UNIVERSITY OF RAJSHAHI

RAJSHAHI 6205, BANGLADESH

CURRICULUM OF
OUTCOME-BASED EDUCATION FOR
BACHELOR OF SCIENCE (HONOURS) PROGRAMME IN ZOOLOGY

DEPARTMENT OF ZOOLOGY

FACULTY OF BIOLOGICAL SCIENCES

2020 ADMISSION ONWARDS

UNIVERSITY OF RAJSHAHI

RAJSHAHI-6205, BANGLADESH

CURRICULUM OF

OUTCOME-BASED EDUCATION FOR

B.Sc. (HONOURS), SESSION: 2020-21

Examinations

B.Sc. (Honours) Part I : 2020

B.Sc. (Honours) Part II : 2021

B.Sc. (Honours) Part III : 2022

B.Sc. (Honours) Part IV : 2023

DEPARTMENT OF ZOOLOGY

FACULTY OF BIOLOGICAL SCIENCES

2020 ADMISSION ONWARDS

Department of Zoology **University of Rajshahi**
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ACKNOWLWEDGEMENTS

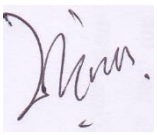
I feel privileged to write a few words on the first ever Curriculum designed for undergraduates of the Department of Zoology, University of Rajshahi, for the academic sessions 2020-2023. It is obviously a huge task to convert the traditional Syllabus into Curriculum, which was not very much familiar to most of the teachers/tutors of the public universities of the country until recently.

There are contrasting differences between *Syllabus* (a Greek word, meaning the subjects in a course of study or teaching) and *Curriculum* (a Latin word, meaning the subjects comprising a course of study in educational institutions like schools, colleges or universities). The two terms, therefore, differ in a sense that curriculum is a combination of some factors which helps in the planning of an educational programme; whereas a syllabus covers the portion of what topics should be taught in a particular subject. In other words, curriculum is a set of plans and arrangements regarding the objectives, content and learning materials as well as the means used to guide the implementation of learning activities to achieve specific educational objectives. Whereas, syllabus is a unit of the curriculum and it connotes the subjects as well as topics covered in the course of study. In developed countries, syllabus is prepared by teachers; conversely, a curriculum is decided by the government or the school, college or university administration. Moreover, the duration of a syllabus is for a year only, but curriculum lasts till the completion of the course. So, the curriculum has a wider scope than the syllabus, because the former is aimed at both physical and mental development of a student. Curriculum, in a nut-shell, is the overall learning experience that a student goes through during the particular course of study.

The Curriculum Development and Review (CDR) Committee of the Department of Zoology, approved by its Academic Committee meeting (No. 14/17; dated 04-08-2019), was headed by Prof. Dr. Md. Habibur Rahman (Convener) and two members, Prof. Dr. Md. Kamrul Ahsan and Dr. Md. Fazlul Haque. Since then, the Committee worked relentlessly to organize, scrutinize and finalize the curriculum to reach up to the mark. In this regard, I express my gratefulness to the CDR committee members as well as to all the honourable members of the Academic Committee of the department for their time, efforts and intellectual contributions to the current status of this curriculum. Nevertheless, minor omissions and mistakes might have still been crept in, which, I am sure, will be rectified during subsequent revisions through Committee of Curriculum (former Committee of Courses) meetings and discussions.

I gratefully acknowledge the help and co-operation received from the Institutional Quality Assurance Cell (IQAC) of the university, especially its former and present Directors and resource personnel, for their cordial assistance in disseminating and sharing their knowledge and thus help upgrading the contents of the curriculum through workshops and fruitful discussions. In addition, active co-operations of the relevant course tutors from the departments of Botany and Chemistry are also thankfully acknowledged. For the financial grant for publishing the curriculum in its present form, the Rajshahi University authority must deserve special mention.

Finally, I would highly appreciate receiving any advice and suggestions regarding the improvement of the curriculum designed for the undergraduates in Zoology from national and global perspectives.



Dr. M. Saiful Islam
Professor and Chairman

04 October, 2020

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PROGRAMME OVERVIEW

- NAME OF THE PROGRAMME

  Bachelor of Science (Honours) programme in Zoology

- DURATION OF THE PROGRAMME

  04 (four) years

- ASSESSMENT SYSTEM OF THE PROGRAMME

  Year-end theoretical and practical examinations, Continuous assessments, Assignments, Dissertation and *Viva-voce*

- TOTAL MINIMUM CREDIT REQUIREMENTS

  160 credits

- GRADING SYSTEM OF THE PROGRAMME

  Cumulative Grade Point Average (CGPA) (Out of 4.0)

- NAME AND ADDRESS OF DEPARTMENT OFFERING THE PROGRAMME

  Department of Zoology

  Faculty of Biological Sciences

  Sir Jagadish Chandra Bose Building

  University of Rajshahi

  Rajshahi 6205

  Bangladesh

  Website: http://www.ru.ac.bd/zoology

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1. INTRODUCTION

The learning outcomes-based curriculum framework for a B.Sc (Honours) degree in Zoology is structured to offer a broad outline within which all aspects of zoological knowledge, skills and attitude could be developed. The course is upgraded keeping in mind the ambitions of students, changing nature of the subject as well as learning environment. Courses within zoology have been reconsidered to integrate recent progresses of knowledge and techniques to upgrade the skills of learners. This framework permits the review of agreed graduate attributes, qualification descriptors, programme learning outcomes and course-level learning outcome periodically. This framework provides students with an exciting and modern programme of study that integrates a range of learning and teaching techniques of relevance to both their educational development and career ambitions. The programme covers the latest developments in Zoology, and provides theoretical knowledge plus training in the practical and intellectual skills to enable students to first understand and then help solve some of the regional and global problems in this subject. Graduates from this programme will be critical thinkers, able to solve complex problems in Zoology and possess the personal and problem-solving skills that will enhance their employability prospects.

2. OVERVIEW OF THE UNIVERSITY OF RAJSHAHI

University of Rajshahi being the second largest University in Bangladesh is the highest seat of learning in the Northern region of the country. Rajshahi University act 1953 (East Bengal Act XV of 1953) was passed by the East Pakistan provincial assembly on March 31, 1953. In 1961 the University moved to its present campus. The present campus of the university is at Matihar on 303.80 hectares of land acquired for the purpose and the construction of new buildings and structures started in 1958. The university's 58 departments are organized into 10 faculties: Engineering, Arts, Law, Science, Medicine, Business Studies, Social Sciences, Biological Sciences, Earth and Geosciences and Agriculture. The six institutes of the university are those of Bangladesh Studies, Biological Sciences, Education and Research, Environmental Science, Business Administration and of English and other languages meant for higher education and research. With more than 25,000 students and around 1200 academic staff, it is one of the largest universities in Bangladesh. The university has 17 residential halls for students, six for female and eleven for male students. Degrees offered by the university include bachelors (Honours) and Masters in different disciplines as well as MPhil, PhD, Diplomas and Certificates.

3. VISION OF THE UNIVERSITY OF RAJSHAHI

To pursue enlightenment and creativity for producing world-class human resources to cater for the needs of changing time.

4. MISSION OF THE UNIVERSITY OF RAJSHAHI

4.1 To ensure a world-class curriculum with talented academicians and conducive academic and research environment for generation and dissemination of knowledge.

4.2 To maintain international standards in education with focus on both knowledge and skills, and humanitarian and ethical values to meet the needs of the society and state.

4.3 To develop strategic partnerships with leading national and international universities, and organizations for academic as well as research collaborations.

5. CORE VALUES

5.1 Upholding the spirit of war of liberation in all aspects of life.

5.2 Maintaining honesty and integrity and showing mutual respect.

5.3 Practicing openness, accountability and transparency in all academic and administrative affairs.

5.4 Ensuring justice for all irrespective of gender, caste, disability, belief and religion.

5.5 Inspiring innovation and youth leadership.

6. OVERVIEW OF THE PROGRAMME OFFERING DEPARTMENT

The Department of Zoology had its origin in the Department of Botany in 1969-70. With the rapid advances in the field of animal science, it was felt necessary to extend it into an independent and full-fledged Department. Thus, the Department of Zoology started functioning in the middle of 1972. Late Professor Dr. Mustafizur Rahman was appointed the founder Head of the Department. Since then the Department has developed at a fast rate to its present state with a view to meeting the growing demand for trained personnel in the fields of classical as well as applied Zoology. Many changes have taken place over the last five decades.

Located on the 303.80 hectare of land of the campus, the Department of Zoology occupies a working area of 2198.91m^2 including classrooms, laboratories, office rooms, corridors, toilets, and museum in the Sir Jagadish Chandra Bose Building (former Third Science Building). The building, a purpose-built facility, was first occupied in 1972. The Department of Zoology occupies the west end of two floors, one floor in the north and together with some rooms on the south of the third floor of the Building. There is a total of 13 offices in the Department. All academic staff have their own individual office space, as do the Departmental Museum Deputy Curator, Administrative Assistants, Technicians and one Store Officer (whose office is used as a stationery store and the reception point for deliveries). The Department has a strong and proud history of serving science and society, and honouring the intellectual traditions of classical Zoology, while embracing new developments. The skills, flexibility and positive attitude of the technical staff have contributed greatly to the development of the Department in its present teaching and research activities.

7. VISION OF THE PROGRAMME

Vision of the B.Sc. (Hons) programme in Zoology is:

- To be one of the premier subjects in RU/Bangladesh, nationally and internationally recognized for teaching and research in emerging areas of Zoology from global perspective.

8. MISSION OF THE PROGRAMME

Mission of the B.Sc. (Hons) programme in Zoology is:

- To familiar the students with the whole Animal Kingdom and bioinformatics; plant taxonomy, pathology and economic Botany; and bio-physical, bio-organic and bio-inorganic Chemistry;
- To introduce the learners with advanced courses ranging from animal physiology to reproductive and population biology;
- To offer such versatile courses as cell and developmental biology and microbiology; genetics, molecular biology and biotechnology; ecology, wildlife, conservation biology and biodiversity; environmental health, parasitology and epidemiology and applied zoological fields like fisheries, farm animals and pest management, coupled with research methodologies in the aforesaid fields;
- To enable Zoology graduates to make the best-informed career decisions in competitive job markets at home and abroad.

9. AIMS AND OBJECTIVES OF THE PROGRAMME

The principal aim of the Zoology department is to teach and research the subject to the highest possible standards. We also aim to communicate our research findings in Zoology in general, to the widest possible audience, thus contributing to the overall integration of scientific knowledge and methods into the fabric of society, in both Bangladesh and global contexts.

The course aims to give a wide coverage of modern Zoology, followed by the opportunity to specialize in one or more areas reflecting the students' particular interests. Since animals cannot be studied in isolation, the course includes elements of plant science, genetics and biochemistry, with the opportunity of carrying some of these additional subjects to a more advanced level.

Graduates in Zoology will have an understanding of the key concepts of modern Zoology, and be aware of the scope and limitations of the subject. In addition, they will have sufficient specialist knowledge in selected areas to allow them to pursue a research degree in Zoology. Graduates will also have acquired a general biological, biodiversity, biostatistics, research methodology and scientific background as well as having gained experience in problem solving and have developed the communication, numerical and computer skills required for a wide range of careers.

10. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

PEOs of the B.Sc. (Hons) programme in Zoology is:

10.1 To impart high quality education in Zoology
10.2 To equip the students with communication skills and professionalism
10.3 To establish culture of research
10.4 To conduct scientific meetings/ conferences/ workshops/ seminars

11. DESCRIPTION OF THE PROGRAMME

The B.Sc. (Honours) in Zoology degree will be offered by the Department of Zoology, Faculty of Biological Sciences, University of Rajshahi, Bangladesh. Subject to the conditions laid down and conditions as set by the admission committee, students passing Higher Secondary Certificate (HSC) examination or an equivalent examination of a recognized University or Board may be admitted to the programme of study leading to the degree of B. Sc. Honours on recommendation of the Academic Committee of the department. Only current students passing the HSC/equivalent examination shall be allowed for admission.

The B.Sc. Honours courses in Zoology shall consist of Zoology Honours (H) and two related (R) subjects such as Botany and Chemistry. Different courses of the honours subject shall altogether carry 3400 marks and the related subjects shall carry 600 marks (300 marks each), the total being 160 credits of 4000 marks (40 units) distributed over four academic years. No student shall be allowed to stay for more than two academic years in each of the 1st, 2nd and 3rd year of the programme. There shall be theoretical, practical and *viva-voce* examinations at the end of each academic year. One unit of course carries 4 credits (100 marks) and half unit of course 2 credits (50 marks). The theoretical examination of one unit course shall be of 4 hours duration and half unit course shall be of 3 hours duration. There shall be continuous assessment (including class attendance) carrying half unit (50 marks) in each year.

12. PROGRAMME LEARNING OUTCOMES (PLOs)

After successful completion of the programme, the students will be able to:

12.1 Identify the major groups of organisms with an emphasis on animals and be able to classify them within a phylogenetic framework.

12.2 Compare and contrast the morphological, anatomical, physiological and behavioural characteristics of animals that differentiate them from each other and other forms of life.

12.3 Use the evidence of comparative biology to explain how the theory of evolution offers the only scientific explanation for the unity and diversity of life on earth. They will be able to use specific examples to explicate how descent with modification has shaped animal morphology, physiology, life history, and behaviour.

12.4 Explain how organisms function at the level of the gene, genome, cell, tissue, organ and organ-system. Drawing upon this knowledge, they will be able to give specific examples of the physiological adaptations, development, reproduction and behaviour of different forms of life.

12.5 Explicate the ecological interconnectedness of life on earth by tracing energy and nutrient flows through the environment. They will be able to relate the physical features of the environment to the structure of populations, communities, and ecosystems.

12.6 Compare and contrast ecological, physiological, biological and immunological relationships between organisms (hosts, parasites and pests) as well as their impacts on human and animal health and economy. They will be able to design the control strategies for different life-threatening diseases.

12.7 Demonstrate skills in the experimental techniques and methods of analysis appropriate for their area of specialization within Zoology.

12.8 Apply the scientific methods to questions in Zoology by formulating testable hypotheses, gathering data that address these hypotheses, and analyzing those data to assess the degree to which their scientific work supports their hypotheses.

12.9 Present scientific hypotheses and data both orally and in writing in the formats that are used by practicing scientists.

12.10 Access the primary literature, identify relevant works for a particular topic, and evaluate the scientific content of these works.

12.11 Apply fundamental mathematical tools (statistics, biometry) and physical principles (physics, chemistry) to the analysis of relevant biological situations.

12.12 Translate zoological knowledge and methods into innovations in applied biological sciences such as ecology, fisheries science, entomology, genetics, sericulture, crop protection, apiculture etc.

12.13 Communicate scientific information effectively to express thoughts in a logical, clear, concise and precise manner.

12.14 Uphold intellectual honesty and integrity in their conduct.

13. GENERIC SKILLS

(To be adopted from National Skills Framework of Bangladesh)

14. MAPPING BETWEEN UNIVERSITY'S MISSION AND PROGRAMME EDUCATION OBJECTIVES

UNIVERSITY'S MISSION (as in Section 4)	PROGRAMME EDUCATION OBJECTIVES (as in Section 10)			
	10.1	10.2	10.3	10.4
4.1	√	√	√	√
4.2	√	√	√	√
4.3			√	√

15. MAPPING BETWEEN PEOs AND PLOs

PROGRAMME EDUCATIONAL OBJECTIVES (as in Section 10)	PROGRAMME LEARNING OUTCOMES (as in Section 12)													
	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	12.9	12.10	12.11	12.12	12.13	12.14
10.1	√	√	√	√	√	√	√	√	√	√	√	√	√	√
10.2									√	√		√		√
10.3							√	√	√	√	√			
10.4									√	√				√

16. COURSES AND MARKS DISTRIBUTION

a) Marks: The programme of study for the B. Sc. Honours degree in Zoology shall carry a total of 4000 marks (40 units, 160 credits), 15-30% of which are for the related subjects and 20-40% for the practical, *viva-voce*, class assessment/ tutorial/ terminal/ home assignment/ field report/ excursion/ project/ thesis/ dissertation etc. The related courses shall have to be completed in the first and second year of the programme.

b) Contact hours: There shall be 30, 45 and 60 lecture hours (each LH contains 45 minutes) in an academic year for each theory course of 0.50, 0.75 and 1.00 unit respectively and at least 30 to 60 laboratory periods in an academic year for each practical course of 0.50 and 1.00 unit. For other fractions of a unit, proportionality should be applied. One laboratory period is equivalent to 3 (three) theoretical lecture periods.

c) Marks distribution: The year-wise distribution of marks among the theory, practical, *viva-voce*, class assessment/ tutorial/ terminal/ home assignment/ field report/ excursion/ project/ thesis/ dissertation etc. shall be as follows:

Year-wise distribution of total marks and units

Categories	1st Year Marks (Units)	2nd Year Marks (Units)	3rd Year Marks (Units)	4th Year Marks (Units)	Total Marks (Units)	Credit Points
Theory	700 (7)	600 (6)	700 (7)	700 (7)	2700 (27)	108
Practical + Dissertation	150 (1.5)	250 (2.5)	250 (2.5)	250 (2.5)	900 (9)	36
Viva-voce	50 (0.5)	50 (0.5)	50 (0.5)	50 (0.5)	200 (2)	8
Field study/ Excursion	50 (0.5)	50 (0.5)	50 (0.5)	50 (0.5)	200 (2)	8
Total	950 (9.5)	950 (9.5)	1050 (10.5)	1050 (10.5)	4000 (40)	160

Year-wise distribution of marks and units for major and related subjects

Subjects	1st Year Marks (Units)	2nd Year Marks (Units)	3rd Year Marks (Units)	4th Year Marks (Units)	Total Marks (Units)	Credit Points
Major	650 (6.5)	650 (6.5)	1050 (10.5)	1050 (10.5)	3400 (34)	136
Related	300 (3)	300 (3)	-	-	600 (6)	24
Total	950 (9.5)	950 (9.5)	1050 (10.5)	1050 (10.5)	4000 (40)	160

17. DESCRIPTION OF THE COURSES

B. Sc. (Honours) Part-I Examination, 2020

Subjects	Course codes	Course titles	Units	Marks	Credits
Honours	Zool. H. 101	Introduction to Zoology and Bioinformatics	1	100	4
	Zool. H. 102	Protista to Mollusca	1	100	4
	Zool. H. 103	Tardigrada to Cephalochordata	1	100	4
	Zool. H. 104	Pisces to Mammalia	1	100	4
	Zool. H. 105	Field study/ Excursion I*	0.5	50	2
	Zool. HV. 106	*Viva-voce* I (Honours courses)	0.5	50	2
	Zool. HP. 111	Zoology Practical I **	1.5	150	6
Related (Botany compulsory and Chemistry or Biochemistry)	Zool. R. 121	Botany I : Introduction to Plant Kingdom and Lower Plant groups	0.5	50	2
	Zool. R. 122	Botany II : Higher plants, Plant anatomy and Tissue culture	0.5	50	2
	Zool. R. 123	Botany III : Taxonomy, Economic Botany and Plant Breeding	0.5	50	2
	Zool. R. 124	Chemistry I: Bio-physical	0.5	50	2
	Zool. R. 125	Chemistry II: Bio-organic	0.5	50	2
	Zool. R. 126	Chemistry III: Bio-inorganic	0.5	50	2
Non-credit	Zool. E. 131	English for Communication and Science	0.5	50	0
		Total	**9.5**	**950**	**38**

* Field report /Excursion =25; Presentation/ *viva-voce* =10; Assessment =10 and Attendance =5; ** 30% for continuous assessment: Marks 9 for attendance, 36 for continuous laboratory assessment.

B. Sc. (Honours) Part-II Examination, 2021

Subjects	Course codes	Course titles	Units	Marks	Credits
Honours	Zool. H. 201	Nutrition, Protection and Support	1	100	4
	Zool. H. 202	Energetics and Homeostasis	1	100	4
	Zool. H. 203	Neurobiology and Endocrinology	1	100	4
	Zool. H. 204	Reproductive and Population Biology	1	100	4
	Zool. H. 205	Field study/ Excursion II*	0.5	50	2
	Zool. HV. 206	*Viva-voce* II (Honours courses)	0.5	50	2

	Zool. HP. 211	Zoology Practical II**	1.5	150	6
Related (Botany compulsory and Chemistry or Biochemistry)	Zool. R. 221	Botany IV: (Plant physiology, Ecology and Fungal diseases)	0.5	50	2
	Zool. R. 222	Botany V: Microbiology and Plant Pathology	0.5	50	2
	Zool. R. 223	Chemistry IV: Bio-physical and Bio-organic			
	Zool. R. 224	Chemistry V: (Bio-inorganic)			
	Zool. RP. 231	Botany Practical	0.5	50	2
	Zool. RP. 232	Chemistry Practical	0.5	50	2
		Total	**9.5**	**950**	**38**

* Field report /Excursion =25; Presentation/ *viva-voce* =10; Assessment =10 and Attendance =5; ** 30% for continuous assessment: Marks 9 for attendance, 36 for continuous laboratory assessment.

B. Sc. (Honours) Part-III Examination, 2022

Course codes	Course titles	Units	Marks	Credits
Zool. H. 301	Cell Biology, Genetics and Animal Breeding	1	100	4
Zool. H. 302	Developmental Biology	1	100	4
Zool. H. 303	Ecology, Ethology and Wildlife	1	100	4
Zool. H. 304	Zoogeography, Palaeontology and Evolution	1	100	4
Zool. H. 305	Taxonomy, Biodiversity and Conservation Biology	1	100	4
Zool. H. 306	Environmental and Health Biology and Epidemiology	1	100	4
Zool. H. 307	Parasitology	1	100	4
Zool. H. 308	Field study/ Excursion III*	0.5	50	2
Zool. HV. 309	*Viva-voce* III	0.5	50	2
Zool. HP. 311	Zoology Practical III**	2.5	250	10
	Total	**10.5**	**1050**	**42**

* Field report /Excursion =25; Presentation/ *viva-voce* =10; Assessment =10 and Attendance =5; ** 30% for continuous assessment: Marks 15 for attendance, 60 for continuous laboratory assessment.

B. Sc. (Honours) Part-IV Examination, 2023

Course codes	Course titles	Units	Marks	Credits
Zool. H. 401	Biometry and Research Methodology	1	100	4
Zool. H. 402	Molecular Biology, Genetic Engineering and Biotechnology	1	100	4
Zool. H. 403	Applied, Medical and Veterinary Entomology	1	100	4
Zool. H. 404	Fisheries	1	100	4

Zool. H. 405	Animals for Farming, Industry and Trade, Zoo-keeping, Animal Ethics and Ethnozoology	1	100	4
Zool. H. 406	Pest Management and Nematology	1	100	4
Zool. H. 407	Microbiology, Animal Pathology and Immunology	1	100	4
Zool. H. 408	Field study/ Excursion IV*	0.5	50	2
Zool. HV. 409	*Viva-voce* IV	0.5	50	2
Zool. HP. 411	Zoology Practical IV**	2	200	8
Zool. HR. 421	Thesis / Dissertation	0.5	50	2
	Total	**10.5**	**1050**	**42**

* Field report /Excursion =25; Presentation/ *viva-voce* =10; Assessment =10 and Attendance =5; ** 30% for continuous assessment: Marks 12 for attendance, 48 for continuous laboratory assessment.

