical (ZOO107)	CO.1 Understand the nervous systems study through practical models. Know about how to prepare permanent slides and specimen preservations. Upgrade the knowledge about taxonomy and identifying features of the animals of different phylum, to understand physico-chemical study of the water and soil and learn statistical estimation and analysis of the biological data

Semester II

Paper-I (ZOO201) Chordata	CO.1 Know about the origin of the chordates
	CO.2 Know about vertebrates animals and their characteristic features
	CO.3 Know about various physiological functions of the animals
	CO.4 Know relation between and among various vertebrates group
	CO. 5 Understand adoptive features of the animals
Paper-II (ZOO202) Animal	CO.1 Understand about structure and function of kidney and heart
	CO.2 Regulation mechanism of various physiological process
	CO.3 Know handling and operating knowledge of various biological

Physiology & Instrumentation	instruments
	CO.4 Able to obtain jobs in clinical pathology
	CO. 5 Understand the principle and functioning of the different types of microscope
Paper-III (ZOO203) Developmental Biology & Animal Behaviour	CO.1 Know about basic concept of embryonic development
	CO.2 Know about aging, stem cell and their application
	CO.3 Know about various kinds of animal behaviour
	CO.4 Know about social and sexual behaviour
	CO.5 Know about signaling communications
Elective Paper Paper-IV (ZOO204EN) Endocrinology	CO.1 Know about endocrine gland and its role
	CO.2 Know about the mechanism hormonal
	CO.3 Know about disease caused by various hormonal disorders
	CO.4 Know for metabolic disorders through hormone
	CO.5 Know for reproductive disorders through hormone
Paper-IV (ZOO204RB) Reproductive Biology	CO.1 Understand knowledge about reproduction system
	CO.2 Understand about modern techniques of fertilization
	CO.3 Understand about sexually transmitted diseases, family planning
	CO.4 Know about the medical research
	CO.5 Use of technology for various sexual disorders
Paper-IV (ZOO20ge) Genetic	CO.1 Understand basic principles of Mendelian inheritance and explore the multi-factorial inheritance.
	CO.2 Learn the linkage concepts, sex determination and sex linked inheritance.
	CO.3 Gain knowledge about the organeller inheritance.
	CO.4 Gain knowledge about the Chromosomal disorders
	CO.5 Understand the role of various mechanism for improvement genetics
Skill Development Paper-V (ZOO205) Vermiculture	CO.1 Understand conceptual knowledge of Vermitechnology
	CO.2 Understand practical knowledge of Vermitechnology
	CO.3 Know about how to use Vermitechnology for self employment. Know about farming in rural areas
Interdisciplinary Course Paper-VI (ZOO206) Ornamental Fishery & Aquarium	(Not for Zoology Students)
	CO.1 Develop skill for aquarium management as a self employment
	CO.2 Know about ornamental fishery
	CO.3 Get self employment jobs on the ornamental fishery
	CO.4 Understand methods of fish marketing
CO.5 Aquarium fish and fishery health education	
Practical (ZOO207)	Understand anatomy of internal ear of Scoliodon and nervous system of catfish through models. Gain practical knowledge of slide preparation of Amphioxus oral hood and velum also test and spicules. Know about taxonomy and identifying features of the animals of different classes, physiological experiments, embryonic development experiment.

Semester-III

Paper-I (ZOO301) Biotechnology	CO.1 Understand about biotechnology and application
	CO.2 Know about of Red, Blue, Green and White biotechnology
	CO.3 Get opportunities in biotechnological and pharmaceutical companies
	CO.4 Get research opportunities in the laboratories of national and international institute
	CO.5 Understand applications of DNA technologies and scope of bioinformatics
Paper-II (ZOO302) Molecular Biology	CO.1 Know about advances of molecular biology
	CO.2 Understand about structure and functions of DNA and RNA
	CO.3 Understand about study of Genetic Engineering and its application for society
	CO.4 Gain insight into the most significant molecular and cell-based of molecular biology.
	CO.5 Understand the regulation of protein synthesis.
Paper-III (ZOO303) Biodiversity, Natural Resources and Conservations	CO.1 Understand about biodiversity and their factors
	CO.2 Understand about community and habitat ecology and biodiversity measurement
	CO.3 Understand about wetland and mangrove communities
	CO.4 Understand about natural resources and their conservation
	CO.5 Understand about various acts, laws regarding biodiversity and conservation
Elective Paper Paper-IV (ZOO304EB) Environmental Biology -1 (Basics of Environmental Biology, Tools & Chemistry)	CO.1 Understand fundamentals of ecosystems
	CO.2 Understand about ecological concepts and models
	CO.3 Understand about and ecosystem structure and functions
	CO.4 Know about various instruments and their techniques for the environmental study
	CO.5 Know about environmental chemistry and toxicology for science and society.
Paper-IV (ZOO304FS) Fishery Science- I (Taxonomy, Morphology and Physiology)	CO.1 Learn about origin and evolution of fish fauna
	CO.2 Know about morphology and anatomy of the fish
	CO.3 Know about fish biology physiology
	CO.4 Know about fish physiology
	CO.5 Understand knowledge of fish physiology for obtaining jobs in fishery sector
Paper-IV (ZOO304CB) Cell Biology –I (Cell morphology and organelles)	CO.1 Understand about cell structure and its functions
	CO.3 Know about architecture and functions of the plasma membrane
	CO.3 Know about bacteria, virus and cytoskeleton
	CO.4 Know about mitochondria, ribosome and endoplasmic reticulum
	CO.5 Understand about mitochondrial born disease
Skill Development Paper-V (ZOO305) Bio informatics	CO.1 Gain knowledge about bio-informatics
	CO.2 Know about data base study of nucleic acid sequence
	CO.3 Know about scientific role of bioinformatics in research

Interdisciplinary course Paper-VI (ZOO306) Apiculture	(Not for Zoology Students)
	CO.1 Understand the basic life cycle of the honeybee
	CO.2 Learn about beekeeping tools and equipment
	CO.3. Know about Honey bee modern methods and bee control measures
	CO.4 Learn about modern methods of apiculture for honey production
	CO.5 Know about diseases of honey bee and enemies

Semester-IV

Paper-I (ZOO401) Biochemistry	CO.1 Know about different bio-molecules and biochemical processes of cells
	CO.2 Know about various enzymatic actions in the metabolism
	CO.3 Know about the concepts of mechanisms of enzymatic activities
	CO.4 Know about the concepts of regulation of enzyme activity
	CO.5 Know about the concepts of metabolic pathways
Paper-II & III (ZOO402+ZOO403) Dissertation+ Viva –Voce	CO.1 Know about dissertation research
	CO.2 Know about writing of introduction, review of literature and methodology
	CO.3 Know about data computation, data analysis, data presentation
	CO.4 Know about data interpretation, discussion and reference writing methods
	CO.5 Open house power point presentation of research work
Elective Course Paper-IV (ZOO404EB) Environmental Biology-II (Application, management & Legal Environmental Biology)	CO.1 Know about ecosystem services and applications
	CO.2 Know as aquatic biodiversity for hydroelectric study
	CO.3 Work as consultant for environmental study.
	CO.4 Get job offers as a environmental executive for EIA and EMP
	CO.5 Knowledge about the various software use in the environmental studies
Paper-IV (ZOO404FS) Fishery Science–II (Capture Fishery)	CO.1 Know about knowledge of fish water resources in India
	CO.2 Know about restoration and management of fish stock
	CO.3 Know about riverine fishery and cold water fishery
	CO.4 Know about estuarine fishery and marine fishery
	CO.5 Generate jobs in freshwater and marine fishery field
Paper-IV (ZOO404CB) Cell Biology–II (Karyology, Cell division and Ageing)	CO.1 Understand about the nucleus and their functions in animal cells
	CO.2 Identify the stages of the cell cycle, by description of major milestones
	CO.3 Identify the stages of mitosis & meiosis to explain nuclear division
	CO.4 Understand mechanism of cell aging and cell death
	CO.5 Understand functions and type of chromosomes

Skill Development Paper-V (Zoo405) Sericulture	CO.1 Know about life cycle of silk moth
	CO.2 Understand the knowledge and techniques about silk culture at large scale
	CO.3 Get job and self employment via silk culture in India and abroad.
Interdisciplinary course Paper-VI (Zoo406) River System	(Not for Zoology students)
	CO.1 Understand about Indian rivers and its ecology
	CO.2 Understand about spiritual and socio-economical use of rivers
	CO.3 Know about the cultural, social, economic and scientific Indian rivers
	CO.4 Understand the heavy metals and impacts in the Ganga river
CO.5 Understand the role of river system for society	

