

[CBCS BASED]
ORDINANCE, REGULATION & SYLLABUS
For
M.Sc. [ZOOLOGY]



Offered by

NEHRU GRAM BHARATI

**(DEEMED TO BE UNIVERSITY),
KOTWA-JAMUNIPUR-DUBAWAL
PRAYAGRAJ-221505
UTTAR PRADESH**

Session:

From 2019 – 2020
POST GRADUATE -PROGRAMME



NEHRU GRAM BHARATI (Deemed to University)

Kotwa – Jamunipur - Dubawal, Prayagraj-221505, U.P.
Tel. (0532) 64539; Website: ngbu.edu.in

20.05.2019

Minutes of meeting

The Board of studies meeting held on May 20th, 2019 (11.00 AM) in the Department of Zoology at Jamunipur campus, NGB (DU), Prayagraj. The meeting was headed by Dean, Faculty of science.

The following members were present at the meeting,

1. Prof. Ram Kripal, Dean Faculty of Science, NGB(DU), Prayagraj
2. Prof. Sandeep Kumar Malhotra, Ex Head, Dept. of Zoology, University of Allahabad, Prayagraj
3. Prof. R.S. Pandey, Dept. of Zoology, University of Allahabad, Prayagraj
4. Dr. Asheesh Shivam, Head, Dept. of Zoology, NGB(DU), Prayagraj
5. Dr. Sukrat Sinha, Asst. Professor, Dept. of Zoology, NGB(DU), Prayagraj
6. Dr. Rudra Prakash Ojha, Asst. Professor, Dept. of Zoology, NGB(DU), Prayagraj

The above said committee has discussed the agenda and following amendments were made;

1. The PG syllabus has been approved after following suggestions
 - i. The topic Animal Distribution has been deleted from the Core paper II in M.Sc. I semesters.
 - ii. The Bio-chemistry is introduced in the M.Sc. IV Semester in place Fundamental Research.
 - iii. The sericulture has shifted as Skill Development course and River System as Interdisciplinary course in M.Sc. IV Semester.
 - iv. Cytology course has deleted from the M.Sc. II Sem elective paper.

The meeting was concluded with vote of thanks offered by Dean, Faculty of Science, NGB(DU), Prayagraj.



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29.05.2019

Minutes of meeting

A meeting of Faculty Board of Science was held on May 29th, 2019 (10:30 AM) under the chairmanship of Dean, Faculty of science at the Civil Lines Campus, NGB (DU), Prayagraj.

The following members were present at the meeting,

S. N.	Name & Designation	Post
1.	Prof. Ram Kripal, Dean Faculty of Science, NGB(DU), Prayagraj	Chairman
2.	Prof. P.K. Singh, Ex. Head, Dept of Mathematics, University of Allahabad, Prayagraj.	Member
3.	Prof. S.N. Srivastava, Dept. of Botany, NGB(DU), Prayagraj	Member
4.	Prof. A. K. Mishra, Dept. of Physics, NGB(DU), Prayagraj	Member
5.	Prof. D.P. Chaudhari, Dept. of Mathematics, NGB(DU), Prayagraj	Member
6.	Dr. Asheesh Shivam, Head, Dept. of Zoology, NGB(DU), Prayagraj	Member
7.	Dr. Anoop Kumar Srivastava, Head, Dept. of Physics, NGB(DU), Prayagraj	Member
8.	Dr. Prasant Kumar Srivastava, Head, Dept. of Chemistry, NGB(DU), Prayagraj	Member
9.	Dr. Adi Nath Upadhyay, Head, Dept. of Botany, NGB(DU), Prayagraj	Member
10.	Dr. Pawan K. Mishra, Head, Dept. of Mathematics, NGB(DU), Prayagraj	Member
11.	Dr. Rudra Prakash Ojha, Assistant Professor, Dept. of Zoology, NGB(DU), Prayagraj	Member
12.	Dr. Anita Singh, Assistant Professor, Dept. of Chemistry, NGB(DU), Prayagraj	Member
13.	Dr. Sunil Som, Assistant Professor, Dept. of Physics, Prayagraj	Member

Minutes

The above said committee discussed the agenda concerning the Choice Based Credit System (CBCS) Syllabus of Masters Degree Programme of Science Faculty, already passed by different Board of Studies of different department.

