CURRICULUM

BS (Honours) Programme in Zoology
under The Four Year Integrated Grading System
for the sessions 2018-2019, 2019-2020, 2020-2021 and 2021-2022

Department of Zoology
University of Dhaka

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BS (Honours) Programme in Zoology

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Preparation and Authentication of the Curriculum

After long deliberations in a series of meetings and Workshops the Academic Committee of the Department of Zoology, University of Dhaka approved the structure and draft of the curriculum prepared by the Curriculum Committee and the course content developed by the concerned faculties. The Academic Council of the University of Dhaka approved it on October, 2019. Finally, the Syndicate accorded approved on October, 2019. This curriculum will be effective from the session 2018-2019.

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BS (Honours) in Zoology

Guidelines for Letter Grading System for BS (Hons.) Programme

Applicable for the Sessions 2018-2019, 2019-2020, 2020-2021, 2021-2022

1. Introduction to the Department of Zoology

The Department of Zoology, University of Dhaka, is one of the oldest departments of the university and the pioneer institute to introduce teaching and research in animal sciences in the country and, therefore, played a commendable role in promoting zoological studies in Bangladesh. Since its inception in 1954, the department has been the best learning seat for zoology in the country and producing graduates of global competence. As a research hub, the department undertakes researches to generate knowledge for the improvement of zoological sciences, food security, biodiversity conservation and management, biotechnology, epidemiology, pest control, etc. The department also provides advisory and community services to government and private sectors, related to biodiversity conservation and environmental protection.

The department is housed in a three-storied building located at a scenic place within the Curzon Hall Campus and has necessary infrastructural facilities. The department has adequate number of lecture rooms and practical laboratories.

Research facilities: Research is also a major focus of the department and carried out in all disciplines of zoology, viz. Entomology, Fisheries, Wildlife Biology, Parasitology, and Genetics & Molecular Biology with focus on demand led areas. The department has moderately equipped specialized research laboratories, representing all specialized branches of the department. The faculties and students publish a good number of research articles every year. Collaborative researches are carried out with different research institutions.

Outdoor facilities and collaborative research opportunity: A pond of 0.99 hectare, located in front of the department is available for aquatic researches. In addition, an animal garden of 0.5 hectare is maintained for animal breeding, rearing and experimentation. The University of Dhaka has been developing marine research facilities at Cox's Bazar and would be available for zoology students for carrying researches on marine ecosystem in near future.

The Department undertakes research programmes in collaboration with other research institutions of the country such as, the Bangladesh Atomic Energy Commission, Bangladesh Council for Scientific and Industrial Research, National Institute of Biotechnology, Bangladesh Jute Research Institute, Bangladesh Rice Research Institute, Bangladesh Agricultural Research Institute, National Institute for Preventive and Social Medicine, Space Research and Remote Sensing Organization, Fisheries Research Institute, ICDDR,B, BIRDEM, BSMMU, etc. Funds are sought from a number of national and international organizations. The national institutions include University Grants Commission, Ministry of Science and Technology and ICT, Bangladesh Agricultural Research Council, Ministry of Environment and Forests, Ministry of Fisheries and Livestock, Ministry of Agriculture, Ministry of Education, etc.

Departmental library: Department of Zoology has a seminar library: Professor Yousuf Zai Seminar Library, named after the first Head of the Department. The library contains more than seven thousand books and a huge number of reading materials, including journals, thesis papers, project reports, etc.

Departmental museum: The department harbors a museum which is the largest of its kind in the country and holds a large number of animal specimens (representing all major phyla), embryological and histological preparations, animal skeletons, models etc. and is used for practical demonstration classes.

Stipends and awards available at the department: The department offers a few stipends and awards to the outstanding students. The department announces such stipends/awards on a yearly basis and invites applications from those who fulfill the criteria set for the stipends/awards.

Academic Programmes of the Department: The department offers four academic degree programmes. These are:

i. Bachelor of Science (Honours) in Zoology- BS (Honours) is a four year integrated degree programme comprising of theory and practical works.
ii. Master of Science (MS) in Zoology- a one year programme based either on course work and practical (Group A: Non-thesis Group) or research and course works (Group B: Thesis Group). MS degree courses are offered in 5 specialized branches of Zoology, viz. Entomology, Fisheries, Wildlife Biology, Parasitology and Genetics & Molecular Biology. An MS student may choose any one of these branches for her/his study.
iii. MPhil in Zoology- is a two year degree, based on course work and research. Courses are offered in the above mentioned specialized branches. Registered students need to successfully complete 8-credit course to be promoted from 1st year to 2nd year of the programme.
iv. PhD in Zoology- is normally a four year degree based on research, however, need to take 8-credit course to be promoted from 1st year to 2nd year of the programme, except for the students completed their 4 years BS and 1 year MS in Dhaka University.

2. Introduction to the BS Programme

Title - Bachelor of Science (Honours) in Zoology/BS (Honours) in Zoology

General Objectives of the Programme

The BS (Honours) Course in Zoology is a comprehensive and integrated degree programme, aligned to meet the expectations of country's policy for tertiary education. The programme is designed to equipping the students with theoretical and practical knowledge and skills in major spheres of zoological studies aiming at producing graduates in zoology of global competence, capable of contributing to national development. The major focuses of the BS study are animal diversity covering the entire animal kingdom, structural, functional and developmental zoology, evolution, ecology, environmental biology, paleontology, ethology, zoogeography, genetics & molecular biology and applied zoology (for example culture, farming of animals, crop protection, etc.). The programme also integrates selected courses, having relevance to zoological sciences, offered by Botany, Biochemistry and Microbiology Departments of the university to meet the needs of the zoology students.

Duration of the Programme: The duration of the BS (Honours) programme is 4 (four) consecutive academic calendar years, designated as 1st, 2nd, 3rd and 4th year, based on an annual course system, in which students complete all assigned courses for a particular year. The time allocation of each academic year includes 42-44 working weeks for lecture and practical classes, 4 weeks as preparatory period for course final examinations and up to a maximum of 8 weeks for taking all course final examinations. Results are published within 6 weeks after completion of course final examinations. However, a student may complete his/her degree within 6 academic years, in case when he/she fails to be promoted in any year. This opportunity can be availed twice for completing the degree.

Eligibility for Admission: The selection of students for enrollment in the 1st year BS (Honours) Course is made through an admission test conducted under 'Ka'-unit admission, controlled centrally by the university. Student seeking admission in Zoology needs to go through the 'Ka'-unit admission test.

3. Structure of Curriculum

3.1 Assignment of Credits and Credit hours: The entire BS (Honours) programme is covered by a set of theoretical and practical (laboratory/field/seminar/project) courses. Each course comprises a number of credits depending on the volume of contents of each individual course, ranging from 1 to 4 credits.

(a) For theoretical courses, a single credit course will have a minimum of 15 class hours (credit hours) during an entire academic year, while there will be a minimum of 30 and 60 lecture hours of each theoretical course for 2 and 4 credit courses per year, respectively.

(b) The duration of one practical class will be equivalent to 3 (three) theory class hours.
(c) Credits assigned to seminar/project will be determined by the Academic Committee of the Department.
(d) Each credit course carries 25 marks.
(e) The total number of course credits for Zoology BS (Honours) degree is 128 and a student must need to earn all the credits for the successful completion of his/her graduation programme.

3.2 Distribution of Credits in Zoology: A year-wise distribution of credits for a four year BS (Honours) in Zoology under the integrated annual grading system is as follows:

	1st Year	**2nd Year**	**3rd Year**	**4th Year**	**Total credit**
Zoology Core courses:					
Theory	12	16	24	28	80
Practical	4	4	8	8	24
Viva-voce	2	2	2	2	8
Extra-Departmental courses: Theory & Practical	4 (Botany-1) 4 (Biochemistry)	4 (Botany-II) 4 (Microbiology)	--	--	16
Total	**26**	**30**	**34**	**38**	**128**

3.3 Assessment System

Course Assessment: The assessment process for any theory course involves a 3-steps scheme: i) in-course examination to be taken by the course teacher usually at the midway of the course duration; ii) course final examination will be held after the completion of the course, conducted centrally by the university; and iii) class attendance.

(a) There will be at least 1 (one) in-course examination for a 2-credit course and at least 2 (two) in-course examinations for a 4-credit course.
(b) The distribution of marks for a theoretical course will be as follows:

Class attendance	5%
In-course examination	35%
Course final examination	60%

(c) In case of practical course, marks distribution will be as follows:

Class attendance	5%
In-course assessment	35%
Course final examination	60%

(d) The distribution of marks for an extra-departmental course will be as follows:

Class attendance	5%
In-course assessment	15%
Practical examination	20%
Course final examination	60%

(e) The course final examinations will be of 3 hours duration for a 4 credit course, 2 and a ½ hours for 3 credit course, and 2 hours for a 2 credit course.
(f) For the evaluation of the course final theoretical examination, there will be two examiners: 1st examiner (course teacher) and the 2nd examiner (anyone other than the course teacher). In case of the assessment of Seminar/Project/Internship, the examination committee of the Department will determine the mode of assessment.
(g) Oral test (viva-voce) will be conducted by the departmental examination committee approved by the university.

(h) Basis for awarding marks for class attendance will be as follows:

Attendance (% of total class held)	Marks (%)	Attendance (% of total class held)	Marks (%)
95 and above	5	80 to less than 85	2
90 to less than 95	4	75 to less than 80	1
85 to less than 90	3	Less than 75	0

(i) **In-course Assessment (theory courses)**

In-course test: In-course tests will be of minimum one hour duration each, to be conducted and evaluated by the course teacher. There will be at least 2 (two) written tests for a 4 credit course and at least 1 (one) written test for a 2 credit course. Questions for in-course tests would be of the objective and short types. The course teacher will show the assessed in-course scripts to the students. Absence in any in-course test will be counted as zero for calculating the average marks for in-course test for that course.

Make-up test: Make-up test will be arranged for a student who fails to appear in in-course test/tests. A student will be able to apply to the Chairman of the department for make-up test. The Chairman will place the application before the Academic Committee of the department, only if the particular student has met with an accident or his/her parent(s) has/have expired or he/she has gone through a surgical procedure or any other such situation which the Academic Committee feels can be considered. The make-up test must be held during the course period.

(j) **The Course Final Examination (theory courses):**

i. The course final examination will be conducted centrally by the Controller of Examinations as per existing system.

ii. For evaluation of the course final examination there will be two examiners: one 1st examiner (the course teachers) and the 2nd examiner (other than the course teacher). In case of difference of more than 20% of marks between the marks given by the two examiners, there will be a 3rd examiner. Marks of nearest two examiners will be averaged to calculate the final marks for that course.

(k) **Viva-Voce/Oral Examination:** Viva-voce/Oral examination will be conducted by the respective Departmental Examination Committee, approved by the University.

(l) **The Grading System:** Marks obtained for each course will be converted to grades. A basic four point (4.00) grading scale is followed. The following letter grades and corresponding grade-points will be used to determine the student's grade point average (GPA):

Marks Obtained	Corresponding Letter Grade	Grade Point
80% or above	A+	4.00
75% to less than 80%	A	3.75
70% to less than 75%	A-	3.50
65% to less than 70%	B+	3.25
60% to less than 65%	B	3.00
55% to less than 60%	B-	2.75
50% to less than 55%	C+	2.50
45% to less than 50%	C	2.25
40% to less than 45%	D	2.00
Less than 40%	F	0.00

Note: Any fractional total marks for a course will be rounded up to next higher marks.

3.4 Grading Description

The explanations of letter grades are described as follows:

A: Exceptional performance, all course objectives achieved; objectives met in a consistently outstanding manner.

B: Very good performance; significantly more than the majority (at least two-thirds) of the course objectives achieved; objectives met in a consistently thorough manner.

C: Satisfactory performance; at least majority of the course objectives achieved; objectives met satisfactorily.

D: Minimally acceptable performance; less than the majority but more than the minimum required course objectives achieved; objectives achieved at a minimally acceptable level.

3.5 Earned Credits

A course in which a student has obtained 'D' or a higher grade will be counted as credits earned by him/her. Any course in which a student has obtained 'F' grade (failed in the course) will not be counted towards his/her earned credits.

3.6 Evaluation of Student's Performance

Marks obtained in in-course exam(s), class attendance and course final examination (average of 1st and 2nd examiners) of a course will be added to get total marks obtained by the students for that course and be converted to percent marks obtained for each of the individual courses. The percent marks obtained in a particular course will be converted to letter grade and GPA for each individual course. The final CGPA will be calculated as follows.

3.7 Calculation of GPA and CGPA

Grade Point Average (GPA) is the weighted average of the grade points obtained in all the courses passed/completed by a student in an academic year. The Grade Point Average (GPA) is computed in the following manner:

$$\text{GPA} = \frac{\sum(\text{Grade points x Credits})}{\text{Sum of Credits Attempted}}$$

The Cumulative Grade Point Average (CGPA) of 2nd year, 3rd year and 4th year results is computed by dividing the total accumulated grade points earned up to date by total credit points attempted. For the student who earned more than the required minimum of 128 credits, after successful completion of his/her 4 year graduate programme, the final CGPA will be calculated using all the credits attempted.

3.8 Eligibility for Appearing for Course Final Examinations

a) A student must attend **at least 75%** of the total classes held in an academic year to be eligible for appearing for the final examination of that year without paying any penalty.

b) A student attending **at least 60%** classes but **less than 75%** classes will be allowed to appear for the examination after paying non-collegiate fees fixed by the university.

c) A student attending **less than 60%** classes will not be allowed to appear for final examination for that year/session.

4. Promotion

a) *Promotion from 1st year to 2nd year*

(i) A student must earn a minimum Grade Point Average (GPA) of 2.0 and must pass all the courses for promotion.

(ii) Students who failed in courses (maximum 8 credit hours), but have earned the required GPA 2.0 will be promoted on probation.

(iii) Those on probation shall appear for a retake examination as mentioned in Retake section (5) and must pass the failed courses to continue studies in the 2nd year.

b) *Promotion from 2nd year to 3rd year*

(i) A student must have earned a minimum Cumulative Grade Point Average (CGPA) of 2.25 and must have passed all the courses for promotion.

(ii) Students who failed in courses (maximum 8 credit hours) but have earned the required 2.25 CGPA will be promoted on probation.

(iii) Students who earned CGPA less than 2.25 but equal to or more than 2.0 without any 'F' grade will also be promoted on probation.

(iv) Those on probation shall appear for a retake examination as mentioned in Retake section (5) and pass the failed courses to continue studies in the 3rd year.

c) *Promotion from 3rd year to 4th year*

(i) A student must have earned a minimum Cumulative Grade Point Average (CGPA) of 2.5 and must have passed all the courses for promotion.

(ii) Students who failed in courses (maximum 8 credit hours) but have earned the required CGPA 2.5 will be promoted on probation.

(iii) Students who earned CGPA less than 2.5 but equal to or more than 2.25 without any 'F' grade will also be promoted on probation.

(iv) Those on probation shall appear in a retake examination as mentioned in Retakes section (5) and pass the failed courses to be allowed to continue studies in the 4th year.

5. Retake Examination (may be taken only in case of course final examination)

Student who has been promoted on probation for failing in course(s) must sit for retake examination of the failed courses, within 6 weeks after publication of results, conducted by the respective original examination committee for the year. Expenses of the retake examinations (as determined by the University) must be borne by the student. After the retake examination, if a student achieves the required credits, he/she will be considered promoted, but his/her transcript will be marked to identify the courses retaken. If any student fails to earn the required credits, his/her promotion on probation will be deemed cancelled.

a) Student who has been promoted on probation for failing to earn requisite CGPA without any 'F' will be allowed to sit for retake examination for maximum 8 credits (including practical course and viva-voce), within 4-6 weeks after publication of results, conducted by the same examination committee for that year. Expenses of the retake examination (as determined by the University) must be borne by the student. After the retake examination, if the student succeeds to earn required CGPA he/she will be considered promoted, but his/her transcripts will be marked to identify the courses retaken. If any student fails to achieve the required CGPA, his/her promotion on probation will be deemed cancelled.

b) Student who failed in maximum of 8 credits of the 4th year, he/she must sit for retake examination of the failed courses, within 4-6 weeks after publication of results, conducted by the same examination committee for the year. Expenses of the retake examination (as determined by the University) must be borne by the student. After the retake examination, if a student achieves the required credits, he/she will be considered for graduation, but his/her transcript will be marked to identify the courses retaken.

6. Readmission

a) A Student failing to earn the requisite credits and/or GPA/CGPA (see clause 4.7 and 4.8 above) for promotion or graduation may seek readmission with the next batch. For readmission, a student will have to apply within one month after announcement of the result of the concerned year. Readmission will be allowed only after the approval of the departmental Academic Committee.

b) On readmission, a student may choose, subject to approval of the academic committee of the department, to keep grades and credits earned earlier or choose to take all or any course(s) again. Student must clearly indicate his/her choice in the application for readmission.

c) On readmission, a student may be allowed by the departmental Academic Committee to retain his/her in-course marks, earned earlier as chosen by him/her.

d) Readmission must not be allowed more than twice during the entire programme. A student will have to complete the BS programme within a period of maximum six years, including readmission.

e) A student attending less than 60% classes will not be allowed to take readmission. Therefore, he/she will be dropped out of the programme forever.

7. Dropout

A student failing to earn the required minimum GPA/CGPA and/or to earn requisite credits after retakes, he/she may take readmission, with the approval of the academic committee of the department, to appear for the course final examinations with the next batch. If he/she fails again to earn the required minimum GPA/CGPA and/or to earn requisite credits he/she will be dropped out of the programme.

8. Improvement of Earned Credits

a) To improve GPA/CGPA, a student may appear in the course final examination (theory courses, practical courses and viva-voce), only once, with the following next batch in a maximum 8 credits in each year. Improved grade point will be used for GPA/CGPA calculation. For improvement of grade in a course the student shall apply to the chairman of the department at least 8 weeks before the start date of the final examination. The transcript will carry a symbol identifying the improved courses.

b) If a student likes to improve the grade point earned in a course of 4^{th} year, he/she must apply for such improvement examination before the award of the degree (i.e., before issuance of certificate). Improvement shall not be allowed once the degree is awarded.

9. Grade codes for Retakes, Readmissions and Improvements

a) If a student succeeded in a retake after promotion on probation his/her letter grade for that course will be preceded by letter **'P'**.

b) If a student succeeded after taking readmission his/her letter grade for the courses will be preceded by letter **'R'**.

c) If a student succeeded in the improvement examination for earned credits his/her letter grade for that course will be preceded by letter **'I'**.

10. Requirements for Graduation

a) To graduate with a Bachelor's degree, a minimum total of 128 credits with no F grade in any course must be earned by a student in the graduation programme. He/she must also have to earn the minimum required **2.5 CGPA on a 4.00 scale**.

b) A student who has fulfilled all the academic requirements for a Bachelor's degree will have to file with the Controller of Examinations, an application for graduation. Provisional degree will be awarded on completion of credit and CGPA requirements. Such provisional degree will be confirmed by the Academic Council.

11. Time Limits for Completion of Bachelor's Degree

A student must fulfill all the requirements for a Bachelor's degree within a maximum period of six academic years, starting from the year of registration.

12. Dean's Award

As a recognition of excellent performance, the names of students obtaining CGPA of 3.75 or above after successful completion of the 4 year graduation courses, will be eligible for the Dean's Award with a maximum of 05 (five) candidates from each Department. Students who have received 'F' grade/taken retakes /taken improvement/taken readmission in any course throughout the graduation programme will not be eligible for the Dean's Award. Students who failed to attend a minimum of 80% of the classes offered during his/her graduation programme will also not be eligible for the Dean's Award.

13. Other General Regulations

a) Respective statutory authorities of the University shall design syllabus, allocate courses for teaching, constitute examination committee and panel of examiners as per the rules of the university.

b) At the beginning of the session, a course teacher shall provide the students a course outline including: teaching approaches (e.g., labs, case studies, field work, etc.) schedule of tests and other required materials.

c) The course teacher shall announce the results of the in-course tests within two weeks of the date of holding the tests and submit the marks to the Chairman of the Examination Committee for the respective session and also a copy to the Controller of Examinations at least two weeks before start of the annual examination. He/she should also submit a statement showing the total number of classes held and the number of classes attended by each student in his/her course to the Chairman of the Examination Committee for the respective session.

d) Tabulation work will be started only after all the marks of the course final examinations for the year are received by the Chairman of Examination Committee. Marks received by the Chairman of the Examination Committee shall remain in the sealed envelope as sent by the Examiner/Examiners until tabulation work is started.

e) The present system of conducting course final examination and publication of results by the office of the Controller of Examinations shall continue.

f) For any matter not covered in these rules, the existing rule of the University of Dhaka will be applicable.

14. Publication of Results

The yearly and final degree results are published centrally by the Controller of Examination Office of the university. The results are published within 4-6 weeks after completion of course final examinations. The results indicate the letter grade as well as average CGPA earned by an individual student.

15. Field Visit/Trips/Local Study Tour

The students are also required to undertake field visits in each academic year. Such study tours are organized locally and students need to submit reports on the field trips and are evaluated by the concerned teachers/examination committees.