M.Sc. – Semester I
Zoology -First Paper
ZOO101: Non-Chordates

Non-Chordates

Unit-1 (Credit – 0.75)	5 Lectures
1. Protozoa	
1.1 Locomotory organs	
1.2 Nucleus and reproduction	
2. Porifera	
2.1 Canal system	
2.2 Skeletal system	
Unit-2 (Credit - 0.75)	10 Lectures
3. Cnidaria	
3.1 Nematocysts	
3.2 Polymorphism	
3.3 Metagenesis in <i>Obelia</i>	
3.4 Coral reef	
4. Helminths (Platyhelminthes, Aschelminthes): Parasitic adaptation & host-parasite relationship	
Unit-3 (Credit –1.0)	18 Lectures
5. Annelida	
5.1 Coelom	
5.2 Metamerism	
6. Mollusca	
6.1 Nervous system in Cephalopoda	
6.2 Modifications of foot	
Unit-4 (Credit – 1.0)	13 Lectures
7. Arthropoda	
7.1 Respiratory organs	
7.2 Crustacean larvae and their significance	
7.3 Insect mouth parts and mode of feeding	
8. Echinodermata: larval forms and their significance	
Unit-5 (Credit - 0.5)	8 Lectures
9. Salient features and affinities of following minor phyla	
9.1. Mesozoa 9.2 Ctenophora 9.3 Rotifera 9.4 Phoronida	

BOOKS RECOMMENDED

1. Barnes: Invertebrate Zoology (4th ed 1980, Holt-Saunders International)
2. Barnes: The Invertebrates – A synthesis (3rd ed 2001, Blackwell)
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. Nigam: Zoology of Non Chordate (2007, Vishal Publication)
6. Kotpal: A text book of Invertebrate (2009, Rastogi Publication)

M.Sc. – Semester I
Zoology –Second Paper
ZOO102: Evolution & Biostatistics

Section A: Evolution

Unit-1 (Credit - 1.0)	8 Lectures
1. The geological time scale of Evolution	
2. Origin and early history of life	
Unit-2 (Credit - 0.5)	10 Lectures
2.1 Modes of speciation,	
2.2 Isolating mechanisms	
2.3 Molecular Evolution	
Unit-3 (Credit - 0.75)	12 Lectures
Population as unit of evolution	
3.1 Gene frequencies in Mendelian population	
3.2 Hardy-Weinberg Equilibrium	
3.3 Major evolutionary forces: Mutation, Selection, Random genetic drift	

Section B: Biostatistics

Unit-4 (Credit - 1.0)	14 Lectures
1. Sampling & Data presentation	
1.1 Population sample, random sample	
1.2 Data presentation in form of tables & graphs (bar graph, histogram, line chart, pie chart)	
2. Distribution	
2.1 Binomial, Poisson and normal distribution	
2.2 Probability distribution & its properties	
3. Measures of central tendency: Mean, Median, Mode	
Unit-5 (Credit - 0.75)	10 Lectures
4. Measures of dispersion: ranges, variance, standard deviation, standard error	
5. Correlation	
6. Test of significance: t-test, chi-square test	
7. Analysis of variance (ANOVA)	

BOOKS RECOMMENDED

1. Freeman and Herron: Evolutionary Analysis (1998, Prentice Hall)
2. Futuyma: Evolutionary Biology (1998, Sinauer)
3. Hartl and Clarke: Principles of Population Genetics (1989 & 1997, Sinauer)
4. Mayr: Populations, Species & Evolution: An Abridgement of Animal Species & Evolution (1971, Belknap Press)
5. Moody: Introduction to Evolution. (1978, Kalyani Pub)
6. Ridley: Evolution. (1993, Blackwell)
7. Savage: Evolution. (1963, Holt, Rinehart and Winston)
8. Stebbins: Processes of Organic Evolution. (1979, Prentice- Hall of India)
9. Strickberger: Evolution. (2000, Jones and Bartlett)
10. Colbert: Introduction to vertebrate evolution (2001, Wiley eastern private ltd.)
11. Arora: Organic Evolution (2010, Himalaya publishing house)

M.Sc. – Semester I
Zoology -Third Paper
ZOO103: Ecology

Unit-1 (Credit – 0.75)	12 Lectures
1. Introduction to ecology, environmental concepts – laws and limiting factors	
2. Population ecology	
2.1 Characteristics of population	
2.2 Logistic and exponential population growth, limits of population growth	
2.3 Population dynamics and age structure.	
3. Ecological Niche	
3.1 Concept of Niche, niche parameters, niche overlap	
Unit-2 (Credit – 0.75)	14 Lectures
4. Competition and coexistence	
4.1 Intra-specific and inter-specific interactions and their models	
4.2 Mutualism and commensalism, prey-predator interactions.	
5. Ecosystem	
5.1 Ecosystem type	
5.2 Ecological energetics, ecological pyramids	
5.3 The biosphere, biome.	
Unit-3 (Credit – 0.5)	10 Lectures
6. Environmental biodegradation	
6.1 Environmental degradation: natural and manmade	
6.2 Global warming, Ozone depletion	
Unit-4 (Credit - 0.25)	10 Lectures
7. Ecotoxicants	
7.1 Major classes, Uptake,	
7.2 Biotransformation, detoxification	
7.3 Elimination and accumulation of toxicants	
Unit-5 (Credit - 0.75)	8 Lectures
8. Biomarkers of environmental health	
9. Remote sensing, molecular ecology	

BOOKS RECOMMENDED

1. Odum: Fundamental of Ecology (1971, W.B. Saunders)
2. Odum and Barrett: Fundamentals of Ecology (5th ed 2005 EWP)
4. Cunningham and Saigo: Environmental Science (5th Ed. 1999, McGraw Hill)
5. Willimer, Stone and Johnston: Environmental Physiology (2000, Blackwell Sci. Oxford 4K)
6. Turk and Turk: Environmental Science (4th Ed. 1993, Saunders)
7. Sharma PD: Environmental Biology and toxicology (2nd ed 2010, Rastogi Publication)

M.Sc. – Semester I
Elective Paper
Zoology- Fourth Paper
ZOO104BW: Biodiversity & Wildlife

Section A: Biodiversity

Unit I (Credit - 0.5) **10 Lectures**

1. Introduction to Biodiversity

- 1.1 Definition, Concepts, Scope and Significance
- 1.2 Levels of Biodiversity- Genetic, Species and Ecosystem
- 1.3 Hotspots- (Western Ghats and Indo- Burma Border)

Unit II (Credit - 0.5) **12 Lectures**

2. Biodiversity measurement

- 2.1 Richness, Evenness
- 2.2 Biodiversity index- types; simpson, Shannon Wiener
- 2.3 Threats - Habitat loss and Man-Wildlife conflict

Unit III (Credit – 0.5) **10 Lectures**

3. Biodiversity conservation and management

- 3.1 Conservation strategies: *in situ*, ex-situ
- 3.2 National parks, Sanctuaries
- 3.3 National Biodiversity Action Plan, 2002

Section B: Wild life

Unit IV (Credit - 0.5) **12 Lectures**

1. Scope of Wildlife Biology

- 1.1 Physiological Basis of; Hibernation, aestivation, Migration
- 1.2 Animal adaptations to water, temperature, predation
- 1.3 Orientation & navigation in animals

Unit V: (Credit - 0.5) **10 Lectures**

2. Wild life and Society

- 2.1 Indian Wildlife (Protection) Act, 1972
- 2.2 Convention for International Trade of endangered species
- 2.3 Wildlife diseases and their control Ecosystem people

BOOKS RECOMMENDED

- 1. Odum and Barrett: Fundamentals of Ecology (5th ed 2005 EWP)
- 2. Cunningham and Saigo: Environmental Science (5th Ed. 1999, McGraw Hill)
- 3. Willimer, Stone and Johnston: Environmental Physiology (2000, Blackwell Sci. Oxford 4K)
- 4. Sharma PD: Environmental Biology and toxicology (2nd ed 2010, Rastogi Publication)
- 5. Aaron, N.M. Wildlife ecology W.H. Freeman Co. San Francisco, U.S.A. 1973
- 6. Ali, Salim, The Book of Indian Birds Oxford University Press, Mumbai 1997
- 7. Anthony R.E. Sinclair, John M. Fryxell and Graeme Caughly Wildlife Ecology, Conservation and Management Blackwell Publishing, U.S.A. 2006
- 8. Arora B.M. and Bipul Chakraborty Colorful Atlas on Indian Wildlife Diseases and Disorders IBDC, Lucknow. 20089. Arora B. M. (Editor) Indian Wildlife Yearbook AIZ & WV, Bareilly, 2002

M.Sc. – Semester I
Elective Paper
Zoology- Fourth Paper
ZOO104IM: Immunology

Unit 1 (Credit: 0.5) Overview of the immune system Introduction to basic concepts in immunology	10 Lectures
Unit 2 (Credit: 0.75) Cells and organs of the immune system- Haematopoeisis Cells of immune system and organs (primary and secondary lymphoid organs) Antigens- Basic properties of antigens B-Cell and T- cell	14 Lectures
Unit 3 (Credit: 1.0) Antibodies- Structure Classes and function of antibodies Monoclonal antibodies Antigen, working of the immune system I Structure and functions of MHC	18 Lectures
Unit 4 (Credit: 0.5) Working of immune system II Basic properties and functions of cytokines	8 Lectures
Unit 5 (Credit: 0.25) Immune system in health and disease	4 Lectures