18. MAPPING BETWEEN PROGRAMME LEARNING OUTCOMES (PLOs) AND THE COURSES

COURSES (As in Section 17)	**PROGRAMME LEARNING OUTCOMES (As in Section 12)**													
	12.1	**12.2**	**12.3**	**12.4**	**12.5**	**12.6**	**12.7**	**12.8**	**12.9**	**12.10**	**12.11**	**12.12**	**12.13**	**12.14**
Zool. H. 101	√									√				√
Zool. H. 102	√	√												√
Zool. H. 103	√	√												√
Zool. H. 104	√	√												√
Zool. H. 105									√				√	√
Zool. HV. 106									√				√	√
Zool. HP. 111	√	√					√	√	√	√	√		√	√
Zool. R. 121	√	√	√	√										√
Zool. R. 122	√	√	√	√										√
Zool. R. 123	√	√		√		√						√		√
Zool. R. 124			√	√	√						√			√
Zool. R. 125			√	√	√	√					√			√
Zool. R. 126			√	√	√	√					√			√
Zool. E. 131									√	√			√	√
Zool. H. 201		√		√		√								√
Zool. H. 202					√						√			√
Zool. H. 203		√		√		√								√
Zool. H. 204		√	√		√		√				√			√

Zool. H. 205									√				√	√
Zool. HV. 206									√				√	√
Zool. HP. 211		√	√	√	√	√	√	√	√		√		√	√
Zool. R. 221		√		√	√	√								√
Zool. R. 222	√		√			√								√
Zool. R. 223			√	√	√						√			√
Zool. R. 224			√	√	√						√			√
Zool. RP. 231	√	√	√			√	√	√			√			√
Zool. RP. 232			√	√	√		√	√			√			√
Zool. H. 301				√								√		√
Zool. H. 302			√	√										√
Zool. H. 303			√		√	√						√		√
Zool. H. 304		√	√		√	√					√			√
Zool. H. 305	√	√	√											√
Zool. H. 306					√	√					√	√		√
Zool. H. 307		√		√	√	√						√		√
Zool. H. 308									√				√	√
Zool. HV. 309									√				√	√
Zool. HP. 311	√	√	√	√	√	√	√	√			√	√	√	√
Zool. H. 401							√	√	√		√			√
Zool. H. 402				√			√					√		√
Zool. H. 403		√				√	√					√		√
Zool. H. 404					√	√						√		√
Zool. H. 405		√										√		√
Zool. H. 406					√	√						√		
Zool. H. 407					√	√						√		
Zool. H. 408									√				√	√
Zool. HV. 409									√				√	√
Zool. HP. 411		√		√	√	√	√	√	√		√	√	√	√
Zool. HR. 421							√	√	√	√	√		√	√

19. TEACHING LEARNING PROCESSES (TLPs)

The teaching learning processes are oriented towards enabling the students to attain the defined learning outcomes relating to the courses within a programme. Hence, the teaching learning processes are significant shifted from teacher centric to learner/ student centric, pedagogies and from passive to active /participatory pedagogies.

Teaching Learning Processes (TLPs) guided by such a framework, may include:

19.1 Lecture supported by group tutorial work; invited lectures.

19.2 Practical and field-based learning.

19.3 The use of prescribed textbooks and e-learning resources and other self-study materials.

19.4 Open-ended project work, some of which may be team based.

19.5 Assignments, seminars and oral presentation.

19.6 Activities designed to promote the development of generic/transferable and subject specific skills.

19.7 Internships and visits to field sites and hospitals or other research facilities.

19.8 Guidance by the 'mentors' and specialists in the field.

20. MAPPING BETWEEN TEACHING LEARNING PROCESSES (TLPs) AND THE COURSES

COURSES (as in Section 17)	**TEACHING LEARNING PROCESSES (as in Section 19)**							
	19.1	**19.2**	**19.3**	**19.4**	**19.5**	**19.6**	**19.7**	**19.8**
Zool. H. 101	√		√		√			
Zool. H. 102	√		√		√			
Zool. H. 103	√		√		√			
Zool. H. 104	√		√		√			
Zool. H. 105	**Evaluation**							
Zool. HV. 106	**Evaluation**							
Zool. HP. 111		√	√	√	√	√	√	√
Zool. R. 121	√		√		√			
Zool. R. 122	√		√		√			
Zool. R. 123	√		√		√			
Zool. R. 124	√		√		√			
Zool. R. 125	√		√		√			
Zool. R. 126	√		√		√			
Zool. E. 131	√		√		√			
Zool. H. 201	√		√		√			
Zool. H. 202	√		√		√			
Zool. H. 203	√		√		√			
Zool. H. 204	√		√		√			
Zool. H. 205	**Evaluation**							

Zool. HV. 206	**Evaluation**							
Zool. HP. 211		√	√	√	√	√	√	√
Zool. R. 221	√		√		√			
Zool. R. 222	√		√		√			
Zool. R. 223	√		√		√			
Zool. R. 224	√		√		√			
Zool. RP. 231		√	√		√	√	√	√
Zool. RP. 232		√	√		√	√	√	√
Zool. H. 301	√		√		√			
Zool. H. 302	√		√		√			
Zool. H. 303	√		√		√			
Zool. H. 304	√		√		√			
Zool. H. 305	√		√		√			
Zool. H. 306	√		√		√			
Zool. H. 307	√		√		√			
Zool. H. 308	**Evaluation**							
Zool. HV. 309	**Evaluation**							
Zool. HP. 311		√	√	√	√	√	√	√
Zool. H. 401	√		√		√			
Zool. H. 402	√		√		√			
Zool. H. 403	√		√		√			
Zool. H. 404	√		√		√			
Zool. H. 405	√		√		√			
Zool. H. 406	√		√		√			
Zool. H. 407	√		√		√			
Zool. H. 408	**Evaluation**							
Zool. HV. 409	**Evaluation**							
Zool. HP. 411		√	√	√	√	√	√	√
Zool. HR. 421		√	√	√				√

21. EVALUATION PROCESS

Examinations

The B. Sc. Honours examination held annually will consist of the (i) B. Sc. Honours Part-l examination at the end of the first academic year, (ii) B. Sc. Honours Part-2 examination at the end of the second academic year,(iii) B. Sc. Honours Part-3 examination at the end of the third academic year and (iv) B. Sc. Honours Part-4 examination at the end of the fourth academic year. An Honours student, for obtaining

the degree, shall have to pass all the examinations within 6 (six) academic years from the date of his/her first admission and shall not be allowed to stay more than 2 (two) academic years in each of his/her first, second and third year Honours classes. The non-credit English course shall have to be passed in 4 (four) academic years from the date of his/her admission.

Eligibility for examinations

(a) **Percentage of Attendance:** In order to be eligible for taking up the B. Sc. Honours examinations, a candidate must have pursued a regular course of study by attending not less than 75% of the total number of classes held (theoretical, practical, class assessment etc.) provided that the Academic Committee of the department on special grounds and on such documentary evidence that may be necessary, may condone the cases of shortage of attendance not below 60%. A candidate, appearing at the examination under the benefit of this provision shall have to pay in addition to the examination fees, the requisite fee prescribed by the Syndicate for the purpose. Candidates having less than 60% attendance shall not be allowed to fill up the examination form.

(b) **Readmission:** A candidate, who failed to appear at the examination or fails to pass the examination, may on the approval of the relevant department be readmitted to the immediate following session in the first, second, third or fourth year of the programme. A readmitted candidate shall have to reappear at all course examinations.

Duration of Examinations: The duration of examinations of the theoretical courses is 3 hours for 0.50 unit and 4 hours for 0.75- and 1.00-unit courses. The duration of practical examinations shall be 6-12 and 12-24 hours (6 hours per day) for 0.50- and 1.00-unit practical courses, respectively.

Medium and Nature of Questions and Answers: Questions are made in English and /or a translated version in Bangla. The medium of answers in the examination of all courses is either English or Bangla. However, a mixing of English and Bangla is never allowed in the answer scripts. At least 50% questions are of short objective type.

Class Assessments: Each class assessment on each theoretical course is taken in one lecture period by the individual course teacher(s) during the middle of the progress and/or the end of the course for internal evaluation. Laboratory assessment is taken by the concerned teacher(s) continuously throughout the year in each laboratory class.

Degree Requirements: The degree shall be awarded on the basis of CGPA obtained by a candidate in B. Sc. Honours Part-I, Part-2, Part-3 and Part-4 examinations. In order to qualify for the B. Sc. Honours degree, a candidate must have to obtain the following within 6 (six) academic years from the date of admission: (i) a minimum CGPA of 2.00; (ii) a minimum GPA of 2.00 in the practical courses in each of Part-I, Part-2, Part-3 and Part-4 examinations, (iii) a minimum TCP of 144 and (iv) “S” letter grade in English course (letter grade “S” corresponds to at least 30% marks).

Publications of Results: The overall results of a successful candidate covering all examinations of four years shall be declared on the basis of CGPA with the corresponding letter grade (LG). The transcript in English shall show the course number, course title, credit, grade and grade point of individual courses, GPA of each year and CGPA for the overall result.

Promotions: In order to be eligible for promotion from one class to the next higher Honours class, a candidate must secure (i) at least 2.00 GP in each of his/her Part-I, Part-2 and Part-3 examinations, (ii) at least 2.00 GPA in each of his/her Part-I, Part-2 and Part-3 practical course examinations, and (iii) 30 credits for each of Part-I and Part-2 and 34 credits in Part-3 examinations.

Course Improvement: A promoted student earning a grade less than 2.75 in individual course shall be allowed to improve the grades on courses, not more than two full unit courses of Part-I, Part-2 and Part-3 examinations or their equivalent courses (in case of changes in the curriculum), defined by the departmental Academic Committee, through the regular examination of the immediate following batch. No improvement shall be allowed in practical course examinations/ *viva-voce*/ class assessment/ tutorial/ terminal / Field report/ excursion/ home assignment and thesis/ dissertation courses. If a candidate fails to

improve his/her course grade, the previous grade shall remain valid. If a readmitted candidate fails to appear at the class assessment/ tutorial terminal / home assignment and thesis dissertation/ Project courses, his/her previous grades shall remain valid.

Result Improvement: A candidate obtaining a CGPA of less than 2.75 at the end of the Part-4 examinations, within 6 (six) academic years, shall be allowed to improve his/her result, on up to a maximum of 4 (four) full units of the Part-4 theoretical courses in the immediate next regular examination after publication of his/her result. The year of examination, in the case of a result improvement, shall remain same as that of the regular examination. No improvement shall be allowed for practical courses/ *viva-voce*/class assessment/ Tutorial/ terminal / home assignment/ thesis/ dissertation/ Field report/ excursion/ courses. If a candidate fails to improve CGPA with the block of new GP in total, the previous results shall remain valid.

Dropping Out: Candidates failing to earn the yearly required GPA after completing regular examinations, and subsequently failed again after taking readmission in the 1st, 2nd or 3rd years, shall be considered as dropped out of the programme.

The Grading Systems

(a) **Credit Point (CP):** The credit points achieved by an examinee for 0.50- and 1.00-unit courses shall be 2 and 4, respectively. For other fractions of a unit, proportionality should be applied.

Numerical Grade (NG), Letter Grade (LG), Grade point (GP) and Credit Point (CP) shall be awarded in accordance with the provisions shown below:

Numerical Grades (NG)	Letter Grade (LG)	Grade point (GP/unit)	Credit Point (CP/unit)
80% or its above	A^+ (A plus)	4.00	4
75% to less than 80%	A (A regular)	3.75	4
70% to less than 75%	A^-(A minus)	3.50	4
65% to less than 70%	B^+ (B plus)	3.25	4
60% to less than 65%	B (B regular)	3.00	4
55% to less than 60%	B^- (B minus)	2.75	4
50% to less than 55%	C^+ (C plus)	2.50	4
45% to less than 50%	C (C regular)	2.25	4
40% to less than 45%	D	2.00	4
Less than 40%	F	0.00	0
Incomplete	I	--	0

Absence from the final examination shall be considered incomplete with the letter grade "I".

LG, GP and CP for non-credit courses:

Numerical Grades (NG)	Letter Grade (LG)	Grade point (GP/unit)	Credit Point (CP/unit)
30% and its above	S	00	00
Less than 30%	U	00	00

Here S and U refer to 'satisfactory' and 'unsatisfactory', respectively.

(b) Calculation of Grade Point Average (GPA), Cumulative Grade Point Average (CGPA) and Total Credit Point (TCP):

The weighted average of the grade points obtained in all the courses by a student and Total Credit Point shall be calculated from the following equations: GPA = Sum of $[(CP)_i \times (GP)_i]$ / sum of $(CP)_{i;}$ TCP = Sum of $(CP)_i$

The weighted average of the GPAs of a student in all four years shall be calculated from the following equation:

CGPA = Sum of $[(TCP)_j \times (GPA)_j]$ / Sum of $(TCP)_j$, where $(GP)_i$ = grade point obtained in individual courses, $(CP)_i$ = credit point for respective course, $(GPA)_j$ = grade point average obtained in a year and $(TCP)_j$ = total point (or that year. GPA and CGPA shall be rounded off up to 2 (two) places after decimal to the advantage of the examinee. For instance, GPA=2.112 shall be rounded off as GPA=2.12.

22. Academic Calendar

The date of beginning and completion of course(s), date of examination, publication of results etc. shall have to be declared by the department concerned through an academic calendar at the beginning of the session. In preparing calendar the following points shall have to be considered:

(a) Course(s) shall have to be completed within 8 (eight) months.
(b) Examination shall start after three weeks from the date of completion of the course(s).
(c) At least 2 (two) theoretical course examinations shall be held per week.
(d) Examination results shall ordinarily be published within 6 (six) weeks from the date of completion of the examination.

Detail curriculum

For First Year Honours Degree

in Zoology

B.Sc. (Honours) Part-I Examination, 2020

Course Title: Introduction to Zoology and Bioinformatics		
Course Code: Zool.H.101	**Course Type:** Theory (Core Course, Mandatory)	**Credits:** 4
Full Marks: 100	**Total Lecture hours:** 60	**Exam Hours:** 4

Course Description

History and miles stones in Zoology:

This course is to be introduced the historical background of the zoological studies and its development; great personalities and their contribution

Bases of Animal Taxonomy: This course is designed to group animals according to their internal and external characters morphological and anatomical characters), so that learners can identify an unknown animal in field and laboratory.

Habits, Habitats and Zoogeography of Bangladesh: Description and adaptive features of different animal habits; types of animal association with examples; discuss animal habitats providing examples from each habitat type; distribution of animal on earth; zoogeography of Bangladesh in brief.

Techniques and methods used in zoological studies: Instruments: Introduced with different instruments/equipments used in zoology lab, their use. To be introduced the lower animal collection, culture and preservation techniques,

Bioinformatics: Introduction of the bioinformatics concepts, vocabularies, and application, familiarize with various bioinformatics tools, databases and resources and provide an understanding of web-accessible bioinformatics applications.

Course Learning Objectives

1. To describe the history and miles stones in Zoology
2. To explain bases of animal Taxonomy
3. To describe habits, habitats and zoogeography of Bangladesh
4. To introduce the techniques and methods used in zoological studies
5. To discuss on Bioinformatics

Course Learning Outcomes (CLOs)

After completion of **Bases of Animal Taxonomy** course, learners will be able to:

1. Describe Animal World, extinct and extant animals, Palaeontology and Neontology;
2. Explain significances of animal in nature and to human being;
3. Define zoology and, discuss on scope and approaches of the subject;
4. Describe origin of life from pre-life stages to cell stage; organization levels of animal (pre-biotic, cell formation, and single celled to multicellular organisms); categorize organisms into population community, fauna, biota, ecosystem and biosphere; division of biodiversity;
5. Define cell, tissue, organ, organ system; describe primitive and ideal cell with characters, functions of cell organelles, types of tissues;
6. Define taxonomy, systematic and classification; define and describe basic taxonomic divisions (taxa)and Linnaean hierarchy;
7. Discuss on different kingdom systems of animals provided by different authors at different time;
8. Explain the bases of animal classification (with examples) e.g., orientation, symmetry, planes and taxes, metamerism, tagmatization, body coverings, appendages, phylogeny, and define each of these terminologies;
9. Define embryology and embryogeny, fertilization, cleavage; egg types based on yolk character; state charcters of Prostomium and Deuterostomium animals; group animal phyla in these two divisions;
10. Define coelom, describe types and functions of coelom; name of germinal layers in vertebrate embryo;
11. Discuss naming (nomenclature) of animals and taxa, specific characters used in nomenclature, provide examples.

After completion of **Habits, Habitats and Zoogeography of Bangladesh** course, learners will be able to:

1. Describe and characterize animal habits like feeding and living, provide adaptive features and examples;
2. Explain different types of animal association, providing examples from each;

3. Classify animal habitats with distinguishing characters, mention examples and distribution of animals in each of these habitats;
4. Discuss spatial and temporal distribution of animals; describe briefly zoogeography of Bangladesh; temporal distribution of animals based on Geological Time Scale (GTS) from beginning of animal life up to recent groups;
5. Describe different eras, periods and epochs with major groups of animals of that times;
6. Discuss on bioecological and agroecological zones of Bangladesh; prepare report on habitat and fauna.

After completion of **History and miles stones in Zoology; Techniques and methods and Bioinformatics** course, learners will be able to:

1. Describe the zoological history, great personalities of Zoology and their contribution in the development of zoological studies.
2. Identify the lower animal specially insect collecting kits and their preservation
3. Describe the lower animal culture techniques.
4. Describe different components of computers including programming languages and networking systems.
5. Describe the computational applications related to biological data.
6. Describe the flow and regulation of biological information.
7. Identify appropriate biological data bases for specific analyses.
8. Manipulate on-line resources appropriately.
9. Manage bioinformatics tools.
10. Apply appropriate statistical methods to determine sequence similarities.
11. Appreciate diversified areas and applications like genomics, drug designing, agri- and health informatics, biotechnology, systems biology and others.

Course contents, subject to the lecture and alignment of topic with CLOs

Course contents	Subject to the lecture	Alignment of topic with CLOs	LH
History and milestone in Zoology			
Historical background of Zoological Studies	❖ Discussion and summarize the topic	CLO 1	2
Great personalities of Zoology of Europe	❖ Discussion and summarize the topic	CLO 1	2
Great personalities of Zoology of Asia Minor, Middle East	❖ Discussion and summarize the topic	CLO 1	2
Great personalities of Zoology of America	❖ Discussion and summarize the topic	CLO 1	2
Great personalities of Zoology of India and Bangladesh	❖ Discussion and summarize the topic	CLO 1	2
Bases of Animal Taxonomy			
Animal World; Significances of animal;	❖ What Animal World means; ❖ Definition will be given on Zoology, Extinct and extant animals with examples; ❖ Palaeontology and Neontology will be defined; ❖ Significances of animals to nature and human being will discussed;	CLO 1 CLO 2	2
Scope and approaches of the subject	❖ Scope of the subject will be discussed at national and global aspects; ❖ Major approaches of zoology study e.g., morphology, anatomy & physiology; ecology; genetics; cytology & histology; evolution; biodiversity, etc. will be discussed;	CLO 2 CLO 3	2
Origin of life and levels of	❖ Lecture will be delivered on origin of life – stages	CLO 4	2

animal organization	from prebiotic up to cell formation, tabulating characters and products of each stage; ❖ Characters of probionts and phases in transformation of microspore into cell will be discussed; ❖ Levels of organization of animals from atomic to biosphere will be discussed with the help of flow chart. ❖ Main evolutionary character and affination of animals from single cell up to the highest form will be discussed; ❖ Biodiversity types will be discussed;		
Types and characteristics of different components of organism	❖ Definition of cell, tissue, organ, organ system and organism/species individual will be provided; ❖ Types of cells and cell inclusions (organelles) and tissues will be described mentioning their respective functions; ❖ Labeled drawings will be shown on these body units.	CLO 5	2
Basic taxonomic divisions of animals, bases of animal classification	❖ Definition of taxonomy, systematic and classification will be given; ❖ Taxonomic divisions (taxa)according to Linnaean hierarchy will be discussed; ❖ Discussion on different kingdom systems of animals provided by different authors at different time will be made; ❖ Bases of animal classification (with examples) e.g., orientation, symmetry, planes and taxes, metamerism, tagmatization, body coverings, appendages, phylogeny, will be discussed defining each of these terminologies;	CLO 6 CLO 7 CLO 8	4
Embryology	❖ Definition of embryology and embryogeny, fertilization and cleavage will be given; ❖ Egg types based on yolk character and cleavage types will be described; ❖ Characters of Prostomium and Deuterostomium animal will be stated: ❖ Animal phyla in these two divisions will be discussed with pictorial chart.	CLO 9	2
Coelom and germinal layers	❖ Define of coelom will be given. ❖ describing types and functions of coelom; ❖ Name of germinal layers in vertebrate embryo will be described briefly.	CLO 10	2
Animal nomenclature	❖ Lecture will provide on naming (nomenclature) of animals and taxa; ❖ Specific characters used in nomenclature of taxa will be discussed with examples.	CLO 11	2
Habits, Habitats and Zoogeography of Bangladesh			
Habits of animal (feeding and living)	❖ Lecture will describe and characterize animal habits like feeding and living; ❖ Adaptive features and examples of different habits will be provided; ❖ Different types of animal association will be explained with examples from each.	CLO 1 CLO 2	2
Animal habitats	❖ Animal habitats will be classified ❖ with distinguishing characters;	CLO 3	2

	❖ Distribution of animals in each of habitat will be mentioned.		
Spatial and Temporal distribution of animals	❖ Spatial and temporal distribution of animals will be discussed; ❖ Brief discussion will be made defining zoogeography, zoogeographical regions of world; ❖ Zoogeography of Bangladesh will be briefly described; ❖ Temporal distribution of animals based on Geological Time Scale (GTS) from beginning of animal life up to recent groups will be described showing flow chart; ❖ Era, period, epoch and age of animals will be defined; ❖ Name of important animal groups of different time periods starting from Archeopelagic to Recent will just be mentioned.	CLO 4 CLO 5	2
Bioecological and agroecological zones of Bangladesh, Report writing on habitat and fauna	❖ Bioecological and agroecological zones of Bangladesh will be discussed; ❖ Technique of report writing on habitat and fauna will be taught.	CLO 6	2
Techniques and methods			
Methods of studying animals: collection, transportation, sampling, curation, preservation and identification	❖ Discussion and summarize the topic	CLO-2	2
Laboratory culture methods of lower animals	❖ Discussion and summarize the topic	CLO-3	2
Instrumentation in zoological studies: microscopy, centrifugation, incubation, balance, collecting devices and kits, microtomes, habitat analytical kits, haemocyto-meter, sphygmomanometer, photography, camera lucida, micrometer. Chemicals and their handlings.	❖ Discussion and summarize the topic	CLO-2	2
Bioinformatics			
History, scope and importance	❖ Discussion and summarize the topic	CLO 11	4
Computers, internet, WWW and NCBI	❖ Discussion and summarize the topic	CLO 4	2
DNA, RNA and proteins	❖ Discussion and summarize the topic	CLO 5-6	2
DNA and protein sequencing and analyses	❖ Discussion and summarize the topic	CLO 7	2
Data bases	❖ Discussion and summarize the topic	CLO 8	2
Tools and their uses	❖ Discussion and summarize the topic	CLO 9-10	2

Assessment Strategy

Type of Assessment	Components	Marks	Methods of Assessment
Final Written Examination	Broad Questions	35	Year-end final exam will be taken.
	Short Questions	35	