17. Academic Year-Wise Distribution of Courses and Credits

FIRST YEAR

Departmental courses

Zool. 101	Introductory Zoology	2 credits
Zool. 102	Protozoology	2 credits
Zool. 103	Porifera, Cnidaria and Ctenophora	2 credits
Zool. 104	Platyhelminthes and Nematoda	2 credits
Zool. 105	Mollusca and Annelida	2 credits
Zool. 106	Arthropoda and Echinodermata	2 credits
Zool. 110	Practical	4 credits
Zool. 111	Viva-voce	2 credits

Extra-Departmental courses

Bot. 001	Botany- I (including practical)	4 credits
BMB. 11	Biochemistry and Molecular Biology (including practical)	4 credits
	Total:	**26 credits**

SECOND YEAR

Departmental courses

Zool. 201	Minor phyla and Lower chordates	2 credits
Zool. 202	Chondrichthyes and Osteichthyes	2 credits
Zool. 203	Amphibia and Reptilia	2 credits
Zool. 204	Aves and Mammalia	2 credits
Zool. 205	Cytology and Histology	2 credits
Zool. 206	Developmental Biology	2 credits
Zool. 207	Animal Systematics and Nomenclature	2 credits
Zool. 208	Economic Zoology	2 credits
Zool. 210	Practical	4 credits
Zool. 211	Viva-voce	2 credits

Extra-Departmental courses

Bot. 002	Botany-II (including practical)	4 credits
Microbiol. 200	Microbiology (including practical)	4 credits
	Total:	**30 credits**

THIRD YEAR

Departmental courses

Zool. 301	Comparative Vertebrate Zoology	4 credits
Zool. 302	Animal Genetics	2 credits
Zool. 303	Ethology	2 credits
Zool. 304	Fundamental and Advanced Ecology	4 credits
Zool. 305	Human physiology, Reproduction & Family Planning and Population Studies	4 credits
Zool. 306	Biostatistics and Research Methodology	4 credits
Zool. 307	Evolution, Zoogeography and Paleontology	4 credits
Zool. 310	Practical	8 credits
Zool. 311	Viva-voce	2 credits
	Total:	**34 credits**

FOURTH YEAR

Departmental courses

Zool. 401	Environmental Pollution, Radiation Biology, Human Ecology and Biosafety Regulation	4 credits
Zool. 402	Biodiversity, Biodiversity Conservation and Bioresource Management	4 credits
Zool. 403	Entomology	4 credits
Zool. 404	Fisheries and Aquaculture	4 credits
Zool. 405	Wildlife and Wildlife Management	4 credits
Zool. 406	General Parasitology	4 credits
Zool. 407	Molecular Genetics	4 credits
Zool. 415	Practical	8 credits
Zool. 416	Viva-voce	2 credits
	Total:	**38 credits**

First Year BS (Honours) Programme in Zoology

Sessions: 2018-2019, 2019-2020, 2020-2021, 2021-2022

Course No.	Course title	No. of credits	Credit hours
Zool. 101	**Introductory Zoology**	**2**	**30**

Introduction to the course

This course is intended to make students familiar with some basic principles, facts and fundamental rules of zoology and terminologies often used in zoology, which will help students to grasp the future learning as the undergraduate programme advances in the subsequent years of their study. The course focuses on how life came into being on earth, basis and facts of structural and functional organization in animal body, basis and scheme of animal classification, basic ideas on species, biodiversity, ecosystems, habitats and, energy flow through food chains. The course also highlights on animal survey and monitoring, methods and tools for collection of animals and their study, fauna of Bangladesh, protected areas and protected animals of Bangladesh. This course is also designed to give students an outline of various aspects and disciplines of zoology in order that the students can, from the very beginning of their study in the first year, understand what is about zoology, what aspects of zoology are taught and what scope and prospects of zoology teaching and research have in career build up.

Specific objectives of the course

- To familiarize the students with major disciplines of Zoology.
- To enable the students to understand the basis and scheme of animal classification, the functional and structural organizations in an animal body and organization at different levels.
- To enhance students' knowledge relating to the origin of life, phylogenetic relationship, evolution, resource conservation, pollution, habitat, ecosystem, food chains, biodiversity, cloning, gene sequencing, etc.
- To increase students' knowledge in biodiversity survey and monitoring.

Course contents and number of classes by course sub-title:

Sub-title of course contents	No. of classes
Introduction to Zoology: Definition, scope, emergence of zoology as a subject. Branches of Zoology and relation to other branches of science. History of the development of zoological studies in Bangladesh.	**2**
Origin and emergence of life: Early earth and the origin of life; major events in the history of life; geological time scale and emergence of various animal groups; law of recapitulation; concept of phylogeny; phylogenetic relationship and phylogenetic tree; fossils, concept of evolution.	**2**
Organization in animal body: Body constituents; biological molecules (biomolecules); cell- cytoplasm and nucleus; tissue, organs; organ systems.	**1**
Basis of animal classification: Cell differentiation; germ layers; coelom, symmetry, segmentation (metamerism); tagmatization, body coverings; appendages, skeleton, etc.	**1**
Functional organization and integration of animal body: Gene and gene function, DNA, nervous and hormonal regulation, homeostasis.	**1**
Levels of organization in organisms: Pre-cellular level - biomolecule; sub-cellular level - organelle; cellular level - cell; Multi-cellular level – tissue; organ, organ system; organism. Level of organization in ecosystem - individual, population, community, ecosystem, biome, biosphere and ecosphere.	**2**
Concept of species, sub-species, variety, sibling species, overview of naming of species.	**1**
Overview of animal classification system: History of classification and classification system, taxonomic categories, taxonomic keys and characters and their uses.	**2**
Methods of studying animals: Collection (sampling), transportation, preservation, identification, description, reference materials and publication.	**1**

Sub-title of course contents	No. of classes
Field observation of animal: Concept of survey and monitoring of animal; qualitative and quantitative observation and methods of observation of different animal groups.	**2**
Beneficial and harmful organisms/animals. Animals used as food and other commercial and aesthetic values.	**1**
Habitat: Concept and types, major habitats in Bangladesh - terrestrial, freshwater, estuary and sea water.	**1**
Ecosystem: Concept, food chain, food web, ecological niche, biomass, ecological pyramid. Ecological foot prints.	**1**
Biodiversity: Concept, components, importance and values, bioresources – threats and conservation importance	**1**
Faunal diversity: Terminology related to fauna; faunal diversity with special reference to Bangladesh.	**1**
Protected areas: Concept, types, purposes, designated protected areas of Bangladesh (national park, wildlife sanctuary, safari park, community conserved areas, Ecologically critical areas, Ramsar site, World heritage site).	**2**
Protected and threatened animals: Definitions, purposes, categories, IUCN's categories of threatened animals, protected animals of Bangladesh, Wildlife Act and Biodiversity of Bangladesh.	
Environmental pollution: Air, water and noise pollution (an outline of causes and effects only).	**2**
Cloning, finger printing, gene sequencing, transgenic animals.	**1**

Note: In in-course and final examinations, no broad questions will be set from this course; only objective type of questions are suggested and each question must not exceed four marks.

Learning outcomes of the course

After completion of the course the students will be able to-

- define and explain various zoological terminologies;
- explain the basic principles, fundamental structural plan of animal body and its functions;
- understand the basis of animal classification;
- explain structural, functional and integral organizations in an animal body;
- understand the level of animal organization in individual, population and community levels;
- demonstrate their skills in collecting, preserving and studying animals;
- explain biodiversity, resource conservation, habitat, environmental pollutions, biodiversity, cloning, gene sequencing, etc. and
- understand the importance of faunal survey and monitoring.

Instructional strategies of the course

The course will be delivered through lectures and discussions in the classrooms, aided by power point presentations, flip charts, video films, etc. Classes will be made participatory and interactive through questions and answers. Group works could be assigned to students.

Distributional class lectures: Total number of classes/lectures- 30

Class/ lecture type	No. of classes	Class/ lecture types	No. of classes
Lecture and discussion	25	Feedback on in-course exam	1
Review class	2	In-course exam	1
Student feedback on course contents and delivery	1		

Assessment

There will be two in-course examinations, consisting of 8.75 marks each, and 2.5 marks will be allocated for students' attendance in the class. The in-course test questions will include definitions and objectives. A course final examination, of 30 marks, will be conducted by the university. The students will be frequently asked questions in the classrooms to assess their performance.

References

Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. 2001. The Invertebrates: A synthesis. Blackwell Scientific Publications, Oxford, UK.

Hickman, C.P., Roberts, L.S. and Larson, A. 2001. Integrated Principles of Zoology. 11th edition. McGraw-Hill Co. Inc., New York, USA.

Jeffries, M.J. 1997. Biodiversity and Conservation. Routledge, London and New York.

Odum, E.P. and Barrett, G.W. 2005. Fundamentals of Ecology. 5th edition. Thomson Brooks/Cole Publishing Co., USA.

Bashar, M.A. 2004. Instant Basics of Environment. Positron Publications. Dhaka.

Gilbert, S.F. 2006. Developmental Biology. Sinauer Associates Inc., USA.

Groombridge, B. 1992. Global Biodiversity. World Conservation Monitoring Centre. Global Biodiversity: Status of the Earth's living resources. Chapman & Hall, London.

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Karp, G. 2005. Cell and Molecular Biology (Concept and Experiments). 4th edition. John Wiley and Sons Inc., New York.

Primack, R.B. 1998. Essential of Conservation Biology. 2nd edition.Sinauer Associates, Inc. Pub., Sunderland, Massachusetts, USA.

Ruppert, E.E. and Barnes, R.D. 1994. Invertebrate Zoology. 6th edition. Saunders College Publishing Co., New York.

Sambrook, J. and Russell, D.W. 2001. Molecular Cloning (A Laboratory Manual). Cold Spring Harbor Laboratory Press, USA.

Turk, A., Wittes, J.J., Turk, J. and Wittes, R.E. 1978. Environmental Science. W.B. Saunders Company, Philadelphia, USA.

Turner, P.C., McLennan, A.G., Bates, A.D. and White, M.R.H. 2000. Instant Notes Molecular Biology. 2nd edition. BIOS Scientific Publishers Limited, UK.

Course No.	Course Title	No. of credits	Credit hours
Zool. 102	**Protozoology**	**2**	**30**

Introduction to the course

Protozoans are the simplest, but a diverse group of unicellular animals widely distributed all over the world. This group is fascinating to study as these perform all body functions within a single cell. Many of these animals are parasitic to human, domesticated and wild animals, and many involved in energy trapping. The course focuses on the detailed classification scheme of protozoans, type study of representative animals, highlighting functional systems, and reproduction. The course is designed to equip students with fundamentals of protozoology applicable in studying, managing and utilizing such creatures of economic and ecological importance.

Specific objectives of the course

- To introduce the students to the great diversity of protozoans.
- To enhance students' knowledge on the different functional systems of different protozoan groups through type studies.
- To give an idea about the biology, ecology and food and feeding habits in.

Course contents and number of classes by course sub-title:

Sub-titles of course contents	No. of classes
Diversity: Introduction to protozoan diversity.	**1**
Classification: Detailed classification up to orders with characteristics and examples of Protozoa.	**5**
Groups of Protoza: Characteristics and examples of the protozoan phyla belonging to the following categories: flagellated Protozoa; amoeboid Protozoa; spore-forming Protozoa; and ciliated Protozoa.	**4**
Type study: Systematic position, habitat, morphology, development, special features (if any) and major systems of the following protozoan species: *Euglena viridis, Paramecium caudatum* and *Entamoeba histolytica.*	**6**
Short description: Habit and habitat, food and feeding, breeding and economic importance of the following protozoans: Flagellated Protozoa: *Ceratium, Trypanosoma, Leishmania, Opalina;* Amoeboid Protozoa: *Amoeba, Actinophrys, Globigerina;* Spore-forming Protozoa: *Monocystis, Gregarina, Toxoplasma, Nosema*; and Ciliated Protozoa: *Vorticella.*	**4**
Comparative study: Body coverings and skeletal structures; locomotor organelles and locomotion; reproduction; nuclear apparatus; and nutrition. (Note: The four types of Protozoa, viz.: flagellated, amoeboid, spore-forming and ciliated Protozoa, are to be compared on the basis of these characteristics).	**5**

Learning outcomes of the course

After studying this course students will be able to-

- learn about the various groups of Protozoa and their classification scheme;
- describe different organelles of protozoans and its functions;
- explain the differences in the functional systems and reproduction in different groups of Protozoa; and
- understand about the ecology and importance of protozoan animals.

Instructional strategies

The course will be delivered through lectures and discussion, aided by multimedia and overhead projectors, video clips, etc. Classes will be made participatory and interactive through questions and answers. Before starting a new topic presupposition of students on the topic will be assessed by asking their idea on the subject area.

Distribution of class lectures: Total number of lectures: 30

Class/ lecture type	Number of classes	Class/ lecture type	Number of classes
Lecture with discussion	25	In-course exam	1
Students' presentation	2	Feedback on in-course exam	1
Review class	1		

Assessment

One in-course examination, consisting of 17.5 marks, of which 2.5 marks allocated for surprise test, of one hour duration, will be held; 2.5 marks will be allocated for students' attendance in the class. The in-course test questions will include definitions and objectives. A course final examination will be taken at the end of the course (consisting of 30 marks) by the university.

References

Barnes, R.D. 1980. Invertebrate Zoology. WB Saunders Co., Philadelphia, USA.

Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. 2001. The Invertebrates: A synthesis. Blackwell Scientific Publications, Oxford, UK.

Hickman, C.P., Roberts, L.S. and Larson, A. 2001. Integrated Principles of Zoology. 11th edition. McGraw-Hill Co. Inc., New York, USA.

Hyman, L.H. 1959. The Invertebrates. Vols. 1-6, MacGraw Hill Co., New York.

Kudo, R.R. 1996. Protozoology. 5th edition. Charles C. Thomas, USA.

Parker, T.J. and Haswell, W.A. 1959. A Textbook of Zoology. Vol. I. MacMmillan & Co., London.

Storer, T.I., Usinger, R.L., Stebbins, R.C. and Nybakken, J.W. 2001. General Zoology. 6th edition. Tata McGraw-Hill Co. Ltd., New Delhi, India.

Course No.	Course Title	No. of Credits	Credit Hours
Zool. 103	**Porifera, Cnidaria and Ctenophora**	**2**	**30**

Introduction to the course

Phyla Porifera, Cnidaria and Ctenophora comprise more than 15000 known living species. These amazing animal groups exhibit different interesting life forms, peculiar anatomical features and diverse adaptive radiations. This course provides an opportunity to learn about the diversity, and structural and functional peculiarities of these groups of animals. Specifically, the course introduces the students with detailed classification scheme, based on morphological characters and anatomical features of different functional systems of the body by studying the representative animal of each phylum with an opportunity to study the comparative account among the different groups. The course also discusses the habit, habitat, reproduction and evolutionary significance of these animal groups.

Specific objectives of the course

- To make the students acquainted with the ranges of animal diversity between and within each phylum studied.
- To provide students with knowledge on morphological and anatomical organizations of the body and the functional systems of the type animals representing the studied phyla.
- To enhance students' learning on the variations in anatomical and functional systems among the entire range of the animal groups studied under this course

Course contents and number of classes by course sub-title:

Sub-titles of course contents	No. of classes
Phylum Porifera: Classification of the phylum Porifera up to orders with diagnostic and general characteristics and examples of each taxonomic category.	**3**
Type study: Systematic position, habitat, morphology, development, special features (if any) and major systems of *Scypha* sp.	**2**
Comparative study of Porifera: Body wall and cell types; skeletal structures; canal systems; reproduction and development; (Note: different classes of sponges are to be compared on the basis of these characteristics).	**3**
Short description: Habit and habitat, food and feeding, breeding and economic importance of the following sponges: *Spongilla, Oscarella, Cliona, Chalina* and *Euspongia*. Affinities and phylogenetic position of Porifera.	**2**
Phylum Cnidaria: Classification of the phylum Cnidaria up to orders with diagnostic and general characteristics with examples of each taxonomic category.	**3**
Type study: Systematic position, habitat, morphology, development, special features (if any) and major systems of the following Cnidaria species: a. *Obelia geniculata* and b. *Aurelia aurita*.	**2**
Comparative study of Cnidaria: Cnidarian tissues, polymorphism and metagenesis. (Note: The different classes of cnidarians are to be compared on the basis of these characteristics).	**3**
Short description: Habit and habitat, food and feeding, breeding and economic importance of the following cnidarians: *Physalia, Cyanea, Cassiopea, Tubipora, Pennatula, Renilla, Adamsia* and *Gorgonia*. **Coral:** Coral reef, coral reef formation and distribution.	**2**
Phylum Ctenophora: Classification of the phylum Ctenophora up to orders with diagnostic and general characteristics with examples.	**1**
Type study: Systematic position, habitat, morphology, development, special features (if any) and major systems of *Hormiphora [=Pleurobrachia];* its affinities with other animals.	**2**
Short description: Habit and habitat, food and feeding, breeding and economic importance of the following ctenophores: *Cestum* and *Beroe*.	**1**

Learning outcomes of the course

After completion of the course the students will be able to-

- learn about the classification scheme of each phylum and their distinguishing characters;
- describe the anatomical features and functions of different organ systems of the body, and the habits, habitats and reproduction;
- compare and contrast the characteristics of these animals with other closely related animals in terms of structure, function, reproduction, etc. and
- understand its evolutionary significance and economic importance.

Instructional strategies of the course

The course will be delivered through lectures and discussions, aided by power point presentations, video clips, etc. Classes will be made participatory and interactive through questions and answers, brainstorming, oral presentations and group exercises.

Distribution of class lectures: Total number of classes/lecture: 30

Class/lecture types	Number of classes	Class/lecture types	Number of classes
Lecture and discussion	24	Review class	1
Students' group presentation	2	In-course exam	1
Feedback on in-course exam	1	Students' feedback on course contents and delivery	1

Assessment

Total marks allocated to in-course examination will be 17.5, of which 15 marks may be allocated to an announced exam and 2.5 marks will be allocated to un-announced class test/s during the course. The students will be frequently asked questions in the classrooms to assess individual performance. 2.5 marks will be allocated for class attendance. The final examination will be of 30 marks.

References

Barnes, R.D. 1980. *Invertebrate Zoology*. WB Saunders Co., Philadelphia, USA.

Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. 2001. *The Invertebrates: A synthesis.* Blackwell Scientific Publications, Oxford, UK.

Hickman, C.P., Roberts, L.S. and Larson, A. 2001. *Integrated Principles of Zoology*. 11th edition. McGraw-Hill Co. Inc., New York, USA.

Ruppert, E.E. and Barnes, R.D. 1994. *Invertebrate Zoology*. 6th edition. Saunders College Publishing Co., New York.

Storer, T.I., Usinger, R.L., Stebbins, R.C. and Nybakken, J.W. 2001. *General Zoology*. 6th edition. Tata McGraw-Hill Co. Ltd., New Delhi, India.

Course No.	Course Title	No. of Credits	Credit Hours
Zool. 104	**Platyhelminthes and Nematoda**	**2**	**30**

Introduction to the course

Platyhelminthes, the flatworms and the nematodes are two fascinating groups of animal with diverse life forms and anatomical peculiarities. Many of them are parasitic to animals, including the human, domestic and wild animals, and show a wide range of adaptive modifications. The course offers learning opportunities for the students on the ranges of diversity of the groups through studying classification, and morphological, anatomical and functional organization of the body by studying type animals, representing different classes under the two phyla. The course also provides a comparative account on different organ systems between and within each phylum. The course will also discuss the adaptive radiations and parasitic mode of life of the parasitic animals, habit and habitats, reproduction, importance and evolutionary significance of these two groups of animals.

Specific objectives of the course

- To introduce students to the classification schemes and ranges in diversity of animals under the phyla Platyhelminthes and Nematoda.
- To enhance students' learning on the morphological characters, anatomical features and functional systems of representative animals of the two groups.
- To increase students understanding on parasitic adaptation and development, including structural forms and functions, and also pathogenic importance of host- parasite relationship.

Course contents and number of classes by course sub-title:

Sub-title of course contents	No. of classes
Phylum Platyhelminthes: Classification of the phylum Platyhelminthes up to orders with diagnostic and general characteristics with examples.	**3**
Type study: Systematic position, habitat, morphology, special features (if any) development and major systems of the following Platyhelminthes species: *Dugesia* sp., *Fasciola hepatica and Taenia solium.*	**7**
Short description: Habit and habitat, food and feeding, breeding and economic importance of the following Platyhelminthes: *Convoluta, Polystomum, Aspidogaster, Schistosoma, Gyrocotyle, Diphyllobothrium* and *Hymenolopis.*	**4**
Comparative study of Platyhelminthes: Parasitic adaptations, holdfast organs; life-cycle patterns and larval forms. (Note: Different classes of Platyhelminthes are to be compared on the basis of these characteristics)	**4**
Phylum Nematoda: Classification of the phylum Nematoda up to orders with diagnostic and general characteristics and examples.	**2**
Type study: Systematic position, habitat, morphology, development, special features (if any) and major systems of *Ascaris lumbricoides.*	**2**
Short description: Habit and habitat, food and feeding, breeding and economic importance of the following nematodes: *Ancylostoma, Enterobius, Wuchereria, Trichinella, Meloidogyne, Dracunculus, Loa* and *Trichuris*.	**4**

Learning outcomes of the course

After completion of the course the students will be able to-

- learn about the classification scheme of the both phyla with identifying characters;
- describe the anatomical features of the functional systems of animals of these two groups;
- explain the evolutionary basis of morphological differences among trematode, cestode and nematode parasites;
- compare the variety of holdfast organs for the attachment and parasitic adaptations to new habitats or niches; and
- know the developmental stages and their importance for the completion of life cycle.

Instructional strategies

The course will be delivered through lectures and discussions, aided by power point presentations, flip charts, video films, etc. Classes will be made participatory and interactive through questions and answers, and group work exercises in the classrooms.

Distribution of class lectures: Total number of classes/lecture: 30

Class/lecture types	Number of classes	Class/lecture types	Number of classes
Lecture and discussion	26	Review class	1
Students' group presentation	1	In-course exam	1
Student feedback on course contents and delivery	1		

Assessment

There will be one in-course test, consisting of 17.5 marks and 2.5 marks will be allocated for students' attendance in the class. The in-course test questions will of objective and short types. A course final

examination will be of 30 marks to be conducted by the university. Students will be frequently asked questions in the classrooms to assess individual performance.