BOOKS RECOMMENDED

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

M.Sc. – Semester I
Elective Paper
Zoology- Fourth Paper
ZOO104AZ: Applied Zoology

Unit 1 (Credit: 0.5) Introduction to Host-parasite Relationship: Host, Definitive host Intermediate host, Parasitism, Symbiosis, Commensalism	10 Lectures
Unit 2 (Credit: 0.5) Epidemiology of Diseases: Transmission Prevention and control of diseases: Tuberculosis, swine flu, typhoid	10 Lectures
Unit 3 (Credit: 1.0) Parasitic Protozoa: Life history and pathogenicity of <i>Entamoeba histolytica</i> , <i>Plasmodium vivax</i> and <i>Trypanosoma gambiense</i> Insects of Medical Importance: Medical importance and control (<i>Pediculus humanus corporis</i> , <i>Anopheles</i> , <i>Culex</i> , <i>Aedes</i> , <i>Xenopsylla cheopis</i>)	18 Lectures
Unit 4 (Credit: 0.5) Animal Husbandry: Preservation and artificial insemination in cattle Induction of early puberty and synchronization of estrus in cattle	8 Lectures
Unit 5 (Credit: 0.5) Poultry Farming: Principles of poultry breeding Breeding stock and broilers Processing and preservation of eggs seed	8 Lectures

BOOKS RECOMMENDED

1. Park, K. (2007). *Preventive and Social Medicine*. XVI Edition. B.B Publishers.
2. Arora, D. R and Arora, B. (2001). *Medical Parasitology*. II Edition. CBS Publications and Distributors.
3. Atwal, A.S. (1986). *Agricultural Pests of India and South East Asia*, Kalyani Publishers
4. Dennis, H. (2009). *Agricultural Entomology*. Timber Press (OR).
5. Hafez, E. S. E. (1962). *Reproduction in Farm Animals*. Lea & Fabiger Publisher
6. Dunham R.A. (2004). *Aquaculture and Fisheries Biotechnology Genetic Approaches*. CABI publications, U.K.
7. Pedigo, L.P. (2002). *Entomology and Pest Management*, Prentice Hall.

M.Sc. – Semester I
Skill Development
Zoology- Fifth Paper
ZOO105: Aquaculture

Unit-1 (Credit:0.5) Principles of aquaculture Definition of aquaculture Types, Composite fish culture Air breathing fish culture	10 Lectures
Unit-2 (Credit:0.5) Integrated fish farming Paddy cum fish culture Paddy cum cattle culture	10 Lectures
Unit-3 (Credit:1.0) Pond preparation: Size, Depth, Water level Pond management Prawn culture: Fresh water and marine water Pearl culture	16 Lectures

BOOKS RECOMMENDED

1. S.S. Khanna (2011). An introduction to Fishes. Silver line Publications, New Delhi
2. Anonyms (2014). A handbook of fish and fisheries, ICAR, New Delhi
3. R.S. Parihar (2015) Fish and Fisheries.

M.Sc. – Semester I
ZOO106: Interdisciplinary Paper
Public Health & Hygiene
(Not for Zoology Students)

Unit 1: (Credit: 0.25) Scope of Public health and Hygiene Nutrition and health	6 Lectures
Unit 2 (Credit: 0.5) Classification of foods Nutritional deficiencies Vitamin deficiencies	8 Lectures
Unit 3: (Credit: 0.75) Environment and Health hazards Environmental degradation Pollution and Associated health hazards	12 Lectures
Unit 4: (Credit: 0.5) Communicable diseases and their control measures Measles, Polio, Chikungunya, Rabies, Plauge, Leprosy and AIDS	10 Lectures
Unit5: (Credit: 1.0) Non-Communicable diseases and their preventive measures Hypertension, Coronary Heart diseases Stroke, Diabetes, Obesity and Mental ill-health	18 Lectures

BOOKS RECOMMENDED

1. C.L. Dunn and DD Pandya. Indian Hygiene and Public health, Elsevier Publication.
2. American Public Health Association (APHA). Hygiene and sanitation: A text book for nurses.

M.Sc. – Semester I
Zoology
ZOO107: PRACTICAL EXAM

Total marks: 75 (Internal assessment: 30 marks + External: 45 marks)

Internal Assessment: 30 marks (Based in internal practical assessment in practical class)

External Practical Examination

Sl. No.	Content	Marks
1	Non Chordata (Display)/Models	10
2	Non Chordata (Permanent slide preparation)	5
3	Biostatistics	5
4	Ecology	5
5	Spotting (1-10)	10
6	Viva voce & Class record	10
	Total	45

Non Chordata

1. Preparation of permanent slides

- Porifera: Gemmules, spicules
- Arthropoda: *Cyclops*, Megalopa/Zoea
- Mollusca: glochidium larva, osphradium, radula, *Pila* gills, *Unio* gills

2. Display/Models

- Arthropoda: Nervous system of *Squilla*
- Mollusca: nervous system of *Loligo*, *Sepia* & *Aplysia*

3. Spotting

- Study of museum specimens
- Study of prepared slides

Ecology

- Study of biotic components of a pond/river ecosystem and description of morphological adaptations of the collected organisms
- Determination of soil type
- Determination of pH, total hardness, free CO₂
- Measurement of dissolved oxygen by Winkler's method
- Estimation of Nitrate & chloride content of water

Biostatistics

- Presentation of data in form of frequency table
- Measurement of central tendencies (arithmetic mean, median & mode)
- Problems based on chi-square test & correlation

List of museum specimens & slides

1. Museum Specimens:

Porifera	:	<i>Leucosolenia, Sycon, Grantia, Cliona, Spongilla, Euspongia, Hylonem</i>
Cnidaria	:	<i>Physalia, Millipora, Aurelia, Rhizostoma, Alcyonium, Tubipora Gorgonia, Pteroids, Adamsia, Madrepora, Fungia, Metridium, Proripita</i>
Platyhelminthes	:	<i>Planaria, Fasciola, Taenia solium</i>
Aschelminthes	:	<i>Ascaris (Male & Female)</i>
Annelida	:	<i>Nereis, Heteroneries, Aphrodite, Chaetopterus, Pontobdella</i>
Mollusca	:	<i>Chiton, Dentalium, Patella, Aplysia, Doris, Pecten, Pinctada Teredo, Loligo, Sepia, Octopus, Nautilus</i>
Arthropoda	:	<i>Lepus, Balanus, Sacculina, Mysis, Eupagurus, Limulus, Julus, Scolopendra, Lepisma</i>
Echinodermata	:	<i>Astropecten, Clypeaster, Holothuria, Antidon, Echinus</i>

2. Permanent Slides:

Protozoa	:	<i>Euglina, Paramecium</i> W.M. Binary Fission, Conjugation in <i>Paramecium, Monocystis, Plasmodium, Opalina, Balantidium, Entamoeba, Leishmania</i>
Porifera	:	Spongin fibres, gemmule, spicules, L.S. & T.S. of <i>Sycon</i>
Cnidaria	:	T.S. of Hydra through gonads, <i>Obelia</i> W.M., <i>Obelia</i> medusae, Ephydra Larva
Helminthes	:	Gravid proglottid of <i>Taenia</i> , Miracidium, Redia, Cercaria, Metacercaria, Cysticercus larva
Annelida	:	T.S. <i>Nereis</i> , parapodium of <i>Nereis</i> and Heteronereis, Trochophore larva,
Arthropoda	:	Megalopa, Mysis, Zoea, Nauplius, <i>Daphnia, Cyclopes</i> , Mouthparts of male and female, <i>Culex</i> and <i>Anopheles</i> , <i>Pediculus</i> W.M., <i>Cimex</i> W.M.
Echinodermata	:	T.S. of arm of starfish, pedicellaria, bipinnaria larva.
Hemichordata	:	T.S. of <i>Balanoglossus</i> through anterior and branchiogenital regions.

BOOKS RECOMMENDED

- Robert William Hegner: Practical Zoology (1922, The Macmillon company)
- P.S. Verma: Invertebrate Practical (2012, S. Chand & Co.)
- S.S. Lal: Invertebrate Practical (2009, Rastogi publications)
- Verma P.S., P.C. Srivastava: Practical Zoology (2012, S. Chand & Co.)