<table>
<tr><td rowspan="2">Continuous Assessment</td><td>Attendance</td><td>10</td><td>% of the assessment marks for attendance will be given as follows:
<table>
<tr><td>Attendance</td><td>Marks</td><td>Attendance</td><td>Marks</td><td>Attendance</td><td>Marks</td></tr>
<tr><td>95 -100%</td><td>20%</td><td>90 -<95%</td><td>18%</td><td>85 -<90%</td><td>16%</td></tr>
<tr><td>80 -<85%</td><td>14%</td><td>75 -<80%</td><td>12%</td><td>70 -<75%</td><td>10%</td></tr>
<tr><td>65 -<70%</td><td>8%</td><td>60 -<65%</td><td>6%</td><td><60%</td><td>0%</td></tr>
</table></td></tr>
<tr><td>Tutorial</td><td>20</td><td>Class test, presentation in group, assignment</td></tr>
</table>

<table>
<tr><td colspan="4">Course Title: Protista to Mollusca</td></tr>
<tr><td>Course Code: Zool.H.102</td><td colspan="2">Course Type: Theory (Core Course, Mandatory)</td><td>Credits: 4</td></tr>
<tr><td>Full Marks: 100</td><td colspan="2">Total Lecture hours: 60</td><td>Exam Hours: 4</td></tr>
<tr><td colspan="4">Course Description
The course has been designed to introduce the students with The Protozoan Phyla (Phylum Karyoblastea through Myxospora) and The Metazoan Phyla (Porifera to Gnathostomula). It will also provide knowledge about the habit, habitat, geographical distribution, morphological feature and economic importance of the representative animal of those Phyla.
The course has been designed to introduce the students with Pseudocoelomates and schizocoelous coelomates. It will also provide knowledge about the habit, habitat, geographical distribution, morphological feature and economic importance of the representative animal of those Phyla.</td></tr>
<tr><td colspan="4">Course Learning Objectives
1. To introduce The Protozoan Phyla and The Metazoan Phyla
2. To introduce Pseudocoelomates and schizocoelous coelomates
3. To provide knowledge about the habit, habitat, geographical distribution, morphological feature and economic importance of the representative animal of those Phyla.</td></tr>
<tr><td colspan="4">Course Learning Outcomes (CLOs)
After completion of the course the Protozoan Phyla (Phylum Karyoblastea through Myxospora) and the Metazoan Phyla (Porifera to Gnathostomula), learners will be able to:
1. Mention the salient features of Protozoan Phyla.
2. Explain the systematic position, habit, habitat, geographical distribution, morphological feature and economic importance of the representative animals under phylum Karyoblastea through Myxospora.
3. Write down the characteristics of The Metazoan Phyla (Porifera to Gnathostomula).
4. Describe systematic position, habit, habitat, geographical distribution, morphological feature and economic importance of the animals under phylum Sipuncula, Echura, Pogonophora, Annelida and Mollusca.
After completion of the course Pseudocoelomates and Schizocoelous coelomates, learners will be able to:
1. Define Pseudocoelomates.
2. Explain the systematic position, habit, habitat, geographical distribution, morphological feature and economic importance of the animals under phylum Gastrotricha, Nematode, Nematomrpha, Kinorhyncha, Loricifera, Priapula, Rotifera and Acanthocephala.
3. Define schizocoeloous coelomates.
4. Explain systematic position habit, habitat, geographical distribution, morphological feature and economic importance of the animals under phylum Sipuncula, Echura, Pogonophora, Annelida and Mollusca.</td></tr>
<tr><td colspan="4">Course contents, subject to the lecture and alignment of topic with CLOs</td></tr>
<tr><td>Course contents</td><td>Subject to the lecture</td><td>Alignment of topic with CLOs</td><td>LH</td></tr>
<tr><td>The Protozoan Phyla (The animal-like phyla of protists)</td><td></td><td></td><td></td></tr>
<tr><td>Phylum Karyoblastea through Myxospora: Entamoeba, Euglena, Trypanosoma</td><td>❖ Lecture is delivered on the description of the animal-like phyla of protists.
❖ Then, the habit, habitat, distribution, morphology and economic importance of the animal under the Phylum</td><td>CLO 1-2</td><td>2</td></tr>
</table>

	Karyoblastea through Myxospora: *Entamoeba, Euglena, Trypanosoma* are described.		
Leishmania, *Volvox* foraminiferans and radiolarians	❖ Lecture is delivered on the description of the habit, habitat, distribution, morphology and economic importance of *Leishmania*, *Volvox* foraminiferans and radiolarians.	CLO 1-2	2
Paramecium, Vorticella, Monocystis	❖ Lecture is delivered on the description of the habit, habitat, distribution, morphology and economic importance of *Paramecium, Vorticella, Monocystis.*	CLO 1-2	2
Eimeria, Plasmodium and *Nosema.*	❖ Lecture is delivered on the description of the habit, habitat, distribution, morphology and economic importance of *Eimeria, Plasmodium* and *Nosema*.	CLO 1-2	2
Superphylum: Parazoa Phylum – Porifera (cellular sponges): *Leucosolenia,*	❖ Lecture is delivered on definition of phylum Parazoa. ❖ Then, the habit, habitat, distribution, morphology and economic importance of *Leucosolenia* and *Scypha* are described.	CLO 3-4	4
Spongilla, Phylum -Symplasma (syncytial sponges):	❖ Lecture is delivered on definition phylum Symplasma. ❖ Then, the habit, habitat, distribution, morphology and economic importanc of *Spongilla* will be described.	CLO 3-4	2
Superphylum: Phagocytellozoa			
Phylum – Placozoa: *Trichoplax*	❖ Lecture is delivered on definition of phylum Placozoa. ❖ Then the habit, habitat, distribution, morphology and economic importance of *Trichoplax* are described.	CLO 3-4	2
Eumetazoa: (Superphylum: Radiata)			
Phylum – Cnidaria: *Obelia, Physalia, Bougainvillia, Porpita,*	❖ Lecture is delivered on definition of phylum Cnidaria. ❖ Then, the habit, habitat, distribution, morphology and economic importance of *Obelia, Physalia, Bougainvillia, Porpita.*	CLO 3-4	2
Tubipora, Gorgonia, Aurelia, any sea anemone.	❖ Lecture is delivered on the habit, habitat, distribution, morphology and economic importance of *Tubipora, Gorgonia, Aurelia,* any sea anemone is described.	CLO 3-4	2
Phylum – Ctenophora: *Pleurobrachia, Hormiphora,* and *Beroe*.	❖ Lecture is delivered on the description of the habit, habitat, distribution, morphology and economic importance of *Pleurobrachia, Hormiphora,* and *Beroe.*	CLO 3-4	2
Superphylum: Mesozoa			
Phylum – Rhombozoa: *Dicyemennea*	❖ Lecture is delivered on the description of the habit, habitat, distribution, morphology and economic importance of *Dicyemennea.*	CLO 3-4	2
Superphylum: Bilateria (Protostomes: Acoelomates)			
Phylum-Platyhelminthes: *Planaria*, *Fasciola, Schistosoma*, *Clonorchis* and *Taenia.*	❖ Lecture is delivered on the description of the habit, habitat, distribution, morphology and economic importance of *Planaria, Fasciola, Schistosoma*, *Clonorchis* and *Taenia.*	CLO 3-4	2
Phylum – Nemertea : *Carinoma, Cerebratulus, Prostoma, Nipponnemertes.*	❖ Lecture is delivered on definition of phylum Mollusca. ❖ Then, the habit, habitat, distribution, morphology and economic importance of *Carinoma, Cerebratulus, Prostoma, Nipponnemertes* will be described.	CLO 3-4	2
Phylum – Gnathostomula: Any gnathostomulid.	❖ Lecture is delivered on the description of the habit, habitat, distribution, morphology and economic importance of Any gnathostomulid.	CLO 3-4	2
Pseudocoelomates			
Phylum –Gastrotricha: Any gastrotrich	❖ Lecture is delivered on definition of Pseudocoelomates.	CLO 1	2

	❖ Then, the habit, habitat, distribution, morphology and economic importance of the animal under phylum Gastrotricha are described.		
Phylum – Nematoda: *Ascaris, Ancylostoma, Enterobius*	❖ Lecture is delivered on description of the phylum Nematoda. ❖ Then, the habit, habitat, distribution, morphology and economic importance of *Ascaris, Ancylostoma, Enterobius* are described.	CLO 2	2
Phylum – Nematoda: *Wuchereria, Trichinella, Ditylenchus*	❖ Lecture is delivered on the description of the habit, habitat, distribution, morphology and economic importance of *Wechereria*, *Trichinella*, *Ditylenchus.*	CLO 2	2
Phylum – Nematoda: *Meloidogyne, Heterodera, Caenorhabdites*	❖ Lecture is delivered on the description of the habit, habitat, distribution, morphology and economic importance of *Meloidogyne, Heterodera*, *Caenorhabdites*.	CLO 2	2
Phylum – Nematomorpha: *Nectonema*	❖ Lecture is delivered on definition of phylum Nematomorpha. ❖ Then, the habit, habitat, distribution, morphology and economic importance of *Nectonema* are described.	CLO 2	2
Phylum – Kinorhyncha: *Echinoderes.* Phylum – Loricifera: *Nanaloricus.*	❖ Lecture is delivered on definition of phylum Kinorhyncha and Loricifera. ❖ Then, the habit, habitat, distribution, morphology and economic importance of *Echinoderes* and *Nanaloricus* are described.	CLO 2	2
Phylum – Priapula: *Tubiluchus, Priapulus*	❖ Lecture is delivered on definition of phylum Priapula. ❖ Then, the habit, habitat, distribution, morphology and economic importance of *Tubiluchus* and *Priapulus* are described.	CLO 2	2
Phylum: Rotifera: Any rotifer. Phylum: canthocephala: *Macranthorhynchus* and two Bangladeshi examples	❖ Lecture is delivered on definition phylum Rotifera and Acanthocephala. ❖ Then, the habit, habitat, distribution, morphology and economic importance of Philodina, Macranthorhynchus and two Bangladeshi examples will be described.	CLO 2	2
Schizocoelous Coelomates			
Phylum – Sipuncula: *Sipunculus, Dendrostomum* Phylum – Echiura: *Echiurus*	❖ Lecture is delivered on definition of phylum Sipuncula and phylum Echiura. ❖ Then the habit, habitat, distribution, morphology and economic importance of *Sipunculus Dendorostotomum* and *Echiurus* are described.	CLO 3-4	2
Phylum – Pogonophora: *Lamellisabella* Phylum – Annelida: *Neanthes, Polynoe, Syllus*	❖ Lecture is delivered on definition of Pogonophora and phylum Annilida. ❖ Then, the habit, habitat, distribution, morphology and economic importance of and *Lamelisabella, Neanthes, Polynoe* and *Syllus* are described.	CLO 4	2
Phylum – Annelida: *Glycera,Chaetopterus, Sabella Tubifex, Dero, Glyphidrilus Eutypheous, Hirudo*, *Perionyx, Lampito*	❖ Lecture is delivered on the description of the habit, habitat, distribution, morphology and economic importance of *Glycera, Chaetopterus, Sabella, Tubifex, Dero, Glyphidrilus, Eutypheous, Hirudo, Perionix, and Lampito*	CLO 4	4
Phylum – Mollusca: *Neopilina, Patella, Pila*	❖ Lecture is delivered on definition of phylum Mollusca. ❖ Then, the habit, habitat, distribution, morphology and economic importance of *Neopilina, Patella,* and *pila* will be described.	CLO 4	2

Phylum – Mollusca: *Lymnaea, Limax, Aplysia Doris, Achatina, Dentalium,* freshwater mussel, *Sepia, Loligo, Octopus Nautilus,* shipworm, edible oysters	❖ Lecture is delivered on the description of the habit, habitat, distribution, morphology and economic importance of *Lymnaea, Limax, Aplysia Doris, Achatina* and *Dentalium* freshwater mussel*, Sepia, Loligo,* and *Octopus* Nautilus, shipworm and edible oyster*.*	CLO 4	4

Assessment Strategy

Type of Assessment	Components	Marks	Methods of Assessment
Final Written Examination	Broad Questions	35	As mentioned in Zool.H.101 (Page No.)
	Short Questions	35	
Continuous Assessment	Attendance	10	
	Tutorial	20	

Course Title: Tardigrada to Cephalochordata		
Course Code: Zool.H.103	**Course Type:** Theory (Core Course, Mandatory)	**Credits:** 4
Full Marks: 100	**Total Lecture hours:** 60	**Exam Hours:** 4

Course Description

The course Zool. H. 103 has been designed to introduce you the phylum Tardigrada to Cephalochordata. The majority animals of minor phyla have neither economic importance nor ecological significance and the study of these animals has been largely neglected. The course will provide knowledge on phylogenecity of animals between minor phyla and major phyla. This course is also aimed to provide information on habit, habitat, systemic position, shape and size, characteristics, morphology of several members of Tardigrada, Pentastoma, Onychophora, Chelicerata, Uniramia and Crustacea. This course provides the information on the economic importance of many unknown animals and their role in ecosystems as well as in the environments.

Tardigrada to Cephalochordata has been designed to introduce the organisms with their diagnostic and special features of each phylum with recent classification, salient features and brief description of the representative animals from the following groups. Finally, it will capable we to apply our knowledge and skill for identify of this type species and conserve the biodiversity.

Course learning Objectives

1. To introduce you the phylum Tardigrada to Cephalochordata.
2. To provide knowledge on phylogenecity of animals between minor phyla and major phyla.
3. To provide information on habit, habitat, systemic position, shape and size, characteristics, morphology and economic importance of several members of minor phyla and major phyla
4. To apply knowledge and skill for identify of this type species and conserve the biodiversity.

Course learning Outcomes (CLOs)

After completion of phylum Tardigrada to Crustacea course, learners will be able to:

1. Define Bilateria
2. Explain the minor phyla and their importance in ecosystems
3. Define coelomates
4. Describe Tardigrada and their importance in animal kingdom as well as in ecosystems.
5. Explain the habit, habitat and morphology of Pentastoma and their economic importance
6. Explain the characteristics of Onychophora and their type study.
7. Describe the salient features of Chelicerata and the habit, habitat, systemic position and their role in various ecosystem.
8. Classify the different types of of animals in Uniramia with their habit, habitat, morphology, reproduction, economic importance.
9. Explain the characteristics of crustacea.
10. Define systemic position of crustacean members with their habit, habitat, morphology, reproduction,

economic importance and their role in environment.

After completion of Phorona to Cephalochordata course, learners will able to:

1. Identify the bilaterian organisms.
2. Classify the phylum Tardigrada to Chordata.
3. Describe the salient feature of the organisms.
4. Describe the habits of the organisms.
5. Describe the habitat of the organisms.
6. Describe the external morphology of the organisms.
7. Describe mode of development, whether it direct or indirect.
8. Work in taxonomical research lab.
9. Explain the affinities of the organisms.

Course contents, subject to the lecture and alignment of topic with CLOs

Course contents	**Subject to the lecture**	**Alignment of topic with CLOs**	**LH**
Phylum-Tardigrada: Macrobiotus, Echiniscus	❖ Lecture will be used to provide definition of minor phyla to give details about tardigrada.	CLO 1-4	2
Phylum- Pentastoma: Linguatula	❖ Lecture will be used to explain the characteristics of the phylum. ❖ Then, habit, habitat and morphology of Linguatula will be discussed.	CLO 5	2
Phylum- Onychophora: Peripatus, Peripetopsis	❖ Lecture will be used to describe the phylum Onychophora. ❖ Then, Peripatus and Peripetopsis will be discuss to learn.	CLO 6	2
Phylum- Chelicerata: King crab, (BD species), Buthus, Ixodes, eriophyid mites	❖ Lecture will be used to interpret the characteristics of the phylum Chelicerata including details about the mentioned animals.	CLO 7	4
Phylum- Uniramia: Scutigera, Scolopendra, Julus, housefly, mosquito, honeybee, firefly, ladybird beetle, Sitophilus, Tribolium, Callosobruchus, Apantalis, Dysdercus, Chilo, syrrphid, Scirpophaga, Sisemia, Kerria, silk-moth, Papilio, Drosophila, dragonfly, grasshopper, ants, termites and aphids.	❖ Lecture will be used to describe the classification, habit, habitat, morphological characteristics including economic importance of the mentioned animals.	CLO 8	14
Phylum- Crustacea: Lepas, Balanus, Argiopes, prawn, Eupagurus, crab, Sacculina, Argulus.	❖ Lecture will be used to describe the detail on crustacea and the type study of mentioned organisms including their economic importance.	CLO 9-10	6
Lophophorate Coelomate			
Phylum – Phorona: *Phoronis.* Phylum – Brachiopoda: *Lingula.* Phylum – Bryozoa (Ectoprocta/Polyzoa): *Bugula*, *Cristatella.* Phylum – Entoprocta: *Urnatella, Pedicellina.* Phylum – Cycliophora: *Symbion*	❖ Class lecture will be delivered to provide morphological description with example.	CLO 1-9	10

Deuterostomes or Enterocoelous coelomates			
Phylum–Chaetognatha: *Sagitta, Spadella.* Phylum– Hemichoradata: *Balanoglossus, Cephalodiscus.*	❖ Class lecture will be delivered to provide morphological description with example.	CLO 1-9	5
Phylum–Chinodermata: *Antedon, Cucumaria, Echinus, Echinarachnius, Astropecten, Ophiura*.	❖ Class lecture will be delivered to provide morphological description with example	CLO 1-9	5
Phylum–Chordata: Sub-Phylum : Urochordata: *Oikopleura, Salpa, Ascidia.* Sub-Phylum: Cephalochordata: *Branchiostoma*.	❖ Class lecture will be delivered to provide morphological description with example.	CLO 1-9	10

Assessment Strategy

Type of Assessment	Components	Marks	Methods of Assessment
Final Written Examination	Broad Questions	35	As mentioned in Zool.H.101 (Page No.)
	Short Questions	35	
Continuous Assessment	Attendance	10	
	Tutorial	20	

Course Title: Pisces to Mammalia		
Course Code: Zool.H.104	**Course Type:** Theory (Core Course, Mandatory)	**Credits:** 4
Full Marks: 100	**Total Lecture hours:** 60	**Exam Hours:** 4

Course Description

Pisces to Mammalia course has been designed to introduce students the phylum: Chordata, Sub-Phylum: Vertebrata, Super - Class: Pisces, Division I: Agnatha Class Myxini. Myxine, class: Cephalaspidomorphi: Petromyzon, class: Ostracodermi Division II: Gnathostomata, class: Placodermi, class Chondrichthyes, and class Osteichthyes and their representative animals. This course will also provide Knowledge on fundamental characteristics and major divisions of Chordate diversity, general characteristics of vertebrates, classification of super class Pisces with characters and examples of its main groups, classification of Cyclostomata with characters and examples and affinities of Cyclostomata, characters, classification, biological importance and affinities of Ostracoderms and Placoderms. Classification of Chondrichthyes and Osteichthyes up to order or family with salient features and examples. Altogether students will learn about habit habitat, geographical distribution, external features labeled diagram, breeding behavior and economic importance of representative fishes of class - Chondrichthyes and Osteichthyes. Finally, it will capable students to apply their knowledge and skill for identifying various types of fishes in the world.

Pisces to Mammalia course has been designed to introduce the students with the super–class: Tetrapoda, Class- Amphibia, Reptilia, Aves and Mammalia and their representative animals. This course is also aimed to provide information salient features and classification of class Amphibia, Reptilia, Aves and Mammalia and you will learn about habit, habitat, geographical distribution, external structure breeding behavour, labeled diagram and economic importance of representative animals of Amphibia, Reptilia, Aves and Mammalia. Finally, it will capable the students to apply their knowledge and skill for identifying various types of animals in the world.

Course Learning Objectives

1. To introduce the phylum: Chordata, Sub-Phylum: Vertebrata, Super - Class: Pisces, Tetrapoda, Class- Amphibia, Reptilia, Aves and Mammalia and their representative animals.
2. To provide Knowledge on fundamental characteristics and major divisions of Chordate diversity, general characteristics of vertebrates, classification of super classes with characters and examples

3. To teach about habit habitat, geographical distribution, external features labeled diagram, breeding behavior and economic importance of representative classes of fishes Tetrapoda, Class-Amphibia, Reptilia, Aves and Mammalia and their representative animals.
4. To apply knowledge and skill for identifying various types of animals in the world.

Course Learning Outcomes (CLOs)

After completion of Class Myxini to Osteichthyes course, learners will be able to:

1. Define Chordata, vertebrata, Pisces, Agnatha, Gnathostomata cold blooded and warm-blooded animals.
2. Classify superclass-Pisces, class- Cychostomata class- Ostracodermi, class- Placodermi, class-Chondrichthyes and class-Osteichthyes.
3. Mention the major divisions of chordate diversity.
4. Describe the general characters of phylum-Chordata, sub-phylum Vertebrata, superclass- Pisces, class-Cyclostomata, class- Ostracodermi, class- Placodermi, class-Chondrichthyes and class-Osteichthyes.
5. Compare and differences between Chordata and vertebrata, Protochordata and Urochordata, chondrichthyes and osteichthyes, *Petromyzon* and *Myxine* Skates and rays.
6. Explain the affinities of ostracoderms and placoderms.
7. Explain the habit and habitat, food, feeding and breeding behavior, geographical distribution, external morphology, economic importance of various type of fishes.