References

Cheng, T.C. 1997. *General Parasitology.* Academic Press, New York.

Schmidt, G.D. and Roberts, L.S. 1996. *Foundations of Parasitology.* W. C. Brown Publishers, USA.

Chatterjee, K.D. 2009. *Parasitology, protozoology and helminthology*. CBS Publishers and Distributors Pvt. Ltd. New Delhi, India.

Kotpal, R.L. 2005. Helminthes. Rastogi Publications. Meerut, India.

Course No	Course title	No of credits	Credit Hours
Zool. 105	**Mollusca and Annelida**	**2**	**30**

Introduction to the course

The Phylum Mollusca is a diverse and economically important amazing group of animals, comprising more than 100,000 species. The annelids are also a diverse and ecologically important group of animals with a different scheme of organization of the body and have got functional peculiarities. The course will expose the students to these two fascinating group of animals and offer learning opportunities on the diversity and biology of these two groups. In particular, the major focuses of the course include detailed classification of each of the groups, study of the structural and functional systems based on study of type animals, and aspects of their habitat, food and feeding, reproduction, adaptation and economic importance.

Specific objectives of the course

- To introduce the students to the diversity of molluscs and annelids.
- To enhance students' learning on the morphological and anatomical details of different functional systems of the body.
- To increase students' knowledge on the ecological requirements and biology of the molluscs and annelids.

Course contents and number of classes by course sub-title:

Sub-title of course contents	No.of classes
Phylum Mollusca: Classification of the phylum Mollusca up to orders with diagnostic and general characteristics and examples.	**3**
Type study: Systematic position, habitat, development, morphological features and major physiological systems of *Pila globosa*.	**5**
Short description: Habit and habitat, basic structure and economic importance of the following molluscs: *Neopilina, Chiton, Aplysia, Dentalium, Lamellidens, Mytillus, Loligo, Sepia, Octopus* and *Nautilus*.	**3**
Comparative study of Mollusca: Adaptive diversity, molluscan shells, torsion and detorsion, ctenidia, foot and its modifications.	**2**
Phylum Annelida: Classification of the phylum Annelida up to orders with diagnostic and general characteristics with examples of each taxonomic category.	**3**
Type study: Systematic position, habitat, development, special features (if any) and major systems of *Nereis* sp.	**4**
Short description: Habit and habitat, basic structure and economic importance of the following annelids: *Metaphere, Tubifex, Chaetopterus, Glycera, Spirorbis, Arenocola, Tomopteris, Amphitrite, Lumbricus, Hirudo, Piscicola* and *Myzostoma.*	**4**
Comparative study of Annelida: Segmental organs, development and larval forms.	**3**

Learning Outcomes

At the end of this course students will be able to-

- differentiate between different taxa of molluscs and annelids with their distinguishing characters;
- describe various organ systems of typical molluscs and annelids;
- explain and compare the organ systems in different groups of animals under these two phyla; and
- tell about the habit and habitat, ecological requirements, food and feeding, etc. of the animals under the two phyla.

Instruction strategies

Oral lectures and power point presentations will be made for lecture delivery. Group discussions and drawing images will be also made available to facilitate teaching in the classroom.

Distribution of class lectures: Total number of classes/lecture: 30

Class/lecture types	Number of classes	Class/lecture types	Number of classes
Lecture and discussion	27	Review & Questionnaire survey	1
Students' group presentation	1	In-course exam	1

Assessment

Students will be assessed by an in-course exam (17.5 marks) and class attendance (2.5 marks). A course final examination of 30 marks will be conducted centrally by the university.

References

Barnes, R.D. 1980. Invertebrate Zoology. WB Saunders Co., Philadelphia, USA.

Hyman, L.H. 1959. The Invertebrates. Vols. 1-6. MacGraw Hill Co., New York.

Kabir, S.M.H., Ahmed, M., Ahmed, A.T.A., Rahman, A.K.A., Ahmed, Z.U., Begum, Z.N.T., Hassan, M.A., and Khondker, M. (ed.) 2009. Encyclopedia of Flora and Fauna of Bangladesh, Vol. 16. Annelida, Echinodermata, Acanthocephala and Minor Phyla. Asiatic Society of Bangladesh, Dhaka.

Ruppert, E.E. and Barnes, R.D. 1994. Invertebrate Zoology. 6th edition. Saunders College Publishing Co., New York.

Siddiqui, K.U., Islam, M.A., Kabir, S.M.H., Ahmed, M., Ahmed, A.T.A., Rahman, A.K.A., Haque, E.U., Ahmed, Z.U., Begum, Z.N.T., Hassan, M.A., Khondker, M. and Rahman, M.M. (ed.). 2007. Encyclopedia of Flora and Fauna of Bangladesh, Vol. 17. Molluscs. Asiatic Society of Bangladesh, Dhaka.

Course No.	Course Title	No. of Credits	Credit Hours
Zool. 106	**Arthropoda and Echinodermata**	2	30

Introduction to the course

Arthropods are the most diverse group of animals, comprising more than 80% of all known animals on earth. They exhibit a great variety of life forms and adaptations, have great evolutionary and economic significance and thus have been a subject of great interest to biologists. Echinoderms are also a highly specialized group, inhabit the marine environment. The course is intended to enhance students' learning on the ranges of diversity of these groups of highly evolved animal. The major focuses of the course are on detail classification of both phyla, morphological and anatomical features of each functional system with their comparative accounts. The course will also discuss the habit and habitat, food and feeding, ecology, reproduction and development of these animals.

Specific objectives of the course

- To give the students a detailed understanding on the diversity of arthropods and echinoderm.
- To introduce the students to how higher invertebrate animals are organized, how they work, how they reproduce, etc.
- To enhance students learning on the biology and ecological aspects of the phyla.

Course contents and number of classes by course sub-title:

Sub-title of course contents	No. of classes
Phylum Arthropoda: Classification of the phylum Arthropoda up to orders with diagnostic and general characteristics and examples.	**4**
Type study: Systematic position, habitat, morphology, development, special features (if any) and major systems of *Macrobrachium rosenbergii*.	**3**
Short description: Habit and habitat, food and feeding, breeding and economic importance of the following arthropods: *Limulus, Eupagurus*, *Sacculina*, *Squilla*, *Scolopendra*, beetles & weevils, moths & butterflies, termite, bug and bees.	**5**
Comparative study of Arthropoda: Appendages, respiratory organs and crustacean larvae. (Note: Different classes of Arthropoda are to be compared on the basis of these characteristics)	**3**
Phylum Echinodermata: Classification of the phylum Echinodermata up to orders with diagnostic and general characteristics and examples.	**3**
Type study: Systematic position, habitat, morphology, development and major systems of *Asterias* sp.	**3**
Short description: Habit and habitat, food and feeding, breeding and economic importance of the following echinoderms: *Astropecten, Ophiura*, *Echinus, Cucumaria* and *Antedon.*	**2**
Comparative study of Echinodermata: Skeletal structures; water vascular system; larval forms. (Note: Different classes of Echinodermata are to be compared on the basis of these characteristics).	**3**

Learning outcomes of the course

After completion of the course, the students will be able to-

- know about the detailed classification of these two groups and tell about the distinguishing characters of major taxa;
- describe the different functional systems of the animals studied;
- explain the differences of the functional systems between and among different groups under these two animal groups; and
- understand about the ecology, food and feeding, reproduction and developmental stages of the animal groups.

Instructional strategies of the course

The course will be delivered through lectures and discussions, aided by power point presentations, video clips, etc. Classes will be made participatory and interactive through questions and answers, and group work exercises in the classrooms. At the beginning of each class students' feedback on previous class lecture will be taken. Students' feedback on the overall course delivery and content will be taken in the last class through a questionnaire survey.

Distribution of class lectures: Total number of classes/lecture: 30

Class/lecture types	Number of classes	Class/lecture types	Number of classes
Lecture and discussion	26	Review	1
Students' group presentation	1	In-course exam	1
Questionnaire survey of the Student feedback on course contents and delivery			1

Assessment

There will be one in-course examination, consisting of 17.5 marks and 2.5 marks will be for class attendance. The students will be frequently asked questions in the classroom to assess individual performances. The course final examination, comprising 30 marks, will be conducted centrally by the university.

References

Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. 2001. *The Invertebrates: A*

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Hickman, C.P., Roberts, L.S. and Larson, A. 2001. *Integrated Principles of Zoology*. 11th edition. McGraw-Hill Co. Inc., New York, USA. (PDF available: http://www.ciens.ucv.ve).
Storer, T.I., Usinger, R.L., Stebbins, R.C. and Nybakken, J.W. 2001. *General Zoology*. 6th edition. Tata McGraw-Hill Co. Ltd., New Delhi, India. (Free download: https://www.goodreads.com/book/show/4452321-general-zoology).

Course No.	Course Title	No. of Credits	Credit Hours
Zool. 110	**Practical**	**4**	**60**

Introduction to the course

The intent of this practical course is to enhance students' skills in the study of animals through laboratory based practical demonstration classes. One of the major focuses of this practical course is the study of museum specimens for identifying the common invertebrates based on their morphological characters. The demonstrations will allow the students to learn how to proceed with identifying an animal species. This course will also provide hands-on training to dissect, detach, distinguish and display different organs and organ systems of some representative invertebrate belonging to different groups of invertebrates to gain skills in investigating internal organs. Field tours will be organized for students to observe the animal species in and around Dhaka.

Specific objectives of the course

- To enhance students' ability to know and identify of common invertebrates available in the country.
- To improve students' skills in performing dissection of representative invertebrates for studying external structures and internal organs.
- To promote students' ability to identify, collect and record animals in field conditions.

Course contents and number of classes by course sub-title:

Title/sub-title of course content	No. of classes
Study of museum specimens Invertebrates representing protozoan phyla to the phylum Echinodermata	**4**
Study of permanent slides and models Invertebrates and their body parts: a. whole mounts; b. appendages; c. parasites (mainly representing Platyhelminthes and Nematoda); and d. different larval forms.	**1**
Morphometrics and meristic study a. Earthworm: morphometrics- total, cliteller and girth lengths, and ratios (somatic indices); meristics- segment numbers, position of different orifices; b. Prawn: total, rostral, carapace, antennary, antenullary, uropod, telson lengths and their ratios; c. Insect: total, cephalic, thoracic, abdominal lengths and widths and their ratios.	**1**
Study of the appendages Dissecting and displaying of appendages of a typical insect and a prawn (*Note. Students will detach organs used for locomotion, flying, food capturing, copulation and defense or offense from the supplied specimens of these two arthropods according to the instruction of class teacher; they will place these on a paper sheet, label and display.).*	**1**
Dissection of the following representative invertebrates *Pila* - digestive and nervous systems; Earthworm - digestive, circulatory and nervous systems; Cockroach - digestive and nervous systems; and Prawn - circulatory and nervous systems.	**4**
Local field tours A number of local field tours will be organized for students to observe invertebrates in the field conditions and know their habit and habitats. **Students need to prepare practical notebooks and field reports.**	**1**

Learning outcomes of the course

Upon successful completion of the course, students will be able to-

- identify species and decide on systemic positions of different invertebrate species and characterize them according to their taxonomic position;
- gather knowledge on the morphometric and meristic parameters of typical invertebrates and identify species by using those parameters;
- know how to identify, detach and display appendages and mouthparts of typical invertebrates and understand their functions and adaptations;
- identify animals in field conditions with notes on ecology, food and feeding of invertebrates; and
- dissect, distinguish and display digestive, circulatory and nervous systems of selected invertebrates.

Instructional strategies

The course will be delivered through holding practical demonstration classes, hands-on trainings and lectures. A number of teachers will guide individual student on how to proceed with their practical works. The classes will be aided with audio-visual materials, video clips relating to current lecture topics. Students will be guided in a participatory approach. In practice, students will work in groups, consisting 6-7 peers in each group. Preserved specimens and mounted slides will be provided to students for museum specimen study, while live or chloroform-treated specimens will be supplied in the class to study mouthparts and appendages, and for dissection. Students require to prepare practical notebooks for each study they perform, field trips will be organized for students guided by the class teacher(s) to know and record species the students observe in the field.

Distribution of class lectures: Total number of classes/lecture (each of 3 credit hours): 20

Class/ lecture type	No. of classes
Introductory class- course content, code of conduct, instructional strategy, final outcomes/outputs of the practical course	1
Practical demonstration class	12
In-course examination	2
Review class	2
Students' feed back on course contents and mode of class	1
Local field visit	1
Report submission and presentation on field trip	1

Assessment

A total of 40 marks are reserved for in-course examination, which will consist of two written in-course tests and 5 marks are reserved for class attendance. The students will have to prepare notebook for each demonstration class, teacher will check, provide feedback on it on a regular basis. The students will be frequently asked questions in the classrooms to assess performance. There will be a course final examination of 60 marks and marks for class note book and tour report are included in this.

References

Ahmed, A.T.A., Kabir, S.M.H., Ahmed, M., Rahman, A.K.A., Haque, E.U., Ahmed, Z.U., Begum, Z.N.T., Hassan, M.A., and Khondker, M. (ed.). 2008. *Encyclopedia of Flora and Fauna of Bangladesh, Vol. 18. Part 11. Arthropoda: Crustacea.* Asiatic Society of Bangladesh, Dhaka.

Barnes, R.D. 1980. *Invertebrate Zoology.* WB Saunders Co., Philadelphia, USA.

Barrington, E.J.W. 1979. *Invertebrate structure and function.* Willy and Sons, New York, USA.

Kabir, S.M.H., Ahmed, M., Ahmed, A.T.A., Rahman, A.K.A., Ahmed, Z.U., Begum, Z.N.T., Hassan, M.A., and Khondker, M. (ed.) 2009. *Encyclopedia of Flora and Fauna of Bangladesh, Vol. 16. Annelida Echinodermata Acanthocephala and Minor Phyla.* Asiatic Society of Bangladesh, Dhaka.

Lal, S. S. (ed.) 2009. *Practical Zoology Invertebrate.* Rajpal and Sons Publishing, India.

Ruppert, E.E. and Barnes, R.D. 1994. *Invertebrate Zoology*. 6th edition. Saunders College Publishing Co., New York.

Verma, P. S. (ed.) 1982. *A Manual of Practical Zoology: Invertebrates.* S. Chand & Company, India.

Course No.	Course Title	No. of Credits
Zool. 111	**Viva-voce**	**2**

Second Year BS (Honours) Programme in Zoology

Sessions: 2018-2019, 2019-2020, 2020-2021, 2021-2022

Course No.	Course Title	No. of Credits	Credit Hours
Zool. 201	**Minor phyla and Lower chordates**	**2**	**30**

Introduction to the course

Animals of minor phyla often do not draw our attention as because these are less diversified groups in terms of species number. However, they are specialized and have great evolutionary significance. Animals of lower chordates are fascinating as they represent a transitional group between the invertebrates and vertebrate groups. The course focuses on classification, morphological characteristics, affinities and evolutionary significance of these animal groups.

Specific objectives of the course

- To introduce the students to the structural and functional organization of animals of reprehensive species from the various minor phyla.
- To enhance students' appreciation of life activities of invertebrate animals and the adaptations of invertebrates to particular environment.
- To introduce the students to the classification scheme of lower chordates.
- To promote students' knowledge on the anatomical and functional organization of the lower chordates and their larval forms.

Course contents and number of classes by course sub-title:

Sub-title of course contents	No. of classes
Minor phyla: Introduction, general characteristics, habitat, distribution, affinities and brief morphological descriptions of the following minor phyla: Mesozoa : *Dicyema* Rotifera : Any typical rotifer Gastrotricha : *Chaetonotus* Nematomorpha : *Gordius* Acanthocephala : *Macrocanthorhynchus* Priapulida : *Priapulus* Onycophora : *Peripatus capensis* Phoronida : *Phoronis* Ectoprocta : *Plumatella* Chaetognatha : *Sagitta* Brachiopoda : a common lampshell Hemichordata : *Balanoglossus*	**15**
Lower chordates: Introduction, classification of the phylum lower Chordates up to orders with diagnostic and general characteristics of each taxonomic category with examples, affinities, etc.	**5**
Type study: Systematic position, habitat, morphology, development, special features and major systems of the following chordates: Urochordata : *Ascidia* Cephalochordata : *Branchiostoma* (*Amphioxus*) Cyclostomata : (a) Lamprey, *Petromyzon* and (b) Hagfish, *Myxine.*	**10**

Learning outcomes of the course

After completion of the course, the students will be able to-

- know the different groups of minor phyla and their morphological characters, their affinities with other groups and evolutionary significances;
- develop skills about classification scheme with diagnostic characters and describe anatomical and functional organization of animal of the lower chordate animals; and
- explain how lower chordates differ from other vertebrates.

Instructional strategies

The course will be delivered through lectures and discussions, aided by power point presentations, flip charts, video films, etc. Classes will be made participatory and interactive through questions and answers, and group work exercises in the classroom.

Distribution of class lectures: Total number of classes/lecture: 30

Class/lecture types	Number of classes	Class/lecture types	Number of classes
Lecture and discussion	26	Review class	1
Students' group presentation	1	In-course exam	1
Student feedback on course contents and delivery	1		

Assessment

There will be one in-course test, consisting of 17.5 marks, and 2.5 marks are allocated for class attendance. The questions of the in-course test will be of objective type. The students will be frequently asked questions in the classrooms to assess performances. A course final examination, consisting of 30 marks, will be conducted by the university.

References

Barnes, R.D. 1980. *Invertebrate Zoology*. 5th edition, WB Saunders College publishing HBJC Publisher, Philadelphia, USA.

Ruppert, E.E. and Barnes, R.D. 1994. *Invertebrate Zoology*. 6th edition. Saunders College Publishing Co., New York, USA.

Hickman, C.P., Roberts, L.S. and Larson, A. 2001. *Integrated Principles of Zoology*. 11th edition. McGraw-Hill Co. Inc., New York, USA.

Parker, T.J. and Haswell, W.A.. 1959. *A Textbook of Zoology*. Vol. 2. Macmillan, & Co., London.

Course No.	Course Title	No. of Credits	Credit Hours
Zool. 202	**Chondrichthyes and Osteichthyes**	**2**	**30**

Introduction to the course

Chondrichthyes and Osteichthyes, popularly known as finfish, constitute the major vertebrate fauna inhabiting both marine and freshwater environment. Because of its enormous economic importance and contribution to food security, these groups of animals have become the focus of modern studies. This course is designed to provide knowledge and understanding on the diversity and biology of the groups. Specifically, the course focuses on the detail classification of the groups and their morphological characters, structural and functional systems of representative type animals. The course also focuses on habit and habitat, food and feeding, reproduction and development of fishes. The course will help to produce biologists in the country with adequate knowledge on the subject area, capable of taxonomic identification of major groups of fishes.

Specific objectives of the course

- To make students familiar with different groups of fish and their corresponding distinguishing characters.
- To develop skills on taxonomic identification of fishes, skates and rays in the laboratory and field.
- To enhance students knowledge on the organ systems of fishes and their functions.
- To increase knowledge of students on the morphology, habit, habitat, food, feeding, development, etc. of selected representatives of these groups.

  To create positive attitude towards the conservation and management of fish, sharks, skates and rays.

Course contents and number of classes by course sub-title:

Sub-title of course contents	No. of classes
Chondrichthyes: Definition and characteristics, morphometric and meristics chapters of Chondrichthyes; Classification up to orders with diagnostic and general characters and examples and affinities; Extinct and archaic fishes.	**5**
Type study: Systematic position, habitat, morphology, development, special features (if any) and major systems of *Scoliodon*.	**3**
Short description of the habit, habitat, food and feeding, breeding of sharks, skates and rays.	**3**
Osteichthyes: Definition and characteristics, morphometric and meristics of Osteichthyes; classification up to orders with examples; extinct and archaic fishes.	**5**
Type study: Systematic position, habitat, morphology, development, special features and major systems of *Labeo rohita*.	**3**
Short description of the habit, habitat, food and feeding, breeding, special features and distribution of lung fishes, carps, catfishes, snakeheads, paddle fish, SIS fishes, perch, shad fish, sea horse, mullets, and exotic fishes.	**6**

Learning outcomes of the course

After completion of the course, the students will be able to-

- differentiate the Chondrichthyes and Osteichthyes and other major groups of fishes;
- understand the diversity of extinct and archaic fishes and their systematic position;
- identify the major groups (orders) of marine and freshwater fishes of Bangladesh;
- know about the habit, habitat, food and feeding, breeding and distribution of lung fishes, carps, catfishes, snakeheads, paddle fish, SIS fishes, perch, shad fish, sea horse, mullets, and exotic fishes; and
- perceive importance of conservation and management of fish, sharks, skates and rays.

Instructional strategies of the course

The course will be delivered through lectures and discussions, aided by power point presentations, models, video clips, etc. Classes will be made participatory and interactive through questions and answers, and group work exercises in the classroom.

Distribution of class lectures: Total number of classes/lecture: 30

Class/lecture types	Number of classes	Class/lecture types	Number of classes
Lecture and discussion	25	Review class	1
Students' group presentation	2	In-course exam	1
Feedback on in-course exam	1		

Assessment

There will be one in-course test, consisting of 17.5 marks, and 2.5 marks will be for class attendance. The questions for in-course test would be of objective and short types. The students will be frequently asked questions in the classrooms to assess performances. A course final examination of 30 marks will be conducted by the university.

References

Bone, Q., Marshall, N.B. and Blaxter, J.H.S. 1995. Biology of fishes. 2nd Edition, London : Chapman & Hall.

Breder, C.M. and Rosen, D.E. 1966. Mode of Reproduction in Fishes. T.F.H. Publications, New Jersey, USA. Compagno, L.J.V. 1984.