The Committee unanimously passed the CBCS Syllabus of M.Sc. Botany, Chemistry, Mathematics, Physics and Zoology to be effective from the session 2019-2020 as annexed herewith.

The meeting concluded with vote of thanks to the chair.

msz
28/05/19
Anand
29.5.19
880M
29.05.19
Prashant
29.5.19
HSC
29/05/19
PICMithun
29-5-2019
D. Sree
29/5/19
Dadyar
29/05/19
Rajesh

PREAMBLE

The syllabus of M. Sc. Zoology based on semester with credit based pattern comprises of four semesters. It is useful for those biology students interested in higher education (academic), research and scientific field. 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.

The examination shall be of 03 core theory papers, each 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.

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.

ORDINANCE AND REGULATIONS

FOR

M.Sc. Zoology Degree -Programme

OFFERED BY

NEHRU GRAM BHARATI

(DEEMED TO BE UNIVERSITY)

KOTWA-JAMUNIPUR-DUBAWAL

PRAYAGRAJ-221505

UTTAR PRADESH

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.

2. The Curriculum and Duration Of Studies

A. (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.

B. The curriculum of study for the Master Degree shall be spread over four Semesters having 80 credits (each semester of 20 credits).

3. Requirement for Admission

A. Registration:

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.

B. 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.

C. 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.

4. Fees

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

5. The course of study, scheme of examination, result and promotion are covered in the regulation, and are given below.

REGULATIONS

1. 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.
2. 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**.
3. The course has 4 components: Core courses, Elective course, Skill Development and Inter-disciplinary course.
4. 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.
5. 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.
6. In the beginning of the Semester III, 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.
7. Each semester shall have minimum 90 teaching days, exclusion of holidays, admission and examinations.

SCHEME OF EXAMINATION

1. 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.**

2. 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.)
3. 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.
4. The duration of the End Semester Examination (ESE) of each course will be 3/2 Hours.

M.Sc. – Zoology CBCS pattern

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 Paper	Paper IV	ZOO104 BW/ ZOO104I M/ ZOO104 AZ	Biodiversity & Wildlife/ Immunology/ Applied Zoology	3	3+0+0	30	45	75
Skill Development	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 Paper	Paper IV	ZOO204 CE/ ZOO204 RB/ ZOO204 GE	Endocrinology /Reproductive Biology/ Genetics	3	3+0+0	30	45	75
Skill Development	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 Paper	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	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	Paper II+ Paper III	ZOO 402+ZO O403	Dissertation & Viva –Voce	8	1+0+7		100+ 100	200
Elective Paper	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	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

Pattern of theory papers & allocation of marks (Seats - 30)

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

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 Baret: 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 and Wild life

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 Baret: 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

Credits: 3

54 Lectures

Unit 1

Overview of the immune system
Introduction to basic concepts in immunology

Unit 2

Cells and organs of the immune system- Haematopoiesis
Cells of immune system and organs (primary and secondary lymphoid organs)
Antigens- Basic properties of antigens
B-Cell and T- cell

Unit 3

Antibodies- Structure
Classes and function of antibodies
Monoclonal antibodies
Antigen, working of the immune system I
Structure and functions of MHC

Unit 4

Working of immune system II
Basic properties and functions of cytokines

Unit 5

Immune system in health and disease

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

Credits: 3

54 Lectures

Unit 1

Introduction to Host-parasite Relationship: Host, Definitive host, Intermediate host, Parasitism, Symbiosis, Commensalism