After completion of Class- Amphibia to Mammalia course, learners will be able to:

1. Define tetrapoda, Amphibia, Reptilia, Aves and Mammalia
2. Classify class Amphibia, Reptilia, Aves and mammalian up to orders with diagnostic characters and examples.
3. Mention the common and scientific name of representative animals of class Amphibia, Reptilia, Aves and mammalian
4. Explain the habit and habitat, food, feeding and breeding behavior, geographical distribution, external morphology, labeled diagram and economic importance of representative animals of Amphibia, Reptilia, Aves and Mammalia.
5. Compare the turtles, tortoises, terrapins; crocodylus, alligator and gavialis; migratory, resident and non- resident bird; Prototheria, Metatheria and eutheria; dolphin, whale and porpoise
6. Distinguish between frogs and toads, lizards and snakes, poisonous and non-poisonous snakes, flightless and flying birds, Indian elephant and African elephant, human beings and apes

Course contents, subject to the lecture and alignment of topic with CLOs

Course contents	Subject to the lecture	Alignment of topic with CLOs	LH
Phylum: Chordata Sub- Phylum: Vertebrata Super-Class: Pisces Division I: Agnatha Class Myxini : *Myxine*	❖ Lecture will be used to provide definition of vertebrata, lower vertebrates and higher vertebrates, protostomia and Deuterostomia, Cyclostomata and Agnatha ❖ Then, the classification of Cyclostomata with characters and examples will be applied to explain. ❖ Then, the systematic position, habit and habitat, external morphology, economic importance of *Myxine* will be described.	CLO 1-6	2
Class Cephalaspidomorphi: *Petromyzon*	❖ Lecture will be used to describe the geographical distribution, habit, habitat, structural features, breeding behavour, economic importance and the affinities and systematic position and labeled diagram of *Petromyzon* and compare the morphology of Petromyzo and Myxine.	CLO 1-6	2
Class-Ostracodermi	❖ Lecture will be used to describe the characters, classification, biological importance and affinities of ostracoderms.	CLO 1-6	2
Division II: Gnathostomata Class-Placodermi	❖ Lecture will be used to describe classification and biological significance of Placoderms.	CLO 1-6	2

Class: Chondrichthyes: Dogfish (*Scoliodon*),	❖ Lecture will be used to provide definition of Chondrichthyes and shark. ❖ Then, the characteristics of Chondrichthyes, classification of Chondrichthyes up to order with salient features and examples will be applied to explain. ❖ Then, the systematic position, geographical distribution, habit, habitat, structure, breeding behavior and economic importance and labeled diagram of Dogfish (*Scoliodon*) will be described.	CLO 1-7	2
Class-Chondrichthyes. sawfish (*Pristis*), hammerhead (*Sphyrna*), sting ray (*Raja*),	❖ Lecture will be used to describe the systematic position, geographical distribution, habit, habitat, structure, breeding behavior and economic importance and labeled diagram of *Pristis*, *Sphyrna* and *Raja*.	CLO-7	2
Class:Chondrichthyes-electric ray (*Narcine*), tiger shark (*Stegostoma*) and rat fish (*Chimaera*)	❖ Lecture will be used to describe the systematic position, geographical distribution, habit, habitat, structure, breeding behavior and economic importance and labeled diagram of *Narcine*, *Stegostoma* and *Chimaera.*	CLO-7	2
Class. Osteichthyes	❖ Lecture will be used to provide definition of Osteichthyes and modern bony fish, ❖ Then, the characteristics and classification of Osteichthyes up to order giving characters and examples, comparison between Chondrichthyes and Osteichthyes will be explained.	CLO-7	2
Major carp (*Labeo*), climbing perch (*Anabas*), river shad (*Tenualosa/Hilsa*),	❖ Lecture will be used to provide definition of major and minor carp. ❖ Then, the types of carp, the structure, food and feeding habit; breeding and carp culture and its impact on socio-economic development will be described.	CLO-7	2
snakehead (*Channa*), catfish (*Heteropneustes*), gar *(Xenontodon*), halfbeak (*Hyporhampus)*	❖ Lecture will be used to describe characteristic features of snake-headed fishes, types of snake-headed fishes found in Bangladesh, external structure of *Channa.* ❖ Then, habit habited breeding economic importance of *Channa, Heteropneustes*, *Xenontodon* and *Hyporhampus* will be described.	CLO-7	2
seahorse (*Hippocampus*), puffer (*Tetraodon*), eel (*Anguilia*), mullet (*Mugil*),	❖ Lecture will be used to describe habit, habitat, breeding and economic importance of *Hippocampus, Tetraodon, Anguiliasual, Mugil.*	CLO-7	2
flatfish (*Cyanoglossus*), mudskipper (*Periopthalmus*), freshwater eel (*Mastacembalus*), sturgeon (*Acipenser*)	❖ Lecture will be used to describe habit habited breeding economic importance of *Cyanoglossus, Periopthalmus, Mastacembalus and Acipensen*	CLO-7	2
flying fish (*Exocoetus*), paddle fish (*Polyodon*), bowfin *(Amia),* bichir	❖ Lecture will be used to describe habit habited breeding economic importance of *Exocoetus, Polyodon, Amia and Polypterus*	CLO-7	2

(*Polypterus*)			
Notopterus and SIS fishes.	❖ Lecture will be used to describe the migratory fish (*Hilsa*) found in Bangladesh and SIS fishes.	CLO-7	2
Class. Osteichthyes (Lung fishes)	❖ Lecture will be used to describe the types of Lung fishes, the discontinuous distribution, structure and phylogenetic relationship of lung fishes.	CLO-7	2
Super-Class: Tetrapoda			
Classification of class amphibia	❖ Lecture is delivered to provide of tetrapoda and amphibia. ❖ Then, the salient features of amphibian. Classification of amphibian up to order giving diagnostic features and examples will be explained.	CLO 1-6	1
Amphibians animals *Necturus* and *Microhyla*	❖ Lecture is delivered to provide definition of larva, pupa, neoteny, paedogenesis, oviparous, viviparous and ovo-viviparous. ❖ Finally, learning will be used to describe the classification, habit and habitat, structural features, economic importance and labeled diagram of *Necturus* and *Microhyla. Distinguish between frogs and toads.*	CLO 1-6	1
Amphibians animals *Salamandra* and *Ambystoma*	❖ Lecture is delivered to describe the classification, habit and habitat, external structure, labeled diagram and economic importance of *Salamandra* and *Ambystoma.*	CLO 1-6	2
Amphibians animal *Seymoria*	❖ Lecture is delivered to provide definition fossil and living fossil. ❖ Then, lecture will be used to the describe the classification, habit and habitat, external structure, labeled diagram and economic importance of *Seymoria.*	CLO 1-6	1
Classification of class Reptilia	❖ Lecture is delivered to provide of reptilia. ❖ Then, the salient features of reptilia, classification of reptilia up to order giving diagnostic features and examples will be explained.	CLO 1-6	1
Reptilian animals *Calotes*, *Draco* and *Sphenodon*	❖ Lecture is delivered to the describe the classification, habit and habitat, external structure, labeled diagram and economic importance of *Calotes*, *Draco* and *Sphenodon.*	CLO 1-6	1
Reptilian animals *varanus,* common wall lizards and *Archaeopteryx*	❖ Lecture is delivered to explain the classification, habit and habitat, external structure, labeled diagram and economic importance *varanus,* common wall lizards and *Archaeopteryx.*	CLO 1-6	1
Reptilian animals-turtles, tortoises and terrapins	❖ Lecture is delivered to define of turtles, tortoises and terrapins of turtles, tortoises and terrapins.	CLO 1-6	1
Local snakes of Bangladesh and Python	❖ Lecture is delivered to explain the general features of snakes, distinguishing features between poisonous and non-poisonous snakes, local snakes of Bangladesh and explain the classification, habit and habitat, external structure, labeled diagram and economic importance *Python.*	CLO 1-6	1
Reptilian animals *Gavialis*, *Crocodilus* and *Alligator*	❖ Lecture is delivered to mention general characters of Crocodilians, explain the classification, habit and habitat, external structure, labeled diagram and economic importance *of Gavialis, Crocodilus and Alligator,* distinguishing features between *Gavialis,*	CLO 1-6	1

	crocodilus and *Alligator*		
Mesozoic reptiles and causes of their extinction	❖ Lecture is delivered to explain the Dinosaurs of Mesozoic era and causes of extinction of dinosaurs.	CLO 1-6	1
Classification of class aves	❖ Lecture is delivered on the characteristics of aves or birds, Classification of flightless and flying birds or Ratitae and carinatae. ❖ Then the chemical reaction involved in catabolism of protein: Transamination and Oxidative deamination will be explained.	CLO 1-6	1
Predatory or Carnivorous birds	❖ Lecture is delivered to provide of Predatory or Carnivorous birds. ❖ Then, the classification, habit and habitat, external structure, labeled diagram and economic importance of Predatory or Carnivorous birds will be described.	CLO 1-6	2
Insectivorous birds	❖ Lecture is delivered to provide of Insectivorous birds. ❖ Then, the classification, habit and habitat, external structure, labeled diagram and economic importance of Insectivorous birds will be described.	CLO 1-6	2
Game birds	❖ Lecture is delivered to describe Game birds. ❖ Then, the classification, habit and habitat, external structure, labeled diagram and economic importance of Game birds will be described.	CLO 1-6	2
Residential and non-resident birds	❖ Lecture is delivered to residential and non-resident birds. ❖ Then, the classification, habit and habitat, external structure, labeled diagram and economic importance of residential and non-resident birds will be described.	CLO 1-6	1
Classification of class Mammalia	❖ Lecture is delivered to provide of mammalia. ❖ Then, the salient features of mammalia. Classification of mammalia up to order giving diagnostic features and examples will be explained.	CLO 1-6	1
Prototheria, metatheria and eutheria	❖ Lecture is delivered to provide of prototheria, metatheria and eutheria ❖ Then, the salient features prototheria, metatheria and eutheria and distinguish between prototheria, metatheria and eutheria will be explained.	CLO 1-6	1
Marsupials	❖ Lecture is delivered to provide definition of Marsupial. ❖ learning will be used to describe the classification, habit and habitat, structural features, economic importance and labeled diagram of Marsupials.	CLO 1-6	1
Ungulates	❖ Lecture is delivered to provide definition of Ungulates. ❖ Finally, learning will be used to describe the classification, habit and habitat, structural features, economic importance and labeled diagram of Ungulates.	CLO 1-6	1
Felids and Candies	❖ Lecture is delivered to describe the classification, habit and habitat, structural features, economic importance and labeled diagram of Felids and Candies.	CLO 1-6	1
Rodents (Rats and mice)	❖ Lecture is delivered to describe the classification, habit and habitat, structural features, economic importance and labeled diagram of Rodents (Rats and mice).	CLO 1-6	1

Rodents (Hares and rabbits)	❖ Lecture is delivered to describe the classification, habit and habitat, structural features, economic importance and labeled diagram of Rodents (Hares and rabbits) and distinguish between Hares and rabbits.	CLO 1-6	1
Antlers (Deer and Rhinos)	❖ Lecture is delivered to describe the classification, habit and habitat, structural features, economic importance and labeled diagram of Antlers (Deer and Rhinos).	CLO 1-6	1
Primates (Apes and monkeys)	❖ Lecture is delivered to describe the classification, habit and habitat, structural features, economic importance and labeled diagram of Primates (Apes and monkeys).	CLO 1-6	1
Cetaceans (Aquatic mammals)	❖ Lecture is delivered to describe the classification, habit and habitat, structural features, economic importance and labeled diagram of Cetaceans (Aquatic mammals), adaptive characters of aquatic mammals, distinguish between cetacean and sirenian aquatic mammals, structure of cetacean and sirenian aquatic mammals.	CLO 1-6	1
Homo	❖ Lecture is delivered to describe the classification, habit and habitat, unique features of human being, distinguish between human being and apes.	CLO 1-6	1

Assessment Strategy

Type of Assessment	**Components**	**Marks**	**Methods of Assessment**
Final Written Examination	Broad Questions	35	As mentioned in Zool.H.101 (Page No.)
	Short Questions	35	
Continuous Assessment	Attendance	10	
	Tutorial	20	

Course: Zool. H. 105

Field study/Excursion

Full marks: 50 (0.5 unit, 2 credits)

Preparation and submission of reports on habitats of terrestrial and aquatic (fresh water, estuarine and marine) fauna; and visit to local meteorological station; Excursion to the National Safari Park at Dulahazara/Gazipur and local ones. Distribution of marks: Field report /Excursion =25; Presentation/ *viva-voce* =10; Assessment =10 and Attendance =5.

Course: Zool. HV. 106
***Viva-voce* I**

Full marks: 50 (0.5 unit, 2 credits)

Viva-voce on theoretical courses from Zool. H. 101 to Zool. H. 104.

Course Title: Zoology Practical I		
Course Code: Zool.HP.111	**Course Type:** Practical (Core Course, Mandatory)	**Credits:** 6
Full Marks: 150	**Total Lecture hours:** 90	**Exam Hours:** 18 (6 hours daily)
Course Learning Objectives To provide practical experience on the topics covered by theoretical courses so that the learner can apply		

their knowledge in lab, workplace and in practical life.

Course Learning Outcomes (CLOs)

After completion of this course, learners will be able to:

1. Display, demonstrate and draw labeled diagrams of the orientation, symmetries, planes and axes of the supplied specimens.
2. Identify cell and tissue types, chromosomes, karyotypes and nucleotides, grade of organization
3. Display, demonstrate and draw labeled diagrams of the metamerism, tagmatization and appendages of the supplied specimens.
4. Collect morphometric/meristic data from the supplied specimen, demonstrate the measurements/counts, calculate ratios between the parameters and leave a graphical presentation of the data.
5. Identify the genus of selected animals and to mention their systematic position with taxon-specific diagnostic characteristics
6. Identify the supplied specimens up to Order using taxonomic keys.
7. Apply and interpret the methods of estimation of the group diversity of different habitats.
8. Prepare and handle the different types of laboratory chemicals
9. Identify, draw labeled diagrams and mention the use of instruments/ equipment/ apparatus

Course contents, teaching strategies and alignment of topic with CLOs

Contents	Alignment of topic with CLOs	LH
Bases of Animal Taxonomy: Orientation: dorsal, ventral, oral, aboral, anterior, posterior, lateral, peduncular (or pedal disc), superior, inferior, subumbrellar, exumbrellar. **Symmetry:** asymmetry; bilateral, radial, biradial and universal or spherical symmetries; symmetry problem. **Planes and Axes:** longitudinal, transverse, dorso-ventral, cross section (CS/XS), transverse section (TS), sagittal, frontal.	CLO 1	12
Grades of organization: Acellular (protoplasmic, cellular, tissue, organ and organ systems. **Identification:** Identification of cell and tissue types, chromosomes, karyotypes and nucleotides using slides, photographs, charts and models.	CLO 2	6
Metamerism and Tagmatization: Pseudometamerism, metamerism; head-thorax-abdomen; cephalothorax; head-trunk-tail; prosoma, mesosoma, opisthosoma, metasoma; secondary loss of segmentation. **Appendages:** Structures used in locomotory, prehensile, food capturing, copulatory, defensive and/or offensive purposes: pseudopodia, flagella, cilia, tentacles, podia (parapodia and legs), antennae, antennules, pineal setae and eye stalks; mouthparts, wings, legs and prolegs, cerci, styles, sting, tentacles and arms; fins, tetrapod appendages, paddles and flippers.	CLO 3	12
Morphometrics: Earthworm: total, clitellar and girth lengths and ratios (somatic indices); Prawn: total, carapace, rostral, antennary, antennulary, telson and uropod lengths and ratios; Any insect: total, cephalic, thoracic and abdominal lengths and widths, head-width, interoccular length, wing span and their ratios; Bony fishes: total, standard, anal, fin lengths and their ratios; Snakes: scale characters of poisonous and non-poisonous species; Mammals: total, head, pinnal and tail lengths and their ratios. **Meristics:** Earthworm: segment numbers, position of different orifices; Prawn: rostral spines; Any insect: number of antennary, tarsal and abdominal segments; Bony fishes: number of fin rays and barbels; fin formulae; Mammals: whisker numbers and dental formulae. **Coelom:** Diagnostic internal features of the representative acoelomate, pseudocoelomate and eucoelomate animals.	CLO 4	15
Animal Taxonomy: Study of preserved and representative museum specimens and their identification based on taxon-specific (PCOFGS) external morphological characters; Identification of supplied animals up to order using keys; Study of planktonic freshwater animals.	CLO 5-6	24
Estimation of habitat-faunal relationships: Collection of local specimens by sweeping, beating, hand-picking, host body-researching etc. and estimation of group diversity (GD); demonstration of the collected specimens by easy conventional methods like temporary or permanent whole mounts; preparation of a field study	CLO 7	12

report on habitat-faunal relationships.		
Instrumentation and Methodologies: Laboratory safety; Use, caring and handling of microscopes: simple, compound, stereo, zoom of all models; Microscopy: magnifications, measurements using micrometers, graticules and camera lucida. Centrifugation (rpm): hand, electric and ultra-centrifuges. Balances: spring, pan and electronic, Scales and measuring tapes. Microtome machine, dissecting box, chromatographic and electrophoretic devices. Incubator and hot-water bath, autoclave, maximum-minimum temperature and estimation of RH. Binocular and camera: natural history photography. Distillation plant. Visit to a weather station (meteorological office) and submission of a report; Preparation of laboratory chemicals and their handlings: Preparation of solution with required concentration, stains, adhesive and fixatives, preservatives; Preparation of pesticide/ extractive doses, preparation of normal (N) and milli Molar (mMol) solutions. **Class/Lab notebooks:** Classroom preparations and class records.	CLO 8-9	9

Assessment Strategy

Type of Assessment	Marks	Methods of Assessment
Practical Examination	105	18-hr practical exam on the above topics (6 hrs daily)
Continuous Assessment	15	As mentioned in Zool.H.101 (Page No.)
	15	Practical class records
	15	Laboratory assessment

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Course Title: English for Communication and Science		
Course Code: Zool.E.131	**Course Type:** Theory (Core Course, non-credit)	**Credits:** 2
Full Marks: 50	**Total Lecture hours:** 30	**Exam Hours:** 3

Course Description

English for communication: This non-credit course is designed to enrich the learners' English for communication and biological sciences. Part 1 of the course is meant for communicative English where appropriate uses of articles, prepositions, tenses, conditional sentences, gerunds, infinitives, verbs, clauses and voice will be discussed to enhance the students' communicative skills by giving adequate exposure in reading and writing.

English for Science: Part 2 of the course is concerned with improving English of the students for biological science, Zoology in particular. It introduces English as the universal language of science along with its opportunities and challenges. Then such pre-writing activities as describing zoological specimens, text book, tables and graphs are included, which help the students with more advanced skills like writing field reports, and knowing about research papers and thesis or dissertations. Finally, the learners will be

introduced with topics like proofreading and editing, and criteria for good oral and poster presentations.

Course Learning Outcomes (CLOs)

After completion of **English for communication** course, the learners will be able to:

1. Show overall control of English grammar
2. Show paraphrasing and elaboration skills
3. Perform coherent organization of information at both sentence and discourse levels
4. Develop vocabulary regarding subject matter
5. Use terminologies specific to biology
6. Build up confidence in oral and interpersonal communication
7. Identify and repair the voids in one's present vocabulary, pronunciation and grammar
8. Show adequate linguistic skills to help them complete standardized tests of English

After completion of **English for Science** course, learners will be able to:

1. Explain that English as the universal language of science: its opportunities and challenges
2. Apply rules of pre-writing activities-1; Describing specimens and books
3. Apply rules of pre-writing activities-2; Describing tables and graphs
4. Write field reports, for example, on habitat-faunal relationship and Rajshahi weather station
5. Define and describe briefly structures of research papers and theses/dissertations
6. Apply rules of proofreading and editing
7. Describe criteria for good oral and poster presentations

Course contents, subject to the lecture and alignment of lectures with CLOs

Course contents	Subject to the lecture	Alignment of topic with CLOs	LH
English for communication			
Elementary English grammar: use of articles and prepositions	❖ Lecture is delivered on the description of the types and rules regarding articles. ❖ Moreover, learners will know where articles should not be used. ❖ Then, lecture is delivered on definition of preposition, explain the characters of preposition, types of prepositions and rules regarding the use of appropriate prepositions.	CLO 1 CLO 6-7	2
Types of Tenses: past, present and future tenses, conditional tenses, Sentence	❖ Lecture is delivered on the definition of tenses along with various types of tenses with correct use. ❖ Then, definition of sentences and their types and practice transformation of sentences will be discussed.	CLO 1 CLO 3 CLO 6-8	2
Gerunds: Forms and uses	❖ Lecture is delivered on the comparison between gerunds and infinitives; proper use of gerunds and infinitives will be explained with example.	CLO 1 CLO 6-8	2
Verbs: Principal and Auxiliary verbs and their uses	❖ Lecture is delivered on the definition of verbs, principal and auxiliary verbs with their correct usage; ❖ Then Regular and Irregular verbs, Transitive, Intransitive and linking verbs will also be discussed with example.	CLO 1 CLO 6-8	2
Types of Clauses and their uses	❖ Lecture is delivered on the definition of clause and identification of the types of clauses.	CLO 1 CLO 3 CLO 6-8	2
Voice: Active and Passive voices and their uses in making sentences	❖ Lecture is delivered on the definition of active and passive voices and transformation of active from passive and vice versa will be practiced. ❖ Then the use of passive voice in scientific writing	CLO 1 CLO 6-8	2

	will be described.		
Prefix and Suffix: use of prefixes and suffixes in Zoology (2 LH)	❖ Lecture is delivered on the identification of prefixes and suffixes used in English. ❖ Moreover, to be familiarized the students with the prefixes and suffixes of zoological terms.	CLO 2 CLO 4	2
Terminology: Basic Zoological terminologies and spelling rules	❖ Lecture is delivered on the build a handsome vocabulary of basic zoological terminologies along with meaning and use. ❖ Then, the spelling rules practiced in English will be explained.	CLO 1-2 CLO 5	1
English for Science			
English as the universal language of science: Opportunities and challenges; use of English in biological science	**Lecture 1:** English as the universal language of science: its opportunities and challenges	CLO 1	2
Writing for science: Pre-writing activities; describing specimens, books, tables, graphs	**Lecture 2:** Pre-writing activity-1; Describing specimens	CLO 2	2
Writing for science: Pre-writing activities; describing specimens, books, tables, graphs	**Lecture 3:** Pre-writing activity-2; Describing books	CLO 2	2
Writing for science: Pre-writing activities; describing specimens, books, tables, graphs	**Lecture 4:** Pre-writing activity-3; Describing tables and graphs	CLO 3	2
Writing reports: Structure of a report; essential stages and features of a good report	**Lecture 5:** Writing field reports	CLO 4	2
Writing theses (or dissertation): Structure of a thesis; references and appendices	**Lecture 6:** Structures of research papers and theses or dissertations	CLO 5	2
Writing a research paper: Structure of a research paper; editing and proof reading	**Lecture 7:** Proofreading and editing	CLO 6	2
Presentations: oral, poster and lecturing	**Lecture 8:** Criteria for good oral and poster presentations	CLO 7	1

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Assessment Strategy

Type of Assessment	Components	Marks	Methods of Assessment
Final Written Examination	Broad Questions	20	As mentioned in Zool.H.101 (Page No.)
	Short Questions	15	
Continuous Assessment	Attendance	5	
	Tutorial	10	

Course Title: Botany 1: Introduction to Plant Kingdom and Lower Plant Groups		
Course Code: Zool.R. 121	**Course Type:** Theory (Core Course, Mandatory)	**Credits:** 2
Full Marks: 50	**Total Lecture hours:** 30	**Exam Hours: 3**

Course Description

Botany I: Introduction to Plant Kingdom and Lower Plant Groups course has been designed to introduce you the living world and non-living environment with examples. It also covers knowledge on plant world with its origin and distribution followed by plants in association with animals. This course deals with major plant taxas in plant kingdom including their feature, classification, and economic importance. It will also provide knowledge about the resemblances and differences among different plant groups. It includes the study of the primitive plants known as algae, fungi, bryophytes and pteridophytes including their life cycle, structure and reproduction. Altogether, you will learn about bacteria including its structure, reproduction, classification and economic importance.

Course Learning Outcomes (CLOs)

After completion of this course, learners will be able to:

7. Explain the living world and non-living environment with examples
8. Interpret the interdependence of organisms
9. Define plant
10. Describe the origin and distribution of plant
11. Interpret what is the relationship between plant and animal
12. Describe the classification of plant kingdom
13. Identify the major groups of plants
14. Compare the characteristics of lower and higher plants
15. Describe the resemblances and differences among the plant taxas
16. Identify the flowering and non-flowering plant
17. Compare vascular and non-vascular plant
18. Identify the embryo bearing plants
19. Describe morphology, anatomy and reproduction of algae, fungi, bryophytes and pteridophytes.
20. Define life cycle of different lower and higher plant
21. Compare the homosporous and heterosporous pteridophytes
22. Compare the sporophytic and gametophytic generation
23. Define alternation of generation
24. Identify the algae, fungi, bryophytes and pteridophytes according their structure, characteristics and classification
25. State, describe and explain the economic importance of algae, fungi, bacteria, bryophytes and pteridophytes.
26. Classify bacteria based on their characteristics and structures.
27. Create the awareness and appreciation of human friendly algae, fungi, bacteria, bryophytes and pteridophytes.
28. Apply different teaching and learning strategies associated with biology when teaching the diversity of different plants through the use of ICT.