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FAO. 2014. On Board Guide for the Identification of Pelagic Sharks and Rays of the Western Indian Ocean.
Nelson, J.S. 1994. Fishes of the World. 3rd edition. John Wiley & Sons, Inc., New York, USA.
Rahman, A.K.A. 2005. Freshwater Fishes of Bangladesh. 2nd edition. Zoological Society of Bangladesh, Dhaka.
Siddiqui, K.U., Islam, M.A., Kabir, S.M.H., Ahmad, M., Ahmed, A.T.A., Rahman, A.K.A., Haque, E.U., Ahmed, Z.U., Begum, Z.N.T., Hasan, M.A., Khondker, M. and Rahman, M.M. (ed.). Encyclopedia of Flora and Fauna of Bangladesh. Vol.23 & 24. Freshwater Fishes and Marine Fishes. Asiatic Society of Bangladesh, Dhaka.
Young, J.Z. 1974. The Life of Vertebrates. Oxford University Press, London.
Nelson, J.S. 1994. Fishes of the World. 3 rd edition. John Wiley & Sons, Inc., New York, USA.

Course No.	Course Title	No. of credits	Credit hours
Zool. 203	**Amphibia and Reptilia**	**2**	**30**

Introduction to the course

Amphibia and reptiles, also known as herpetofauna, are two important groups of vertebrate animals with an interesting evolutionary history and is a major focus of zoological study worldwide. This course introduces the students to the diversity and biology of these groups, particularly focusing on classification, morphology and anatomy of different functional systems of the body and a comparative account of the organ systems. The course will also introduce the student to ecology, food and feeding, parental care of different groups of these animals. The course offers learning opportunities for students to know about dinosaurs. .

Specific objectives of the course

- To familiarize the students with classifications scheme of Amphibia and Reptilia.
- To enhance students' knowledge on the morphological and anatomical features of the organ systems of selected types of animals.
- To provide a comparative account of the organ systems found in different groups of Amphibia and Reptilia.
- To familiarize with the behaviour of different animal of these two groups.

Course contents and number of required classes:

Sub title of course contents	No. of classes
Amphibia: Classification up to orders (living and nonliving) with characteristics and examples.	**2**
Type study: Systematic position, habitat, morphology, development, special features and major systems of toad/frog.	**8**
Short description of the habit, habitat, food and feeding, breeding, special features and distribution of caecilians, *Necturus*, *Salamander*, *Ambystoma*, *Typhlops*, *Seymouria* and extinct amphibians. **Adaptive radiation**, secondary sex characters and parental care.	**3**

Reptilia: Classification of living (up to sub-orders) and extinct (up to orders) reptiles with characteristics and examples.	**2**
Type study of *Hemidactylus*: External morphology; internal anatomy including skeletal, digestive, respiratory, circulatory, excretory, nervous and reproductive systems; food and feeding habits.	**8**
Short description of the habit, habitat, food and feeding, breeding, special features (if any) and distribution of lizards, tortoise/turtles, terrapins, *Sphenodon*, alligator and crocodile with special references to Bangladesh fauna.	**3**
Economic importance of reptiles. Snake venom, venomous and non-venomous snakes, poison apparatus and biting mechanism in snakes; key for identification of poisonous and non-poisonous snakes.	**2**
Adaptive radiation and difference between lizards and snake, tortoise/turtles and terrapins, alligator and crocodile.	**2**

Learning outcomes of the course

After completion of the course, the students will be able to-

- learn about the classification schemes and differentiate between different groups of both the classes on the basis of their morphological characters;
- describe the different anatomical features of different organ systems;
- explain variations in organ systems in different groups of animals under both the classes; and
- understand behaviour, ecology, distribution and economics of these groups of animals.

Instructional strategies of the course

The course will be delivered through lectures, aided by multimedia and overhead projectors, video clips, etc. Classes will be made participatory and interactive through questions and answers.

Distribution of class lectures: Total number of lecture: 30

Class/ lecture type	Number of classes	Class/ lecture type	Number of classes
Lecture with discussion	26	In-course examination	1
Students' presentation	1	Feedback on in-course examination	1
Review class	1		

Assessment

One in-course test of one hour duration will be taken for this course. The in-course marks comprise 17.5 for in-course test and 2.5 marks for class attendance. The questions for in-course will be of short and objective types. A course final examination, comprising 30 marks, will be held as per the set rules of the university.

References

Hickman, C.P., Roberts, L.S. and Larson, A. 2001. *Integrated Principles of Zoology.* 11th edition. McGraw-Hill Co. Inc., New York, USA.

Kabir, S.M.H., Ahmed, M., Ahmed, A.T.A., Rahman, A.K.A., Ahmed, Z.U., Begum, Z.N.T., Hassan, M.A., and Khondker, M. (ed.). 2009. *Encyclopedia of Flora and Fauna of Bangladesh, Vol. 25. Amphibians and Reptiles.* Asiatic Society of Bangladesh, Dhaka.

Weichart, C.K. 1959. *Element of Chordate Anatomy*. McGraw-Hill Book Company Inc., New York, USA.

Young, J.Z. 1974. *The Life of Vertebrates.* Oxford University Press, London, UK.

Zug, G.R. 1993. *Herpetology: An Introduction to Biology of Amphibians and Reptiles.* Academic Press Inc., San Diego, USA.

Parker, T.J. and Haswell, W.A.. 1959. *A Textbook of Zoology.* Vol. 2. Macmillan, & Co., London, UK.

Course No.	Course Title	No. of Credits	Credit Hours
Zool. 204	**Aves and Mammalia**	**2**	**30**

Introduction to the course

As a major focus of the undergraduate course in zoology, the study of animal diversity progresses with knowing the animals from lower to higher taxa as the programme advances. This course introduces the students to the two highest categories of animal taxa, the birds and the mammals, with particular focuses on their classification schemes, morphological and anatomical features based on the study of two animals, one representing each of the groups. These are highly evolved groups and show fascinating adaptive radiations. The course also highlights on the habitat, habit, adaptation, behaviour, dispersal, animal migration to give the students a comprehensive understanding on the diversity, and structural and functional organization of these two groups of animals.

Specific objectives of the course

- To enhance students' understanding on diversity and classification scheme of birds and mammals.
- To promote students' knowledge on the anatomical features of each individual organ systems of the body.
- To introduce the students to habit and habitat, adaptation, social behavour, migration, etc. of these animal groups.

Course contents and number of classes by course sub-title:

Sub-title of course contents	No. of classes
Aves: Classification of the class Aves up to orders with characteristics and examples.	**2**
Type study of pigeon: Morphology, skeletal, digestive, respiratory, circulatory, excretory, nervous, muscular, and reproductive systems; air sacs, feathers and flight adaptation.	**4**
Short description of the habit, habitat, food and feeding, breeding, dispersal and migration and social behaviour; migratory birds, flightless birds, carnivorous birds, waders, pheasants, game birds (with special emphasis on Bangladesh fauna).	**6**
Mammalia: Classification of the class Mammalia up to orders with diagnostic characters and examples.	**2**
Type study of Guinea-pig: External morphology, skeletal, digestive, respiratory, circulatory, excretory, nervous, reproductive, and endocrine systems.	**4**
Short description of the habit, habitat, food and feeding, breeding and distribution of egg laying mammals, marsupials, aquatic mammals, flying mammals, nonhuman primates, rodents.	**6**

Learning outcomes of the course

After completion of the course, the students will be able to-

- learn the classification schemes with diagnostic and general characters;
- tell about anatomical details of different functional systems of the body of these groups of animals;
- explain the habit and habitat, social behaviour, migration, animal dispersal, adaptive radiations, flying adaptation, food and feeding, etc.; and
- know about the ancestral history and adaptive radiations in these two groups of animals.

Instructional strategies of the course

The course will be delivered through lectures and discussions, aided by power point presentations, flip charts, video films, etc. Classes will be made participatory and interactive through questions and answers, and group work exercises in the classroom.

Distribution of class lectures: Total number of classes/lecture: 30

Class/lecture types	Number of classes	Class/lecture types	Number of classes
Lecture and discussion	24	Review class	1
Students' group presentation	2	In-course exam	1

Feedback on in-course exam	1	Student feed back on course contents and delivery	1

Assessment

There will be one in-course examination, consisting of 17.5 marks, and a 2.5 marks will be reserved for students' attendance in the class. The in-course examination will have short and objective types of questions. The students will be frequently asked questions in the classrooms to assess performances. A course final examination of 30 marks will be conducted by the university.

References

Kotpal, R.L. 1992. *Modern Textbook of Zoology: Vertebrates.* Rastogi Publications, Meerut.

Sinha, A.K., Adhikari, S. and Ganguly, B.B. 1988. *Biology of Animals, Vol. II.* New Central Book Agency, Calcutta, India.

Starr, C. and Taggart, R. 1981.*Biology: The Unity and Diversity of Life.* Wadsworth Publishers. Co., California, USA.

Welty, J. C. & Baptista, L. 1988. *The Life of Birds*. (4th ed). W.B. Saunders Co., Philadelphia.

Young, J.Z. 1974. *The life of vertebrates*. Oxford University Press, London, UK.

Course No.	Course Title	No. of Credits	Credit Hours
Zool. 205	**Cytology and Histology**	**2**	**30**

Introduction to the course

The cell and its functions are the basis for the structural and functional organization of all life forms. Recent advances in cell research are enormous and unveil the ultra-structures, cellular functions and biosynthesis of basic macromolecules of life. This course deals with the biology of cells of higher organisms: structure and functions of cells, and biosynthesis of cellular membranes and organelles; cell growth; and transport, receptors, and cell signaling; the cytoskeleton, the extracellular matrix and cell movements. The course will also discuss the types and functions of tissues, histological make up of various organ systems, and organization of cells into various tissue and tissue systems.

Specific objectives of the course

- To introduce the students to cell structure and functions along with the conceptual build up into cellular activities in body functions.
- To enhance students' knowledge on the types of tissue systems and its functions.

Course contents and number of classes by course sub-title:

Sub-title of course contents	No. of classes
Cytology: Part I - Introduction; preview of cell; chemistry of the cell; macromolecules (proteins and nucleic acids); eukaryotic cell organelles; stem cell; cell differentiation- cell growth and aging, causes of aging and theories of aging.	**4**
Cytology: Part II - Bioenergetics: Cell membrane structure and functions; cell membrane models- early models, and fluid mosaic model; transport across membranes (diffusion), active transport.	**3**
Intracellular compartments: endoplasmic reticulum and Golgi complex- glycosylation, exocytosis, endocytosis; lysosomes, vacuoles, peroxisomes, Redox reactions and glycolysis; mitochondria and aerobic respiration.	**4**
Nucleus: chromosome structure, types, models and chemistry; DNA as the genetic material; structure of DNA; DNA packing.	**3**
Cytoskeletal systems- microtubules, microfilaments and intermediate filaments.	**2**

Histology: Tissue, structure and functions; types of tissues- epithelial, connective, muscular and nervous tissue with locations and functions.	**2**
Histology of alimentary canal- esophagus, stomach, duodenum, intestine and rectum.	**2**
Histology of pancreas, liver, lung, kidney, and gonad, ovary and testis.	**2**

Learning outcomes of the course

After completion of the course, the students will be able to-

- learn about the ultrastructure of different cell organelles and their functioning;
- explain cell differentiation and various theories and mechanism of aging;
- describe the structure and functions of chromosomes, DNA and RNA;
- tell about the major types of tissue and their functions; and
- explain the major concepts and principles underlying cell and tissue level organization, along with major applications.

Instructional strategies of the course

The course will be delivered through lecture and discussion, aided by power point presentations, flip charts, video films, etc. Classes will be made participatory and interactive through questions and answers, and group work exercises in the classroom.

Distribution of class lectures: Total number of classes/lecture: 30

Class/lecture types	Number of classes	Class/lecture types	Number of classes
Lecture and discussion	22	Review class	2
Students' group presentation	3	In-course exam	2
Feedback on in-course exam and on course contents and delivery	2		

Assessment

There will be two in-course examinations, consisting of 8.75 marks each, and 5 marks are allocated for class attendance. Questions for in-course examination will be of objective and short types. The students will be frequently asked questions in the classrooms to assess performances. A course final examination will be of 30 marks, to be conducted by the university.

References

Alberts B., Johnson, A., Lewis, J., Raff, M., Roberts, K. and Walter, P. 2002. *Molecular Biology of the Cell*. 4th edition. Garland Science, New York, USA.

Brown, T. 2012. *Introduction to Genetics: A Molecular Approach*. Garland Science, New York, USA.

Snustad, P. and Simmons, M. J. 2003. *Principles of Genetics*. 3rd Edition. John Willey and Sons. Inc., New York, USA.

Klug, W.S. and Cummings, M.R. 2003. *Concepts of Genetics*. 7th edition. Pearson Education, Inc., New Jersey, USA.

Course No.	Course Title	No. of Credits	Credit ours
Zool. 206	**Developmental Biology**	2	30

Introduction to the course

Developmental biology is a fascinating aspect of biological study that focuses on the embryological development of animal within an egg or in mother's body. The embryonic development process passes through a number of distinct, but continuous stages displaying the ancestral history. This course specifically highlights the theories of embryonic development, and developmental stages, including cleavages, germ layer formation, cell differentiation and organogenesis until formation of a complete or incomplete life form. The course also offers the embryological studies of three model animals- *Neries*,

chick and zebrafish. The course will also discuss about some recent innovations and applied aspects of developmental biology, including cryopreservation, embryonic stem cell, infertility and its treatments.

Specific objectives of the course

- To make comprehensive understanding on the concepts and processes of embryonic development
- To enhance students' knowledge on the events in the different stages of embryonic development
- To make the students familiar with the developmental science, for example use of stem cell, infertility and cryopreservation.

Course contents and number of classes by course sub-title:

Sub-title of course contents	No. of classes
Introduction: Theories of developmental biology (epigenesis, pangenesis and germplasm).	**4**
Reproductive process: Asexual, sexual and parthenogenesis reproduction; reproductive peculiarities; monogamy and polygamy.	**2**
Gametes and gametogenesis: Ultra-structure of a typical sperm, Spermatogenesis; Ultra-structure of an egg, types of eggs, oogenesis.	**4**
Fertilization: Types and significance of fertilization; sperm-egg interactions; fate of sperm mitochondria.	**4**
Major events in fertilization: Cleavage, cleavage patterns and types; formation of morula and blastula, gastrula, process of gastrulation and sequence of events; basic differences between protostomes and deuterostomes development.	**3**
Organogenesis: Fate of germ layers, early embryology of *Nereis* and chicks; embryonic development of zebrafish (*Danio rerio*).	**3**
Embryological derivatives of mammals: Placentation, types and functions of placenta in mammals.	**2**
Applied embryology: Fruit fly in research. Cryopreservation. Infertility and its treatment in human. Embryonic stem cell for human welfare. Animal farming and transgenic animals.	**4**

Learning outcomes of the course

After the completion of the course, the students will be able to-

- explain basic and functional processes of embryonic development;
- learn and explain various stages and events of development, including cleavages, formation of blastula, gastrula and germ layers, cell differentiation and organogenesis;
- understand the significance of fertilization in terms of sperm and egg interactions, and gamete fusion process complexity;
- learn the embryological derivatives and placentation in mammals; and
- get familiarity with the cryopreservation process, infertility, stem cell and farming of experimental animals.

Instructional strategies of the course

The course will be delivered through lectures and discussions, aided by power point presentations, flip charts, video films, etc. Classes will be made participatory and interactive through questions and answers, and group work exercises in the classrooms.

Distribution of class lectures: Total number of classes/lecture: 30

Class/lecture types	Number of classes	Class/lecture types	Number of classes
Lecture and discussion	26	Review class	1
Students' group presentation	1	In-course exam	1
Student feed back on course contents and delivery	1		

Assessment

There will be one in-course examination, consisting of 17.5 marks, and 2.5 marks will be dedicated for students' attendance. Questions for in-course examination will be of short and objective types. The

students will be frequently asked questions in the classroom to assess performances. The marks for course final examination will be of 30.

References

Balinsky, B.L. 1981. *An Introduction to Embryology*, 5thedn.W B Saunders Co., Philadelphia, USA.
Gilbert, S.F., 1985. *Developmental Biology*, Sinauer Associates Inc, Massachusetts, USA.
Oppenheimer, S.B., 1980. *Introduction to Embryonic Development*. Allyn and Bacon Inc. Boston, USA.
Raven, H. and Johnson, B. *Biology*, 4thedn. WBC McGraw-Hill Book Co. Inc. Boston, USA.

Course No.	Course title	No. of credits	Credit hours
Zool. 207	**Animal Systematics and Nomenclature**	**2**	**30**

Introduction to the course

Animal systematics is one of the essential basic branches of zoology which deals with scientific classification of all the existing living animals based on certain sets of characters for their easy identification. It provides an idea of its position in the phylogenetic tree of organisms showing their evolutionary relationship. This course introduces the students to the basic and fundamental principles, schemes and rules of animal classification, related to taxonomic collections, procedural steps in animal identification and describing and naming of a new species, type specimens, and taxonomic publications. The course is intended for students willing to develop professionalism in taxonomic study of animals.

Specific objectives of the course

- To build students' conceptual understanding on the importance and functions of systematics and taxonomy, and taxonomic categories.
- To make students familiar with basic and fundamental rules and regulations of taxonomy.
- To enhance students' knowledge and skills for collection, preservation and identification of animal specimens.

Course contents and number of classes by course sub-title:

Sub-title of course contents	No. of classes
Animal systematics	
Taxonomy and systematics: Definition, and differences between taxonomy and systematics; importance of taxonomy; role of taxonomy.	**1**
History of taxonomy: Old and new systematics; levels of taxonomy.	**2**
Zoological classification: Definition; kinds of classification; Linnaean hierarchy.	**1**
Taxonomic categories: a. Species category - concepts of species; polytypic species and its significance; b. Higher categories - genus, family, order, class and phylum; superspecies; c. Lower categories (infra specific categories) - variety, subspecies, race, cline, deme, morph.	**4** **2**
Taxonomic collection, preservation, curating, identification (different methods of identification including taxonomic keys), taxonomic publication.	**2**
Types of taxonomic publications; reference works in taxonomy.	**1**
Taxonomy and biodiversity: Taxonomy, a vital component of biodiversity management.	
Cladistics: Concepts; cladogram.	**1**
Barcoding in taxonomy.	**1**
Nomenclature	

International Code of Zoological Nomenclature (ICZN): Origin of ICZN; the International Zoological Commission and the International Zoological Congress, and their roles in nomenclature.	**2**
Type method: Definition of type and typification; kind of types; significance.	**1**
Formation of names: Generic and specific names.	**2**
Description of a new species: Objectives, procedure, type depository, naming.	**2**
Rules of nomenclature: Essential rules including law of priority (not more than 15 rules).	**3**

Learning outcomes of the course

After completion of the course, the students will be able to-

- explain the principles and concepts of systematics and nomenclature, and define the various taxonomic terms;
- demonstrate their skills in identifying and classifying unknown animals;
- understand the theoretical basis and methods of modern biological systematics and classification; and
- describe a new species and give its name.

Instructional strategies of the course

The course will be delivered through lectures and discussions, aided by power point presentations, charts, video films, etc. Classes will be made participatory and interactive through questions and answers, and group work exercises in the classroom.

Distribution of class lectures: Total number of classes/lectures: 30

Class/ lecture type	No. of classes	Class/ lecture type	No. of classes
Lecture and discussion	25	Feedback on in-course exam	1
Review class	2	In-course exam	1
Student feed back on course contents and delivery	1		

Assessment

There will be an in-course examination, consisting of 17.5 marks, and 2.5 marks will be allocated for students' attendance in the class. Questions for in-course examination will be of short and objective types. The course final examination will be conducted by the university and will carry 30 marks. The students will be frequently asked questions in the classroom to assess performances.

References

Blackwelder RE. 1967. *Taxonomy - A Text and Reference Book*. JohnWiley & Sons, New York.

Kapoor, V.C. 2017. *Theory and Practice of Animal Taxonomy*. 8th edition. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, India.

Mayr, E. and Ashlock, P.D. 1969. *Principles of Systematic Zoology*. 2nd edition. McGraw Hill Education Pvt. Ltd. (Reprinted in 2014), India.

Quicke, D.L.J. 1993. *Principles and Techniques of Contemporary Taxonomy*. BlackWell, London.

Course No.	Course Title	No. of Credits	Credit Hours
Zool. 208	**Economic Zoology**	**2**	**30**

Introduction to the course

Economic Zoology sketches economic viewpoint of the animal world with emphasis on beneficial and harmful species, popular farming practices, animal-borne diseases and finally mitigation principles of integrated pest management. These, in turn, signify the approaches to the sustainable use of animal resources. There are enormous opportunities for using zoological objects for economic purposes and also

controlling harmful ones to save the damages to economy caused by them. The course focuses on some of these opportunities from economic perspective.

Specific objectives of the course-

- Delineating the theme of economic zoology and values of animal diversity.
- Introducing the students to major pests and its control techniques.
- Briefing monetary influences of a few economically important invertebrates and vertebrates.
- Sharing fundamentals of popular culture practices.

Course contents and number of classes by course sub-title:

Sub-title of course contents	No. of classes
Introduction to Economic Zoology.	**1**
Ways of animal cultivation and cropping; culture, ranching, rearing and capture.	
Introduction to invertebrate and vertebrate pests, methods of damage caused by major pests Integrated pest management.	**2** **4**
Vectors and parasites of major animal diseases.	**2**
Zoonosis and anthroponosis.	**2**
Economic importance: molluscs, crustaceans, fishes, amphibians, reptiles, birds and mammals	**6**
Sericulture, lac culture, apiculture and pearl culture.	**3**
Beneficial and harmful insects	**2**
Venomous animals	**2**

Learning outcomes of the course

After completion of the course the students will be able to understand

- the major economically important animals including pests;
- the basics of integrated pest management;
- the economic importance of a few groups of animals; and
- the principles of popular insect and mollusc farming practices.