M.Sc. – Semester II
Zoology -First Paper
ZOO201: Chordata

Unit-1 (Credit – 0.75) Origin of Chordata, Characteristic features and affinities of the following lower chordates a. Hemichordata b. Protochordata	12 Lectures
Unit-2 (Credit – 0.75) Pisces a. Peculiar features of Lung fishes (Dipnoi) b. Electric organs Amphibia: Origin of Tetrapodes	12 Lectures
Unit-3 (Credit -0. 25) Reptile a. Origin of reptiles b. Mesozoic reptiles	10 Lectures
Unit-4 (Credit – 0.25) Aves a. Flightless birds b. Modification of beak, feet and palate in birds	8 Lectures
Unit-5 (Credit – 1.0) Mammal a. Characteristic features of monotremes, marsupials & placentals b. Adaptive radiation in placental	12 Lectures

BOOKS RECOMMENDED

1. Prasad & Kashyap: A Textbook of Vertebrate Zoology (14th ed 2011, New Age publication)
2. Harvey et al: The Vertebrate Life (2006)
3. Colbert et al: Colbert's Evolution of the Vertebrates (5th ed 2002, Wiley - Liss)
4. Hildebrand: Analysis of Vertebrate Structure (4th ed 1995, John Wiley)
5. Jordan and Verma: Chordate Zoology (1998, S. Chand)
6. Kotpal: The Birds (4th ed 1999, Rastogi Publications)
7. McFarland et al: Vertebrate Life(1979, Macmillan Publishing)
8. Parker and Haswell: TextBook of Zoology, Vol. II (1978, ELBS)
9. Romer and Parsons: The Vertebrate Body (6th ed 1986, CBS Publishing Japan)
10. Sinha, Adhikari and Ganguli: Biology of Animals, Vol. II (1988, New Central Book Agency)
11. Young: The life of vertebrates (3rd ed 2006, ELBS/Oxford)

M.Sc. – Semester II
Zoology –Second Paper
ZOO202: Animal Physiology & Instrumentation

Section A: Animal Physiology

Unit-1 (Credit – 0.5) **10 Lectures**

1. Digestion and nutrition

- 1.1 Absorption of macronutrients and their regulation
- 1.2 Obesity and starvation

2. Circulation

- 2.1 Types, Blood and Lymph composition & function,
- 2.2 Heart: Origin and conduction of cardiac impulse, ECG and cardiac cycle

Unit-2 (Credit – 0.75) **14 Lectures**

3. Excretion

- 3.1 Structure and function of Kidney
- 3.2 Urine formation and regulation

4. Neuromuscular system

- 4.1 Types, Mechanism of contraction, Muscular dystrophy
- 4.2 Nerve conduction & neurotransmitters

Unit-3 (Credit – 0.1) **10 Lectures**

5. Respiration

- 5.1 Mechanism & regulation of breathing
- 5.2 Transport of gases & Gaseous exchange
- 5.3 Hypoxia and oxygen therapy

Section B: Instrumentation **10 Lectures**

Unit-4 (Credit - 0.75)

6. Centrifugation: Basic principles, Types of rotors, Ultracentrifuge

7. Spectrophotometer: Types of spectrophotometer and function

Unit-5 (Credit 1.0) **10 Lectures**

8. Electrophoresis and Microscopy: Principles and function

9. Microscopy: Principles and function

10. Chromatography: Principles type & Function

BOOKS RECOMMENDED

1. Eckert and Randell: Animal Physiology: Mechanisms & Adaptations (2nd ed 2005, CBS Publishers)
2. Berry: Textbook of Animal Physiology (11th ed 2008, Emkay Publications)
3. Guyton and Hall: Text Book of Medical Physiology (11th ed 2006, W.B. Saunders)
4. Srivastava, Agrawal and Kumar: Animal Physiology (2011, S.Chand & co. ltd.)
5. Chaudhuri: Concise Medical Physiology (2nd ed 1993, New Central Book Agency Ltd.)
6. Bentley: Comparative Vertebrate Endocrinology (1998, Cambridge University Press)
7. Norris: Vertebrate Endocrinology (4th ed 2007, Elsevier)
8. Brooks and Marshall: Essentials of Endocrinology (1995, Blackwell Science)
9. Turner and Bagnara: General Endocrinology (1984, Saunders)
10. Larson: Williams Textbook of Endocrinology (10th ed 2002, Saunders)
11. Berg et al: Biochemistry (5th ed 2001, Freeman)
12. Nelson et al: Lehninger Principles of Biochemistry (3rd ed 2004, Pearson)
13. Harper's Review of Biochemistry (22nd ed 1991, Lange Medical Books)
14. Stryer L.: Biochemistry (5th ed 2002, Freeman)
15. Rawn: Biochemistry (2nd ed 1989, Neil Patterson)

M.Sc.– Semester II
Zoology -Third Paper
ZOO203: Developmental Biology & Animal Behaviour

Section A: Developmental Biology

Unit-1 (Credit - 0.5)	9 Lectures
1. Introduction and basic concepts	
1.1 The origin of developmental biology- cell theory	
1.2 Mosaic and regulative development	
2. Fertilization in mammals	
2.1 Gametogenesis, Acrosomal reaction	
2.3 Prevention of polyspermy and gamete fusion	
2.4 Parthenogenesis	
Unit-2 (Credit – 1.0)	18 Lectures
3. Embryonic development	
3.1 Egg type, Cleavage	
3.2 Blastulation in amphibians	
3.3 Gastrulation: Fate maps	
3.4 Embryonic Induction	
4. Placentation in mammals	
Unit-3 (Credit - 0.5)	5 Lectures
5. Growth (concept, mechanism, curves) & Aging, homeobox	
6. Stem cells and their applications	

Section B Animal Behavior

Unit-4 (Credit - 0.5)	10 Lectures
1. Methods of studying of animal behavior: Neuro-anatomical, Neurophysiological, Neurochemical	
2. Mechanism of behavior: Neural and endocrine regulation	
Unit-5 (Credit - 0.5)	12 Lectures
3. Animal signals and communication	
3.1 Kinds of stimuli, stimulus filtering	
3.2 Evolution of language in Primates	
4. Social behavior; Social organization in insects, Group selection, kin selection, Altruism	
5. Sexual behaviour: Sexual selection, courtship behaviour	

BOOKS RECOMMENDED

1. Gilbert: Developmental Biology (2006, Sinauer Publications)
2. Kalthoff: Analysis of Biological Development (1996, McGraw Hill)
3. Monk: Mammalian Development – A Practical Approach (1987, IRL Pub.)
4. O’Rahilly and Muller: Human Embryology and Teratology (1992, Wiley)
5. Rana: Human Embryology Made Easy (1998, CRC Press)
6. Balinsky: An Introduction to Embryology (5th ed 1981, Saunders College Pub.)
7. Alcock : Animal Behaviour: An Evolutionary Approach (7th ed 2005, Sinaur)
8. Bolhuis & Giraldeau: The Behavior of Animals: mechanisms, function, and evolution (2005, Blackwell)
9. Drickamer, Vessey & Jakob: Animal Behavior: Mechanisms, Ecology, Evolution (2007, McGraw-Hill)
10. Grier: Biology of Animal Behaviour (1984, Mosby)
11. Manning & Dawkins: An introduction to Animal Behaviour (5th ed 1998, Cambridge Univ. Press)
12. Mathur Reena: Animal Behaviour (2010, Rastogi Pub.)

M.Sc.– Semester II
Elective Paper
Zoology- Fourth Paper
ZOO204EN: Endocrinology

Unit 1 (Credit: 0.75)	14 Lectures
Endocrine system: Description of organization and function Endocrine gland: Role in hormonal control of body Mechanism of Endocrine gland functioning	
Unit 2 (Credit: 0.50)	8 Lectures
Hypothalamus –Hypophysial system Origin of Pituitary gland Hormones from Pituitary gland and their functioning	
Unit 3 (Credit: 0.75)	14 Lectures
Thyroid gland: Histology, hormones and their disorder Thyroidism, Goitre, Hashimoto’s disease Adrenal gland: Histology, hormones and their disorder Addison’s disease; Cushing’s syndrome; Grave’s disease	
Unit 4 (Credit: 0.50)	8 Lectures
Hormones and metabolic disorders Diabetes (Type I and Type II) Obesity	
Unit 5 (Credit: 0.5)	10 Lectures
Reproductive/sexual disorders Polycystic ovarian disease Osteoporosis Endocrine disruptors and disease susceptibility	

BOOKS RECOMMENDED

- 1 Bentley: Comparative Vertebrate Endocrinology (1998, Cambridge University Press)
- 2 Norris: Vertebrate Endocrinology (4th ed 2007, Elsevier)
- 3 Brooks and Marshall: Essentials of Endocrinology (1995, Blackwell Science)
- 4 Turner and Bagnara: General Endocrinology (1984, Saunders)
- 5 Larson: Williams Textbook of Endocrinology (10th ed 2002, Saunders)

M.Sc.– Semester II
Elective Paper
Zoology- Fourth Paper
ZOO204RB: Reproductive Biology

Unit 1 (Credit: 0.5) Reproductive System Development of gonads, genital ducts, external genitalia Mechanism of sex differentiation	10 Lectures
Unit 2 (Credit: 0.75) Outline and histological of male reproductive system in rat and human Spermatogenesis; Sperm transportation in male tract Outline and histological of female reproductive system in rat and human Oogenesis; ovulation, Secretion of ovarian hormones	12 Lectures
Unit 3 (Credit: 0.75) Reproductive cycles (rat and human) and their regulation Changes in the female tract; Ovum transport in the fallopian tubes Sperm transport in the female tract, fertilization	12 Lectures
Unit 4 (Credit: 0.5) Hormonal control of implantation Gestation, pregnancy diagnosis, Mechanism of parturition Infertility in male and female; causes, diagnosis and management	10 Lectures
Unit 5 (Credit: 0.5) Assisted Reproductive Technology: sex selection, sperm banks, frozen embryos In vitro fertilization, ET, EFT, IUT, ZIFT, GIFT, ICSI, PROST Modern contraceptive technologies, Family planning	10 Lectures

BOOKS RECOMMENDED

1. Austin, C.R. and Short, R.V. reproduction in Mammals. Cambridge University Press
2. Degroot, L.J. and Jameson, J.L. (eds). Endocrinology. W.B. Saunders and Company
3. Knobil, E. et al. (eds). The Physiology of Reproduction. Raven Press Ltd.
4. Hatcher, R.A. et al. The Essentials of Contraceptive Technology. Population Information Programme.