Unit 2

Epidemiology of Diseases: Transmission, Prevention and control of diseases: Tuberculosis, swine flu, typhoid

Unit 3

Parasitic Protozoa: Life history and pathogenicity of *Entamoeba histolytica*, *Plasmodium vivax* and *Trypanosoma gambiense*, Insects of Medical Importance: Medical importance and control (*Pediculus humanus corporis*, *Anopheles*, *Culex*, *Aedes*, *Xenopsylla cheopis*)

Unit 4

Animal Husbandry: Preservation and artificial insemination in cattle; Induction of early puberty and synchronization of estrus in cattle

Unit 5

Poultry Farming: Principles of poultry breeding, breeding stock and broilers
Processing and preservation of eggs seed

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
Zoology -Five Paper
ZOO105: Skill Development
Aquaculture

Credit 2

Lectures: 36

Unit-1

Principles of aquaculture
Definition of aquaculture
Types, Composite fish culture
Air breathing fish culture

Unit-2

Integrated fish farming
Paddy cum fish culture
Paddy cum cattle culture

Unit-3

Pond preparation: Size, Depth, Water level
Pond management
Prawn culture: Fresh water and marine water
Pearl culture

BOOKS RECOMMENDED

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

M.Sc. – Semester I
ZOO106: Interdisciplinary Course
Public Health & Hygiene

Lectures: 54

Credits: 3.0

Unit 1: Scope of Public health and Hygiene
Nutrition and health

Unit 2
Classification of foods
Nutritional deficiencies - Vitamin deficiencies.

Unit 3:
Environment and Health hazards – Environmental degradation – Pollution and Associated health hazards.

Unit 4:
Communicable diseases and their control measures such as Measles, Polio, Chikungunya, Rabies, Plauge, Leprosy and AIDS

Unit5:
Non-Communicable diseases and their preventive measures
Hypertension, Coronary Heart diseases
Stroke, Diabetes, Obesity and Mental ill-health

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: 15 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, Fungia, Rhizostoma, Proropita</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>Euglena, 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 nereis and heteronereis, trochophore larva,
Arthropoda	:	Megalopa, Mysis, Zoa, Nauplius, Daphnia, Cyclopes, Mouthparts of male and female, <i>Culex</i> and <i>Anopheles</i> , Pediculus 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

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

Credit: 3.0

54 Lectures

Unit 1 (Credit: 0.75)

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)

Hypothalamus –Hypophysial system
Origin of Pituitary gland
Hormones from Pituitary gland and their functioning

Unit 3 (Credit: 0.75)

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)

Hormones and metabolic disorders
Diabetes (Type I and Type II)
Obesity

Unit 5 (Credit: 0.5)

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

Credit: 3.0

54 Lectures

Unit 1

Reproductive System
Development of gonads, genital ducts, external genitalia
Mechanism of sex differentiation

Unit 2

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

Unit 3

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

Unit 4

Hormonal control of implantation
Gestation, pregnancy diagnosis
Mechanism of parturition
Infertility in male and female; causes, diagnosis and management

Unit 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

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
ZOO20GE: Genetics

Credit: 3.0

54 Lectures

Unit 1

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

Unit 2

Multiple alleles, Lethal alleles, Epistasis, Pleiotropy,
Environmental effects on phenotypic expression, sex linked inheritance
Extra-chromosomal inheritance involving mitochondria and chloroplast

Unit 3

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

Unit 4

Chromosomal Mutations: Deletion, Duplication, Inversion, Translocation
Aneuploidy and Polyploidy; Gene mutations: Induced versus Spontaneous mutations
Back versus Suppressor mutations, Molecular basis of Mutations

Unit 5

Chromosomal mechanisms, dosage compensation
Quantitative and multifactor inheritance
Transgressive variations, Heterosis

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
Zoology -Fifth Paper
ZOO205: Vermiculture