Instructional strategies of the course

The course will be delivered through lectures and discussions, aided by power point presentations, by showing video clips, etc. Classes will be made participatory and interactive through questions and answers, and individual/group work exercises in the classroom.

Distribution of class lectures: Total number of classes/ lectures: 30

Medium of communication	Credit hours	Medium of communication	Credit hours
Lecture and discussion	24	Conservation documentary/movie	1
Students' presentation	3	In-course exam	1
Feedback on In-course exam	1		

Assessment

There will be one in-course examination, comprising 17.5 marks, and there will be 2.5 marks for class attendance. Questions for in-course examination will be of short and objective types. The course final examination consisting of 30 marks.

References

Ahmed, Z.U., Begum, Z.T., Hassan, M.A., Khondker, M., Kabir, S.M.H., Ahmad, M. and Haque, E. U. (eds.). 2008. *Encyclopedia of flora and fauna of Bangladesh*. Vol. 27. *Mammals.* Asiatic Society of Bangladesh, Dhaka.

Barnes, R.D. 1980. *Invertebrate Zoology*. 5th edition, WB Saunders College publishing HBJC Publisher, Philadelphia, USA.

Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. 2001. *The Invertebrates: A synthesis*. Blackwell Scientific Publications, Oxford, UK.

Goin, C.J. and Goin, O.B. 1971. *Introduction to Herpetology*. W.H. Freeman & Co., San Francisco, USA.

Hickman, C.P., Roberts, L.S. and Larson, A. 2001. *Integrated Principles of Zoology*. 11th edition. McGraw-Hill Co. Inc., New York, USA.

Shukla, G.S. and Upadhayay, V.P. 2008. *Economic Zoology*. Rastogi Publications, Meerut, India.

Course No.	Course Title	No. of Credits	Credit Hours
Zool. 210	**Practical**	**4**	**60**

Introduction to the course

Vertebrates represent a wide range of groups, including ichthyofauna, herpetofauna, avifauna and mammals and have always been a major focus of zoological study. This course offers learning opportunities about the vertebrate group based on practical demonstrations and hands on training in the laboratory. In particular, the course focuses mainly on the museum specimens study in order to facilitate knowing the animals and also developing skills in dissecting different functional systems of some representative animals, required for internal investigation. The course will also introduce the students to the embryological developmental stages of a representative animal taking chick as a type animal. The students will also undertake field tour to observe and identify vertebrate animals in the field conditions. Overall, this course is designed for students to explore and align the links between theoretical knowledge gained and practical skills needed for zoological study.

Specific objectives of the course

- To familiarize students with the representatives of different vertebrate groups i.e. ichthyofauna, herpetofauna, birds and mammals.
- To provide hands on training on dissection, and enable students to distinguish and display different systems and organs.
- To give hands-on training on the identification and comparative study of vertebrate skeleton structure, and preparation of vertebrate skeleton.
- To make an understanding of the students on the developmental stages of chick embryo.

Course contents and number of classes by course sub-title (each of 3 credit hours): 20

Sub-title of course content	No. of classes
Study of museum specimens: Museum study of higher vertebrates: Chondrichthyes, Osteichthyes, Amphibia, Reptilia, Aves and Mammalia.	**6**
Study of bones: Skeletal structures of fishes, amphibians, reptiles, birds and mammals; preparation of a skeleton of any cultured/largely available vertebrate.	**2**
Dissection: Dissection and display of the digestive, circulatory, respiratory, nervous and reproductive systems of lata (snakehead) fish, lizard and guinea pig; Air sacs of birds; Brain, cranial nerves, eye muscles and internal ear of dogfish.	**6**

Embryological studies: Study of prepared embryological slides/mounts representing embryonic development of frog/toad and chick; Observation of different stages of embryonic development of chick. **Local study tour and preparation of a report on the tour** **Preparation of practical notebooks and field reports**	**2**

Learning outcomes of the course

If students successfully complete the course, they will be able to-

- recognize different vertebrate species and learn to classify according to their taxonomic positions;
- identify different bones of vertebrates and, prepare and preserve a full skeleton of vertebrates from a carcass;
- dissect, distinguish and display the digestive, circulatory, nervous and reproductive systems of vertebrates;
- identify and compare developmental stages of selected vertebrate embryo; and
- conduct a simple survey-based field investigation to survey vertebrates, obtain relevant data, and present the results in a report.

Instructional strategies

The course will be delivered through holding practical demonstration classes, hands-on trainings and lectures. A number of teachers will guide individual students in the laboratory on how to proceed with their practical works. The demonstration classes will be aided with audio-visual materials, video clips relating to current lecture topics. Students will be guided in a participatory approach. In practice, students will work in groups, consisting 6-7 peers in each group. Preserved specimens and mounted tissue slides of various organs will be provided in the class to conduct taxonomic and histological studies, respectively. Live or chloroform-treated specimens will be supplied to the class to perform dissections, and preserved skeletons of representative vertebrates will be provided to study and compare different skeleton structures. Students are required to prepare practical notebook for each practical study they conduct, submit a complete skeleton of one representative vertebrate. Field trips will be organized for students guided by the class teacher(s) to identify and record the species the students observe in the field and prepare report.

Distribution of class lectures: Total number of classes: 20

Class/ lecture type	No. of classes
Lecture and Practical exercise	16
In-course exam	2
Feedback on in-course exam, and students' feedback on course contents and delivery	2

Assessment

There will be two in-course examinations, each consisting of 17.5, and 5 marks for class attendance. A course final examination, comprising of 60 marks will be held, which will also include marks for practical note books and study tour reports.

References

Balinsky, B.L. 1981. An Introduction to Embryology. 5th edition. WB Saunders Co., Philadelphia, USA.

Kabir, S.M.H., Ahmed, M., Ahmed, A.T.A., Rahman, A.K.A., Ahmed, Z.U., Begum, Z.N.T., Hassan, M.A., and Khondker, M. (ed.). 2009. *Encyclopedia of Flora and Fauna of Bangladesh*, Vol. 25. Amphibians and Reptiles. Asiatic Society of Bangladesh. Dhaka.

Kent, G.C. 1965. *Comparative Anatomy of the Vertebrates*. The C.V. Mosby Company and Toppan Company Ltd. Tokyo, Japan.

Oppenheimer, S.B. 1980. *Introduction to Embryonic Development*. Allyn and Bacon Inc., Boston, USA.

Rahman, A.K.A. 2005. Freshwater Fishes of Bangladesh. 2nd edition. Zoological Society of Bangladesh, Dhaka.

Siddiqui, K.U., Islam, M.A., Kabir, S.M.H., Ahmad, M., Ahmed, A.T.A., Rahman, A.K.A., Haque, E.U., Ahmed, Z.U., Begum, Z.N.T., Hasan, M.A., Khondker, M. and Rahman, M.M. (ed.). 2007. *Encyclopedia of Flora and Fauna of Bangladesh*. Vol.23. Freshwater Fishes. Asiatic Society of Bangladesh, Dhaka.

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Wolff, R.G. 1994. *Functional Chordate Anatomy*. CBS Publishers and Distributors. New Delhi, India.

Chatterjee, C.C.. 1985. *Human Physiology*. Medical Allied agency, Calcutta, India.

Zug, G.R. 1993. *Herpetology: An Introduction to Biology of Amphibians and Reptiles*. Academic Press Inc., San Diego, USA.

Course No.	Course Title	No. of Credits
Zool. 211	**Viva-voce**	**2**

Third Year BS (Honours) Programme in Zoology

Sessions: 2018-2019, 2019-2020, 2020-2021, 2021-2022

Course No.	Course Title	No. of Credits	Credit Hours
Zool. 301	**Comparative Vertebrate Zoology**	4	60

Introduction to the course

Phylogeny of the vertebrates is usually related to the evolutionary diversification and adaptive radiation of all vertebrate groups, including structure and function. Comparative morphology deals with the study of parts and structure, and the corresponding functions. This course examines the adaptive radiation, basic plan of different organ systems, anatomical similarities and modifications among different vertebrate classes to provide a comprehensive understanding on the diversifications in the structure and functions of vertebrate groups and their common ancestry in the evolutionary process.

Specific objectives of the course

- To know the fundamental concept of species adaptation and development, including structural forms and functions.
- To enhance students' knowledge on major anatomical structures in diverse vertebrate groups, specially including cartilaginous and bony fishes, amphibians, reptiles, birds and mammals.

Course contents and number of classes by course sub-title:

Sub-title of course contents	No. of classes
Adaptive radiation in different groups of vertebrates Adaptive radiation in fishes, amphibians, reptiles, birds and mammals.	**5**
Integumentary system: Definition, structure and comparative anatomy of integument proper in different vertebrate groups.	**3**
Integumentary derivatives: glands, scales, feathers, hair, beaks, claws, nails, hoops, horns and antlers.	**6**
Digestive system: General structure and modification of alimentary canal in different vertebrate groups; associated glands in the digestive system.	**8**
Teeth: function, structure, types and comparative anatomy in different groups; dentition in mammals.	**4**
Basic plan and phylogenic modifications among vertebrate classes **Skeletal system:** Endoskeleton, axial and appendicular skeletons; jaw suspension and visceral arches.	**5**
Excretory system: Pro-, meso- and meta-nephric kidneys; succession of kidney; evolution of urino-genital ducts**.**	**4**
Circulatory system: Modification of aortic arches in reptiles, birds and mammals.	**4**
Nervous system: Brain, spinal cord and cranial nerves of vertebrates**.**	**3**
Respiratory system and accessory respiratory system of vertebrates; mechanism of breathing among vertebrates.	**4**
Muscular system: Different types of muscles, ultra structure of skeletal muscle; endocrine system.	**3**
Sense organs: Classification of receptors; structure and working of mammalian eye and ear.	**3**

Learning outcomes of the course

After completion of the course, the students will be able to-

- explain the rapid diversification of a species or species population into a variety of different adaptive types and abrupt availability of new habitats or niches;
- acquire knowledge about basic plan of different anatomical structures of fishes, amphibians, reptiles, birds and mammals; and

- demonstrate a fundamental knowledge of comparative vertebrate anatomy of different classes of vertebrates.

Instructional strategies of the course

The course will be delivered through lecture and discussion, aided by power point presentations, flip charts, video films, etc. Classes will be made participatory and interactive through questions and answers, and group work exercises in the classrooms**.**

Distribution of class lectures: Total number of classes/lecture: 60

Class/lecture types	Number of classes	Class/lecture types	Number of classes
Lecture and discussion	52	Review class	2
Students' group presentation	2	In-course exam	2
Student feed back on course contents and delivery	2		

Assessment

There will be two in-course examinations, each 17.5 of marks, and 2.5 marks will be dedicated for students' attendance in the class. Questions of in-course examinations will be of short and objective types. A course final examination of 60 marks will be conducted by the university. The students will be frequently asked questions in the classrooms to assess performances.

References

Kardong, K.V. 2005. *Vertebrates Comparative Anatomy, Function and Evolution.* McGraw Hill Higher Education, London.

Kent, G.C. and Carr, R.K. 2000. *Comparative Anatomy of Vertebrates.* McGraw Hill Company, London.

Weichert, C.K. 1970. *Anatomy of Chordates.* McGraw Hill Co., London.

Young, J.Z. 1962. *Life of Vertebrates*. 2nd edition. Oxford at the Clarendon Press, London.

Course No.	Course Title	No. of Credits	Credit Hours
Zool. 302	**Animal Genetics**	**2**	**30**

Introduction to the course

Genetics provides clue to the basis for life functions centering genes and advances in genetics have resulted in the control of diseases, improvement in animals' functions and its productive uses in the industry. The sophistication of this branch of biological science has created enthusiasm and interest among students for studying genetics. This course will provide an understanding on the principles and concepts of animal genetics and a basic knowledge on genetics with the mechanism of inheritance of traits, transmission of genes in individuals and from one generation to the next. The course also provides a comprehensive package of learning of the structural organization of chromosomes and the genetic structure of population and also highlights on the practical application of genetics for human welfare. The course is designed to produce geneticists with adequate knowledge on the subject.

Specific Objectives of the course

- To enhance conceptual understanding of students on the Mendel's laws and its modifications, inheritance, chromosomal structure and Hardy-Weinberg's law related genetic issues.
- To increase students' learning on the phenomenon of crossing over, gene mutations and chromosomal aberrations in understanding the root causes for variations in the living world.
- To make the students familiar with the applications of the knowledge of animal genetics for human welfare.

Course contents and number of classes by course sub-title:

Sub-title of course contents	No. of classes
General Genetics: Introduction, history, development and scope of animal genetics; Mendel's laws and modification of Mendelian ratios; pedigree; epistasis, penetrance and expressivity, reversion, pleiotropism; types and theories of linkage; mechanism, types and theories of crossing over; sex determination systems and theories in animal; sex-linked inheritance; types and significance of mutations.	**11**
Cytogenetics: General outline of chromosome structure, mitotic karyotypes of fruit fly, carp fish and human; Nucleosome and its structural organization in eukaryotic chromosomes; Types and significance of chromosomal aberrations with special reference to animals; Types and mechanism of gynandromorphism; Cytogenetic analysis of animal chromosomal anomalies with reference to polytene and lampbrush chromosomes.	**7**
Population Genetics: Gene pool and gene frequency; equilibrium of gene frequencies and Hardy-Weinberg's Law; changes in allelic frequencies mutation, migration, selection and genetic drift.	**4**
Eugenics and Animal breeding: Concept of eugenics; Introduction, application of breeding system, viz. inbreeding and out-breeding, pure line selection; application of breeding systems to economically important animals.	**3**

Learning outcomes of the course

After completion of the course, the students will be able to-

- explain the basic laws in genetics and its exceptions, crossing over and mutations;
- learn about types, structure and anomalies in chromosomes and explain the causes of known genetic disorders;
- design and implement cross breeding programmes;
- conduct karyotype analysis; and
- determine genetic drift in a particular animal.

Instructional strategies of the course

The course will be delivered through lectures and discussions, aided by power point presentations, video clip, etc. Classes will be made participatory and interactive through questions and answers, and group work exercises in the classroom. At the beginning of each class students' feedback on previous class lecture will be taken. Student feedback on the overall course delivery and content will be taken in the last class through a questionnaire survey.

Distribution of class lectures: Total number of classes/lecture: 30

Class/lecture types	Number of classes	Class/lecture types	Number of classes
Lecture and discussion	25	Review & Questionnaire survey	2
Students' group presentation	1	In-course exam	2

Assessment

There will be two in-course examinations, each consisting of 8.75 marks each, and 2.5 marks are allocated for class attendance. The in-course questions will be of short, objective types. The students will be frequently asked questions in the classrooms to assess individual's performance. The course final examination will be conducted by the university and will be of 30 marks.

References

Brooker, R.J. 2016. *Concepts of genetics*. 2nd Ed. McGraw-Hill Company, London. (free copy available: https://www.mheducation.com/ highered/product/concepts-genetics brooker/ M0073525359.html)

Lewin, B., Krebs, J., Stephen, T. K. and Elliott, S.G. 2016. *Genes*. 11th Ed. Pearson Education, Inc., New Jersey, USA. (PDF available https://ms2016asab.files.wordpress.com/2016/09/lewins-genes-xi.pdf)

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Weaver, R. and Hedrick, P.W. 1995. *Basic Genetics.* 2nd edition. Wm. C. Brown Publishers, St. Louis, USA.

Course No	Course title	No of credits	Credit Hours
Zool. 303	**Ethology**	**2**	**30**

Introduction to the course

Ethology is the scientific and objective study of animal behaviour, usually with a focus on behaviour under natural conditions, and viewing behaviour as an evolutionarily adaptive trait. Ethology is a rapidly growing field and study of animal behaviour has become an integral part of learning zoology. This course will introduce the students with the fascinating world of animal behaviour. In particular, the course will focus on the different types of instinct and learning behaviour, influence of environment on behavioural development, patterns of behaviour and forms of behaviour. The course also highlights the influence of genes on the behavioural pattern and performances.

Specific Objectives of the course

- To provide students with basic conceptual understanding on animal behaviour and and its importance.
- To enhance students knowledge about the type, forms and behavioural patterns in animals and the mechanism of behavioural expressions.
- To make students understand the evolutionary significance of behaviour.

Course contents and number of classes by course sub-title:

Sub-title of course contents	No. of classes
Introduction to ethology: Definition, historical background, environmental influence and natural selections. Population breeding potential (BP) - environmental resistance (ER).	**3**
Evolution and development of behaviour	**5**
Instinct versus learning: Instinct, different kinds of learning; sensitive period; use of tools; intelligence and cognition	**3**
Patterns of behaviour: tropism, taxes, reflexes; thermoregulation, play; biol ogical clocks; body maintenance. Photoperiodism and its influence. Peck order and its types. Scent marking and its kinds; hoarding and types.	**6**
Different forms of behaviour: Feeding behaviour; anti-predatory behaviour, locomotary behaviour; conflict behaviour, communication behaviour; social behaviour; breeding behaviour; parental care and sexual behaviour in different groups of animals. Breeding behaviour of sea horse; 3-spined stickleback and sea-gull.	**7**
Behavioural genetics: Influences of genes in behavioural pattern and performances	**3**

Learning Outcomes of the course

After completion of the course students will be able to-

- explain the conceptual aspects of animal behaviour and mechanism of behavioural expression;
- tell about the different types and forms of behavour;

- explain the influence of environment and genes on the behavioural development in animals;
- understand the differences between learning and instinct; and
- describe the courtship and breeding behviour in some selected animals.

Instruction strategies

Students will be given oral lectures and power point presentations. Discussion in groups in the classrooms will also be the methods of teaching. The classes will be made participatory through questions and answers in the classroom.

Distribution of class lectures: Total number of classes/lecture: 30

Class/lecture types	Number of classes	Class/lecture types	Number of classes
Lecture and discussion	27	Review	1
Students' group presentation	1	In-course exam	1

Assessment

Students will be assessed by taking an in-course exam, consisting of 17.5 marks; 2.5 marks are reserved for class attendance. Questions of in-course test will be of short and objective types. The course final examination will be of 30 marks, to be conducted by the university.

References

Alcock, J. 2005. *Animal Behaviour. An Evolutionary Approach*. 8th Edition. Sinauer Associates Inc. Publishers, Sunderland, Massachusetts, USA.

Arora, M.P., Kanta, C., Eds. 2003. *Animal Behaviour*. 6th Edition. Himalaya Publishing House. Mumbai, India.

Krebs, J. R. and N. B. Davies (eds.). 1980. An introduction to behavioural ecology. Sinauer Associates, Sunderland, Massachusetts, USA.

McFarland, David. 1999. Animal Behaviour: Psychobiology, Ethology and Evolution. 3rd Edition. Pearson Education Limited. England.

Singh, H. 2003. A textbook of Animal Behaviour. Arora, C.K. Eds. 3rd Edition. Anmol Publications Pvt. Ltd. New Delhi, India.

Course No.	Course title	No. of credits	Credit hours
Zool. 304	**Fundamental and Advanced Ecology**	**4**	**60**

Introduction to the course

As a basic science, ecology informs us about the processes governing the patterns of nature. In fact, ecological processes are keeping the world functioning and are linked to all the life processes of all organisms, including the human, and has become a major focus of biological study. From an applied perspective, ecology provides insights and solutions to many of the environmental issues we face now-a-days. This course will provide students with insight and understandings on fundamental aspects of ecology with major focuses on ecosystems and its functions, biogeochemical cycles, biotic and abiotic interactions, energy flow through living systems, structure and functions of different habitat and biotic adaptations in it, and biotic associations and interactions. The course will also highlight on some advanced and applied aspects of ecology, including the population and community ecology, life table construction and ecological modeling.

Specific objectives of the course

- To provide students with conceptual understanding on the fundamental aspects of ecology.
- To introduce students to the ecological principles that pertain to individual organisms to populations and to ecosystems.

- To make students understand the mechanism of energy transfer through food chains and biogeochemical cycles operating in ecosystems.
- To enhance students' learning the characteristic adaptations to different biomes and habitats.
- To introduce the students to applied aspects of ecology.

Course contents and number of classes by course sub-title:

Sub-title of course contents	No. of classes
Fundamental Ecology:	
Concepts, types and scopes of ecology. Ecological principles and concept of ecosystem.	**1**
Ecosystem: Energy flow in ecosystem; food chains; food webs and trophic levels; trophic structure and ecological pyramids; transfer of food energy; ecological efficiencies. Development and evolution of ecosystem; concept of the climax; evolution of the ecosystem; coevolution; group selection.	**8**
Ecological factors: biotic and abiotic.	**1**
Biogeochemical cycles: Nitrogen, water and carbon cycles.	**3**
Principle of limiting factors: Liebig's Law of the Minimum; Shelfod's Law of Tolerance.	**2**
Concepts of habitat and ecological niche: Ecological equivalent; character displacement; allopatry and sympatry; biological clock.	**2**
Terrestrial ecology: Tundra, forest, desert and grassland biomes including their physical characters, climatic conditions, vegetation and animal adaptations.	**4**
Fresh water ecology: Lotic and lentic habitats and their characteristics; major fauna; pond, lake and river ecosystems.	**3**
Estuarine ecology: Characteristics; major fauna.	**1**
Marine ecology: Marine environment, marine biota, zonation of the sea, communities of the marine environment.	**2**
Advanced Ecology:	
Population ecology: Definition of population; principles and concepts of organization at population level; group properties - density, natality, mortality, biotic potential, population age distribution; population growth forms - J and S shaped, dispersion, isolation and territoriality. Concept of carrying capacity; concept of population regulation and stability; concept of density dependent and density independent action.	**9**
Interactive ecology: impacts of climate change on the life of animals; different types of interactions-competition, prey-predator interaction, herbivory. Host-parasite interaction, coexistence, mutualism, proto-cooperation, and commensalism.	**8**
Community ecology: Biotic community concept; concept of ecological dominance; community structure; composition and stratification; community analysis; species diversity in community; pattern in communities; ecotones and concept of edge effect; ecological corridor.	**4**
Introduction to landscape ecology: landscape structure (patches, corridors, matrix, network), concept of ecotope, landscape change (geomorphology, disturbances, plant and animal invasions), landscape function, landscape management, effects of animals in landscapes.	**3**
Life table: concept, types and construction.	**1**
Ecological models: Concept, types and significance.	**1**
Systems ecology: concepts.	**1**

Learning outcomes of the course

After completion of the course, the students will be able to -

- understand the basic principles of ecology ;
- describe ecosystem and its functions, energy transfer through food chains, trophic levels, food web, and ecological pyramid;
- explain process and significance of biogeochemical cycles;
- describe the characteristics of flora, fauna and adaptation of animals and plants different types of habitats and biomes.