M.Sc.– Semester II
Elective Paper
Zoology- Fourth Paper
ZOO204GE: Genetics

Unit 1 (Credit: 0.75) Mendel's work on transmission of traits, Genetic Variation Molecular basis of Genetic, Information Principles of Inheritance, Chromosome theory of inheritance Pedigree analysis, Incomplete dominance and codominance	14 Lectures
Unit 2 (Credit: 0.5) Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Environmental effects on phenotypic expression, sex linked inheritance Extra-chromosomal inheritance involving mitochondria and chloroplast	8 Lectures
Unit 3 (Credit: 0.75) Linkage and crossing over, Cytological basis of crossing over Molecular mechanism of crossing over, Recombination frequency Linkage intensity, two factor and three factor crosses Interference and coincidence	12 Lectures
Unit 4 (Credit: 0.5) Chromosomal Mutations: Deletion, Duplication, Inversion, Translocation Aneuploidy and Polyploidy; Gene mutations: Induced versus Spontaneous mutations Back versus Suppressor mutations, Molecular basis of Mutations	10 Lectures
Unit 5 (Credit: 0.5) Chromosomal mechanisms, dosage compensation Quantitative and multifactor inheritance Transgressive variations, Heterosis	10 Lectures

BOOKS RECOMMENDED

1. Snustad, D.P., Simmons, M.J. (2009). *Principles of Genetics*. V Edition. John Wiley and Sons Inc.
2. P S Verma and V K Agrwal (2010) Cell biology, genetics, molecular biology and Evolution. S. Chand & Company
3. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. *Introduction to Genetic Analysis*. IX Edition. W. H. Freeman and Co.
4. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). *Principles of Genetics*. VIII Edition. Wiley India.
5. Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). *Concepts of Genetics*. X Edition. Benjamin Cummings. Russell, P. J. (2009). *Genetics- A Molecular Approach*. III Edition. Benjamin Cummings.

M.Sc. – Semester II
Skill Development Course
Zoology -V Paper
ZOO205: Vermiculture

Unit 1 (Credit: 0.1.0)	16 Lectures
Introduction about vermiculture Vermicomposting Requirements of Vermicomposting and vermiculture Choice of species, Composting species	
Unit 2 (Credit: 0. 5)	10 Lectures
Species for Solid waste management Physical factors: Temperature and moisture, shelter Aeration, Chemical factors; Hydrogen Ion Concentration (pH)	
Unit 3 (Credit: 0. 5)	10 Lectures
Feed and feeding materials for vermiculture Mineralization and Humification Vermiculture methods Vermiwash technology	

BOOKS RECOMMENDED

1. Charls Darwin s Plough Tools for vermiculture by Madhab Chandra Das
2. Vermiculture: From Soil Health to Human Health 2006 by L.S. Ranganathan, 139 pp.

M.Sc.– Semester II
Interdisciplinary Course
ZOO206: Ornamental Fishery & Aquarium
(Not for Zoology Students)

Unit1 (Credit: 0. 75)	14 Lectures
Introduction, advantage of Ornamental fish keeping Export potential of ornamental fish Design and construction of ornamental fish tank Commercially important ornamental fishes	
Unit 2 (Credit: 1.0)	18 Lectures
Scope of Aquarium Fish Industry as a Cottage Industry Exotic and endemic species of Aquarium fishes General Aquarium maintenance Budget for setting upon aquarium fish farm as a Cottage Industry	
Unit 3 (Credit: 0. 5)	8 Lectures
Food and feeding of Aquarium fishes Use of live fish feed organisms. Preparation and composition of formulated fish feeds	
Unit 4 (Credit: 0. 25)	4 Lectures
Live fish transport - Fish handling, Methods of fish packing Forwarding techniques	
Unit 5 (Credit: 0. 5)	10 Lectures
Health Education in India – WHO Programmes – Government and Voluntary Organizations and their health services – Precautions First Aid and awareness on sporadic disease	

BOOKS RECOMMENDED

1. A.D. Dholakia. Ornamental fish culture & Aquarium management. Daya Publishing House, New Delhi
2. T.K. Ghosh. Aquarium & Ornamental fish
3. Archana Sinha. Ornamental Fish of India. Central Institute of Fishery Education, Mumbai.

M.Sc. – Semester II

ZOO 207: PRACTICAL EXAM

Total marks: 75 (Internal Assessment: 30 marks + Practical: 45 marks)

Internal Assessment: 30 marks (Based in internal practical assessment in practical class)

External Practical Examination

Sl. No.	Content	Marks
1	Chordata (Display)/Model	10
2	Chordata (Permanent slide preparation)	5
3	Mammalian physiology	5
4	Developmental biology	5
5	Spotting (1-10)	10
6	Viva voce & Class record	10
	Total	45

Chordata

- **Permanent preparation**
 1. Study of external features of *Amphioxus* and permanent preparation of its oral hood and velum
 2. Permanent preparation of test and spicules of *Herdmania*
- **Display:** Demonstration of internal ear of *Scoliodon*, nervous system of catfish
- **Spotting**
 - Study of museum specimens
 - Study of prepared slides
 - **Osteology**
 1. Study of endoskeleton of bony fish, amphibian, reptiles, birds and mammals
 2. Reptilian skull, palate in birds
- Different types of feathers in birds

Mammalian Physiology

- Differential leucocytes counting (DLC) in human blood
- Determination of blood groups (ABO and Rh)
- Studies on frog skeletal muscle (gastrocnemius muscle preparation) contraction, and to observe the effects of increasing voltage, frequency of stimulus and load
- Studies on frog heart beat *in situ*, and to observe the effects of temperature

Developmental Biology

- Collection of frog spawns and observation of different developmental stages
- Study of embryonic development in chick through slides
- Window preparation to study chick embryo development

1. Museum Speciation

Protochordata	:	<i>Herdmania, Amphioxus</i>
Cyclostomes	:	<i>Petromyzon, Ammocoete larva, Myxine</i>
Pisces	:	<i>Trygon, Pristis, Torpedo, Protopterus, Hilsa, Labeo, Wallago, Exocoetus, Hippocampus, Anabas, Chimera, Diodon, Synaptura, Echeneis, Tetradon, Amia, Holocephali, Ecipensor</i>
Amphibia	:	<i>Icthyophis, Ambystoma, Axolotal larva, Salamendra, Amphiuma, Proteus, Siren, Alytes, Pipa</i>

Reptilia	:	<i>Chelone, Testudo, Sphenodon, Chaemeleon, Phrynosoma, Draco, Iguana, Haloderma, Typhlops, Python, Bangarus, Naja, Hydrophis, Viper, Natrix, Crotalus</i>
	:	
Aves	:	Pigeon, Fowl
Mammals	:	<i>Hedgehog, Manis, Hystrix, Bat</i>

2. Permanent Slides

Protochordata	:	W.M. <i>Salpa, Doliolum</i> , T.S. of <i>Amphioxus</i> , Spicules of <i>Herdmania</i>
Amphibia	:	V.S. of Skin, T.S. through alimentary canal, C.S. of Liver, C.S. of Lung, T.S. of Kidney, T.S. of gonads
Aves	:	W.M. of filoplumes, W.M. of down feather
Mammals	:	V.L.S. through Skin, T.S. of Liver, T.S. of Lung, T.S. of Kidney, T.S. of Gonads

BOOKS RECOMMENDED

- P.S. Verma: Vertebrate Practical (2012, S. Chand & Co.)
- S.S. Lal: Vertebrate Practical (2009, Rastogi publications)
- Asthana, Agrawal and Jindal: Vertebrate Zoology (2012, Pragati Prakashan)
- Robert William Hegner: Practical Zoology (1922, The Macmillon company)