Credit 2.0

Unit 1

18 Lectures

1. Introduction about vermiculture
2. Vermicomposting
3. Requirements of Vermicomposting and vermiculture
4. Choice of species, Composting species

Unit 2

10 Lectures

1. Species for Solid waste management
2. Physical factors: Temperature and moisture, shelter Aeration,
3. Chemical factors; Hydrogen Ion Concentration (pH)

Unit 3

10 Lectures

1. Feed and feeding materials for vermiculture
2. Mineralization and Humification
3. Vermiculture methods
4. 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

54 Lectures

Credit 3.0

Unit 1

Introduction, advantage of Ornamental fish keeping
Export potential of ornamental fish
Design and construction of ornamental fish tank
Commercially important ornamental fishes

Unit 2

Scope of Aquarium Fish Industry as a Cottage Industry
Exotic and endemic species of Aquarium fishes
General Aquarium maintenance
Budget for setting up an aquarium fish farm as a Cottage Industry

Unit 3

Food and feeding of Aquarium fishes
Use of live fish feed organisms.
Preparation and composition of formulated fish feeds

Unit 4

Live fish transport - Fish handling, Methods of fish packing
Forwarding techniques

Unit 5

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
ZOOLOGY
ZOO 207: PRACTICAL EXAM

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

Internal Assessment: 20 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
7	Spotting (1-10)	10
9	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>Ichthyophis, 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: 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 PAPER
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 PAPER
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 Fishries
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 PAPER
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)

4. Ribosomes and Endoplasmic reticulum

12 Lectures

- 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
Zoology- Fifth Paper
ZOO305: Bioinformatics

Credit: 2.0

36 Lectures

Unit 1

Introduction to Bioinformatics
Basic concepts of biological databases;
Introduction to genomics and proteomics
Databases nucleic acid sequence database

Unit 2

Databank search- data mining
Data management and interpretation
Multiple sequence alignment, genes, primer designing

Unit 3

Protein modeling, protein structure analysis
phylogenetic analysis
Introduction to computational genomics and proteomics
Basics of designing a microarray

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

Credit: 3

54Lecture

Unit 1

History – Biology and classification of honey bees,
Species of honey bees, Social organization of honey bee colony

Unit 2

Bee hive – Flora for apiculture – Selection of bees for apiculture
Method of bee Keeping – Indigenous method of Extraction of honey

Unit 3

Modern method of apiculture – Appliances for modern method
Diseases of Honey bee and control measures

Unit 4

Products of bee keeping : Honey – Bee wax– Hone : Production
Chemical composition – Economic importance of Honey bee wax

Unit 5

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

Credit: 4

72 Lecture

Unit –I

Thermodynamics
Second law and its application
Concept of free energy and calculations based on free energy change

Unit – II

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

Derivation of Michaelis-Menten equation,
Related calculations and MM & LB plots
Mechanism of action

Unit IV

Enzymes, Enzyme kinetics
Lowering of activation energy
Active site, substrate binding, transition state analogues and Abzyme
Concepts of regulation of enzyme activity

Unit IV

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. Rawns: Biochemistry, Neil Patterson, 1989
8. Primrose et al: Principles of gene manipulation (6th Ed.), Blackwell Scientific, 2001.

M.Sc. – Semester IV
Zoology-Second Paper +Third 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 PAPER
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 PAPER
Zoology-Third 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 PAPERS
Zoology- Third 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**

ZOO405: Sericulture

Credit: 2

36 Lectures

Unit 1

Classification of commercial varieties of mulberry
Mulberry plantation
Establishment and cultivation practices
Diseases of mulberry

Unit 2

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

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

Credit: 3

54 Lectures

Unit 1

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

Ecology of the Ganga and Yamuna, Central Indian rivers
Nektons, Benthos

UNIT-3

Factors governing the distribution of Planktons, Benthos
Dams, Barrage, Canals

UNIT-4

Heavy Metals, Pesticides, Weed
Eco-toxicological Effluents of the Ganga river

UNIT-5

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