- learn how biotic and abiotic factors affect the abundance and distribution of animals in natural communities;
- describe the regulation and stability of population; and
- construct life table and develop ecological modeling.

Instructional strategies of the course

Lectures and discussions will be the main strategies strategy for delivering the course with the aid of multimedia power point presentations, flip charts, video films, etc. Classes will be made participatory and interactive through questions and answers, and group work exercises.

Distributional class lectures: Total number of classes/ lectures: 60

Class/ lecture types	No. of classes	Class/ lecture types	No. of classes
Lecture and discussion	54	Review class	2
Students/ group presentation	2	In-course exam.	1
Student feed back on course contents and delivery	1		

Assessment

There will be two in-course examinations, each consisting of 17.5 marks; 5 marks are allocated for students' class attendance. Questions of in-course examinations will be of short and objective types. The students will be frequently asked questions in the classroom to assess performances. A course final examination of 60 marks will be conducted by the university.

References

Begon, M., Townsend, C. R., Harper, J. L. 2006. *Ecology: From individuals to ecosystems*. (4th ed.). Blackwell, New Jersey, USA.

Odum, E.P. and Barrett, G.W. 2005. *Fundamentals of Ecology*. 5th edition. Thomson Brooks/Cole Publishing Co., USA.

Primack, R.B. 1998. *Essential of Conservation Biology*. 2nd edition. Sinauer Associates, Inc. Pub., Sunderland, Massachusetts, USA.

Ricklefs, R.E. and Miller, G.L. 1999. *Ecology*. W.H. Freeman and Company, New York.

Smith, T. M. and Smith, R.L. 2012. *Elements of Ecology*. 8th Edition. Pearson, USA.

Southwood, T.R.E. 1978. *Ecological methods- with particular reference to the study of insect populations*. Chapman and Hall, London.

Turk, A., Wittes, J.J., Turk, J. and Wittes, R.E. 1978. *Environmental Science*. W.B. Saunders Company, Philadelphia, USA.

Course No.	Course Title	No. of Credits	Credit Hours
Zool. 305	**Human Physiology, Reproduction and Family Planning, and Population Studies**	**4**	**60**

Introduction to the course

This course comprises three important and inter-linked disciplines of modern zoology - human physiology, reproduction and family planning, and population studies. Knowledge on physiology is crucial to study as it relates to body functions and provides the basis for diagnosis and treatment of illness. The focuses of the physiological study include digestion, excretion, respiration, circulation and maintaining homeostatis, muscle contraction, neural and hormonal regulation of body functions. The family planning part of the course introduces the students to the basis, methods and techniques of family planning. There is a mutual and strong relationship between the development and composition of a society's population and changes in the economy, cultural values and institutions. The course will also introduce the students to basic techniques of demographic analysis, measures of mortality, fertility, marriage and migration levels and patterns. Life table, standardization and population projection techniques will also be explored.

Specific objectives of the course

- To enhance students' learning about the different organ systems and physiology of major body functions, and hormonal and neural regulations of physiological functions of human body.
- To introduce the students to physiology of reproduction, hormonal regulation of menstrual cycles and pregnancy.
- To make students familiar to the methods and techniques of birth control.
- To introduce students to the different measures of demography and its uses in demographic projections and demographic analysis.

Course contents and number of classes by course sub-title:

Sub-title of course contents	No. of classes
Human Physiology:	
Digestion: Definitions of food, nutrition and digestion, digestion of carbohydrates, proteins and lipids; role of liver and pancreas in digestion.	**3**
Circulation: Pulmonary and systemic circulation, portal circulation; physiology of circulation; composition of blood and other body fluids; their functions; formation of blood cells; blood groups; coagulation of blood and blood pressure.	**3**
Respiration: Definition and phases; respiratory movement of breathing; physiology of respiration and regulation of respiration.	**4**
Excretion: Definition; physiology of excretion and urine formation; regulation of excretion.	**2**
Muscle contraction: Chemistry and theories of muscle contraction; neuromuscular action; characteristics of muscle twitch; motor unit; summation; tetanus and muscle dystrophies.	**3**
Bone: Structure and types; ossification; bone growth; reabsorption and bone disorder.	**2**
Hormone: Types, sources and functions; regulation of hormone secretion; mode of action of hormone; effects of abnormal secretions of hormones.	**3**
Metabolism: Carbohydrates, glycolysis and citric acid cycle, electron transport system.	**4**
Nervous system: Neurons, physiology of different types of nervous system; role of cranial nerves; physiology of hearing; equilibrium and balance of vision.	**3**
Reproduction & Family Planning:	
Human reproductive system and accessory glands; sex hormones; regulation of menstrual cycle and pregnancy. Disorders of reproductive system.	**5**
Fertilization; pregnancy and placenta, and faetal development. Importance of family planning; birth control principles and methods.	**5**
Population Studies:	
Demographic perspective: Introduction; population and its growth; nature of population; population changes; pre-modern population doctrines.	**3**
The Malthusian perspective; the Marxist perspective; revised Malthus and modern population theories; theory of the demographic transition.	**3**
An overview of world population. Population processes. Components of mortality, measuring mortality; social class differential in mortality; trends and levels in mortality.	**3**
Fertility concepts and measurements; fertility trends; levels and explanations. Population structures and characteristics; age and sex structure.	**3**
Human migration: definition, types and explanations of migration and measuring migration. Population growth and development.	**3**

Learning outcomes of the course

After completion of the course, the students will be able to

- describe the anatomical features of major human organs, its functions and basic physiological principles of different organ systems;
- explain the physiological processes and mechanism of digestion, blood circulation, respiration, excretion, muscle contraction and maintenance of homeostasis;

- describe reproductive anatomy and physiology of reproduction;
- know about hormonal regulations of menstrual cycle and maintenance of pregnancy;
- learn about the birth control methods and techniques demonstrate the understanding of demographic pattern and process;
- describe different demographic parameters and their measurements and methods of demographic analysis; and
- demonstrate ability to apply methods and data appropriately to answer to demographic questions and problems

Instructional strategies of the course

The course will be delivered through lecture and discussion, aided by power point presentations, flip charts, video films, etc. Classes will be made participatory and interactive through questions and answers, and group work exercises in the classroom.

Distribution of class lectures: Total number of classes/lecture: 60

Class/lecture types	Number of classes	Class/lecture types	Number of classes
Lecture and discussion	52	Review class	2
Students' group presentation	2	In-course exam	2
Feedback on in-course exam	2	Student feedback on course contents and delivery	2

Assessment

There will be two in-course examination s, each consisting of 17.5 marks; 5.0 marks are allocated for class attendance. The in-course exam questions will be of objective and short types. The students will be frequently asked questions in the classrooms to assess performances. The course final examination will be conducted by the university and will carry 60 marks.

References

Chatterjee, C.C. 1977. *Human Physiology*. Medical Allied Agency, Kolkata, India.
Weeks, J.R. 2016. *Population: An Introduction to Concepts and Issues*. 12th edition.

Course No.	Course Title	No. of Credits	Credit Hours
Zool. 306	**Biostatistics and Research Methodology**	**4**	**60**

Introduction to the course

This course deals with the two important subject areas, Biostatistics and Research Methodology, and aims at developing student's capability to design and conduct quality researches. The biostatistics part is designed to provide the student with knowledge, skills and understanding on the collection, summarization, analysis of data and interpretation of research findings. The research methodology part focuses on providing the students with the knowledge and skills required to competently undertake research assignments, and specifically highlights on developing research hypothesis and research questions and experimental design of researches, developing research methodology and setting strategies for implementation of research, and critical evaluation of research findings to arrive at a genuine conclusion and finally preparing the research reports and scientific papers.

Specific objectives of the course

- To enhance students learning on collection, summarization and analysis of data.
- To make students familiar with various statistical tools and techniques for performing various statistical treatments and solving problems.
- To increase student's knowledge and skills to apply statistical tools to validate research findings and design.

- To introduce the students to processes and techniques in identifying research areas, developing research hypothesis and questions.
- To promote students' ability to design and implement research programme, develop research proposals and write research reports scientific papers.

Course contents and number of classes by course sub-title:

Sub-title of course contents	No. of classes
Biostatistics:	
Definition, scope and application of biostatistics in biological sciences. Collection, processing and presentation of statistical data. Variables and frequency distribution.	**3**
Measures of central tendency- arithmetic mean; weighted mean; mode and median. Measure of dispersion- variance; standard deviation; standard error.	**3**
Estimation of confidence limit. Non-parametric analysis – Man-Whitney, Kruskal-Willis, Wilkockson, and Friedman tests; Chi-square test for independent and goodness of fit.	**4**
Parametric tests- Regression analysis and correlation; Linear regression analysis, Least square method. Analysis of variance (ANOVA - one and two way ANOVA. Multiple range test (MRT).	**7**
Distribution of statistical dat - normal and poison distributions; transformation of data for normality. Significance test based on normal distribution; F-test; Probit analysis. Experimental designs. Sampling.	**8**
Research Methodology:	
Research concept, definition and process; Planning a research project - background information; types; adaptive and on-firm researches; innovative research.	**3**
Hypothesis and setting research questions; approach to experimental design; statistical design and development of methodology. Data collection and analysis.	**4**
Writing research proposals; thesis; scientific papers and field reports with case studies for each.	**5**
Types of research papers; monographs; serials; series; periodicals; reviews; journals, etc.	**2**
Environmental impacts of research; ethics in research. Precaution against hazards during research work.	**3**
Concept and importance of commercialization of research and entrepreneurship.	**2**
Use of Zoological records; periodicals and biological abstracts. Quality of publications; impact factors.	**2**
Intellectual Property Rights (IPR) - concept, importance and processes.	**2**

Learning outcomes of the course

After completion of the course, the students will be able to-

- perform basic statistical analysis of data specifically that relate to summarizing data, estimating central tendency and dispersion, correlation and regression analysis, using appropriate methods and tools;
- decide and apply significance tests, specifically t-tests, ANOVA, Chi-square tests, to interpret research results;
- learn about how to proceed step by step for identification and formulation of research programs
- propose and distinguish appropriate research designs and methodologies to apply to a specific research project;
- develop a comprehensive research methodology for a research question;
- write a research report, scientific article and thesis, and research proposal; and
- organize and conduct research in a methodical manner.

Instructional strategies of the course

The course will be delivered through lecture and discussion, aided by power point presentations, models, video clips, etc. Classes will be made participatory and interactive through questions and answers, and group work exercises in the classrooms.

Distribution of class lectures: Total number of classes/lectures: 60

Class/lecture types	Number of classes	Class/lecture types	Number of classes
Lecture	50	Review class	2
Students' group presentation and discussion	4	In-course exam	2
Feedback on in-course exam	2		

Assessment

There will be two in-course examinations, consisting of 17.5 marks each, and 5 marks are reserved for class attendance. Questions of in-course examinations will be of short and objective types. The students will be frequently asked questions in the classrooms to assess individual's performances. The course final examination will consist of 60 marks and be conducted by the university.

References

Parker, R.E. 1983. *Introductory Statistics for Biology.* The Institute of Biology's Studies in Biology. 43, Edward Arnold, UK.

Sokal, R.R. and Rohlf, F.J. 1981. *Biometry - The Principles and Practice of Statistics in Biological Research.* W.H. Freeman and Company, New York.

Course No.	Course Title	No. of Credits	Credit Hours
Zool. 307	**Evolution, Zoogeography and Palaeontology**	**4**	**60**

Introduction to the course

Evolution, Zoogeography and Palaeontology are three fascinating inter-linked disciplines of biological sciences as these help us to explore how the diversity of the animals on earth evolved, how individual species formed with time and their past and present distribution pattern on the planet. The course will introduce the students to these fundamental natural processes that shape and govern the diversity in animal kingdom, changes in species and their distribution. The study of evolution includes the ideas, concepts and processes of evolution, species formation and the driving forces that dictate the formation of new species. The palaeontological part focuses on the processes of fossilization, paleontological evidences in support of the past history of evolving of some selected animals. Zoogeography part highlights the past and present distribution patterns of important animal groups on earth, factors and barriers that dictate this distribution pattern and also highlights the glaciation and continental drift, and their impacts on the distribution pattern of animals.

Specific Objectives of the course

- To introduce the students with different theories of evolution, underlying facts and processes of species formation.
- To enhance students' knowledge on the distribution pattern of higher animals and factors affecting animal distribution, causes for the glaciation and continental drift and its impacts on animal distribution.

- To increase students' knowledge and understanding of fossils and its formation, the history and natural evolution of selected animals and their palaeogeography.

Course contents and number of classes by course sub-title:

Sub-title of course contents	No. of classes
Evolution:	
Origin of life: theories, main lines of animal evolution.	**2**
History of evolutionary thoughts of Lamarck, Darwim and Wallace	**2**
Evidences of organic evolution- biogeography, comparative anatomy, embryology, comparative physiology, biochemistry, palaeontology and genetics.	**4**
Origin of variation: gene mutation, chromosomal mutation, continuous versus discontinuous variations.	**3**
Origin of species: natural selection, isolation, and species formation. Polyploidy, convergent, divergent and parallel evolution.	**2**
Adaptation and animal variation and distribution of species.	**2**
Process of evolution: Macro-and micro-evolution, *Archaeopteryx*.	**1**
Speciation: Concept, factors and process of evolution.	**2**
Modern trends in evolutionary thoughts.	**1**
Paleontology:	
Introduction: Concept, history and scope of paleontology.	**2**
Fossils: types and significance of fossils; fossilization processes.	**3**
Geological time scale with characteristic fauna.	**2**
History of evolution of horse, camel, elephant and man.	**4**
Zoogeography:	
Introduction: definition, scopes, determinants and barriers of animal distribution;, history of emergence of zoogeography.	**3**
Past history of land water distribution; Pangea and Gondwana land.	**2**
Continental drift: theories, evidences and impacts on animal distribution.	**1**
Pleistocene glaciation: causes, facts and impacts on animal distribution.	**3**
Zoogeographical Regions: definition, boundary, land mass, sub-regions, climatic and vegetation conditions of each recognized region; animal distribution pattern in each region; endemic, major common, endemic and shared animal groups in each region.	**6**
Faunal relationship among different zoogeographical regions.	**1**
Insualr and transitional and Siwalik Fauna.	**3**

Learning outcome of the course

After completion of the course, students will be able to-

- explain and critically evaluate the various theories of evolution;
- explain the evidences of evolution and causes of variations;
- describe the causes and processes of species formation;
- tell about the types and processes of fossil formation, history of man, camel and horse with palaeontological evidences;
- describe the geological time scale in relation to emergence and extinction of animal groups and characteristic fauna;
- know about the recognized zoogeographical regions, distribution pattern of different groups of animals in it, factors that dictate this distribution patter; and
- learn about the transitional and island fauna, continental drift and glaciation on the distribution of animals on earth.

Instructional strategies of the course

The course will be delivered through lectures and discussions, aided by power point presentations, flip charts, video films, etc. Classes will be made participatory and interactive through questions and answers, and group work exercises in the classroom.

Distribution of classes: Total number of classes: 60

Type class/lecture	No. of classes	Type class/lecture	No. of classes
Class lecture	50	Review classes	3
In-course examination	3	Feedback on course and course delivery	3
Feedback on in-course exams	3	Group work/presentation, etc.	3

Assessment

There will be 3 in-course examinations, one consisting of 17.5 marks and the other two consisting of 8.75 marks each. A 5 marks will be reserved for class attendance. Questions for in-course examination will be of short and objective types. The course final examination will be of 60.

References

Darlington, P.L. 1957. *Zoogeography*. John Wiley and Sons Inc., USA.

Dobzhansky, T., Ayala, F.J., Stebbins, G.L. and Valentine, J.W. 1977. *Evolution.* W.H. Freeman and Company, San Francisco, USA.

Romer, A.S. 1956. *Vertebrate Paleontology.* Univ. of Chicago Press, USA.

Michael, J. B. and David A. T. H. 2009. Introduction to Paleobiology and the Fossil Record, 1st edition. Wiley-Blackwell, New Jersey, USA.

Course No.	Course Title	No. of Credits	Credit hours
Zool. 310	**Practical**	**8**	**120**

Introduction to the course

Practical demonstration is a major focus of third year study and is aligned with the major theoretical courses taught in the third year of the BS program. The course is designed to equip the students with the practical knowledge and skills that are often applied in the field and offers a comprehensive package of practical learning opportunities in the diverse ranges of fields of biological sciences. In particular, the practical demonstrations will focus on microtomy techniques, water analysis, study of zooplankton and benthos, study of pest and parasites of economic importance, measuring some blood parameters, activities on classical genetics, animal behavior and applied biostatistics. In addition to practical demonstration classes, hands on training and field tours will be organized for the students.

Specific objectives of the course

The specific objectives of this course include -

- To give hands' on training on some applicable knowledge of histology, physiology, ecology, genetics, behavior, economic aspects , biostatistics and research methodology.
- To provide insights into how the mentioned areas of science can be used in solving real problems.

Course contents and number of classes by course sub-title:

Sub-title of course contents	No. of classes
Microtomy: Technique of histological slide/whole-mount preparation.	**7**
Blood grouping: Blood grouping and preparation of human blood smear.	**2**
Water quality: Measurement of dissolved oxygen, carbon dioxide, ammonia, nitrite, pH, turbidity, salinity, alkalinity and hardness of water.	**4**
Freshwater organisms: Identification of planktonic and benthic macro- and micro-fauna.	**5**
Laboratory culture: Culture of protozoans (*Paramecium* sp., *Euglena* sp.), rotifers, *Hydra*, earthworm, *Drosophila*, cockroach or any stored product insect pest.	**2**

Sub-title of course contents	No. of classes
Ecology: a. Study of the population dynamics of any one of the above cultured/reared species in the laboratory and studying there growth rate calculation of the intrinsic rate of natural increase; carrying capacity; population growth form, whether J-shaped or logistic [S-shaped]; identification of mortality factors; data collection, analysis, description and comments/remarks; b.Study of the abundance of the population of a species in a given area by using quadrat/transect method; c. Visiting a pond to study pond ecosystem including faunal and floral composition and food chain; d. Local field visit to a forest to study its ecology, the animals and their adaptations; preparation of a report on the visit; e. Tour to a seashore to study the animals and their ecological adaptations; preparation of a report on the visits.	**5**
Animal Genetics: Activity on Mendelian pattern of inheritance in *Drosophila* sp.	**2**
Animal behaviouur: Observation and analysis of animal behaviour.	**2**
Biostatistics: Preparation of frequency distribution table; measures of arithmatic mean, mode, median, variance, standard deviation and standard error; correlation and regression analysis; Chi-square test and t-test; ANOVA.	**4**
Research methodology: Activity on research process.	**2**
Preparation of practical notebooks, field reports and other assignments	

Learning outcomes of the course

After completion of the course, the student will be able to-

- prepare and study the histological slides of different tissue samples;
- measure water parameters and selected blood parameters;
- determine the status and distribution of aquatic micro- and macro-fauna;
- identify parasites of fish, poultry, livestock and human;
- explain the differences between the different groups of parasites;
- culture different organisms;
- understand animal ecology; and
- explain Mendelian pattern of inheritance.

Instructional Strategies

The course will be delivered through practical demonstration classes, hands-on trainings and lectures. A number of teachers will be present in the classroom to guide the individual students on how to proceed with their practical works in the laboratory. The classes will be aided with audio-visual materials, video clips relating to different topics. Necessary study materials, logistics and equipment will be provided to students, as required. The students will prepare practical note books on each practical work performed in the laboratory. Study tours will be organized and guided by the course teachers. Students are also required to prepare and submit study tour reports which will be evaluated.

Distribution of class lectures: Total number of classes/ lecture (each of 3 credit hours): 40

Distribution of class/ lecture types	No. of classes
Practical demonstration classes and hands-on training	35
In-course Examination	3
Feedback on in-course Examination	1
Feedback on course Contents and activity	1

References

Microtomy:

Carson, F.L., and Hladik. C. 2009. *Histotechnology: A Self-Instructional Text*. 3rd edition. American Society of Clinical Pathologists, Chicago, IL,USA.

Gray, P. 1952. *Handbook of basic microtechniq*ue. Blakiston Company. New York, USA.

Humason, G.L. (1972) Animal tissue techniques. 3rd Edition, W.H. Freeman and Company, San Francisco. USA.

Sheehan, D.C. and Barbara, B.H. 1980. *Theory and Practice of Histotechnology*. 2nd ed., C.V. Mosby Co., India.

Reza, S. 2007. *Gross Anatomy, Cell Biology and Histology*. Essence Publications, Dhaka.

Water analysis, Freshwater studies, Laboratory culture/rearing, Ecology:

Odum, E.P. and Barrett, G.W. 2005. *Fundamentals of Ecology.* 5th edition. Thomson Brooks/Cole Publishing Co., USA.

Mellanby, H. 1963. *Animal Life in Freshwater-A guide to freshwater invertebrates*. 6th edition. Methuen & Co. Ltd., London.