M.Sc.- Semester III
Zoology-First Paper
ZOO301: Biotechnology

Unit-1 (Credit – 0.5)	10 Lectures
1. Scope & importance of biotechnology	
2. Recombinant DNA technology	
2.1 Introduction	
2.2 Enzymes used in DNA technology: Restriction endonucleases, Exonucleases, Polymerases, Ligase, kinases, phosphatases	
Unit-2 (Credit – 0.75)	14 Lectures
3. Cloning vectors: Plasmids, Phages, Cosmids, Artificial chromosomes, Expression vectors	
4. Construction of genomic and cDNA libraries	
5. Screening and characterization of clones	
4.1 Gene probes: Properties and application	
4.2 Principles of hybridizations and hybridization based techniques: colony, plaque, Southern, Northern and in situ hybridizations	
Unit-3 (Credit – 0.5)	10 Lectures
6. Basic principles and applications of the following techniques	
5.1 DNA sequencing, Polymerase Chain Reaction, Microarray	
5.3 DNA fingerprinting. Biosensors & biochips	
7. Site directed mutagenesis	
Unit-4 (Credit – 0.75)	12 Lectures
8. Gene transfer techniques	
8.1 Electroporation and microinjection	
8.2 Embryonic cell transfer, Animal cloning	
9. Animal Tissue culture	
9.1 Cell culture, organ culture and culture media	
9.2 Hybridoma technology & monoclonal antibodies	
Unit-5 (Credit – 0.5)	8 Lectures
10. Applications of Recombinant DNA Technology	
10.1 Biosynthesis of insulin	
10.2 DNA drugs and vaccines, Sewage treatment	
11. Introduction and scope of bioinformatics	

BOOKS RECOMMENDED

1. Ausubel et al.: Short Protocols in Molecular Biology. (2002, Wiley Pub.)
2. Glick and Pasternak: Molecular Biotechnology. (2003, ASM Press)
3. Kracher: Molecular Biology - A Practical Approach (1995, Academic Press)
4. Krenzer and Massey: Recombinant DNA and Biotechnology (2000, ASM Press)
5. Meyers (Ed.). Molecular biology and biotechnology. (1995, VCH Publishers)
6. Smith: Biotechnology (5th ed 2009, Cambridge University Press)

M.Sc. – Semester III
Zoology -Second Paper
ZOO302: Molecular Biology

Section A: Molecular Biology

Unit-1 (Credit – 0. 5)	10 Lectures
1. DNA Replication	
1.1	Replication in Prokaryotic and Eukaryotic Cell
1.2	The replicons, origin, primosome and replisomes
1.3	DNA polymerases
Unit-2 (Credit – 0.75)	12 Lectures
2. Mechanism of Transcription	
2.1	Prokaryotic transcription: Promoters, bacterial RNA polymerase; initiation, elongation and termination.
2.2	Eukaryotic transcription: Promoters, enhancers, factors & properties of RNA polymerase I, II, III.
2.3	Reverse transcription
2.4	Inhibitors of transcription
Unit-3 (Credit – 0.75)	12 Lectures
3. Post transcriptional Processing	
3.1	Maturation of rRNA, mRNA and tRNA
3.2	RNA splicing, introns and exons,
3.3	Consensus sequence function. 3' Poly A tail, 5' capping.
Unit-4 (Credit – 0.75)	12 Lectures
4. Translation	
4.1	Formation of initiation complex, chain elongation, translocation & termination
4.2	Inhibitors of protein biosynthesis.
4.3	Comparison of protein biosynthesis in prokaryotes with eukaryotes.
4.4	Post Translational processing, chaperones and protein folding
Unit-5 (Credit – 0.75)	12 Lectures
5. Regulation of Transcription and Translation	
5.1	Positive and negative control
5.2	Repressor & Inducer
5.3	Concept of operon, lac-, trp-operons

BOOKS RECOMMENDED

1. Alberts et al: Essential Cell Biology (1998, Garland)
2. Alberts et al: Molecular Biology of the Cell (2002, Garland)
3. Bostock & Sumner: Eukaryotic Chromosome (1987, North-Holland)
4. Brooker: Genetics: Analysis and Principles (1999, Addison-Wesley)
5. DeRobertis & DeRobertis: Cell and Molecular Biology (1987, Lee & Febiger)
6. Griffith et al: Modern Genetic Analysis (2002, Freeman)
7. Hartl & Jones: Essential Genetics: A Genomic Perspective (2002, Jones & Bartlet)
8. Karp: Cell and Molecular Biology (2002, John Wiley & Sons)
9. Abbas et al: Cellular and Molecular Immunology (2007, Saunders)
10. Barrett: Text Book of Immunology (1988, Mosloy)
- 11 Benjamin et al: Immunology – A Short Course (2003, Wiley-Liss)
- 12 Kuby: Immunology (2006, Freeman)
- 13 Roitt: Essential Immunology (2003, Blackwell)

M.Sc.– Semester III
Zoology - Third Paper

ZOO303: Biodiversity, Natural Resources and Conservations

Section A: Biodiversity

Unit-I (Credit – 0.75) **12 Lectures**

1. Biodiversity

- 1.1 Biodiversity: Definition, type
- 1.2 Threats & Factors governing biodiversity: Historical & Proximate
- 1.3 Measurement of biodiversity: diversity indices, similarity indices
- 1.4 Hotspots of Biodiversity

Unit-II (Credit –0.75) **12 Lectures**

2. Community Ecology

- 2.1 Terrestrial Biodiversity: Forest, Grass land, Savanah
- 2.2 Plankton, Nekton, Benthos
- 2.3 Factors governing the community distribution

Unit-III (Credit – 0. 5) **10 Lectures**

3. Habitat Diversity

- 3.1 Wetlands; types & ecological importance
- 3.2 Wastelands, types& ecological importance
- 3.3 Mangroves, types & ecological importance

Section B: Natural resources and conservations

Unit-IV (Credit – 0.5) **10 Lectures**

4. Natural Resources

- 4.1 Definition, type: Conventional and non-conventional
- 4.2 Natural energy resources: Air, water, Solar
- 4.3 Alternate energy resources :Atomic, Thermal and Hydro- energy
- 4.4 Conservation of natural resources

Unit-V (Credit – 0. 5) **10 Lectures**

5. Conservation

- 5.1 Definition, Concept & Types
- 5.2 *In-situ* and *ex-situ* Conservation
- 5.3 Endemic & Endangered Species, Vulnerable Species, Red Data Book,
- 5.4 National Biodiversity ACT, Biodiversity Registers

BOOKS RECOMMENDED

1. Declaration of: The Stockholm Conference, Rio, Rio+5 and Rio+10.
2. Anti – Pollution Acts (3) and Commentaries published theorem.
3. Constitution of India [Referred articles from Part-III, Part-IV and Part-IV-A].
4. Pares Distn. Environmental Lows in India (Deep. Deep, Lated edn.)
5. P. Leelakrishnan, Environmental and the last (Bullorthworths, Latold, edn.).
6. Basic environmental technology: Jerry; A. Nathanson.

M.Sc.– Semester III
Elective Course
Zoology –Fourth paper
ZOO304EB: Environmental Biology -1
(Basics of Environmental Biology, Tools & Chemistry)

Section A: Basics of Environmental Biology, Tools

Unit-I (Credit – 0.5) **10 Lectures**

1. Fundamentals of Ecology & Tools

- 1.1. Fundamentals of Ecology, definition and types
- 1.2. Habitat Ecology
- 1.3. Community Ecology
- 1.4. Environmental tools & techniques

Unit-II (Credit – 0.75) **12 Lectures**

2. Fundamentals of Ecosystem

- 2.1 . Definition and types: lotic & lentic
- 2.2 . Lotic: Stream, river, spring, rill, fall
- 2.3 Lentic; Pool, reservoir, lake
- 2.4 . River Continuum Concept (RCC)

Unit-III (Credit – 0.75) **12 Lectures**

3. Types of Ecosystem

- 3.1 Freshwater ecosystem: Ganga, Yamuna, Sone, Ken
- 3.2 Terrestrial ecosystem: Forest, Mangrove, Mountain
- 3.3 Marine ecosystem: Continental shelf, continental zone, EEZ

Section B: Environmental Chemistry

Unit-IV (Credit – 0.5) **10 Lectures**

4. Environmental Chemistry

- 4.1 Concept, Scope & importance
- 4.2 Chemistry of Water: pH, conductivity, DO, Total Hardness,
- 4.3 Total alkalinity, & Soil Nitrate, Phosphorus, Silicate

Unit-V (Credit – 0.5) **10 Lectures**

5. Environmental Toxicology

- 5.1 Concept, Scope & importance
- 5.2 Type and sources of toxic substances: rural and urban area
- 5.3 Factors affecting environmental toxicity