Course contents, subject to the lecture and alignment of topic with CLOs

Course contents	**Subject to the lecture**	**Alignment of topic with CLOs**	**LH**
Introduction			
Living world and non-living environment	❖ Lecture is delivered on the definition of different types of environment with examples. ❖ Then, the living world and non-living environment are explained.	CLO 1-2	3
Plant world: Origin and distribution and plants in association with animals	❖ Lecture is delivered on the description of the origin and distribution of plants. ❖ Then, the association of plants with animals will be explained.	CLO 3-5	3
Classification of plant kingdom	❖ Lecture are used to describe the classification of plants kingdom with examples.	CLO 6 CLO 22	2

Different major taxas of plants	❖ Lecture is delivered on the description of the basic characteristics of different major plant taxas with appropriate examples. ❖ Then, lecture will be applied to interpret the differences and resemblances among the different plant taxas.	CLO 7-9 CLO-22	2
Flowering and non-flowering plants; Vascular and Non-vascular plants	❖ Lecture are used to describe the flowering and non-flowering plants with examples and their differences. ❖ Then, lecture will be applied to interpret the basic characteristics of vascular and non- vascular plants with examples and their differences.	CLO 10-11	3
Embryo bearing plants	❖ Lecture is used to describe the characteristics of embryo bearing plants with examples.	CLO 12 CLO 22	2
Lower plants			
Algae: Characteristics, Classification, Economic Importance, Structure, reproduction and life cycle of *Volvox*, *Ulothrix*, *Choleochaeta*.	❖ Lecture is used to describe the characteristics, classification and economic importance of algae. ❖ Then, the structure, reproduction and life cycle of *Volvox*, *Ulothrix*, *Choleochaeta* are described.	CLO 13-14 CLO 17-19 CLO 21	3
Fungi: Characteristics, Classification, Economic Importance, Structure, reproduction and life cycle of *Penicillium*, *Helminthosporium*, *Agaricus*.	❖ Lecture is delivered to describe the characteristics, classification and economic importance of fungi. ❖ Then, lecture will be applied to discuss the structure, reproduction and life cycle of *Penicillium*, *Helminthosporium*, *Agaricus*.	CLO 13-14 CLO 18-19 CLO 21	3
Bacteria: Structure, Classification, Reproduction and Economic Importance	❖ Lecture is used to draw the structure and interpret the classification and reproduction of bacteria. ❖ Then, the economic importance of bacteria is described.	CLO 19-21	3
Bryophytes: Characteristics, Classification, Economic Importance, Structure, reproduction and life cycle of *Riccia* and Moss.	❖ Lecture is used to describe the characteristics, classification and economic importance of bryophytes. ❖ Then, lecture will be applied to discuss the structure, reproduction and life cycle of *Riccia* and Moss.	CLO 13-14 CLO 18-19 CLO 21	3
Pteridophytes: Characteristics, Classification, Economic Importance, Structure, reproduction and life cycle of *Equisetum* and a fern.	❖ Lecture is delivered on the description of the characteristics, classification and economic importance of pteridophytes. ❖ Then, lecture will be applied to discuss the structure, reproduction and life cycle of *Equisetum* and a fern.	CLO 13-19 CLO 21-22	3

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Assessment Strategy

Type of Assessment	Components	Marks	Methods of Assessment
Final Written Examination	Broad Questions	20	As mentioned in Zool.H.101 (Page No.)
	Short Questions	15	
Continuous Assessment	Attendance	5	
	Tutorial	10	

Course Title: Botany II: Plant Anatomy & Plant Tissue Culture		
Course Code: Zool.R. 122	**Course Type:** Theory (Core Course, Mandatory)	**Credits:** 2
Full Marks: 50	**Total Lecture hours:** 30	**Exam Hours: 3**

Course Description

This course has been designed to introduce the gamete formation, pollination, fertilization and embryogenesis of plant. Plant anatomy is the general term or study of the internal structure of plants. While originally it introduced plant morphology, which is the description of the physical form and external and internal structure of plants. Plant tissue culture is the aseptic culture of cells, tissue, organs, and their components under deferent chemical and physiological condition *in vitro*.

Course Learning Outcomes (CLOs)

After completion of this course, learners will be able to:

1. Describe the gamete formation, pollination, fertilization and embryogenesis
2. Explain internal structure and organization of plants
3. Describe cell, cell wall, tissue and tissue system, meristems, stomata, primary and secondary structure of stem and root.
4. Demonstrate a general familiarity with basic plant structure and organs; the detail structure of roots, stems and leaves of plants.
5. Explain the methods involved in tissue culture
6. Apply skills to establish *in vitro* culture techniques in agriculture and food industry

Course contents, subject to the lecture and alignment of topic with CLOs

Course contents	Subject to the lecture	Alignment of topic with CLOs	LH
Plant Anatomy			
Embryology	❖ Introduction ❖ Definition and historical background of embryology	CLO-1	1
Microsporangium and male gametophyte	❖ Microsporangium: structure and development of anther ❖ Microsporogenesis and dehiscence of anther ❖ Structure of pollen ❖ Development of male gametophyte	CLO-2	2
Megasporangium and female gametophyte	❖ Microsporangium: types of ovule ❖ Megasporogenesis: emale gametophyte ❖ Structure of a typical embryo sac; types of embryo sac	CLO-2	2
Fertilization and embryogenesis	❖ Definition, mechanism ❖ Double fertilization	CLO-3	2
Embryo	❖ Classification of embryo ❖ Embryo development in monocotyledonous plants ❖ Embryo development in dicotyledonous plants	CLO-1 CLO-2	3
Structure and composition of plant cell	❖ Cell: definition, cellular complexity in plants, origin, development, structure shape, type and function	CLO-4	2
Organization of tissue	❖ Tissue and tissue systems: definition, classification,	CLO-4	4

	origin, development, structure and function ❖ Meristem: meristem and meristematic tissues, classification, origin, development and function ❖ The shoot and root apical meristem: theories of apical organizations, structural organization of shoot and root apex, structural differentiation and function ❖ Stomata: definition, origin, development, types, structure and function		
Plant body structure	❖ Primary and secondary structures: root and stems. Anomalous secondary growth in stems and roots ❖ Periderm: origin, development, structure, location and function ❖ Transition: root-stem transition in plants, transition of vegetative to reproductive meristem, basic development of reproductive meristem ❖ Vascular differentiation: pattern of vascular differentiation in higher plants ❖ Stele: structure, types and evolution	CLO-3 CLO-4	4
Plant Tissue Culture			
Cellular totipotency	❖ Basic concept of cell theory and Cellular differentiation. ❖ Tissue culture media and components. ❖ Differentiation, de-differentiation and re- differentiation.	CLO-5	4
Application of plant tissue culture	❖ Micropropagation methods, axillary bud formation ❖ Direct and indirect organogenesis ❖ Somatic embryogenesis ❖ Meristem culture and stages of micropropagation, hardening and acclimatization, transplantation. ❖ Advantage and disadvantage of micropropagation.	CLO-6	6

Learning Resources:

Bhattacharya, K, Maumdar MR and Bhattacharya SG 72011. A text book of plant palynology. New central book agency, India

Bhojwani, S.S. and Bhatnagar SP 2014. The embryology of angiosperms. Vikas publication house pvt. Ltd. New Delhi.

Bhojwani, S.S. and Razdan, M.K. 1993. Plant Tissue Culture: Theory and Practice. Elsevier Sci. Publ., Amsterdam, The Netherlands.

George, E.F., Hall, M.A. and DeKlerk G. 2008. Plant Propagation by Tissue Culture, 3rd Ed. Vol 1, Agritech Publ. NY, USA.

Razdan, M.K. 1993. An Introduction to Palnt Tissue Culture. Oxford and IBH Publ. Co. Pvt. Ltd. New Delhi, India.

Assessment Strategy

Type of Assessment	Components	Marks	Methods of Assessment
Final Written Examination	Broad Questions	20	As mentioned in Zool.H.101 (Page No.)
	Short Questions	15	
Continuous Assessment	Attendance	5	
	Tutorial	10	

Course Title: Botany III: Taxonomy, Economic Botany & Plant Breeding		
Course Code: Zool.R. 123	**Course Type:** Theory (Core Course, Mandatory)	**Credits:** 2
Full Marks: 50	**Total Lecture hours:** 30	**Exam Hours: 3**

Course Description

Taxonomy of Angiosperms is the science of identification, classification and diversity studies of flowering plants. This course provides knowledge of economically important plants and plant products. Introduces the systematic of diseases and pathogens, host-pathogen interactions, pathogenesis and disease

management. Students will know the history, fundamental principles, practices and techniques of plant breeding. It includes productivity, disease resistance and breeding methodologies for pollinated and clonal crops.

Course Learning Outcomes (CLOs)

After completion of this course, learners will be able to:

1. Describe the plant classification as a foundation for plant recognition and family's identification.
2. Apply the basic knowledge on plant breeding and explore the necessary strategies and methods used in the breeding of different crop plants.
3. Apply the skill to identification and management of common weeds in the crop fields.
4. Apply the knowledge on commercial products derived from plants that provide us with consumable products such as oil, tea and materials such as fiber and practice of herbal medicine.
5. Identify the different symptoms and causal agents of some plant diseases and disease management.
6. Describe the various conventional and molecular methods or strategies for the genetic improvement of crops to achieve food and nutritional security.

Course contents, subject to the lecture and alignment of topic with CLOs

Course contents	Subject to the lecture	Alignment of topic with CLOs	LH
Classification of Angiosperms			
Classification	❖ Systems of classification ❖ Bentham and Hooker's system ❖ Englar and Prantle's system	CLO-1	3
Study of families	❖ Study of the Moraceae *(Morus),* Gramineae. Cruciferae, Leguminosae, Solanaceae, Nymphaceae, Labiatae, Apocynacceae, Malvaceae, Compositae, Palmae and common weeds in the crop fields (minimum 10 species name).	CLO 1 CLO 3	7
Economic Botany			
Sources, methods of cultivation, processing and uses of oil, fibre, tea and medicinal items	❖ Sources, methods of cultivation, processing and uses of oil. ❖ Sources, methods of cultivation, processing and uses of fibre. ❖ Sources, methods of cultivation, processing and uses of tea. ❖ Sources, methods of cultivation, processing and uses of medicinal items.	CLO-4	5
Role of lower plants	❖ Role of lower plants in maintaining the environment and their economic importance	CLO-4	1
Plant diseases	❖ Plant diseases caused by fungi in rice ❖ Plant diseases caused by fungi in jute ❖ Plant diseases caused by fungi in sugarcane ❖ Plant diseases caused by fungi in potato	CLO-5	4
Plant breeding			
Introduction to plant breeding	❖ Definition and importance, ❖ history and principles	CLO-2	3
Methods of plant breeding	❖ Methods of plant brreding ❖ Bredding systems of plants	CLO-2	4
Breeding	❖ domestication and evolution of crops ❖ breeding for disease resistance, basis of resistance, breeding strategies and methods	CLO-2	3

Learning Resources:

Allard, R.W. 1960. Principle of Plant Breeding. John Willey and Sons, New York.

Chaudhury, R.C. 1993. Introduction to Plant Breeding. Oxford &IBH Publishing Co. New Delhi, India.

Cronquist, A. 1981. An Integrated System of Classification of Flowering Plants. Columbia University Press, U.S.A..

Ghani, A. 2003. Medicinal Plants of Bangladesh with Chemical Constituents and Uses (2nd ed.). Asiatic Society of Bangladesh.

Hill,A.F. 1952. Economic Botany : a textbook of useful plants and plant products(2nd ed.). Mc-Graw-Hill, New York,USA.

Rangaswami, G. and Mahadevan, A. 2014. Discases of Crop Plants in India (4th Edition). PHI Learning Private Limited, Delhi-110092, India.
Sharma, O.P. 2004. Plant Taxonomy. Tata MacGraw Hill Publihing Co. Ltd. New Delhi.
Singh, B.D. 1983. Plant Breeding. Kalyani Publishers, New Delhi, India.
Singh, R.S., 1979. Introduction to the Principles of Plant Pathology (2nd Edition). Oxford and IBH Publishers, New Delhi, India.
শষ্যের রোগ - হাসান আশরাফুজ্জামান, ১৯৮৯, বাংলা একাডেমি, ঢাকা।

Assessment Strategy

Type of Assessment	Components	Marks	Methods of Assessment
Final Written Examination	Broad Questions	20	As mentioned in Zool.H.101 (Page No.)
	Short Questions	15	
Continuous Assessment	Attendance	5	
	Tutorial	10	

Course Title: Chemistry I: Bio-physical		
Course Code: Zool.R. 124	**Course Type:** Theory (Core Course, Mandatory)	**Credits:** 2
Full Marks: 50	**Total Lecture hours:** 30	**Exam Hours: 3**

Course Description

This course describes the concept and applications of chemical thermodynamics. The course also provides the students with the knowledge of chemical calculations and data treatment, thermodynamics of solutions, ligand binding and nonequivalent ligand sites on a macromolecule, modern concepts of acids and bases, solubility product and its analytical applications. At the end of the course, students will enrich their knowledge about the energetics of physical and chemical changes, phase and reaction equilibria. The students can apply their achievements to predict the stabilities of reactants and products and optimize the physical and chemical processes.

Course Learning Outcomes (CLOs)

After completion of this course, students will be able to:

1. Associate physical quantities with their International System of Units (SI) and perform conversions among SI units using scientific notation
2. Relate measurement uncertainty to significant figures and apply the rules for using significant figures in calculations
3. Correctly create, label, and identify relationships in graphs using mathematical relationships (e.g., slope, *y*-intercept, inverse, quadratic and logarithmic)
4. Write out various numbers in scientific notation and vice versa
5. Write out various numbers with the proper amount of significant figures
6. Use thermodynamic terminology appropriately
7. Explain fundamental thermodynamic properties
8. Derive and discuss the first and second laws of thermodynamics
9. Solve problems using the properties and relationships of thermodynamic fluids
10. Describe what information is obtained from the second Law of thermodynamics about speeds of chemical and physical changes
11. Use the second law of thermodynamics to predict the spontaneity of physical and chemical changes
12. Describe the meaning of a positive value, a negative value, and a value of zero,for ΔG (ΔG^o)
13. Explain the physical significance of entropy
14. Relate the concept of energy change to chemical reactions that occur in the body
15. Describe why a physical or chemical change is spontaneous only if ΔG is negative
16. Predict whether or not a physical or chemical change is spontaneous given the temperature and the enthalpy and entropy changes
17. Describe why do chemical reactions occur and the driving force(s) that are responsible for physical and chemical changes/reactions.
18. Describe what information is provided by the value of the equilibrium constant for a chemical reaction
19. Describe the difference between ΔG and ΔG^o
20. Describe the basic units of the macromolecules and the types of linkages between them

21. Analyze ligand binding to macromolecules quantitatively for both simple and complex systems
22. Describe the various concepts for acids and bases
23. Describe the difference(s) between strong acids/bases and weak acids/bases
24. Describe how the strength of either an acid or a base is indicated by the magnitude of its equilibrium constant (i.e., K_a or K_b)
25. Calculate the pH, pOH, $[H_3O^+]_{tot}$ and/or $[OH^-]_{tot}$ for a solution given one of these values
26. Describe the relationship between both equilibrium constant expressions and pH,and activities/activity coefficients
27. Describe the two main factors that need to be considered to determine if a substance will behave as an acid, a base, or neither
28. Describe the analytical significance of common ion effect and solubility products.
29. Explain the nature (acidity or basicity) of the salt's solution
30. Interpret fundamental concepts of solution thermodynamics involving ideal and non-ideal systems
31. Derive fundamental equations that govern the estimation of solution properties
32. Explain the role of Donnan membrane equilibrium in generation of resting membrane potential

Course contents, subject to the lecture and alignment of topic with CLOs

Course contents	Subject to the lecture	Alignment of topic with CLOs	LH
Measurement and Units			
Dimensions and units, SI units, Uncertainties in measurements	❖ Lecture is used to provide clear concept about the units and uncertainties in measurement with suitable examples	CLO 1-2	2
Significant figures and rounding off numbers, Slope and intercepts of a linear plot, analysis of errors and reporting data.	❖ Lecture is delivered to understand the rules of significant figures and rounding off numbers with proper examples.	CLO 3-5	2
Thermodynamics			
First law: Definitions, Interactions of systems with surroundings, Applications of first law	❖ Lecture is used to provide clear concept about the first law of thermodynamics and the terms involved in it. ❖ Then, it will be applied to provide knowledge about the interactions of systems with surroundings clearly.	CLO 6-9	3
Thermochemistry, Bond energies, Second Law: Entropy, statement of the law, Reversible and irreversible processes	❖ Lecture is delivered on the definition of the important terms involved in thermochemistry ❖ Then, the significance of second law of thermodynamics, entropy change and their relation with reversible and irreversible processes are explained.	CLO 10-13	3
Free energy, Standard states, and biochemical standard state, Direction of chemical and biochemical processes, Energetics of biochemical reactions	❖ Lecture is delivered on the definition of free energy, standard states and biochemical standard state with example. ❖ Then, the direction of chemical and biochemical processes and energetics of biochemical reactions are explained.	CLO 14-17	3
Chemical equilibrium and Ligand binding to macromolecules			
Relationship between ΔG^0 and equilibrium constant, Distinction between ΔG and ΔG^0, Variation of equilibrium constant with temperature, Measurement of thermo-dynamic functions of	❖ Lecture is used to explain the relationship between ΔG^0 and equilibrium constant. ❖ Then, variation of equilibrium constant with temperature is explained.	CLO 18-19	3

reactions			
The binding equation, Treatment of binding data, Multiple binding site equilibrium	❖ Lecture is used to provide knowledge about the ligand binding to a macromolecule. ❖ Then, interactive question and answering technique will be used to understand multiple ligand binding sites on a macromolecule.	CLO 20-21	3
Nonequivalent ligand sites on a macromolecule, Experimental methods for obtaining data.	❖ Lecture is used to explain the nonequivalent ligand sites on a macromolecule.	CLO 20-21	2
Acids and Bases			
Concepts of acid and bases, pH, buffer, indicators and its dissociation, Effect of ionic strength on acid-base equilibria, Common ion effect, Solubility product principle with applications.	❖ Lecture is delivered on the description the modern concepts of acids and bases and the effect of ionic strength on acid-base equilibria. ❖ Then, the significance of common ion effect and solubility product in analytical chemistry is explained.	CLO 22-29	3
Thermodynamics of solutions			
Raoult's law, Properties of ideal and non-ideal solutions, Anomalous molecular weight, Concept of activity, Solutions of macro molecules	❖ Interactive question and answering technique will be used to describe the Raoult's law and properties of ideal non-ideal solutions. ❖ Then, same technique will be adopted to explain the concept of activity and activity co-efficient.	CLO 30-31	3
The Donnan effect, Macro-molecules, Molecular weight, Number and weight average molecular weight, concept of chemical potentials.	❖ Lecture is used to describe the Donnan effect. ❖ Then, the concept of chemical potentials is explained.	CLO 32	3

Learning Resources:

P.W. Atkins, J. Paula: Atkin's Physical Chemistry (10th edition).
I.N. Levine: Physical Chemistry (6th edition).
R.G. Mortimer: Physical chemistry.
N. Kundu, S.K. Jain: Physical Chemistry.
R.D. Madan: Modern Inorganic Chemistry.
G.G. Hammes, S.H. Schiffer: Physical Chemistry for the Biological Sciences.

Assessment Strategy

Type of Assessment	Component	Marks	Methods of Assessment
Final Written Examination	Broad Question	20	As mentioned in Zool.H.101 (Page No.)
	Short Question	15	
Continuous Assessment	Attendance	5	
	Tutorial	10	

Course Title: Chemistry II: Bio-organic		
Course Code: Zool.R. 125	**Course Type:** Theory (Core Course, Mandatory)	**Credits:** 2
Full Marks: 50	**Total Lecture hours:** 30	**Exam Hours: 3**

Course Description

This course has been designed for the students to provide an understanding about the basic concepts of organic Chemistry including classification and purification of organic compounds and detection of elements in organic compounds. This course is also aimed to provide information about the study of

nomenclature, classification, general methods of preparation and reactions, uses etc. of hydrocarbons, derivatives of hydrocarbons and organic compounds containing nitrogen and sulpher. The topic concentrates on biological molecules and stereoisomerism**.** The students will enrich their knowledge through this course and can apply that knowledge in different aspect in chemistry.

Course Learning Outcomes (CLOs)

After completion of this course, students will be able to:

1. Classify and purify the organic compound.
2. Describe the detection processes of elements presence in organic compound.
3. Describe the process of making stock solution that can be used to detect elements presence in organic compound.
4. Name different alkanes and cycloalkanes, organic compounds containing oxygens and Organic compounds containing nitrogen and sulfur.
5. Classify different alkanes and cycloalkanes, organic compounds containing oxygens and Organic compounds containing nitrogen and sulfur.
6. Describe general method of preparation of different alkanes and cycloalkanes, organic compounds containing oxygens and Organic compounds containing nitrogen and sulfur.
7. Write reaction and uses of different alkanes and cycloalkanes, organic compounds containing oxygens and Organic compounds containing nitrogen and sulfur.
8. Describe different type of amino-acid.
9. Write structure of proteins with their function.
10. Describe the optical isomerism of simple compounds having one asymmetric carbon.
11. Describe the geometrical isomerism of simple organic compounds.

Course contents, subject to the lecture and alignment of topic with CLOs

Course contents	Subject to the lecture	Alignment of topic with CLOs	LH
Introduction			
Introduction: Classification and purification of organic compounds, detection of elements in organic compounds.	❖ Lecture is delivered on the classification and purification of the organic compound. ❖ Then, the detection processes of elements in organic compound will be discussed. ❖ Then, lecture will be finished to discuss the process of making stock solution that can be used to detect elements in organic compound	CLO 1-3	4
Hydrocarbons (Alkanes and cycloalkanes): The alkane series, alkenes and alkynes, aromatic hydrocarbons, petroleum refining.	❖ Lecture is delivered on different alkanes and cycloalkanes, ❖ Then, general method of preparation of different alkanes and cycloalkanes, ❖ Then, reaction and uses of different alkanes and cycloalkanes will be shown.	CLO 4-7	5
Derivatives of hydrocarbons (organic compounds containing oxygens): Alcohols, and ethers, aldehydes and ketones, carboxylic acids and esters, esterification and saponification, polyesters.	❖ Lecture is delivered on Alcohols, and ethers, aldehydes and ketones, carboxylic acids and esters, esterification and saponification, polyesters, ❖ Then, general method of preparation of Alcohols, and ethers, aldehydes and ketones, carboxylic acids and esters, esterification and saponification, polyesters. ❖ Then, reaction and uses of alcohols, and ethers, aldehydes and ketones, carboxylic acids and esters, esterification and saponification, polyesters will be shown.	CLO 4-7	5
Organic compounds containing nitrogen and sulfur: Amines and amides, thiols and disulfides.	❖ Lecture is delivered on Amines and amides, thiols and disulfides. ❖ Then, general method of preparation of Amines and amides, thiols and disulfides.	CLO 4-7	4

	❖ Then, reaction and uses of amines and amides, thiols and disulfides will be shown.		
Biological molecules			
Biopolymers, amino acids, protein/enzyme, protein structure, conformation and functions	❖ Lecture is delivered on different type of amino-acid. ❖ Then, lecture is used to describe protein/enzyme. ❖ Then, structure of proteins with their function will be shown.	CLO 8-9	6
Stereoisomerism			
Optical isomerism of simple compounds having one asymmetric carbon	❖ Lecture is delivered on the description of the optical isomerism of simple compounds having one asymmetric carbon. ❖ Necessary condition for a compound to exhibit optical isomerism will be discussed.	CLO 10	3
geometrical isomerism of simple organic compounds	❖ Lecture is delivered on the description of the geometrical isomerism of simple organic compounds. ❖ Necessary condition for a compound to exhibit geometric isomerism will be discussed.	CLO 11	3

Learning Resources:
Bahl, B.S. and Bahl, A., Advanced Organic Chemistry.
Ebbing, D.D., General Chemistry.
Morrison, R.T. and Boyed, R.N., Organic Chemistry.