Economic Zoology:

Chatterjee, K.D. 2009. *Medical Parasitology.* CBS Publishers & Distributors, India.

Cheng, T.C. 1997. *General Parasitology.* Academic Press, New York, USA.

Metcalf, C.L. and Flint, W.P. 1962 (revised by R.I. Metcalf). *Destructive and Useful Insects- their habits and control.* Tata McGraw Hill Publ. Co. Ltd., New Delhi, India.

Pedigo, L.P. 2002. *Entomology and Pest Management*. 4th edition. Prentice-Hall of India Pvt. Ltd., New Delhi, India.

Biostatistics:

Parker, R.E. 1983. *Introductory Statistics for Biology.* The Institute of Biology's Studies in Biology. 43, Edward Arnold, UK.

Sokal, R.R. and Rohlf, F.J. 1981. *Biometry - The Principles and Practice of Statistics in Biological Research.* W.H. Freeman and Company, New York.

Animal Genetics:

Snustad D. P., M. J. Simmons. 2015. *Principles of Genetics*. 7th Ed. John Willey and Sons. Inc. New York, USA. (PDF available:https://www.slideshare.net/hijobaba/principles-of-genetics-6-e-isbn-978-0470903599-snustad-simmons)

Animal behavior:

Arora, M.P. 2003. *Animal Behaviour*. Kanta, C. Eds. 6th Edition. Himalaya Publishing House. Mumbai, India.

Research Methodology:

Sokal, R.R. and Rohlf, F.J. 1981. *Biometry - The Principles and Practice of Statistics in Biological Research.* W.H. Freeman and Company, New York.

(Books for further consultation will be recommended by the course teachers.)

Course No.	Course Title	No. of Credits
Zool. 311	**Viva-voce**	**2**

Fourth Year BS (Honours) Programme in Zoology

Sessions: 2018-2019, 2019-2020, 2020-2021, 2021-2022

Course No.	Course Title	No. of credits	Credit hours
Zool. 401	**Environmental Pollution, Radiation Biology and Human Ecology**	**4**	**60**

Introduction to the course

This course comprises three major areas of environmental biology. Pollution is one of the recognized environmental problems that has detrimental effect on our ecosystems. The course discusses the sources, impacts of and remedial measures for controlling air, water, soil and noise pollution. The course also highlights the environmental impact assessment (EIA) and development of environmental management plan (EMP), necessary for protecting environment from negative impacts of developmental activities. The course also focuses on uses and abuses of ionizing radiations, specifically on the effects of ionizing radiations on biological systems, human health and safe handling of radiations, and its beneficial applications in agricultural, biological, food and medical sciences. Human ecology is an emerging environmental concern and the course will introduce the students to the environmental impacts on shaping human races. The course is designed to develop students' capabilities and skills in recognizing the problems and addressing the environmental issues.

Specific objectives of the course

- To increase students' understanding on the causes and consequences of pollution.
- To enhance students' learning and skill in dealing with the control of environmental pollution and preparing environmental management plan.
- To promote students' knowledge on the sources, impacts, uses and abuses of radioisotopes and ionizing radiations.
- To make the students aware of the drivers and impacts of human activities on the environment and its linkages to life and livelihoods.

Course contents and number of classes by course sub-title:

Sub-title of course content	No. of classes
Environmental Pollution:	
Introduction: Concept, terminologies, definitions and types of pollution.	**2**
Air pollution: Definition, major types, sources, effects on biosphere and control measures.	**3**
Noise pollution: Definition, sources, effects on human and animals and prevention methods.	**2**
Water pollution: Definition, sources, types, effects on ecosystem and treatment methods.	**3**
Soil pollution: Definition, sources, effects on ecosystem and prevention.	**2**
Environmental Impact Assessment (EIA): Introduction, definition, stages/levels, clearance categories; procedural steps; assessment methods and report structure.	**4**
Environmental Management Plan (EMP): Purpose, definitions, components including mitigation; enhancement and monitoring plans; implementation and people's participation.	**4**
Radiation Biology:	
Introduction to radiobiology and its status; atomic structure and radiation phenomenon.	**3**
Types of radiation and its characteristics; units of measurement of radiation.	**3**
Sources of radiations-natural and artificial sources.	**3**
Biological hazards of radiation and effects of radiation on human.	**3**
Permissible doses, safe handling and personal monitoring; detectors.	**2**
Radioisotopes and their use in biological, medical and agricultural researches.	**4**

Sub-title of course content	No. of classes
Use of radiation in food preservation and protection.	**2**
Human ecology:	
Introduction; History of human distribution.	**3**
Human types and their distribution.	**3**
Ecological impact on man's physical features, social and cultural life.	**3**
Impact of population expansion on environment.	**2**
Developmental activities and their impacts on environment.	**2**

Learning outcomes of the course

After completion of the course, the students will be able to

- explain causes and impacts of different types pollution and suggest its control measures;
- tell the procedural steps for environmental impact assessment and develop environmental management plans;
- demonstrate the phenomenon of radiations, radiation types and its properties;
- gain knowledge about the uses of radiation in different sectors of human needs; and
- describe different environmental conditions in shaping human races and the impact of developmental activities on the environment vis-à-vis on mankind.

Instructional strategies of the course

The course will be delivered through lectures and discussions, aided by power point presentations, flip charts, video films, etc. Classes will be made participatory and interactive through questions and answers, and group work exercises.

Distribution of class lectures: Total number of classes/lecture: 60

Class/lecture types	Number of classes	Class/lecture types	Number of classes
Lecture and discussion	50	Review class	2
Students' group presentation	2	In-course exam	2
Feedback on in-course exam	2	Student feed back on course contents and delivery	2

Assessment

There will be two in-course examinations, each consisting of 17.5 marks. Questions for in-course examinations will be of short and objective types. The students will be frequently asked questions in the classrooms to assess individual's performance. The course final examination will be of 60 marks.

References

DOE. 1997. *EIA Guidelines for Industries.* Department of Environment, Ministry of Environment and Forest. Govt. of the People's Republic of Bangladesh, Dhaka, Bangladesh.

FPCO. 1992. *Guidelines for Environmental Impact Assessment (EIA).* Flood Plan Coordination Organization, GoB, Dhaka, Bangladesh.

Miller, G.T. 1985. *Living in the Environment*. Wodsworth Publishing Company, Belmont, California, USA.

Odum, E.P. 1971. *Fundamentals of Ecology*. W.B. Saunders Company, Philadelphia, USA.

Townsley, P. 1993. *A manual on Rapid Appraisal Methods for Coastal Communities*. BOBP, Dhaka, Bangladesh.

Turk, A., Wittes, J.J., Turk, J. and Wittes, R.E. 1978. *Environmental Science*. W.B. Saunders Company, Philadelphia, USA.

Course No.	Course Title	No. of credits	Credit hours
Zool. 402	**Biodiversity, Biodiversity Conservation and Bioresource Management**	**4**	**60**

Introduction to the course

The rapid degradation to biodiversity is a serious concern worldwide. Global and national efforts are in place to conserve biodiversity for attaining sustainable development and presently it is considered a priority area of biological science. The course provides a comprehensive package of learning opportunities centered on approaches, methods and tools for biodiversity conservation, assessment and monitoring of biodiversity, and legal regime that govern biodiversity conservation in Bangladesh. The course is designed to produce professionals in the country with adequate knowledge about the subject area, capable of assessing biodiversity, developing and implementing biodiversity conservation programmes.

Specific objectives of the course

- To enhance conceptual understanding of the students on biodiversity, its values and services.
- To increase students' learning on methods and tools for assessment, monitoring, conservation and management of biodiversity.
- To promote students' capacity in understanding and applying the legal tools for biodiversity conservation and setting conservation priorities.

Course contents and number of lectures by title/sub-titles:

Sub-title of course contents	No. of classes
Biodiversity:	
Introduction to biodiversity: Definition, concept, types and components of biodiversity. National and global biodiversity status and trend.	**2**
Importance and value of biodiversity: Use value, non value, intrinsic, optional, bequest and cultural values of biodiversity; ecosystems services provisioning, regulating, supportive and recreational services.	**4**
Valuing biodiversity: Concept, definitions, purposes, types and methods of economic valuation; TEVB.	**4**
Biodiversity survey and monitoring: Purposes and types; methods and tools; preparation of animal inventories and its matrices.	**3**
Biodiversity hotspots, mega biodiversity and other terminologies related to biodiversity studies.	**2**
Biodiversity Conservation:	
Threats to biodiversity: Issues and types of threat; threat analysis and mapping; consequences of biodiversity loss.	**4**
Conservation: types- *ex-situ* and *in-situ* conservation; setting conservation priorities	**4**
Conservation strategies: Major strategies for biodiversity conservation.	**3**
Conservation approaches: Habitat-, ecosystem-, landscape and co-management and community based management approaches.	**5**
Legal regime in biodiversity conservation in Bangladesh: Acts, policies and rules related to biodiversity and wildlife conservation in Bangladesh.	**3**
International conventions, protocol and treaties related to biodiversity conservation in Bangladesh (CBD, CITES, RAMSAR convention. Nagoya/Cartegena Protocol, etc.),	**5**
SDG targets related to biodiversity and ecosystem conservation.	**1**

Sub-title of course contents	No. of classes
Bioresource management: **Introduction to bioresource management:** Definition, scopes, classification of bioresources; conservation vs management. **Protected area:** Definition, IUCN categories; Protected Areas (PAs) in Bangladesh. **Protected animals:** categories and stratus in Bangladesh. **Threatened animals:** Categories and status in Bangladesh. **Species and ecosystem management**: types- manipulative and management; methods and tools; forest and wetland management. PA management in Bangladesh; Development of Biodiversity Management Plan and Action Plan; Major conservation/management initiatives in Bangladesh and its impacts.	**2** **2** **2** **1** **3**

Learning outcomes of the course

After completion of the course, the students will be able to-

- learn about the biodiversity, its components, uses and values;
- identify threats to biodiversity and set conservation priorities and strategies;
- Understand the approaches and legal regime in biodiversity conservation in Bangladesh;
- design and implement biodiversity survey and monitoring programmes; and
- management plans and action plans for biodiversity conservation.

Instructional strategies of the course

The course will be delivered through lectures and discussion, aided by power point presentations, flip charts, video films, etc. Classes will be made participatory and interactive through questions and answers, and group work exercises in the classroom.

Distribution of class lectures: Total number of classes/lecture: 60

Class/lecture types	Number of classes	Class/lecture types	Number of classes
Lecture and discussions	50	Review class	2
Students' group presentation	2	In-course examination	2
Feedback on in-course exam	1	Guest lecture	1
Student feedback on course contents and delivery	1	Management/Action Plans development exercise	1

Assessment

There will be two in-course examinations, each consisting of 17.5 marks, and 5 marks are allocated for class attendance. The questions of the in-course examination will be of fill in the blanks, objective and short types. A course final examination will be of 60 marks.

References

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Course No.	Course title	No. of credits	Credit hours
Zool. 403	**Entomology**	**4**	**60**

Introduction to the course

Entomology is a branch of zoology that deals with the study of insects and its interactions with the environment, other species and humans. Insects are the most diverse organisms on the earth; they are essential for the functions of most the ecosystems, particularly the terrestrial ecosystems. Much of our economic productivity depends upon insects, they also cause immense damage to agriculture and transmit some of the most common and lethal diseases. The objective of this course is to give a generalized idea centered on the above mentioned areas of entomology with particular focuses on the insect taxonomy highlighting the classification scheme of insects, diverse anatomical and morphological features across the groups, insect ecology, physiology, reproduction and developmental stages in insects. The course also focuses on some applied aspects of entomology, including the pest control, culture of insects for agricultural and other product purposes.

Specific objectives of the course

- To provide general knowledge about the insect structure, function and classification schemes.
- To learn about the different morphological structures, anatomical features of different organ systems and their physiological functions.
- To increase students' ability to identify insects in the field and in the laboratory.
- To introduce the students to some aspects of insect biology, life history; nature of damage and control measures of insect pests of agricultural importance.

Course contents and number of classes by course sub-title:

Sub-title of course contents	No. of classes
Insect morphology:	
Body wall: Structure and derivatives.	**2**
Head: Types, segmentation, sutures and areas; mouth parts- types, modifications and feeding adaptations; antenna - types and structure;	**3**
Eye: Compound eye and ocellus structure, and image formation.	**3**
Thorax: Wing- structure, venation and modifications; leg- structure and modifications.	**2**
Muscles: structure and types.	
Insect life stages: egg, nymph/larva, and pupa.	**3**
Insect taxonomy:	
Insect identifying characters; principles of insect classification.	**1**
Detailed classification of the class Insecta up to orders and sub-orders.	**1**
Description of the following orders including their general and diagnostic characteristics, habit, habitat, reproduction and life cycle, economic importance: **Apterygota** - Collembola; **Exopterygota** - Ephemeroptera, Odonata, Orthoptera, Isoptera, Mallophaga, Anoplura, Hemiptera, and Homoptera; and **Endopterygota**- Coleoptera, Lepidoptera, Diptera and Hymenoptera.	**11**
Insect physiology:	
Physiology of digestion, dietary requirements of insects, role of microorganisms in insect nutrition and digestion.	**2**
Physiology of circulation; haemolymph, connective tissue and plasma.	**2**
Physiology of respiration in terrestrial, aquatic and endoparasitic insects.	**2**
Physiology of excretion: salt and water regulation; excretion of ingested organic molecules;	**2**
physiology and integration of nervous system.	**2**
Physiology of moulting: exocrine glands and defensive secretions;	**1**
eye vision, light production; perception and cryptobiosis.	**2**
Agricultural entomology:	

Sub-title of course contents	No. of classes
General information on insects related to agricultural crops; stored grains; grain products; vegetables, fruits, tea and forest trees.	**1**
Pest: Definition and types.	**1**
Biology, life history, nature of damage and control measures of the following pests: **Jute pests** - jute hairy caterpillar, jute semilooper and jute mites; **Sugarcane pests** - sugarcane top shoot borer and stem borer; **Rice pests** - rice ear-cutting caterpillar, rice stem borers, rice hispa; **Vegetable pests** - brinjal fruit and shoot borer, potato tuber worm, epilachna beetle and mustard aphid; **Fruit tree pests & fruit pests** - mango fruit borer, mango stem and shoot borer, citrus leaf miner, palm beetle; **Tea pests**- tea pest-chart of Bangladesh; tea pest problems; mite pests; insect pests (shoot pests, leaf pests, flush pests, root pests); and **Forest tree/timber pests** - pest problems in forest nurseries and plantations.	**9**
Biology, nature of injury and control measures of major and minor insect pests of **f**orest trees and vegetation; stored grains and grain products - rice weevil, rice moth, red flour beetle, rice meal moth, saw-toothed grain beetle, pulse beetles, and dried-fish pests.	**2**

Learning outcomes of the course

After completion of the course the students will be able to

- describe the classification schemes of insects and the characters of major orders of insects;
- explain the morphological and anatomical features of different organ systems across different groups of insects;
- learn about the major aspects of insect biology;
- describe the functions of different systems in insect body; and
- identify the agricultural insect pests and gain practical knowledge of controlling them.

Instructional strategies

The course will be delivered through lectures and discussions, aided by power point presentations, charts, video films, etc. Classes will be made participatory and interactive through questions and answers, and group work exercises in the classroom.

Distributional class lectures: Total number of classes/ lectures: 60

Class/ lecture type	No. of classes	Class/ lecture types	No. of classes
Lecture and discussion	52	Review class	2
Students/ group presentation	2	In-course exam.	2
Student feedback on course contents and delivery	2		

Assessment

There will be two in-course examinations, consisting of 17.5 marks each and 5 marks will be allocated for students' attendance in the class. The question in the in-course tests will be of fill in the blanks, objective and short types. The students will be frequently asked questions in the classroom to assess performances. A course final examination, consisting of 60 marks, will be taken centrally by the university.

References

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Snodgrass, R.E. 1935. *Principles of Insect Morphology*. Tata McGraw Hill Publ. Co. Ltd., New Delhi, India.
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Course No.	Course Title	No. of Credits	Credit Hours
Zool. 404	**Fisheries and Aquaculture**	4	60

Introduction to the course

This course provides students with some basic aspects of fisheries, emphasizing on systematics, biology, population dynamics, resource management, aquaculture, post harvest technology and fish diseases. Biological concepts of the course include morphology, behaviour, reproduction and life history strategies of fisheries species. It also covers the logistic and quantitative methodologies associated with undertaking a biological investigation into the population dynamics of a species. These assessments of fisheries species include reproductive biology, age determination, growth modeling, stock discrimination, population stock abundance and dietary analysis. This course will also introduce the students to a range of aquaculture practices of common cultureable finfish and shrimp species in the country, induced breeding techniques, broodstock management, common fish harvesting and processing techniques and practices.

Specific objectives of the course

- To introduce the students to a wide range of aspects related to fisheries biology, fisheries management and aquaculture practices.
- To make students understand the major aspects of fish biology and fish population dynamics.
- To enhance students' knowledge about the fisheries resources of the country and its management.
- To make students familiar with the fish and shrimp culture techniques, induced breeding of fishes and fish processing techniques.

Course contents and number of classes by course sub-title:

Sub-title of course contents	No. of classes
Fishery systematic: Principles and techniques of fishery systematics including collection, preservation and taxonomic studies of fish and shellfishes; classification of fishes with diagnostic characters and examples.	**6**
Fish biology and population dynamics: Principles and techniques of fish biology; food and feeding, growth, condition factor and meristic relationship. Maturation and spawning habit; reproductive biology including fecundity; GSI, refractory period. Estimation of mortality rates; population size and MSY. Theories of fishing. Age and growth and estimation of growth parameters, gear selectivity; tagging and marking types and techniques. Analysis of exploited population.	**12**
Fishery resources: Fish habitat diversity; shellfish and finfish resources of Bangladesh. Fish production statistics. Government and non-government fisheries organizations; research institutions; cooperatives and their activities. Principles and techniques of fisheries resources management. Concept of fish sanctuaries. Fish conservation acts and Fisheries Policy of Bangladesh.	**6**

Sub-title of course contents	No. of classes
Fish harvesting and processing: Traditional fish harvesting crafts, gears and lines of Bangladesh; modern trawl fishing and miscellaneous techniques of harvesting. Fish spoilage and post-mortem changes; principles, and physical, chemical and microbial aspects of spoilage; Rigor mortis. Fish processing and preservation by icing and freezing, drying, salting, smoking, pickling and canning.	**7**
Aquaculture: Concept, history and scope of aquaculture. Site selection factors/criteria and categories for aquafarm; components of carp and shrimp hatchery. Design and construction of ponds, cages and pens; Culture types and common farmed species of fish. Shellfish and seaweed. Steps of pond fish culture. Integrated fish farming types. Induced breeding techniques of carp and shrimp. Inbreeding problems and preventive measures. Mariculture/coastal aquaculture types; shrimp, pearl, oyster and fish culture in the coast and mangrove areas.	**15**
Fish diseases: Concepts, scopes and economic role of fish diseases. Microbial bacterial and fungal diseases of shrimp and fish. Parasitic disease (protozoan and metazoan diseases) of fish with their causes, mode of infection; symptoms and control measures. Miscellaneous non-infectious and nutritional diseases of carp and catfish.	**8**

Learning outcomes of the course

After completion of the course the students will be able to-

- learn the classification schemes of fishes, methods and techniques used for identifying finfish and shellfish species;
- understand the biological parameters like growth, maturation and reproduction;
- demonstrate age and growth of fish leading to estimate stock and abundance of fish;
- apply basic strategies to manage fish populations;
- learn the methods and techniques for the culture of fish and shrimp species, induced breeding;
- become familiar with the components of hatchery and its management;
- enhance knowledge about fish harvesting and fish processing techniques like fish drying, canning, freezing, etc.; and
- explain some common fish diseases, its effects on growth and survival and treatment measures of fish diseases.

Instructional strategies of the course

The course will be delivered through lectures and discussions, aided by power point presentations, flip charts, video films, etc. Classes will be made participatory and interactive through questions and answers, and group work exercises in the classroom.

Distribution of class lectures: Total number of classes/lectures: 60

Class/lecture types	Number of classes	Class/lecture types	Number of classes
Lecture and discussion	54	Review class	2
Feedback on in-course exam	1	In-course exam	2
Student feed back on course contents and delivery	1		

Assessment

There will be two in-course examinations, each consisting of 17.5 marks, and 5 marks will are allocated for students' class attendance. In in-course examination, questions will be of objective and short types. The students will be frequently asked questions in the classrooms to assess performances. A course final examination of 60 marks will be conducted by the university.

References

Bardach, J.E., Ryther, J.H. and McLarney, W.O. 1972. Aquaculture: the farming and husbandry of

freshwater and marine organisms. Wiley-Blackwell, New Jersey, USA.
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Course No.	Course Title	No. of Credits	Credit Hours
Zool. 405	**Wildlife and Wildlife Management**	**4**	**60**

Introduction to the course

Study of wildlife and wildlife management has been a focus area of biological studies with the growing concern over rapid decline in wildlife worldwide. This course focuses on the four most evolved and highest classes of animals: Amphibia, Reptilia, Aves and Mammalia with particular concentration on the diversity in Bangladesh. This course also offers an abridged concept of wildlife management, Wildlife (Conservation and Security) Act 2012 as well as of the protected areas of Bangladesh. The particular focuses of the course include classification of these four groups of animals, some aspects of wildlife biology, behaviour, ecology and their economic importance. The course also highlights the methods and tools for wildlife conservation and protected area management.

Specific objectives of the course

- To introducing the amphibians, reptilians, birds and mammals, their diversity, ecology and behaviour.
- To disseminating information on the status of wildlife management in Bangladesh.
- To delineating Conservation (Wildlife and Security) Act 2012.
- To familiar IUCN Red List and Protected Area Categories.