BOOKS RECOMMENDED

1. Odum: Ecology
2. Welch: Limnology Vols. I-II
3. Bouhey: Ecology of populations
4. Arora: Fundamentals of environmental biology
5. APHA (2000): American Public Health Association
6. J. W. Moore and E. A. Moore: Environmental Chemistry
7. Environmental Chemistry: B.K. Sharma, and H. Kaur
8. H.V. Jadhav Elements of Environmental Chemistry

M.Sc.– Semester III
Elective Course
Zoology –Fourth paper
ZOO304FS: Fishery Science-I
(Taxonomy, Morphology and Physiology)

Section A: Taxonomy

Unit-I (Credit –0.5) **10 Lectures**

- 1.1 General characters and classification of fishes
- 1.2 Modern classification of fishes
- 1.3 General characters and classification of Elasmobranch

Unit –II (Credit- 0.5) **10 Lectures**

- 2.1 General characters and classification of Osteochthys
- 2.2 Affinities of Actinopterygians.
- 2.3 Affinities of lung fishes

Section B: Morphology & Physiology

Unit-III (Credit –0.25) **6 Lectures**

- 1.1 Definition, scope and importance
- 1.2 General structure of fish and terminology
- 1.3 Length-weight

Unit-IV (Credit –0.75) **20 Lectures**

- 1.1 Integumentary system; scale, type
- 1.2 Digestive system: Food and feeding, gut analysis
- 1.3 Structure and function of kidney
- 1.4 Respiratory system: structure and function
- 1.5 Swim bladder, Accessory respiratory organ

Unit –V(Credit 1.0) **18 Lectures**

- 3.1 Circulatory system: structure and function of Heart
- 3.2 Reproduction, breeding biology
- 3.3 Excretion of nitrogenous wastes, water and ion balance
- 3.4 Endocrine glands

BOOKS RECOMMENDED

1. Dutta Munshi, J.S. and M.P. Srivastava Natural History of Fishes and Systematics of Fresh water Fishes of India, 2006 Narendra Publishing House, New Delhi.
2. Gupta S.K. and Gupta P.C. General and applied Ichthyology.
3. Day, F. 1958. The fishes of India: being a natural history of the fishes known to inhabit the seas and freshwater of India, Burma and Ceylon. William Dawson, London
4. Jayaram, K.C. 2002. The freshwater fishes of the Indian region. Narendra Publishing House, Delhi, pp 551.
5. Talwar, P. K. And Jhingran, A. G. 1991. Inland fishes of India and adjacent countries Vol. 1&2. Oxford & IBH Publishing, New Delhi, pp 1062.
6. Srivastava C.B.L. A text book of Fishery Science and Indian Fisheries
7. Lagler et al Ichthyology
8. Norman J.R. A History of Fishes.
9. S.S. Khanna An Introduction of fishes

M.Sc.– Semester III
Elective Course
Zoology –Fourth paper
ZOO304CB: Cell Biology –I
(Cell morphology and organelles)

Section A: Cell morphology

Unit-1 (Credit – 0.75) **12 Lectures**

1. Prokaryotes

- 1.1 Viruses: structure and replication
 - a. Bacteriophage (Lambda phage, ϕ x 174)
 - b. Retroviruses (HIV)

- 1.2 Bacteria: Structure and reproduction of *E. coli*

Unit-2 (Credit – 0.5) **10 Lectures**

2. Plasma Membrane

- 2.1 Architecture
- 2.2 Function: transport across membrane

Unit-3 (Credit – 0.5) **10 Lectures**

3. Cytoskeleton

- 3.1. Microfilaments: Structural organization and function
- 3.2. Microtubule: Structural and functional organization, cilia, flagella, centriole
- 3.3. Intermediate filaments

Section B: Cell organelles

Unit-4 (Credit – 0.75) **12 Lectures**

4. Ribosomes and Endoplasmic reticulum

- 4.1 Ribosomes in prokaryotes & eukaryotes: Structure and function
- 4.2 Endomembrane system: Structure and function of cell
- 4.3 Protein sorting and secretion
- 4.4 Mechanism of intracellular digestion

Unit-5 (Credit – 0.50) **10 Lectures**

5. Mitochondria

- 5.1 Ultrastructure and function
- 5.2 Mitochondrial born diseases

BOOKS RECOMMENDED

1. Alberts et al: Essential Cell Biology (1998, Garland)
2. Alberts et al: Molecular Biology of the Cell (2002, Garland)
3. DeRobertis & DeRobertis: Cell and Molecular Biology (1987, Lee & Febiger)
4. Karp: Cell and Molecular Biology (2002, John Wiley & Sons)
5. Lodish et al: Molecular Cell Biology (2000, Freeman)
6. Pollard & Earnshaw: Cell Biology (2002, Saunders)
7. Alberts et al: Molecular Biology of the Cell (4th ed 2002, Garland)
8. Lodish et al: Molecular Cell Biology (6th ed 2007, Freeman)
9. Karp: Molecular Cell Biology (2002, John Wiley & Sons)
10. Sheeler & Bianchi: Cell and Molecular Biology (3rd ed 2006, John Wiley & Sons)
11. Gupta: Gupta P K: Cytology (2009, Global media publications)

M.Sc.– Semester III
Skill Development course
Zoology -Fifth Paper
ZOO305: Bioinformatics

Unit 1 (Credit – 0.75) Introduction to Bioinformatics Basic concepts of biological databases; Introduction to genomics and proteomics Databases nucleic acid sequence database	14 Lectures
Unit 2 (Credit – 0.50) Databank search- data mining Data management and interpretation Multiple sequence alignment, genes, primer designing	8 Lectures
Unit 3 (Credit – 0.75) Protein modeling, protein structure analysis phylogenetic analysis Introduction to computational genomics and proteomics Basics of designing a microarray	14 Lectures

BOOKS RECOMMENDED

1. Bioinformatics for Dummies, Claverie J. M., Notredame C., (2nd Ed., 2007), Wiley Publishing, Inc., New York, USA
2. Bioinformatics: Sequence and Genome Analysis, Mount, D. W. (2nd Ed., 2001), Cold Spring Harbor Laboratory Press, New York, USA

M.Sc.– Semester III
Interdisciplinary course
ZOO306: Apiculture
(Not for Zoology Students)

Unit 1 (Credit – 0.5)	8 Lectures
History – Biology and classification of honey bees	
Species of honey bees, Social organization of honey bee colony	
Unit 2 (Credit – 0.75)	14 Lectures
Bee hive, Flora for apiculture	
Selection of bees for apiculture	
Method of bee Keeping: Indigenous method of Extraction of honey	
Unit 3 (Credit – 0.5)	10 Lectures
Modern method of apiculture – Appliances for modern method	
Diseases of Honey bee and control measures	
Unit 4 (Credit – 0.75)	14 Lectures
Products of bee keeping	
Honey – Bee wax– Hone: Production	
Chemical composition – Economic importance of Honey bee wax	
Unit 5 (Credit – 0.75)	8 Lectures
Bee enemies – Bee keeping industry – Recent efforts	
Modern method in employing honey bees for cross pollination in horticultural gardens	

BOOKS RECOMMENDED

1. Guide to Bees and Honey, Ted Hooper, Northern Bee Books
2. The Bee Book, DK, Dorling Kindersley

M.Sc.– Semester IV
Zoology -First Paper
ZOO401: Biochemistry

Unit –I (Credit – 0.5)	8 Lectures
Thermodynamics Second law and its application Concept of free energy and calculations based on free energy change	
Unit – II (Credit – 1.5)	28Lectures
Protein structure Primary structure, peptide bond Secondary structure α helix, β pleated sheet & bends Prediction of secondary structure, Ramachandran Tertiary structure Forces stabilizing tertiary structure: Domains and motifs Quaternary structure	
Unit –III (Credit – 0.5)	8 Lectures
Derivation of Michaelis-Menten equation, Related calculations and MM & LB plots Mechanism of action	
Unit IV (Credit – 0.5)	10 Lectures
Enzymes, Enzyme kinetics Lowering of activation energy Active site, substrate binding, transition state analogues and Abzyme Concepts of regulation of enzyme activity	
Unit V (Credit – 1.0)	18 Lectures
Metabolism Concept of metabolic pathways Gluconeogenesis, Hexose monophosphate pathway Glycogen metabolism, peptidoglycan, β -oxidation and synthesis of fatty acids	

BOOKS RECOMMENDED

1. Berg et al.: Biochemistry (5th Ed.), Freeman, 2001
2. Nelson et al: Lehninger Principles of Biochemistry (3rd Ed.), Pearson, 2004
3. Mathews et al.: Biochemistry (3rd Ed.), Benjamin/Cummings Publishing, 1990
4. Segal Biochemical calculations (2nd.), John Wiley & Sons, 1976
5. Watson et al: Molecular Biology of the Gene (2nd Ed.), Benjamin/Cummings, 1976
6. Zubay et al: Principles in Biochemistry (2nd Ed.), WCB, 1995
7. Rawn: Biochemistry, Neil Patterson, 1989
8. Primrose et al: Principals of gene manipulation (6th Ed.), Blackwell Scientific, 2001.