Assessment Strategy

Type of Assessment	Components	Marks	Methods of Assessment
Final Written Examination	Broad Questions	20	As mentioned in Zool.H.101 (Page No.)
	Short Questions	15	
Continuous Assessment	Attendance	5	
	Tutorial	10	

Course Title: Chemistry III: Bio-inorganic		
Course Code: Zool.R. 126	**Course Type:** Theory (Core Course, Mandatory)	**Credits:** 2
Full Marks: 50	**Total Lecture hours:** 30	**Exam Hours: 3**

Course Description
This course has been designed for students to provide an understanding about the basic concepts of Inorganic Chemistry including atomic structure, periodic classifications of the elements, and different types of chemical bonding. This course is also aimed to provide information about the source and effects of oxides and oxyacids of nitrogen, phosphorus, sulfur and carbon compounds such as CO, CO_2 and chlorofluorocarbon on life and environment. The students will gather knowledge through this course and can apply that knowledge in different aspect in chemistry.

Course Learning Outcomes (CLOs)
After completion of this course, students will be able to:
1. Write the fundamental particles of atom.
2. Use the rutherford's scattering experiment and the discovery of the nucleus.
3. Explain the bohr's model of the atom and somerfield's extension of bohr's atomic model.
4. Describe the atomic spectrum of hydrogen atom.
5. Calculate quantum numbers and to write the electronic configuration of elements.
6. Write the wave mechanical model of atom and orbitals.
7. Make the modern periodic table and periodic law.
8. Describe the types of elements in the periodic table on basis of electronic configuration.
9. Write the periodic properties of elements viz. ionization potential, electron affinity, electro negativity, atomic and ionic radii.
10. Describe the different types of chemical bonding: ionic, covalent, coordinate and hydrogen bond.
11. Explain the bond angle, bond energy and bond length.

12. Explain the hybridization of atomic orbital and shapes of molecules.
13. Write the elementary idea of metallic bond and vander waals forces.
14. Describe the source and toxic effects of oxides and oxyacids of nitrogen, phosphorus, and sulfur on life and environment.
15. Describe the preparation, properties and the effects of oxides and hydroxides of alkali and alkaline earth metals on life and environment.
16. Write the source and toxic effects of carbon compounds such as co, co_2 and chlorofluorocarbon on life and environment.

Course contents, subject to the lecture and alignment of topic with CLOs

Course contents	Subject to the lecture	Alignment of topic with CLOs	LH
Atomic Structure			
Fundamental particles, discovery of electron, charge, mass, proton and neutron, Rutherford atom model, hydrogen spectra	❖ Lecture method as well as interactive question and answering technique will be used to provide idea on fundamental particles of atom. ❖ Then, same technique will be applied to explain the Rutherford atom model and origin of hydrogen spectrum.	CLO 1-2	2
Bohr atom model, four quantum numbers, Pauli exclusion principle, electronic configuration of elements	❖ To be described the Bohr atomic model and its limitations, quantum numbers, and electronic configuration of elements.	CLO 3-5	4
Elementary idea about the wave mechanical model of atom, atomic orbitals.	❖ Lecture method as well as interactive question and answering technique will be used to explain wave mechanical model of the atom, and atomic orbitals.	CLO 6	2
Periodic classification of elements			
Modern periodic table, periodic law	❖ Lecture delivered on the modern periodic table and periodic law.	CLO 7	2
Periodic system and electronic configuration of atoms	❖ To be described the types of elements in the periodic table on basis of electronic configuration.	CLO 8	2
Types of elements in the periodic table, correlation of atomic structure with periodic properties of elements, viz. ionization potential, electron affinity, electro negativity, atomic and ionic radii	❖ Lecture is delivered on the periodic properties of elements viz. ionization potential, electron affinity, electro negativity, atomic and ionic radii.	CLO 9	3
Different types of bonds			
Ionic, covalent, coordinate and hydrogen bond	❖ To be described the different types of chemical bonding: ionic, covalent, coordinate and hydrogen bond.	CLO 10	2
bond angle, bond energy and bond length	❖ To be explained the bond angle, bond energy and bond length.	CLO 11	2
hybridization of atomic orbital and shapes of molecules, elementary idea of metallic bond and vander Waals forces.	❖ To be explained the hybridization of atomic orbital and shapes of molecules.	CLO 12	3
Chemistry of the following and their effects on life and environment			
Oxides and oxyacids of	❖ Lecture method is used to explain the source and	CLO-14	4

nitrogen, phosphorus and sulfur	effects of oxides and oxyacids of nitrogen and phosphorus on life and environment. ❖ Then, same technique will be applied to explain the source and effects of oxides and oxyacids of sulfur on life and environment.		
Oxides and hydroxides of alkali and alkaline earth metals	❖ Lecture method is used to describe the preparation, properties of the oxides and hydroxides of alkali and alkaline earth metals. ❖ Then, same method will be used to explain the effects oxides and hydroxides of alkali and alkaline earth metals on life and environment.	CLO-15	2
Carbon compounds such as CO, CO_2 and chlorofluorocarbon	❖ Interactive question and answering technique will be used to define CFC. ❖ Then Lecture method will be applied to explain the source and effects of carbon compounds such as CO, CO_2 and CFC on life and environment.	CLO-16	2

Learning Resources:

S.Z. Haider : Modern Inorganic Chemistry
J.E. Huheey : Inorganic Chemistry: principles of structure and reactivity
R.D. Madan : Modern Inorganic Chemistry
C.E. Housecroft & A.G. Sharpe : Inorganic Chemistry
W.U. Malik, G.D. Tuli, R.D. Madan : Selected Topics in Inorganic Chemistry

Assessment Strategy

Type of Assessment	Components	Marks	Methods of Assessment
Final Written Examination	Broad Questions	20	As mentioned in Zool.H.101 (Page No.)
	Short Questions	15	
Continuous Assessment	Attendance	5	
	Tutorial	10	

Course Title: Biochemistry I: Physical

Course Code: Zool.R. 127	**Course Type:** Theory (Core Course, Mandatory)	**Credits:** 2
Full Marks: 50	**Total Lecture hours:** 30	**Exam Hours:** 3

Sub-units	Contents	LH
I	**Atomic structure:** Definition of electron, proton, neutron, nucleus, atomic number, isotopes; Dalton's atomic theory; electronic structure of atom; types of bonds; periodic table (preliminary treatment).	6
II	**Gases**: Laws of gases; Avogadros's law, Graham's law, Dalton's law of partial pressure; gas constant; kinetic energy of gases (simple treatment).	6
III	**Thermodynamics:** Concept of first and second laws of thermodynamics.	2
IV	**Acidimetry and Alkalimetry:** Bornated theory of acids and bases; ionization of acids; desiccation of water; pH indicators; buffers; concept of activity and activity coefficient; types of solutions and concentration units.	8
V	**Spectrophotometry:** The electromagnetic spectrum; Beer-Lambert law and determination of concentration based on the Beer-Lambert law; appropriate concentration range; two absorbing compounds and isosbestics points.	8

Assessment Strategy

Type of Assessment	Component	Marks	Methods of Assessment
Final Written Examination	Broad Question	20	As mentioned in Zool.H.101 (Page No.)
	Short Question	15	

Continuous Assessment	Attendance	5	
	Tutorial	10	

Course Title: Biochemistry II: Organic		
Course Code: Zool.R. 128	**Course Type:** Theory (Core Course, Mandatory)	**Credits:** 2
Full Marks: 50	**Total Lecture hours:** 30	**Exam Hours:** 3

Sub-units	**Contents**	**LH**
I	**Chemistry of aliphatic hydrocarbons:** Nomenclature, preparation, characteristic reaction and biological occurrence of the following: (i) Saturated and unsaturated hydrocarbons; (ii) Monohydric alcohols; (iii) Aldehydes and ketones (iv) Monocarboxylic acids and (v) Amines.	10
II	**Chemistry of aromatic hydrocarbons:** Nnomenclature, preparation, chemical properties and biological occurrence of phenols, amines and diazonium salts.	10
III	**Primary concept of stereoisomerism:** Brief idea of optical isomerism of simple compounds having 1 asymmetric carbon. Geometrical isomerism of simple organic compounds.	10

Assessment Strategy

Type of Assessment	**Component**	**Marks**	**Methods of Assessment**
Final Written Examination	Broad Question	20	As mentioned in Zool.H.101 (Page No.)
	Short Question	15	
Continuous Assessment	Attendance	5	
	Tutorial	10	

Course Title: Biochemistry III: Biomolecules and Molecular Biology		
Course Code: Zool.R. 129	**Course Type:** Theory (Core Course, Mandatory)	**Credits:** 2
Full Marks: 50	**Total Lecture hours:** 30	**Exam Hours:** 3

Sub-units	**Contents**	**LH**
I	**Basic molecules of life**: Definition, classification and chemistry of protein, lipid and carbohydrates; preliminary ideas of hormones, enzymes, chemistry of DNA and RNA. Alkaloids: nature, chemistry, source and biological role of atropine and ephedrine.	8
II	**Central dogma of molecular biology**: Replication, transcription and translocation, genetic code (preliminary ideas).	6
III	**Genetic engineering**: Gene structure, mutation (molecular mechanism), genetic manipulation, use of genetic engineering in medicine and agriculture.	8
IV	**General features:** Prokaryotic cells; shape and size of microorganisms, classification, Gram staining and bacterial growth curve.	8

Assessment Strategy

Type of Assessment	**Component**	**Marks**	**Methods of Assessment**
Final Written Examination	Broad Question	20	As mentioned in Zool.H.101 (Page No.)
	Short Question	15	
Continuous Assessment	Attendance	5	
	Tutorial	10	

Detail curriculum

For Second Year Honours Degree

in Zoology

B.Sc. (Honours) Part-II Examination, 2021

Course Title: Nutrition, Protection and Support		
Course Code: Zool.H.201	**Course Type:** Theory (Core Course, Mandatory)	**Credits:** 4
Full Marks: 100	**Total Lecture hours:** 60	**Exam Hours:** 4

Course Description:

Basic organization of structures; Feeding and nutrition; Digestion and assimilation: This course has been designed to introduce you with the basic organization of structures, feeding, nutrition, digestion and assimilation. It will also provide knowledge on level and grade of organization in animal world. This course is also aimed to provide information on different aspect of feeding, nutrition and foraging theory. Altogether, you will learn about the types and diversity of digestive system in different Phylum with the process of digestion. Finally, it will capable you to understand ingestion, digestion, absorption, assimilation and egestion and roles of hormones and enzymes in digestion physiology.

Protection and Support; Movement and locomotion: This course has been designed to introduce you the body covering of animals which protect themselves from harmful influences of external environment. It will also provide knowledge about skeletal systems of different animals in Protozoa to Chordata. This course is also aimed to provide information on muscles and musculature. Altogether, you will learn about different locomotory organelles and mechanism of locomotion. Finally, it will capable you to apply your knowledge and skill to compare anatomy, physiology and evolutionary trends in Protozoa to Chordata.

Course Learning Objectives:

1. To provide knowledge on the basic organization of structures, feeding, nutrition, digestion and assimilation
2. To provide knowledge on protection and support; movement and locomotion

Course Learning Outcomes (CLOs):

After completion of **Basic organization of structures; Feeding and nutrition; Digestion and assimilation** courses, learners will be able to:

1. Describe the levels of organization in life from sub-atomic particle to ecosystem;
2. Explain the evolutionary sequences of cellular to organ system grade of organization;
3. Introduce visceral organ in 3 major regions;
4. Illustrate the germinal layer and their derivations with origin;
5. Describe the modes of feeding;
6. Mention the types of feeding behavior with interactions;
7. Describe types of nutrition especial reference with the ways of obtaining and using nutrients;
8. Explain how a tapeworm obtains its nutrition along with structural adaptations;
9. Introduce foraging and their influencing factors, types of foraging and cost and benefits of group foraging;
10. Explain optimal foraging theory (OFT);
11. Describe the various types of digestive systems found in animals with view of evolutionary trends;
12. Describe the digestive system of Protozoa, Porifera, Cnidaria, Nematoda and Platyhelminthyes with comparative anatomy, physiology and evolution;
13. Explain the digestive system of Annelida and Mollusca with comparative anatomy, physiology and evolution.
14. Elucidate the digestive system of Arthropoda and Echinodermata with comparative anatomy, physiology and evolution;
15. Describe embryonic digestive system and its derivatives and digestive tract;
16. Compare vertebrate digestive structures with figures;
17. Compare of mouth to esophagous of vertebrates with physiology;
18. Compare of stomach to intestine of vertebrates with physiology;
19. Describe the accessory digestive organs and their roles in digestion;
20. Explain the roles of digestive hormones in digestion.
21. Describe the digestive enzymes and their roles in digestion.
22. Interpret absorption of nutrients with their absorptive mechanisms.
23. Describe the process of assimilation and egestion.

After completion of **Protection and Support; Movement and locomotion** courses learners will be able

to:

1. Explain how invertebrates are protect themselves by their body walls or covering.
2. Describe different types of endo- and exoskeletons in phylum Protozoa to Echinodermata.
3. Define locomotion and movement with example.
4. Compare different types of locomotory organelles and mechanism of locomotion in phylum Protozoa to Echinodermata.
5. Describe different types of water vascular systems in Echinodermata.
6. Explain how vertebrates are protect themselves by their integuments.
7. Describe different types of derivatives of integument in vertebrates.
8. Compare different types of bones of skull found in Pisces to Mammalia.
9. Compare vertebral columns in Pisces to Mammalia.
10. Compare ribs, sternum, pectoral girdle and pelvic girdle bones found in Pisces to Mammalia.
11. Compare different types of appendicular skeletons (fore limb and hind limb) in Pisces to Mammalia
12. Describe the muscles and muscular systems in vertebrates.
13. Describe different types of locomotory organelles and mechanism of locomotion in vertebrates.
14. Mention the types of locomotion.

Course contents, subject to the lecture and alignment of topic with CLOs:

Course contents	Subject to the lecture	Alignment of topic with CLOs	LH
Basic organization of structures			
Organ and organ systems with regard to level of organization	❖ Lecture is delivered on the definition of level of organization with example. ❖ Then, the levels of organization in life from atomic particles to ecosystem will be explained.	CLO-1	2
Organ and organ systems with regard to grade of organization	❖ Lecture is delivered on the explanation of the evolutionary sequences of cellular to organ system grade of organization.	CLO-2	2
Viscera and germinal layer derivations	❖ Lecture is delivered on the introduction of visceral organ in 3 major regions. ❖ Then, the germinal layer and their derivations with origin will be illustrated.	CLO-3 CLO-4	2
Feeding and nutrition			
Modes of feeding, Classification of feeding mechanisms	❖ Lecture is delivered on the definition of feeding and nutrition; explanation the modes of feeding ❖ Then, the different kind of modes of feeding in animals will be described in detail about.	CLO-5	2
Types of feeding behavior	❖ Lecture is delivered on the description of the types of feeding behavior with interactions.	CLO-6	2
Modes of nutrition	❖ Lecture is delivered on the description of types of nutrition especial reference with the ways of obtaining and using nutrients. ❖ Then, how a tapeworm obtains its nutrition along with structural adaptations will be described.	CLO-7 CLO-8	2
Cost and benefits of feeding: foraging theory	❖ Lecture is delivered on the introduction of foraging and their influencing factors, types of foraging and cost and benefits of group foraging. ❖ Then, optimal foraging theory (OFT) will be explained.	CLO-9 CLO-10	2
Digestion and assimilation			
Types of digestive system	❖ Lecture is delivered on the description of the various types of digestive systems found in animals with view of evolutionary trends. ❖ Then, visual overview of digestion will be showed by Multimedia projector.	CLO-11	2

	❖ Then comparison between the aerobic and anaerobic respiration will be showed.		
Digestive system of Protozoa, Porifera, Cnidaria, Nematoda and Platyhelminthyes	❖ Lecture is delivered on the description of the digestive system of Protozoa, Porifera, Cnidaria, Nematoda and Platyhelminthyes with comparative anatomy, physiology and evolution.	CLO-12	2
Digestive system of Annelida and Mollusca	❖ Lecture is delivered on the explanation of the digestive system of Annelida and Mollusca with comparative anatomy, physiology and evolution.	CLO-13	2
Digestive system of Arthropoda and Echinodermata	❖ Lecture is delivered on the elucidation of the digestive system of Arthropoda and Echinodermata with comparative anatomy, physiology and evolution.	CLO-14	2
Embryonic digestive system and its derivatives; digestive tract; comparative of vertebrate digestive structures	❖ Lecture is delivered on the knowledge of embryonic digestive system and its derivatives and digestive tract. ❖ Then, vertebrate digestive structures with figures will be compared.	CLO-15 CLO-16	2
Comparative of mouth to esophagus of vertebrates	❖ Lecture is used to compare of mouth to esophagus of vertebrates with physiology.	CLO-17	2
Comparative of stomach to intestine of vertebrates and accessory digestive organs	❖ Lecture is delivered on the comparison of stomach to intestine of vertebrates with physiology. ❖ Then, the accessory digestive organs and their roles in digestion will be described.	CLO-18 CLO-19	2
Digestive hormones and enzymes, nutrient absorption of nutrients, assimilation and egestion	❖ Lecture is delivered on the explanation of the roles of digestive hormones in digestion. ❖ Then, the digestive enzymes and their roles in digestion will be described. ❖ Then, absorption of nutrients with their absorptive mechanisms will be interpreted. ❖ Then, the process of assimilation and egestion will be described.	CLO-20 CLO-21 CLO-22 CLO-23	2
Protection and Support; Movement and locomotion			
Body covering and skeleton in protozoa	❖ Lecture is delivered on the body covering and different types of skeleton in Protozoa with example.	CLO-1 CLO-2	1
locomotory organelles and locomotion in Protozoa	❖ Lecture is delivered on the description of the locomotory organelles and locomotion in different classes of protozoa.	C LO-3 CLO-4	2
Body covering in Porifera	❖ Lecture is delivered on the description of the body covering in Porifera and differences among their canal systems with example.	CLO-2	2
Spicules in Porifera	❖ Lecture is delivered on the classification of different types of spicules found in Porifera.	CLO-2	1
Body wall and nematocyst in Cnidaria	❖ Lecture is delivered on the description of the body wall and the different types of nematocyst found in Cnidaria.	CLO-1	2
Comparative	❖ Lecture is delivered on the comparison of the body wall in	CLO-1	2

account of body wall in Platyhelminthes and Nematoda	Platyhelminthes and Nematoda and their parasitic habitat.	CLO-4	
Protection and locomotion in Annelida.	❖ Lecture is delivered on the description of the body wall of annelids, their locomotory patterns and mechanism of locomotion in different classes.	CLO-1 CLO-4	2
Body wall and locomotion in Arthropoda	❖ Lecture is delivered on the comparison of the body walls found in different classes in phylum Arthropoda. ❖ Then the mechanism of locomotion and different types of locomotory pattern in different classes of Arthropods will be explained.	CLO-1 CLO-4	2
Shell and body covering in Mollusca	❖ Lecture is delivered on the description of the body covering and different types of shells found in Mollusca. ❖ Then, the formation of pearl will be described.	CLO-1 CLO-2	2
Locomotion in Mollusca	❖ Lecture is delivered on classification of the different classes of molluscs according to their foots. ❖ Then, the mechanism of locomotion in phylum Mollusca will be described.	CLO-4	2
Body covering and locomotion in Echinodermata	❖ Lecture is delivered on the description of the spines and pedicellariae of echinoderms which protect themselves. ❖ Then, different types of water vascular system found in five classes in Echinodermata which help them to move will be described.	CLO-1 CLO-4 CLO-5	2
Integument and its derivatives in phylum Chordata	❖ Lecture is delivered on the comparison of the evolutionary changes of integuments in different classes (pisces to mammalia) of chordates. ❖ Then, the derivatives of integuments and its function will be described.	CLO-6 CLO-7	2
Skeletal systems of chordates	❖ Lecture is delivered on the definition of the skull, axial and appendicular skeleton. ❖ Then the bones of skull and vertebral column will be described.	CLO-8 CLO-9	2
Skeletal systems of chordates	❖ Lecture is delivered on description of the bones of ribs, sternum, pectoral and pelvic girdles of pisces to mammalia. ❖ Then the bones of limbs of tetrapods (amphibia to mammalia) will be described.	CLO-10 CLO-11	2
Muscle and Musculature of chordates	❖ Lecture is delivered on the description of different types of muscles from pisces to mammalia. ❖ Then the mechanism of muscle contraction will be described.	CLO-12	2
Locomotion of chordates	❖ Lecture is delivered on the description of different types of locomotion found in chordates. ❖ Then the mechanism of locomotion and their evolutionary changes will be described.	CLO-13 CLO-14	2

Learning Resources:

Assessment Strategy

Type of Assessment	**Components**	**Marks**	**Methods of Assessment**
Final Written Examination	Broad Questions	35	Year-end final exam will be taken.
	Short Questions	35	
Continuous Assessment	Attendance	10	% of the assessment marks for attendance will be given as follows

Attendance	Marks	Attendance	Marks	Attendance	Marks
95 -100%	20%	90 -<95%	18%	85 -<90%	16%

			80 -<85%	14%	75 -<80%	12%	70 -<75%	10%
			65 -<70%	8%	60 -<65%	6%	<60%	0%
	Tutorial	20	Class test, presentation in group, assignment					

Course Title: Energetics and Homeostasis		
Course Code: Zool.H.202	**Course Type:** Theory (Core Course, Mandatory)	**Credits:** 4
Full Marks: 100	**Total Lecture hours:** 60	**Exam Hours:** 4

Course Description:

Allocation of resources; Circulation and gaseous exchange: This course has been designed to introduce about the physiology of blood circulation, waste removal and energy production in major phylum of animal kingdom. It will also provide knowledge regarding the allocation of available resources in vital life processes of an organism. You will also learn about the basic/unifying themes of animal physiology stating that all organism should follow some universal sets of laws to survive and adapt. This course is also intended to provide information on circulatory system, lymphatic system, respiratory system and excretory system of animals. After completing this course, you will be able to compare above mentioned physiological process in different organisms (from major invertebrate to vertebrate phylum). You can also elucidate the evolutionary significance on the basis of structure and function of heart and blood vessels; lymphatic system and its components; organs involved in respiration and excretion in different invertebrate, and vertebrate classes. Altogether, you will be able to explain the distribution of available resources, nutrient transport, energy production and waste removal through different organ and organ system. Finally, it will educate you to apply your knowledge and skill for understanding vital physiological processes and how they coordinate to function for the healthy survival of an animal.

Respiration and Energy production; Excretion and Regulation: This course has been designed to introduce you to resource allocation and its relation with metabolism, anabolism and catabolism. It is also provided knowledge on circulatory system (Invertebrate and vertebrate), structure and physiology of heart, function of blood and blood corpuscle, signification of respiration, central importance of ATP in respiration, modification of respiratory structure in animals (due to invasion from water to land). Although you will learn about excretory system, osmotic and ionic regulation, control of water and solutes, buoyancy, homeostasis and thermoregulation. Finally, it will capable you to apply your knowledge and skill for diagnosis of cardiovascular disease in human, kidney disease and heat disorders in man.