Course contents and number of classes by course sub-title:

Sub-title of course contents	No. of classes
Herpetology: Diversity of herpetofauna. Adaptation to different habitats. Status and distribution of amphibians and reptiles of the Oriental Region with special reference to Bangladesh. Food and feeding habits of amphibians and reptiles in relation to agriculture, forestry and fisheries. Breeding biology: season, nesting, egg-laying and parental care of amphibians and reptiles.	**16**
Ornithology: Diversity of birds. Locomotor and feeding adaptations. Food and feeding habits. Breeding behaviour: territoriality, courtship, mating, nests, eggs, incubation, nestlings, breeding success, breeding season, brood parasitism, parental care, migration patterns: timing and significance.	**10**
Mammalogy: Diversity of mammals with special reference to Bangladesh; status and distribution of mammals of the Oriental Region with special reference to Bangladesh. Mammalian adaptations to different habitats. Food and feeding behaviour of mammals: (i) foraging and food selection, (ii) diet, (iii) grazing and browsing. Breeding biology - breeding season, calls, territoriality, mating, pregnancy, gestation, lactation and parental care of deer, squirrel and primates. Extinct and threatened mammals of Bangladesh.	**18**
Wildlife Management: Introduction, concept and principles. Causes of decline of wildlife population. Wildlife	**10**

Sub-title of course contents	No. of classes
Herpetology: Diversity of herpetofauna. Adaptation to different habitats. Status and distribution of amphibians and reptiles of the Oriental Region with special reference to Bangladesh. Food and feeding habits of amphibians and reptiles in relation to agriculture, forestry and fisheries. Breeding biology: season, nesting, egg-laying and parental care of amphibians and reptiles. conservation measures. Population, population density and population dynamics. Frequency of occurrence and relative abundance. Various methods of population analysis. Bangladesh Wildlife (Conservation & Security) Act 2012. Concept and types of protected areas. Protected areas of Bangladesh. Protected area management.	**16**

Learning outcomes of the course

After completion of the course the students will be able to-

- tell about the classification schemes of the four groups of wildlife with their distinguishing characters;
- gain knowledge about the different areas of wildlife biology and ecology, including migration, breeding and breeding behavior, food and feeding, habit and habitat, parental care, etc.;
- learn approaches, strategies, methods & techniques of wildlife management;
- know about the protected areas of Bangladesh and its management prospects; and
- learn the major features of Wildlife (Conservation and Security) Act 2012 of Bangladesh.

Instructional strategies of the course

The course will be delivered through lectures and discussions, aided by power point presentations and video presentations. Classes will be made participatory and interactive through questions and answers, and individual/group work exercises in the classroom**.**

Distribution of class lectures: Total number of classes/lectures: 60

Class/lecture types	Number of classes	Class/lecture types	Number of classes
Lecture and discussion	54	Conservation documentary/movie	1
Students' individual/group presentation	3	In-course exam	2

Assessment

Two in-course examinations, each of one hour duration and consisting of 17.5 marks each, will be taken. A total of 5 marks is allocated for students' class attendance. The questions for in-course examinations will be of objective, short types. A course final examination will be conducted by the university, which will carry 60 marks.

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Course No.	Course Title	No. of credits	Credit hours
Zool. 406	**General Parasitology**	**4**	**60**

Introduction to the course

Knowledge on general parasitology is essential to control parasitic diseases and public health since a vast majority of parasites share human and other animals as their host; transmit via contamination of our food and environment. The course particularly focus on basic idea of parasitology, host-parasite association, distribution of parasites, control of parasites and biology of common parasites of different groups of vertebrate animals including man. Basic understanding of Parsaitology and knowledge of common parasites are essential for students of Zoology, particularly useful to those who would like to specialized and develop career in Parasitology.

Specific objectives of the course

- To give a detailed idea on the different types of relationships among animals, specially of parasitism.
- To enhance students' understanding about the history and evolution of parasites.
- To enhance students' knowledge about the different parasites of humans and domesticated animals, their biology, development and effects on hosts.
- To enable students' learning on the control of common parasites of human and domesticated animals.

Course contents and number of classes by course sub-title:

Sub title of contents	No. of class
Introduction to parasitology: concept, types and related terms.	**2**
Detailed study of basic ideas and principles of different types of association.	**3**
History of parasitology: origin of parasites and evolution of different groups of parasites.	**4**
Host-parasite relationship: tissue and organ level effects: (a) effects of parasites on host; and (b) effects of hosts on parasites. Effects of host behaviour, diet and hormone.	**6**
Vectors: vectors and their role in parasitology.	**2**
Common animal parasites: systematic position, morphology, life-cycle, pathogenicity, epidemiology and control of important parasites of different groups of animals:	
Parasites of invertebrate hosts: *Nosema, Haplosporidium, Aspidogaster, Agamermis and Sacculina.*	**4**
Parasites of fish: *Cryptobia, Henneguya, Myxobolus, Trichodina, Ichthyophthirius, Gyrodactylus, Gnathostoma, Pallisentis, Argulus, Ergasilus, Lernaea and Caligus.*	**5**
Parasites of amphibians: *Opalina, Polystoma* and *Haematoloeclus.*	**3**
Parasites of reptiles: *Haemogregarina, Megalodiscus* and *Amplicaecum.*	**3**
Parasites of birds: *Eimeria, Leucocytozoon, Histomonas, Heterakis, Raillietina and Argas.*	**4**
Parasites of mammals other than humans: *Moniezia, Dicrocoelium, Dipylidium, Dirofilaria, Capillaria, Ixodes, Dermacentor, Ornithodoros* and *Demodex.*	**6**
Parasites of humans: *Cryptosporidium, Leishmania, Trypanosoma, Toxoplasma, Giardia, Trichomonas, Clonorchis, Schistosoma, Taenia, Echinococcus, Trichurus, Ancylostoma, Strongyloides, Ascaris, Enterobius, Wuchereria, Pediculus* and *Sarcoptes.*	**12**

Learning outcomes of the course

After studying the course the students will learn the following:

- describe different types of relationships among animals;
- appreciate history, evolution and effects of parasites; and
- know about detailed biology of common animal parasites, their developmental stages, effects on hosts and control of parasitic diseases.

Instructional strategies of the course

Classes will be made interactive through questions and answers practices. At the beginning of the start of a class on a particular topic students' preoccupation will be captured by asking questions. Students will take part in discussion in lecture hours. The course will be delivered by lectures, aided by multimedia, video clips, etc.

Distribution of class lectures: Total number of lecture: 60

Class/ lecture type	Number of classes	Class/ lecture type	Number of classes
Lecture with discussion	54	In-course exam	2
Review class	2	Feedback on in-course exam.	2

Assessment

Two in-course examinations, each of one hour duration and consisting of 17.5 marks each, will be taken. A total of 5 marks is allocated for students' class attendance. The questions for in-course examinations will be of objective, short types. A course final examination will be conducted by the university, which will carry 60 marks.

References

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Course No.	Course Title	No. of Credits	Credit Hours
Zool. 407	**Molecular Genetics**	**4**	**60**

Introduction to the course

Molecular genetics is a frontier science of the 21st century. This science combined with classical genetics has disclosed many biological phenomena and enabled us to alter genetic makeup of the organisms of our needs. The course is designed to help student learn the necessary details, concepts, selected techniques and problem-solving skills related to modern genetics. Specifically, the course will discuss about structure and functions of DNA and RNA, DNA replication, RNA transcription, regulation of gene functions, genetic engineering and some aspects of applied genetics. After completion of the course, the students will be equipped with appropriate knowledge and skills instrumental to contribute nationally and globally in academic research, sustainable industrial growth in the related fields like health, food, etc. and in biodiversity conservation.

Specific objectives of the course

- To make students' broader conceptual understanding about the core concepts of genes and gene functions in the light of molecular biology.
- To enhance students' learning the basic techniques used to study and manipulate genes and its functions.
- To familiarize the students with the application of genetic techniques in the applied field of industrial production and crop production and in medical sciences.

Course contents and number of classes by course sub-title:

Sub-title of course contents	No. of classes
DNA- the chemical nature of the gene: Characteristics of genetic material; the molecular basis of heredity; the structure of DNA; DNA packaging – nucleosome and its structural organization.	**5**
DNA replication and recombination: DNA replication: semi-conservative replication, DNA polymerase; events at the replication fork; replication of the lagging strand; replication of telomeres; consequences of defects in telomerase. Replication of genomes: origins of replication; cell cycle control of DNA replication. Molecular basis of recombination.	**7**
Transcription: Structure and function of gene; promoters and terminators; transcriptional initiation, elongation and termination, RNA polymerases.	**3**
RNA molecules and RNA processing: mRNA, tRNA and rRNA; RNA splicing; RNA editing; microRNA.	**3**
The Genetic Code and Translation: The genetic code, codons, anticodons, the ribosome and translation.	**4**
Control of Gene Expression: General principles of gene regulation; Prokaryotic gene regulation: the Lac operon; Eukaryotic gene regulation: regulation of transcription, promoters, enhancer elements; post-transcriptional and post-translational regulation.	**6**
Gene Mutations and DNA Repair: Types and Causes of mutations: replication errors, mutagens; DNA repair: Mismatch Repair, Direct Repair, Base-Excision Repair, Nucleotide-Excision Repair and Other Types of DNA Repair. Genetic diseases and faulty DNA repair.	**5**
Genetic Engineering: Basic concepts; recombinant DNA techniques; cloning genes; PCR amplification of DNA; use of PCR in species identification; transgenesis - generating transgenic animals with special reference to model organisms: fruitfly and mouse.	**12**
Broader areas of application of Genetics: Pharmaceuticals; Specialized Bacteria; Agricultural Products; Oligonucleotide Drugs; Genetic Testing; Gene Therapy; Gene Mapping; DNA Fingerprinting. Future scope of Genetics.	**5**

Learning outcomes of the course

After completion of the course, the students will be able to-

- explain molecular basis of gene structure and function;
- describe and explain the process of DNA replication, RNA transcriptions and regulation of gene expression;

- appreciate mutation at the level of the genotype and its manifestations at the phenotypic level;
- gain familiarity with the concepts and principles underlying gene technology and its applications to the different branches of applied zoology.

Instructional strategies of the course

The course will be delivered through lectures and discussions, aided by power point presentations, video clips, etc. Classes will be made participatory and interactive through questions and answers, brainstorming, oral presentations and group exercises in the classroom**.**

Distribution of class lectures: Total number of classes/lecture: 60

Class/lecture types	Number of classes	Class/lecture types	Number of classes
Lecture and discussion	50	Review class	2
Students' group presentation	2	In-course exam	2
Feedback on in-course exam	2	Student feedback on course contents and delivery	2

Assessment

There will be two in-course examinations, each consisting of 17.5 marks, and 5 marks are allocated for students' class attendance. The in-course exam questions will be of objective and short type as per course teacher's instruction. The students will be frequently asked questions in the classroom to assess performances. A course final examination of 60 marks will be conducted by the university.

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Course No.	Course Title	No. of Credits	Credit Hours
Zool. 415	**Practical**	**8**	**120**

Introduction to the course

The main purpose of this course is to provide students with practical knowledge and skills related to five areas of animal science, namely, entomology, fisheries, genetics and molecular biology, parasitology and wildlife biology. This will have broader implications and applicability in the relevant industry and academic research. The course is based on a number of practical demonstrations, hands-on training in the laboratory and field tours.

Specific objectives of the course

- To enhance students skills in taxonomic study of animals with emphasis on the use of methods and techniques to identify various groups of animals related to entomology, fisheries and wildlife;

- To help students to comprehend major systems of insects and fishes in the light of functional relevance;
- To provide exposure to students on general techniques applicable in the sectors like fisheries, agricultural entomology, parasitology and wildlife conservation; and
- To make students to realize broader applications of genetics and molecular science through some relevant exercises in the laboratory.

Course contents and number of classes by course sub-title:

Sub-title of course contents	**No. of classes**
Entomology:	**7**
Insect Taxonomy: Collection of insects of common orders. Insect identification: Selected insects up to family level; Insects up to generic and species levels; Collection, preservation and identification of insects; Report preparation (Class teacher will give guidelines).	**2**
Insect morphology: Different types of the mouth parts, antennae, wings and wing venation, legs of insects. (students will detach the above mentioned insect body parts, display, draw and label them and make comments on their adaptations).	**1**
Insect anatomy: Study of the functional systems of insects through dissection of selected insects: a) Digestive system: Structural variations related to feeding habits. b) Reproductive system: Male and female systems- testis, ovary and ovariole.	**2**
Insect physiology: Haemocytes of insects (students will prepare slides for the haemocytes of insects and draw and label them).	**1**
Agricultural entomology: Collection and identification of the pests of different agricultural crops and vegetables, fruits, stored grains and grain products, dry-fish pests. (Students will collect the above mentioned insect pests and study them in the classroom. The study includes proper recording with labeled diagrams, classification, characteristics and taxonomic notes).	**1**
Fisheries:	**7**
Taxonomic identification of crustaceans, molluscs and fishes of Bangladesh. **Dissection of** the digestive, circulatory respiratory and nervous and reproductive systems of *Labeo rohita.*	2 1
Study of mouth structure of fish in relation to food and feeding habits.	1
Age determination of fish by scale, otolith and fin ray.	
Crafts and gears modules.	1
Qualitative and quantitative study of plankton and macro benthic organisms.	1
Feed formulation and feed preparation techniques.	1
Field visits: Hatchery operation; fish processing; catch assessment and fishing effort survey.	
Wildlife Biology:	**7**
Taxonomy of museum specimens: Amphibians, reptiles, birds and mammals.	4
Wildlife study technique: Population census, transect and plot counting, netting and trapping, preservation and identification, tagging, marking, ringing, observatory.	1
Preparation of slides: Hairs of mammals.	1
Food habit analysis: Frog/lizard/pigeon.	1
Field trips and reports.	
Parasitology:	**7**
Basic procedures for collection, fixation and preservation of protozoans, helminths and arthropod parasites for microscopic study.	2
Taxonomic identification of animal and human parasites of different groups.	1
Procedure for inventory of ectoparasites and endoparasites of vertebrate host/s.	1
Demonstration of parasites from invertebrate hosts like snail and cockroach.	1
Collection, preparation and identification of parasites from faecal samples.	1

Sub-title of course contents	No. of classes
Sub-title of course contents	**No. of classes**
Genetics and Molecular Biology: **Basic/ Mendelian Genetics**: Exploring genetic inheritance in *Drosophila* sp. **Cytogenetics**: (a) Study of different stages of mitotic and meiotic cell division by smearing fruit fly/grasshopper testis, (b) Study of polytene chromosomes from third instar larvae of *Drosophila/Bactrocera*. **Molecular Genetics**: Genomic DNA isolation, PCR analysis and Agarose Gel Electrophoresis. **Population Genetics**: Measuring genetic diversity by multiple alleles (e.g ABO blood groups. **Preparation of practical notebooks and field reports**	**7** 1 2 3 1

Note: One Practical demonstration class equivalent to 3 three credit hours.

Learning outcomes of the course

Upon successful completion of the course students will be able to-

- identify taxonomic positions of most of the animals;
- dissect, distinguish and display different systems of insects and fishes, and describe their functional role;
- design, evaluate and appreciate experiments of economic importance in major areas of zoology; and
- initiate DNA extraction, set up PCR reaction and analyze gel pictures.

Instructional strategies of the course

The course will be delivered through holding practical demonstration classes, hands-on trainings and lectures. A number of teachers will be present in the laboratory during the practical classes and guide the students on how to proceed with their practical works in the laboratory. The classes will be aided with audio-visual materials, video clips relating to current lecture topics. Necessary study materials, logistics and equipment will be provided to students as required. The students will prepare practical note books on each practical work performed in the laboratory. Study tours will be organized, guided by the course teachers for making observation on the species, its ecology, food, feeding habitat, breeding, etc. Students are also required to prepare and submit study tour reports which will be evaluated.

Assessment

There will be 5 in-course examinations, each consisting of 14 marks, and 10 marks are allocated for class attendance. The course final practical examinations will be of 120, a portion of which will be allocated for practical note books and study tour reports. The table below shows the detailed break up of in-course exam marks.

Distribution of class lectures: Total number of classes/lecture: 40

Distribution of Class/ lecture types	No. of classes
Practical demonstration classes and hands-on training	35
In-course Examination	3
Feedback on in-course Examination	1
Feedback on Course Content and Activity	1

Distribution of marks for each branch:

Heading	Distribution	Marks	Marks for Each Branch (one fifth of total)
Class attendance	5% of 8 credits	10	2
In-course assessment (in-course exam+practical notebook+assignment)	35% of 8 credits	70	14

Total marks	**80**	**16**

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Course No.	Course Title	No. of Credits
Zool. 416	**Viva-voce**	**2**

First Year BS (Honours) in Zoology

(Extra Departmental Course)

Sessions: 2018-2019, 2019-2020, 2020-2021, 2021-2022

Course No.	Course Title	No. of Credits	Credit Hours
Zool. 1001	**Animal Diversity (including practical)**	**4**	**60**

Introduction to the course

Knowing the diverse range of animals and their activities has been a fascination to mankind. This course offers a comprehensive package of learning opportunities for beginner students in zoology, aiming at introducing themselves to the diverse range of animal groups, their morphological and anatomical features and its biology. In particular, students will be studying the classification schemes of major phyla with distinguishing characters, structural and functional systems of representative animals along with notes on their biology, ecology, food and feeding and reproduction under this course. The course is integrated with a practical component for providing practical knowledge and skills focusing on animal identification and investigation of the internal organs through dissecting animal's body. The course is useful for the students who require some generalized ideas about the animal kingdom, a glimpse of their biology and wildlife management.

Specific objectives of the courses

- To enhance students' ability to understand the diversity of animal kingdom.
- To increase students' knowledge about the different non-chordate and chordate phyla, their morphological characteristics, habits, habitats, and economic importance.
- To provide an overview on the context of wildlife conservation in Bangladesh.

Course contents and number of classes by course sub-title:

Sub-title of course contents	No. of classes
A. Non-Chordata: **Classification**: Brief classification of each non-chordate phylum up to orders with special reference to local forms, their affinities and economic importance. **Type study**: Detailed type study including habit, habitat, morphology and major systems of the following: **Protozoa**: *Paramecium* and *Entamoeba*. **Porifera:** *Sycon*. **Coelenterata:** *Obelia;* Coral reef, its types and formation. **Platyhelminthes:** *Taenia solium*. **Nematoda:** *Tylenchus*. **Annelida:** *Nereis*. **Mollusca:** food and feeding habits, digestive, respiratory, circulatory, excretory, nervous and reproductive systems of *Pila*. **Arthropoda:** *Apis* sp. and its social behaviour; Life-cycle of jute-hairy caterpillar; Pulse Beetle and Rice Hispa. **Echinodermata:** General characters of different classes of echinoderms; Type study of *Astropecten.* **Minor phyla:** General idea about the different groups of animal under minor phyla. **Hemichordata:** General characters and affinities.	**22**
B. Chordata: **Classification**: Broad classification up to class with special reference to local forms and their economic importance. **Type study:** Detailed type study including habit, habitat, morphology and major systems of the following: **Urochordata**: *Ascidia*. **Cephalochordata:** *Branchiostoma*. **Cyclostomata:** *Petromyzon*. **Chondrichthyes**: *Scoliodon*. **Osteichthyes:** Food and feeding habits, digestive, respiratory, circulatory, excretory, nervous and reproductive systems of *Labeo*. **Amphibia:** fossil and living amphibians. **Reptilia:** General idea about dinosaurs. **Aves:** *Columbia*; General idea about flight and flightless birds, flight adaptation and feather types. **Mammalia:** *Cavia*.	**19**

Sub-title of course contents	No. of classes
C. Wildlife biology: Introduction to wildlife, and the broad classification of the wildlife of Bangladesh; Wildlife preservation and its importance in Bangladesh.	**2**
D. Practical: a. **Study of museum specimens** representing all major non-chordate and chordate phyla. b. **Cockroach**: External morphology, mouth parts, salivary gland and dissection of nervous system. c. **Prawn**: External features, dissection of digestive system. d. ***Labeo***: External morphology, dissection of circulatory system and reproductive systems. e. **Preparation of practical notebooks**	**5**

Learning outcomes of the course

After completion of the course, students will be able to-

- get familiarity with classification schemes of different groups of chordate and non-chordate animal groups;
- describe the morphological and anatomical features of various organ systems and their function;
- learn about some aspects of animal biology, ecology, food and feeding, reproduction and economic importance of different animal groups;
- recognize different species of non-chordates and chordates, and learn their classification as well as identifying characteristics;
- gain skills for studying internal organ system by dissecting representative animals; and
- learn about the conservation methods and techniques.

Instructional strategies of the course

The course will be delivered through lectures and discussions, aided by power point presentations, video clips, etc. Classes will be made participatory and interactive through questions and answers, and group work exercises in the classroom**.** For practical component of the course, practical demonstration classes will be organized. Museum specimens will be provided to study, and the dissection practices will be performed on a number selected animals. A number of teachers will guide the students in the laboratory**.** Content/s of the upcoming class will be announced to the students. At the beginning of each class, there will be a brief review session on the previous lecture topic.

Distribution of class lectures: Total number of classes/lecture: 50; credit hours: 60

Class/lecture types	Number of classes	Number of credit hours
Lecture and discussion (1 credit hours each)	43	43
Practical class (3 credit hours each)	05	15
In-course exam for theory	01	1
Review class on in-course exam, and students' feedback on course contents and delivery	01	1
Total	50	60

Assessment

The theory and practical component of the course will comprise 80% and 20% marks respectively. There will be two in-course examinations for the theory part of the course, which will comprise a total marks of 32 inclusive of marks for class attendance (4 marks). A course final examination on theoretical part (48

marks) and final practical examination (20 marks) will be held separately. Practical note book will be evaluated.

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