M.Sc.– Semester IV
Zoology- II & III Paper
ZOO402+ZOO403: Dissertation+ Viva –Voce

Total 8 Credits

- A. Topic will be based on elective paper opted by the students.
- B. Dissertation/Project will based on practical in nature include laboratory based work.
- C. Dissertation/Project work would be assigned at the end of Semester III to enable students to initiate work on the same.
- D. Dissertation/Project report will be submitted and presented via open house power point presentation in presence of external examiner.

M.Sc.– Semester IV
Elective Course
Zoology -Fourth paper
ZOO404EB: Environmental Biology -II
(Application, management & Legal Environmental Biology)

Section A: Application & Management of Environmental Biology

Unit-I Credit – 0.5) **11 Lectures**

1. Environmental Flow

- 1.1 Environmental flows: Importance for the aquatic flora & fauna
- 1.2 Methodology of Environmental flows assessment
- 1.3 Build Block Methodology (BBM)

Unit-II (Credit – 0.75) **13 Lectures**

2. Environmental Management

- 2.1 Environmental management Programme (EMP): Urban & Rural
- 2.2 Hydroelectric Projects (HEP)
- 2.3 Environmental Impact Assessment (EIA)

Unit-III (Credit – 0.75) **12 Lectures**

3. Environmental Management

- 3.1 Global agreements and national concerns.
- 3.2 RAMSAR sites,
- 3.3 Quarantine Regulations, National Forest Policy,
- 3.4 Biodiversity Act., Wild-life Protection Act

Section A: Legal Environmental Biology & Computer

Unit-IV (Credit – 0.5) **9 Lectures**

4. Environmental Policies, Acts and Rules

- 4.1 Environmental laws in India
- 4.2 Factories Act, Motor Vehicle Act,
- 4.3 Hazardous Waste legislation for pollution
- 4.4 Anti-Pollution Acts: The water Act. 1974.

Unit-V (Credit – 0.5) **9 Lectures**

5. Computer applications

- 5.1 Basic knowledge of Microsoft office: Word, Excel, Power Point
- 5.2 Knowledge of various soft were: OMNIDIA, Statistica, SPSS
- 5.3 Truss and CANOCO soft water

BOOKS RECOMMENDED

1. Declaration of: The Stockholm Conference, Rio, Rio+5 and Rio+10.
2. Anti – Pollution Acts (3) and Commentaries published theorem.
3. Constitution of India [Referred articles from Part-III, Part-IV and Part-IV-A].
4. Pares Distn. Environmental Lows in India (Deep. Deep, Lated edn.)
5. P. Leelakrishnan, Environmental and the last (Bullorthworths, Latold, edn.).
6. Basic environmental technology: Jerry; A. Nathanson.
7. Canter, L. W. Environmental Impact Assessment, Mc. Graw Hill Publication, New York.

M.Sc.– Semester IV
Elective Course
Zoology -Fourth paper
ZOO404FS: Fishery Science –II
(Capture Fishery)

Section A: Freshwater Fishery

Unit I: (Credit 0.75) **12 Lectures**

- 1.1 Fishery resources in different river System: Ganga & Yamuna
- 1.2 Regulation, exploitation and improvement of fish stocks
- 1.3 Present and future prospects of riverine fishery in India

Unit II (Credit 0.75) **12 Lectures**

- 2.1 Dams and their effect on fishery
- 2.2 Cold water fishery and its resources
- 2.3 Fisheries management in cold water
- 2.4 Present and future prospects of Cold water fishery in India

Unit III (Credit 0.5) **10 Lectures**

- 3.1 Estuarine fisheries and resources
- 3.2 Problems confronting brackish-water capture fisheries
- 3.3 Present and future prospects of estuarine fishery in India

Section B: Marine Fishery

Unit IV (Credit 0.5) **10 Lectures**

- 4.1 Marine fishery in India
- 4.2 Coastal fishery resources of India
- 4.3 Inshore fishery & off shore fishery
- 4.4 Deep sea fishery

Unit V (Credit 0.5) **10 Lectures**

- 5.1 Oceanography in relation to fishery
- 5.2 Exclusive economic zone (EEZ)
- 5.3 Present and future prospects of marine fishery in India

BOOKS RECOMMENDED

1. Jhingran V.G. Fish and Fisheries of India
2. Beavan, C.R. Handbook of Freshwater fishes of India
3. Bal and Rao. marine Fisheries
4. Gupta S.K. and Gupta P.C. General and applied Ichthyology.
5. Srivastava C.B.L. A text book of Fishery Science and Indian Fisheries
6. S.S. Khanna An Introduction of fishes

M.Sc.– Semester IV
Elective Course
Zoology -Fourth paper
ZOO404CB: Cell Biology –II
(Karyology, Cell division and Ageing)

Section A: Karyology

Unit 1 (Credit – 0.5)	
1. Nucleus	10 Lectures
1.1 Ultrastructure	
1.2 Function	
1.3 Chemical composition and its significance	
Unit-2 (Credit – 0.75)	12 Lectures
2.0 Giant chromosomes: Structure and function	
2.1 Polytene chromosome	
2.2 Lamp-brush chromosome	
Unit-3 (Credit - 0.5)	10 Lectures
3. Cell-Cell Interactions	
3.1 Cellular junctions	
3.2 Extracellular matrix	
3.3 Desmosomes	

Section B: Cell division & ageing

Unit-4 (Credit – 0.5)	10 Lectures
4. Cell cycle	
4.1 Interphase	
4.2 Cell division: 1) Mitosis, 2) Meiosis	
4.3 Regulation of cell cycle	
Unit -5 (Credit – 0.75)	12 Lectures
5. Cell aging & death	
5.1 Theories: Modern concept	
5.2 Apoptosis and necrosis	

BOOKS RECOMMENDED

1. Alberts et al: Essential Cell Biology (1998, Garland)
2. Alberts et al: Molecular Biology of the Cell (2002, Garland)
3. DeRobertis & DeRobertis: Cell and Molecular Biology (1987, Lee & Febiger)
4. Karp: Cell and Molecular Biology (2002, John Wiley & Sons)
5. Lodish et al: Molecular Cell Biology (2000, Freeman)
6. Pollard & Earnshaw: Cell Biology (2002, Saunders)
7. Alberts et al: Molecular Biology of the Cell (4th ed 2002, Garland)
8. Lodish et al: Molecular Cell Biology (6th ed 2007, Freeman)
9. Karp: Molecular Cell Biology (2002, John Wiley & Sons)
10. Sheeler & Bianchi: Cell and Molecular Biology (3rd ed 2006, John Wiley & Sons)
11. Gupta: Gupta P K: Cytology (2009, Global media publications)

M.Sc.– Semester IV
Skill Development course
Zoology - Fifth Paper
ZOO405: Sericulture

Unit 1 (Credit – 0.75)	12 Lectures
Classification of commercial varieties of mulberry	
Mulberry plantation	
Establishment and cultivation practices	
Diseases of mulberry	
Unit 2 (Credit – 0.75)	12 Lectures
Silkworm rearing operations	
Chawki rearing and late age rearing techniques	
Physical and commercial characters of Cocoons	
Reeling operations	
Importance of by-products of Sericulture	
Unit 3 (Credit – 0.75)	12 Lectures
Economics of Sericulture	
Future and progress of Sericulture Industry in India	
Prospects of Sericulture as Self-Employment venture	

BOOKS RECOMMENDED

1. V.B. Shukla and Upadhaya. Economic Zoology, Rastogi Publication, Meerut.
2. P. Venkatanarasaih: Sericulture, APH Publishing House, New Delhi
3. R.K. Patnaik: Sericulture Manual, APH Publishing House, New Delhi

M.Sc. – Semester IV
Interdisciplinary course
ZOO406: River System
(Not for Zoology students)

Unit 1 (Credit – 1.0)	22 Lectures
Origin and descriptions of major river system of India: Ganga River System Brahmaputra River System Indus River System East Coast River System and West Coast River System	
UNIT-2 (Credit – 0.25)	6 Lectures
Ecology of the Ganga and Yamuna, Central Indian rivers Nektons, Benthos	
UNIT-3 (Credit – 0.5)	9 Lectures
Factors governing the distribution of Planktons, Benthos Dams, Barrage, Canals	
UNIT-4 (Credit – 0.75)	9 Lectures
Heavy Metals Pesticides Weed Eco-toxicological Effluents of the Ganga river	
UNIT-5 (Credit – 0.5)	8 Lectures
Role of the river Ganga in Society and Science Ecosystem Services	

BOOKS RECOMMENDED

1. S. S. Khanna. An introduction to fishes. Silver Line Publication, New Delhi
2. Welch: Limnology
3. Jhingran V.G. Fish and Fisheries of India