Course Learning Objectives:

1. To introduce about the physiology of blood circulation, waste removal and energy production in major phylum of animal kingdom
2. To provide knowledge on respiration and energy production; excretion and regulation

Course Learning Outcomes (CLOs):

After completion of **Allocation of resources; Circulation and gaseous exchange** courses, learners will be able to-

1. Define resource allocation (RA) and metabolism.
2. Interpret the relationship of RA with metabolism and reproduction (in different phylum).
3. Describe primary nutritional groups and their mode of energy transfer with example.
4. Explain the basic/unifying themes of animal physiology in the animal kingdom.
5. Describe how all animal is following a basic set of physical and chemical laws to survive and adapt.
6. Demonstrate and compare the structure and types of circulatory system (CS) found among animals.
7. Describe different components of CS and their function in different animal phyla.
8. Illustrate the structure, comparative anatomy and physiology of heart in different vertebrate classes.
9. Interpret the evolutionary significance of heart from Protozoa to Chordata.
10. Describe the composition and function of blood and its corpuscles, blood vessels and its structure.
11. Elucidate blood clotting process and capillary filtration of blood.
12. Describe the hemodynamics of arterial system in different vertebrate classes.
13. Interpret the evolutionary significance of aortic arches from Pisces to Mammalia.
14. Compare the structure and function of venous system found different vertebrate classes.
15. Describe major electrolytes and their function in an animal.

16. Elucidate different circulatory fluid (except blood) compartment and their composition in an animal.
17. Explain Sodium-Potassium pump and their function in homeostasis.
18. Describe different cardiovascular diseases; their risk factors, symptoms, diagnosis and treatment options.
19. Illustrate the structure and function of advanced lymphatic system (LS) found in mammals.
20. Explain the presence or absence of LS or homologous to LS in other animal phyla with evolutionary significance.

After completion of **Respiration and Energy production; Excretion and Regulation** courses, learners will be able to:

1. Define respiration, and its types with example.
2. Compare the aerobic and anaerobic respiration.
3. Mention how factors influence respiration in animals.
4. Define respiratory organs, structure (gills, larynx, syrinx, trachea, lungs) and describe its function.
5. Describe the respiratory organs of invertebrates (Protozoa to Echinodermata)
6. Define accessory respiratory organ and mention its types.
7. Mention the mechanism of breathing.
8. Explain the importance of ATP in respiration (glycolysis and creb"s cycle.
9. Explain major modifications of respiratory structure in animals (due to invasion from water to land.
10. Define excretion, excretory system and mention the parts of nephron and functions of kidney.
11. Describe excretory organs of invertebrates (Protozoa to Echinodermata).
12. Interpret osmotic and ionic regulation, control of water and solutes and buoyancy.
13. Define homeostasis and mention types of homeostasis and (biological and ecological homeostasis)
14. Define thermoregulation (vertebrates and man).
15. Classify heat disorder in man and its treatments.

Course contents, subject to the lecture and alignment of topic with CLOs:

Course contents	Subject to the lecture	Alignment of topic with CLOs	LH
Allocation of resources			
Resource allocation (RA) and its relation with metabolism; Primary nutritional group; Factors affecting metabolism	❖ Lecture is delivered on the definition of RA with example ❖ Then, the significance of metabolism and its type, primary nutritional groups and factors affecting metabolism will be explained. ❖ The relationship of RA with metabolism will be explained using scientific paper/thesis/web resources etc.	CLO-1 CLO-2 CLO-3	6
Resource allocation and its relation with reproduction	❖ Lecture is delivered on the description of the types of reproduction, their characteristics and examples.	CLO-1 CLO-2 CLO-3	2
Unifying themes/basis of animal physiology	❖ Lecture is delivered on the definition of Physiology, animal physiology and its significance with reference. ❖ Then, the unifying/universal themes of animal physiology with related examples will be explained.	CLO-4 CLO-5	2
Circultion and Gaseous exchange			
Circulatory System (CS): Definition, functions, components of CS, types of CS	❖ Lecture is delivered on the explanation of how many types of CS is found in animal kingdom (invertebrate and vertebrate). ❖ Then, the various components of a CS and their function will be explained.	CLO-6 CLO-7	2
Heart: Structure of heart; Comparative anatomy & physiology	❖ Lecture is delivered on the role of heart in a CS. ❖ Then, the anatomy and evolution of heart in different	CLO-8 CLO-9	4

of heart; Evolution of Heart	vertebrate classes will be compared. ❖ Visual illustrations will be used to indicate the gradual evolution of heart in different vertebrate classes.		
Blood and Blood Vessels: Comparative anatomy and function; Blood clotting process	❖ Lecture is delivered on the description of the structure and function of blood and blood vessels in an animal. ❖ Then, information on the mechanism of blood clotting and capillary filtration of blood will be provided.	CLO-10 CLO-11	2
Arterial system and evolution aortic arches	❖ Lecture is delivered on the explanation of arterial system and aortic arches. ❖ Then, underlying evolutionary significance of aortic arches with help of visual illustrations will be explained.	CLO-12 CLO-13	2
Comparative account of venous system in different vertebrate classes	❖ Lecture is delivered on the comparison of the venous system of different vertebrate classes.	CLO-14	2
Circulatory fluid (CF) compartments: Composition of extracellular (ECF) and Intracellular (ICF) fluids; Major electrolytes of ECF and ICF	❖ Lecture is delivered on the explanation of the circulatory fluid (except blood) and its compartments. ❖ Then, information on different types of circulatory fluid and their location, various electrolytes and their function will be provided.	CLO-15 CLO-16 CLO-17	2
Cardiovascular diseases in human	❖ Lecture is delivered on the discussion of different cardiac diseases with their symptoms, risk factors, and diagnosis and treatment options.	CLO-18	2
Cardiovascular diseases in human	❖ Lecture is delivered on the explanation of different vascular (blood vessel) diseases with their symptoms, risk factors, and diagnosis and treatment options.	CLO-18	2
Lymphatic system (LS): Structure and function of lymph, lymphatic vessel and lymphatic organs	❖ Lecture is delivered on the description of the structure and function of advanced mammalian LS. ❖ Then, the evolutionary significance of LS in different invertebrate and vertebrate animals will be explained.	CLO-19 CLO-20	2
Respiration and energy production			
Definition, type, significance of aerobic and anaerobic respiration	❖ Lecture is delivered on the definition of respiration. ❖ Then, the significance of aerobic and anaerobic respiration will be explained.	CLO-1 CLO-2	2
Factors influencing respiration, respiratory organs	❖ Lecture is delivered on the factors influencing respiration, respiratory organs	CLO-3	2
Respiratory organs, structure and function	❖ Lecture is delivered on the description of the types of respiratory organs, structure and function.	CLO-3	2
Accessory respiratory organs	❖ Lecture is delivered on the description of the accessory respiratory organs	CLO-4	2
Mechanism of breathing	❖ Lecture is delivered on the description of the mechanism of breath	CLO-5 CLO-6	2
Central importance of ATP in respiration	❖ Lecture is delivered on the description of the steps of glycolysis.	CLO-7 CLO-8	2
Central importance of ATP in respiration	❖ Lecture is delivered on the definition of creb's cycle. ❖ Then, the steps of creb's cycle will be explained.	CLO-9 CLO-10	2

Major modifications of respiratory structure in animals (due to invasion from water to land)	❖ Lecture is delivered on the modified respiratory organs in animals (due to invasion from water to land).	CLO-11 CLO-12	2
Excretion and regulation			
Excretory systems and excretion.	❖ Lecture is delivered on the definition of excretion. ❖ Then, excretory organs and definition, function and structure of nephron will be described.	CLO-13	2
osmotic and ionic regulation	❖ Lecture is delivered on the osmotic and ionic regulation in animals.	CLO-13	2
Control of water and solutes and buoyancy.	❖ Lecture is delivered on the explanation of control of water and solutes. ❖ Then buoyancy will be described.	CLO-13	2
Homeostasis.	❖ Lecture is delivered on the definition of homeostasis. ❖ Then the types of homeostasis (biological and ecological) will be explained.	CLO-13	2
Thermoregulation	❖ Lecture is delivered on the thermoregulation in animals.	CLO-14	2
Heat disorders in man	❖ Lecture is delivered on the heat disorders in man.	CLO-15	2

Assessment Strategy

Type of Assessment	**Components**	**Marks**	**Methods of Assessment**
Final Written Examination	Broad Questions	35	As mentioned in Zool.H.201 (Page No.)
	Short Questions	35	
Continuous Assessment	Attendance	10	
	Tutorial	20	

Course Title: Neurobiology & Endocrinology		
Course Code: Zool.H.203	**Course Type:** Theory (Core Course, Mandatory)	**Credits:** 4
Full Marks: 100	**Total Lecture hours:** 60	**Exam Hours:** 4

Course Description:

Coordinating system I (Neurobiology): The course Neurobiology has been designed to introduce the students regarding the evolutionary trends of the nervous system from lower invertebrates to higher vertebrates including human. It provides the information about the division of the nervous system and composition i.e. the cells that constitute the nervous system. The course is aimed to provide knowledge how our brain perceives the external world, how our brain thinks, how our brain responds to the outside of the world. The course also provides information to the students about the basic anatomy and function of the nerve tissues; sensory and motor pathways; how a neuron function at rest and transmits signal through a neuron, and between neurons or neuron to other cells across the synapse. The course focused on the chemicals used in impulse transmission; sensory input and motor output.

Coordinating System II (Endocrionology): This course covers the glands and hormones of the endocrine system in vertebrate and invertebrate animals. Furthermore, the synthesis, structure, secretion, function and mode of action of hormones are discussed in details. In addition, the integration between endocrine glands and other body systems in regulating homeostasis and the factors that affect hormonal balance are discussed. Finally, this course covers the clinical aspects of hormonal disturbances including causes, diagnosis and treatment.

Course Learning Objectives:

1. To introduce the students regarding the evolutionary trends of the nervous system from lower invertebrates to higher vertebrates including human.
2. To introduce the students regarding the evolutionary trends of the endocrine system from lower invertebrates to higher vertebrates including human.

Course Learning Outcomes (CLOs):

After completion of **Coordinating system I (Neurobiology)** course, learners will be able to:

1. Define neurobiology and nervous system; role of nervous system in maintaining body's homeostasis.
2. Explain the development of simplest nervous system - nerve net in Cnidaria to simple brain in bilateral invertebrates; development of central and peripheral nervous system in chordates.
3. Describe organization of vertebrate nervous system: The gross anatomy of the central and peripheral nervous systems, the site of information receiving, analysing, processing and transmitting.
4. Explain how the central nervous system protects from external injury; Basic structures and parts of human brain, and function of each part; anatomy of the spinal cord.
5. Describe the location and function of lobes of the brain.
6. Illustrate the structure and role of the parts of the lymbic system and ventricular system; and the brain waves.
7. Describe the role of Somatic, autonomic, sympathetic and parasympathetic divisions of the peripheral nervous system.
8. Mention then names and functions of the peripheral nerves i.e. cranial and spinal nerves.
9. Define nerve tissues i.e. neurons and glial cells, and mention the types and functions of glial cells.
10. Define nerve and neuron, and describe the basic structure, types and function of a neuron.
11. Illustrate the properties of a neuron plasma membrane, and role of ion channels and myelin sheath.
12. Explain how a neuron functions at rest, how information is relayed within a neuron, and how neurons relay information to other neurons or other cells.
13. Interpret how our nervous system response to external world involuntarily and spontaneously.
14. Mention the chemical compounds use to communicate between neurons, or neuron and other cells.
15. Describe the sensory receptors - receive stimuli.
16. Describe the effectors where response is produced.

After completion of **Coordinating System II (Endocrinology)** course, learners will be able to:

1. Define endocrinology and exocrinology and hormone; types of hormones; mode of action relating to homeostasis in vertebrate and invertebrate animals
2. Describe the synthesis and function of different hormones and mechanism of secretion in endocrine glands
3. Determine the chemical structure and mode of action including the hormonal imbalance
4. Gather knowledge regarding the binding mechanism of steroid and non-steroid hormones in target cells; hormonal target cell and receptor.
5. Discuss the different types of hormonal pathway and its role in vertebrate and invertebrate animals.
6. Learn the different types of hormonal chemical messengers and their mechanism in vertebrate and invertebrate animals; different types of hormonal cell signals; mechanism of different feedback occurs in different endocrine system.
7. Gather knowledge on the thyroid and pituitary glands including their role and major function in vertebrate animal.
8. Describe of role of reproductive glands including their secretion as well as function in vertebrate animal.
9. Illustrate the role of pancreas gland and their secretion of hormones including the function; mechanism of homeostasis in insulin and glucagon.
10. Interpret the body function including the major endocrine disorders
11. Describe the practical application of hormones in animals
12. Discuss the endocrine systems in invertebrates' animals
13. Explain the mechanism of endocrine systems in occur in advanced phyla including mollusc and annelids.
14. Illustrate the function of endocrine systems in arthropods including the role of different types of hormone in insects.
15. Compare the function as well as role of hormone secreting in different glands of vertebrate and invertebrate animals.

Course contents, subject to the lecture and alignment of topic with CLOs:

Course contents	Subject to the lecture	Alignment	LH

		of topic with CLOs	
Coordinating system I (Neurobiology)			
Introduction	**Lecture – 1.** Introduction: how nervous system regulates the other organ systems; difference between invertebrate and vertebrate NS.	CLO - 1	1
Evolutionary trends of the nervous system in animals from Protista to Chordata	**Lecture – 2.** Unifying principles of animal NS and the development of simplest NS, and development of cephalization in bilateral invertebrates	CLO - 2	1
Evolutionary trends of the nervous system in animals from Protista to Chordata	**Lecture – 3.** Development of dorsal tubular nerve cord, notochord, and central and peripheral NS in chordates (Urochordata to vertebrata)	CLO - 2	2
Organization of nervous system	**Lecture – 4.** Flow chart of basic organization of vertebrtae NS, Structure & role of protective membranes of CNS.	CLO - 3 CLO - 4	1
Central nervous system (brain and spinal cord)	**Lecture–5.** Anatomy and functions of the spinal cord; Basic parts of human brain (Forebrain, mid brain and hind brain)	CLO - 4	1
structures and functions of brain	**Lecture – 6.** Structures and functions of each part of human brain (midbrain & hindbrain: brain stem, cerebellum)	CLO - 4	1
structures and functions of brain	**Lecture – 7.** Structures and functions of each part of human forebrain (cerebrum, thalamus and hypothalamus)	CLO - 4 CLO - 5	1
structures and functions of brain	**Lecture – 8.** Structures and functions of the lymbic system and ventricular system of the brain; production & flow of CSF within the brain ventricles; Role of brain waves.	CLO - 6	1
peripheral nervous system	**Lecture – 9.** Structures and functions of peripheral nervous system; secretions of chemicals	CLO - 7	1
Origin and distribution of nerves with functions;	**Lecture – 10.** Origin & distribution, and functions of peripheral nerves (cranial & spinal)	CLO - 7	1
Nerve tissues			
glial cells**:** Structure, functions and types	**Lecture 11.** Introduction, development structures, types and functions of glial cells	CLO - 8	2
Neuron**:** Structure, functions	**Lecture 12.** Definition of nerve and neuron; difference between neuron and other cells; Structures and functions of neuron	CLO - 8 CLO - 9	2
types of Neuron	**Lecture 13.** Types of neurons on the basis of different categories and their functions	CLO - 9	2
Potentials			
Membrane potential	**Lecture 14.** Properties of neuron's plasma membrane; membrane potential and establishment of resting membrane potential	CLO - 10 CLO - 11	2
action potential; Generation and propagation of action potential;	**Lecture 15.** Action potential & Stimulus; generation & transmission of nerve impulse within a neuron	CLO - 10 CLO - 11	2
Structure of synapses: synaptic transmission;	**Lecture 16.** Types of synapse; transmission of nerve impulse across the synaptic cleft; and role of chemical transmitters	CLO - 10 CLO - 11	1
Structure of synapses: synaptic transmission;	**Lecture 17.** Definition, Types and mechanism of reflex action	CLO - 12	1
Structure of synapses: Neurotransmitters and their functions	**Lecture 18.** Neurotransmitters: introduction, discovery, characters, mechanism and types	CLO - 13	1

Sensory system in animals			
Reception, transduction and perception; categories of sensory receptors and their functions in invertebrate	**Lecture 19.** Sensory receptors: definition, general types and functions; Different types of receptors in invertebrates	CLO - 14	2
Reception, transduction and perception; categories of sensory receptors and their functions in vertebrate animals.	**Lecture 20.** Perception, vision, hearing, navigation system in vertebrates	CLO - 14	2
Organization of motor outputs			
Effectors in invertebrate and vertebrate animals	**Lecture 21.** The effectors: definion, types and functions in invertebrates and vertebrates, where response produced	CLO - 15	2
Coordinating System II (Endocrinology)			
Endocrine system	**Lecture–1.** Definition of endocrine glands and hormones; types of hormones; importance of homeostasis in vertebrate and invertebrate animals **Lecture–2.** Description of synthesis of hormones secreted from different endocrine gland **Lecture–3.** Description of function of hormone from different endocrine glands **Lecture–4.** Chemical structure and mode of action including the symptoms for the disorders associated with hormonal imbalance	CLO – 1 CLO – 2 CLO – 2 CLO – 3	4
Bindings of hormones	**Lecture–5.** Binding mechanism of steroid and non-steroid hormones in target cells including the target cell and receptor.	CLO – 4	2
Hormonal pathways	**Lecture–6.** Description of different hormonal pathways and its role in vertebrate and invertebrate animals	CLO – 5	2
Hormonal cell signal	**Lecture–7.** Hormonal chemical messengers and their mechanism in vertebrate and invertebrate animals; Hormonal cell signal; **Lecture–8.** mechanism of different feedback occurs in different endocrine system	CLO – 6 CLO – 6	2
Mechanisms of hormone	**Lecture–9.** Mechanisms of hormonal action in vertebrate and invertebrate animals	CLO – 7	2
Role of endocrine system	**Lecture–10.** Description of roles of endocrine systems and their applications.	CLO – 7	2
Feedback systems	**Lecture–11.** Feedback systems in thyroid and pituitary glands	CLO – 7	2
Hormonal Glands	**Lecture–12.** Description of role of pituitary glands including their function **Lecture–13.** Description of role of reproductive glands including their function **Lecture-14.** Description of role of pancreas including their function	CLO –7 CLO – 8 CLO – 9	4
Hormonal disorders	**Lecture–15.** Body function including the major endocrine disorders	CLO – 10	2
Application	**Lecture–16.** Description of practical application of hormones	CLO – 11	2
Invertebrate endocrine system	**Lecture–17.** Illustration of endocrine systems in invertebrates **Lecture–18.** Perception of endocrine system in mollusc	CLO – 12 CLO – 13	4

	and annelids **Lecture–19.** Description of endocrine system in arthropods	CLO – 14	
Comparative studies	**Lecture–20.** Comparative studies in the role of hormone secreting in different glands of vertebrate and invertebrate animals.	CLO – 15	2

Assessment Strategy			
Type of Assessment	**Components**	**Marks**	**Methods of Assessment**
Final Written Examination	Broad Questions	35	As mentioned in Zool.H.201 (Page No.)
	Short Questions	35	
Continuous Assessment	Attendance	10	
	Tutorial	20	

Course Title: Reproductive and Population Biology		
Course Code: Zool.H.204	**Course Type:** Theory (Core Course, Mandatory)	**Credits:** 4
Full Marks: 100	**Total Lecture hours:** 60	**Exam Hours:** 4

Course Description:

Reproductive Biology: In this course, students will investigate the biological processes of reproduction, Patterns of sexuality; significance of sexual and asexual reproduction; Organization of sexual reproduction and life histories; reproductive traits and functions; systems for sexual reproduction (myxis), parthenogenesis; control of reproductive processes; Ultimate and proximal factors; hermaphroditism *versus* gonochorism. This course will also include a focus on the synchronous reproduction of marine invertebrates; diapause in terrestrial and freshwater environments; biorhythmicity (circadian rhythm); photoperiodism and biological clock. Students will explore the potential impacts of asexual and sexual reproduction, environmental factors by comparing the life histories of organisms, how differences in modes of fertilization and parental care might influence the phenotype and, consequently, the fitness of offspring and student will explain the circadian rhythm, photoperiodism and biological clock in human.

Life cycles; Population: This course has been designed to introduce you the reproductive biology, life cycles and population biology. It will also provide knowledge on larval development followed by different types of metamorphosis and their control. This course is also aimed to provide information on different types of regeneration found in different animal groups. Altogether, you will learn about individual, population, population group properties, population dynamics, different types of regulating processes and how to construct a life table. Finally, it will make capable you to apply your knowledge and skill for identification of organisms' life cycle, indirect development of larva, regeneration processes found in animal kingdom and different parameters on population.

Course Learning Objectives:

1. To provide knowledge on reproductive biology
2. To provide knowledge on life cycles of different organisms, and population

Course Learning Outcomes (CLOs):

After completion of **Reproductive Biology** course, students should/will be able to:

1. Define reproduction as a most important characteristics of living beings, Origin of Life/Historical Background
2. Describe the pattern of sexuality, explain the importance of reproduction, describe the types of reproduction. Discuss the asexual reproduction in invertebrates. explain the advantages and disadvantages of asexual reproduction
3. Describe the Comparative study of asexual reproduction and sexual reproduction, explain the several patterns of sexual reproduction, Discuss the different forms of sexual reproduction, explain the Conditions of sexuality in invertebrates
4. Define sexual reproduction, explain the characters of sexual reproduction, Describe the Life cycles and sexual reproduction in invertebrate, Describe the Process of conjugation, explain the factors and conditions of conjugation

5. Define the Systems for sexual reproduction (Mysis), discuss the characters of sexual reproduction, describe the process of exchange of genetic materials in viruses, describe the Bacteriophage viruses and the life cycle, Discuss the Genetic exchange and recombination in bacteria and lower group, classification of bacteria on the basis of cell wall, describe the process of bacterial conjugation, define and types of plasmid, explain roll of plasmid in conjugation
6. Describe the organization of sexual reproduction and life histories: reproductive trait and functions, describe A functional analysis of the life histories of Insects, explain the different instar with different function base on some principles, explain A functional analysis of the life histories of insects, Orthoptera, Diptera, aquatic and terrestrial insect with examples, hymenopter, honey bee etc. explain reproductive strategy.
7. Define parthenogenesis, describe different types of parthenogenesis, describe the parthenogenesis in aphid, rotifer, discuss the importance of parthenogenesis and disadvantage as well.
8. Describe the life cycle of some multicellular animals, explain asexual reproduction (Amixis), describe the mechanism of parthenogenesis (Automixis), define, Arrhenotoky, thylotoky, sexual reproduction Significance of sexual and asexual reproduction. Discuss the Life cycle of Daphnia, rotifer and Aphid.
9. Describe the control of reproductive process, explain and describe the factor on reproductive cycle, explain ultimate and proximate factor, describe the difference between ultimate factors and proximate factors
10. Describe hermaphroditism, discuss the types of hermaphroditism, describe gonochorism and comparative study of hermaphroditism *versus* gonochorism and explain an investment trade off.
11. Explain synchronous reproduction of marine invertebrates, describe the Co-variable traits in marine invertebrates, explain the non-marine invertebrates' reproductive traits, Describe the reproduction and life history of marine invertebrates, synchronous production strategies and advantages,
12. Describe the reproduction and life history of marine invertebrates, synchronous production strategies and advantages, Synchronous reproduction of marine invertebrates, describe the Co-variable traits in marine invertebrates, explain the non-marine invertebrates' reproductive traits,
13. Define dormancy, describe the types of dormancy, diapause in terrestrial and freshwater environments: Phases of insect diapause, Comparison of Diapause Periods, discuss the hibernation and aestivation.
14. Define Biorhythmicity (circadian rhythm); Define chronobiology, explain the general criteria of biological rhythm, describe the importance of biological rhythm in animal, explain the light-dark cycle, Biological clock in mammals and its location, discuss biological marker, describe the Outside the "Master Clock", impact on human health and related diseases.

After completion of **Life cycles; Population** course, learners will be able to:

1. Define life cycle
2. Compare the haplontic, diplontic and haplodiplontic biological life cycles with examples
3. Describe the types zygotic and gametic meiosis
4. Define larva and knowing different forms of larvae found in different animal phyla
5. Compare different types of metamorphosis in animal keeping efficiency on insect metamorphosis
6. Interpret what is molting and ecdysis
7. Describe factors (physical & physiological) responsible for regulation of metamorphosis
8. Define regeneration and description of different types of regeneration found in animals
9. Define population, deme, mono and polyspecific populations
10. Explain basic characteristics of population keeping role in increase or decline density
11. Define and compare different types of group properties of population
12. Explain different types of density
13. Define immigration, emigration and migration in a population
14. Compare different types population dispersion

15. Define mortality with its different forms
16. Explain survivorship curves
17. Define biotic potential and its effect on population
18. Define and compare J-shaped and S-shaped growth forms in population
19. Describe different age structures and age pyramids
20. Interpret natality with its different types, fecundity and fertility
21. Describe different types of life table and how to construct a life table.
22. Explain biotic and abiotic factors
23. Define population dynamics, gain and loss which can cause a great change in population
24. Explain different equations stating population status
25. Define population regulation, carrying capacity and types of factors regulate population size
26. Define population ecology and different views on population regulation
27. Describe the theories on population regulation

Course contents, subject to the lecture and alignment of topic with CLOs:

Course contents	**Subject to the lecture**	**Alignment of topic with CLOs**	**LH**
Reproductive Biology			
Introduction to reproduction;	❖ Lecture is delivered on the definition of reproduction as a most important characteristics of living beings, origin of Life and historical background ❖ Then, the importance of reproduction with the types of reproduction will be explained.	CLO-1	2
Pattern of sexuality, significance of sexual and asexual reproduction	❖ Lecture is delivered on the description of pattern of sexuality, explain the importance of reproduction; describe the types of reproduction, discuss the asexual reproduction in invertebrates. Explain the advantages and disadvantages of asexual reproduction and examples	CLO-2	2
Pattern of sexuality, significance of sexual and asexual reproduction	❖ Lecture is delivered to describe sexual reproduction, explain the characters of sexual reproduction, describe the Life cycles and sexual reproduction in invertebrate, describe the process of conjugation, explain the factors and conditions of conjugation	CLO-2	2
Organization of sexual reproduction and life histories;	❖ Lecture is delivered to describe the Comparative study of asexual reproduction and sexual reproduction, explain the several patterns of sexual reproduction, discuss the different forms of sexual reproduction, explain the Conditions of sexuality in invertebrates	CLO-3	2
Reproductive traits and functions; Systems for sexual reproduction (myxis)	❖ Lecture is delivered to describe sexual reproduction, explain the characters of sexual reproduction, describe the Life cycles and sexual reproduction in invertebrate, Describe the Process of conjugation, explain the factors and conditions of conjugation. ❖ It will be continued to explain the systems for sexual reproduction (Mysis), discuss the characters of sexual reproduction, describe the process of exchange of genetic materials in viruses, describe the bacteriophage viruses and the life cycle, discuss the genetic exchange and recombination in bacteria and lower group, classification of bacteria on the basis of cell wall, describe the process of	CLO-4, CLO-5	2

	bacterial conjugation, define and types of plasmid, explain roll of plasmid in conjugation.		
Reproductive traits and functions; Systems for sexual reproduction (myxis)	❖ Lecture is delivered to describe sexual reproduction in higher organism: describe the organization of sexual reproduction and life histories: reproductive trait and functions, describe A functional analysis of the life histories of Insects, explain the different instar with different function base on some principles, describe the life histories Orthoptera, Diptera, aquatic and terrestrial insect with examples, hymenopter, honey bee etc. explain reproductive strategy.	CLO-6	2
Parthenogenesis; Control of reproductive processes;	❖ Lecture is delivered to define parthenogenesis, describe different types of parthenogenesis, describe the parthenogenesis in aphid, Rotifers, discuss the importance of parthenogenesis, advantage and disadvantage as well.	CLO-7	2
Parthenogenesis; Control of reproductive processes	❖ Lecture is delivered to describe the life cycle of some multicellular animals, explain asexual reproduction (Amixis), describe the mechanism of parthenogenesis (Automixis), define, Arrhenotoky, thelytoky, sexual reproduction Significance of sexual and asexual reproduction. Discuss the Life cycle of Daphnia, rotifer and Aphid.	CLO-7 CLO-8	2
Ultimate and proximal factors; hermaphroditism *versus* gonochorism: an investment tread off	❖ Lecture is delivered to describe the control of reproductive process, explain and describe the factor on reproductive cycle, explain ultimate and proximate factor, describe the difference between ultimate factors and proximate factors. ❖ Explain an investment trade off.	CLO-9	2
Ultimate and proximal factors; hermaphroditism *versus* gonochorism: an investment trade off	❖ Lecture is delivered to describe hermaphroditism, discuss the types of hermaphroditism, describe gonochorism and comparative study of hermaphroditism *versus* gonochorism and explain an investment trade off.	CLO-10	2
Synchronous reproduction of marine invertebrates	❖ Lecture is delivered to synchronous reproduction of marine invertebrates, describe the Co-variable traits in marine invertebrates, explain the non-marine invertebrates' reproductive traits	CLO-11	2
Synchronous reproduction of marine invertebrates	❖ Lecture is delivered to describe the reproduction and life history of marine invertebrates, synchronous production strategies and advantages, Synchronous reproduction of marine invertebrates, describe the Co-variable traits in marine invertebrates, explain the non-marine invertebrates' reproductive traits.	CLO-11	2
Diapause in terrestrial and freshwater environments	❖ Lecture is delivered to Define dormancy, describe the types of dormancy, diapause in terrestrial and freshwater environments: phases of insect diapause, comparison of diapause periods, discuss the hibernation and aestivation.	CLO-12	2
Biorhythmicity (circadian rhythm); photoperiodism and biological clock	❖ Lecture is delivered to define Biorhythmicity (circadian rhythm); define chronobiology, explain the general criteria of biological rhythm, describe the importance of biological rhythm in animal	CLO-13	2

Biorhythmicity (circadian rhythm); photoperiodism and biological clock	❖ Lecture is delivered to explain the light-dark cycle, biological clock in mammals and its location, discuss biological marker, describe the Outside the “Master Clock", impact on human health and related diseases.	CLO-14	2
Life cycles			
Biological life cycle	❖ Lecture is delivered to provide definition of different types of life cycles with examples. ❖ Then, the gametic and zygotic meiosis will be explained.	CLO-1 CLO-2 CLO-3	2
Larval development	❖ Lecture is delivered to describe the types of larva found in different animal groups	CLO-4	2
Metamorphosis	❖ Lecture is delivered to describe the types of metamorphosis found in animal groups with examples. ❖ Then, the molting and ecdysis, and factors controlling metamorphosis will be explained.	CLO-5 CLO-6 CLO-7	2
Regeneration	❖ Lecture is delivered to explain different types of regeneration found in animal kingdom ❖	CLO-8	2
Population biology			
Population	❖ Lecture is delivered to describe population, deme and the different types of population. ❖ Then, the basic characteristics keeping role in the increase or decline the density and to mention the group properties of population will be interpreted.	CLO-9 CLO-10 CLO-11	2
Population density	❖ Lecture is delivered to explain the different types of density mechanisms and to define immigration, emigration and migration in a population. ❖ Then, different types of dispersion will be compared.	CLO-12 CLO-13 CLO-14	2
Population mortality and biotic potential	❖ Lecture is delivered to define mortality with its different forms and to explain survivorship curves. ❖ Then, biotic potential and its effect on population will be defined.	CLO-15 CLO-16 CLO-17	2
Growth forms	❖ Lecture is delivered to define and compare J-shaped and S-shaped growth forms in population.	CLO-18	2
Age structure	❖ Lecture is delivered to describe different age structures and age pyramids. ❖ Then, natality with its different types, fecundity and fertility will be interpreted.	CLO-19 CLO-20	2
Life table	❖ Lecture is delivered to describe different types of life table and how to construct a life table.	CLO-21	2
Abiotic and biotic factors	❖ Lecture is delivered to explain abiotic and biotic factors.	CLO-22	2
Population dynamics	❖ Lecture is delivered to define population dynamics, gain and loss causing change in population. ❖ Then different equations stating population status will be explained.	CLO-23 CLO-24	4
Population regulation	❖ Lecture is delivered to define population regulation, carrying capacity and types of factors regulate population size.	CLO-25	2
Population regulation	❖ Lecture is delivered to define population ecology and different views on population regulation. ❖ Then, theories on population regulation will be described.	CLO-26 CLO-27	2
Learning Resources: Barnes *et. al*., Campbell biology-Urry *et al*., The Invertebrate Zoology- Check Online search engine			

related to reproductive Biology. See the Ref.
R.S.K. Barnes, P. Calow, P.J.W. Olive, D.W. Golding and J.I. Spicer (2001). The Invertebrates, A synthesis.
Eugene.P. Odum, Gary W. Barrett. (5th Edn.) (2005). Fundamentals of Ecology.
J.L. Chapman, M.J. Reiss (1992). Ecology. Principles and Applications.
E. Lendell Cockrum, William J. McCauley (1965). Zoology.
P.S. Verma, V.K. Agarwal (1974). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology.
Internet.

Assessment Strategy

Type of Assessment	**Components**	**Marks**	**Methods of Assessment**
Final Written Examination	Broad Questions	35	As mentioned in Zool.H.201 (Page No.)
	Short Questions	35	
Continuous Assessment	Attendance	10	
	Tutorial	20	

Course: Zool. H. 205

Field study/Excursion

Full Marks 50 (0.5 unit, 2 credits)

Preparation and submission of reports on slaughtering, meat and fish flesh selling shops to demonstrate and illustrate different anatomical aspects of organs and organ systems of larger animals; Submission of any autopsy report if available; and visit to an abattoir, if possible. (Distribution of marks: Local field report =25; Presentation/*viva-voce*=10; Assessment=10; Attendance=5).

Course: Zool. HV. 206

Viva-voce II

Full marks: 50 (0.5 unit, 2 credits)

Viva-voce on theoretical courses from Zool. H. 201 to Zool. H. 204.

Course Title: Zoology Practical II		
Course Code: Zool.HP.211	**Course Type:** Practical (Core Course, Mandatory)	**Credits:** 6
Full Marks: 150	**Total Lecture hours:** 90	**Exam Hours:** 18 (6 hours daily)
Course Learning Objectives To provide practical experience on the topics covered by theoretical courses so that the learner can apply their knowledge in lab, workplace and in practical life.		
Course Learning Outcomes (CLOs) After completion of this course, learners will be able to:		

1. Dissect and display the different organs and organ systems of the representative animals of different taxa.
2. Provide comparative interpretation of evolution and adaptations of the different organs and organ systems of the representative animals of different taxa.
3. Describe the structures of the representative organs and organ systems of the rare/endangered specimens.
4. Draw labeled diagram of dissected and/or displayed organs and organ systems of different animals.
5. Identify special structures, integumentary derivatives, bones, teeth with dental formula, organ and organ system of the representative animals of different taxa.
6. Demonstrate and describe the procedure for detection of urea, albumen and glucose in given samples as well as for measurement of blood pressure.

Course contents, teaching strategies and alignment of topic with CLOs

Contents	Alignment of topic with CLOs	LH
Dissection and displaying of the different organs and organ systems of the following animals showing the relevance to evolution and adaptations that are practicable: Earthworm, any insect (cockroach, grasshopper), prawn, freshwater mussel, snail, starfish/sea star, available cartilaginous and bony fishes, commercially available birds (chicken/pigeon) and mammals (lab mice/rats); endocrine glands of chordates.	CLO 1-2 CLO 4	30
Study of the representative organs and organ systems of the rare/endangered specimens: Dissected animals displaying different systems of toad/frog and lizard, nictitating membrane and hyoid apparatus of frog/toad etc. will be provided to the classroom for observation and study.	CLO 1-4	30
Identification of statocyst of prawn; radula and osphradium of snail; loreal pits in vipers, larval forms; internal ear of dogfish; Weberian ossicles of any bony fish; pecten of bird; teeth and dentition in mammals.	CLO 1 CLO 4-5	10
Identification of integumentary derivatives, sound producing organs and skeletal systems of chordates.	CLO 5	10
Detection of urea, albumen and glucose in given samples; measurement of blood pressure.	CLO 6	10

Assessment Strategy

Type of Assessment	Marks	Methods of Assessment
Practical Examination	105	18-hr practical exam on the above topics (6 hrs daily)
Continuous Assessment	15	As mentioned in Zool.H.201 (Page No.)
	15	Practical class records
	15	Laboratory assessment

Learning Resources:

Barrington, EJW. 1979. Invertebrate Structure and Function (2nd edn). John Wiley and Sons, New York

Beklemishev. Comparative Anatomy of Invertebrates. Vol. I Promorphology; Vol. II Organology

Dales, RP. 1981. Practical Invertebrate Zoology. Blackwell Scientific Publications. London.

Eckert R. and Randall D. 1978. Animal Physiology. WH Freeman and Co., New York.

Eddy, S. 1949. Atlas of Drawings for Chordate Anatomy. John Wiley and Sons Inc., New York.

Goodrich, ES. Comparative Anatomy of Vertebrates.

Griffin, DR and Novick, A. 1962. Animal Structure and Function. Holt, Rinehart and Winston, Inc., New York.

Guyton, AC and Hall, JE. 2000. Textbook of Medical Physiology (10th edn). W.B. Saunders, Philadelphia.

Kent, G and Carr, R. 2000. Comparative Anatomy of the Vertebrates (9th edn). McGraw-Hill Science, London.

Hildebraand, M. 1988. Analysis of Vertebrate Structure. John Wiley and Sons. Inc., New York.

Marshall DT. 1967. The Physiology of Mammals and other Vertebrates. Cambridge Univ. Press. London.

Parker, TJ and Haswell, WA. 1962. A Text-Book of Zoology (7th edn). McMillan and Co. Ltd. London.

Pearson, R and Ball, JN. 1981. Lecture Notes on Vertebrate Zoology. Blackwell Scientific Publications. Oxford, London.

Pechenik, JA. 1985. Biology of the Invertebrates. PWS Publishers, Boston.

Pfeiffer, P. (ed) 1985. Predators and Predation: The Struggle for life in the Animal World: Facts on file. New York. Oxford

Rugh, R. 1968. The Mouse - its reproduction and development. Burgess Publishing Co., Minneapolis, Minn.

Walker, WF Jr. 1987. Functional Anatomy of the Vertebrates: An Evolutionary Perspective. Sander's College Publishing, USA.

Walker, WF. 1975. Vertebrate Dissection. W.B. Sander's Co., London.

Walker, WF. 1980. Vertebrate Dissection. Sanders Co., Philadelphia.

Webster, D and Webster, M. 1974. Comparative Vertebrate Morphology. Academic Press, New York, London.

Weickert, CK. 1965. Anatomy of the Chordates (3rd edn). McGraw-Hill, New York.

Wigglesworth, VB. 1965. The Principles of Insect Physiology. ELBS and Methuen and Co.

Williams, P, Stone, G and Johnston, I. 2005. Environmental Physiology of Animals (2nd edn). Blackwell Scientific Publications, Oxford. London.

Course Title: Botany IV: Plant Physiology, Ecology and Fungal diseases		
Course Code: Zool.R. 221	**Course Type:** Theory (Core Course, Mandatory)	**Credits:** 2
Full Marks: 50	**Total Lecture hours:** 30	**Exam Hours:** 3

Course Description

Plant physiology is a branch of biology which deals a wide range of processes and functions that plants use to live and survive. The courses discuss some basic contents including minerals and nutrients transportation, photosynthesis, respiration, metabolism, transpiration, plant hormones and enzymes.

Plant Ecology deals with the reciprocal relationship between plants and their environments. This course will introduce students to the basic ecological principles related to ecosystem, plant succession and distribution of plants with biotic and abiotic environments.

The course will be conducted on basic concepts of zoo-pathogenic fungi and the occurrence of muscardine disease of silkworm, skin disease of human beings, fungal diseases of economically important animals.

Course Learning Outcomes (CLOs)

Upon completion of this course, the students will be able to:

1. Describe the basic physiological, ecological and fungal diseases and familiarize the subjective matters.
2. Analyze different physiological and ecological processes and functions and their interactions within plants and environment. Disease manifestation by fungi and their pathogenic behaviour to animals especially humans to be studied.
3. Apply knowledge to find out physiological processes and functions of plants to develop better crop cultivation practices. On the other hand, to apply ecological principles, to find out the present and future situation of plant distribution, succession, better adaptation of plants in Bangladesh. The knowledge of fungal diseases would be helpful to take precautions from harmful diseases.
4. Create awareness on various physiological and ecological acts and fundamental knowledge of fungal diseases which will be associated with human welfare.

Course contents, subject to the lecture and alignment of topic with CLOs

Course contents	Subject to the lecture	Alignment of topic with CLOs	LH
Plant Physiology			
Concept, osmosis, absorption of water, minerals, nutrients, role of nutrients, transportation, types and factors affecting transpiration.	❖ Lecture is delivered on concept, osmosis, absorption of water, minerals, nutrients. ❖ Then, role of nutrients, transportation, types and factors affecting transpiration will be explained.	CLO-1 CLO-2 CLO-3	4
Photosynthesis, mechanism in C_3 and C_4 plants, factors affecting the rate of photosynthesis, respiration types, mechanism of anaerobic and aerobic respiration.	❖ Lecture are used to describe Photosynthesis, mechanism in C_3 and C_4 plants, factors affecting the rate of photosynthesis. ❖ Then respiration types, mechanism of anaerobic and aerobic respiration	CLO-1 CLO-2 CLO-3	3
Phytohormone, enzymes, germination of seeds and viability of seeds.	❖ Lecture is delivered on the description of phytohormone, enzymes, germination of seeds and viability of seeds.	CLO-1 CLO-2 CLO-3	3
Ecology			
Concept, ecosystem, components of ecosystem, ecosystem of Bangladesh.	❖ Lecture are used to describe the Concept, ecosystem and components of ecosystem, ❖ Then, ecosystem of Bangladesh will be discussed.	CLO-1 CLO-2 CLO-3	3

Edaphic, climatic and biotic factors in relation to growth, development and distribution of plants, succession sere, xero and hydro-sere.	❖ Lecture is used to describe the Edaphic, climatic and biotic factors in relation to growth, development and distribution of plants. ❖ Then succession sere, xero and hydro-sere will be discussed.	CLO-1 CLO-2 CLO-3	4
Adaptations of hydrophytes and xerophytes; distribution and floristic composition of forests in Bangladesh.	❖ Lecture is used to describe the Adaptations of hydrophytes and xerophytes. ❖ Then distribution and floristic composition of forests in Bangladesh will be discussed.	CLO-1 CLO-2 CLO-3	3
Fungal diseases			
Introduction, elementary knowledge of zoo-pathogenic fungi.	❖ Lecture is used to describe the elementary knowledge of zoo-pathogenic fungi.	CLO-1 CLO-2 CLO-3	2
Study of the following diseases: muscardine diseases of silkworm, skin diseases of human beings.	❖ Then, muscardine diseases of silkworm, skin diseases of human beings are discussed.	CLO-1 CLO-2 CLO-3	3
Mycoses, fungal diseases of economically important animals.	❖ Lecture is used to discuss the mycoses and fungal diseases of economically important animals.	CLO-1 CLO-2 CLO-3	2

Learning Resources:

V K Jain. 2015. Plant Physiology; S. Chand and Co. India.
S. N. Pandey and B.K. Sinha. 2001. Plant Physiology; Vikas Publishing House, India.
Shukla, R.S. and Chandel P.S. 2001. Plant Ecology. Publisher: S Chand & company Ltd. New-Delhi, India.
Shukla, R.S. and Chandel P.S. 2003. Plant Ecology and soil science. Publisher: S Chand & company Ltd. New Delhi, India
B.S. Mehotra. 1992. The fungi: An Introduction. New Delhi, India.
R.S. Sing Udvit Sarirbiddya: N. K. Paul (Bengali Book). 2002. Plant pathology: Bangla Academy, Dhaka, Bangladesh.
Internet source.

Assessment Strategy

Type of Assessment	Components	Marks	Methods of Assessment
Final Written Examination	Broad Questions	20	As mentioned in Zool.H.201 (Page No.)
	Short Questions	15	
Continuous Assessment	Attendance	5	
	Tutorial	10	

Course Title: Botany V: Microbiology and Plant Pathology		
Course Code: Zool.R. 222	**Course Type:** Theory (Core Course, Mandatory)	**Credits:** 2
Full Marks: 50	**Total Lecture hours:** 30	**Exam Hours: 3**

Course Description

This course is designed to help students to understand regarding the basic concept of microbiology and plant pathology. Students can explore various topics of microbiology and plant pathology including characteristics, habit, habitat, etiology, diseases and their industrial use. It also helps the students to be familiar with different characteristics to identify viruses, bacteria and plant diseases causing organisms.

Course Learning Outcomes (CLOs)

By studying plant microbiology and plant pathology, students will be able to:

1. Define and understand characteristics of different organisms and their biological nature.
2. Describe microbiological mode of function, pattern of environmental and nutritional factors, as well as relationship of fungi with agriculture, crop plants and human/animals.
3. Collect, identify and use different microorganisms.

Course contents, subject to the lecture and alignment of topic with CLOs

Course contents	Subject to the lecture	Alignment of topic with CLOs	LH
Microbiology			
Microbiology	❖ Introduction, Definition of microorganism and microbiology, A brief history of microbiology.	CLO 1	3
Viruses	❖ Introduction, biological status of viruses, nature, structure, chemical composition, replication and classification.	CLO 1-3	3
Bacteria	❖ Morphology of bacteria, structure of bacteria cells, internal structures, the cell wall and plasma membrane, staining reactions, colony morphology, classification, reproduction and special structure.	CLO 1-3	5
Actinomycetes	❖ Discovery, structure, classification, distribution, multiplication and economic importance.	CLO 1-2	2
Industrial uses of microorganisms	❖ Antibiotics, vinegar, alcohol, baker's yeast.	CLO 2-3	3
Bacterial and viral diseases	❖ Causal organisms, symptoms and control measures of tuberculosis, diphtheria, pneumonia, cholera, shigellosis, typhoid, tetanus, influenza, polio and dengue.	CLO 2-3	3
Plant Pathology			
	❖ Importance of plant pathology in modern agriculture.	CLO 1-2	1
	❖ Parasitism, disease development and stages in the development of disease	CLO 2-3	2
	❖ How pathogen attack plants	CLO 1	3
	❖ Forecasting of plant disease	CLO 1-2	1
	❖ Plant quarantine	CLO 1-2	1
	❖ Control of plant disease.	CLO 2-3	3

Learning Resources:

P.D. Sharma (2010). Microbiology & Plant Pathology.
DK Maheshwari (1999). A textbook of microbiology.
Ashok Kumar Sinha (1989). Plant Pathology.
George N. Agrios (2005). Plant Pathology.
RS Singh (1975). Introduction to Principles of Plant Pathology.
BP Pandey (1982). Plant Pathology.

Assessment Strategy

Type of Assessment	Components	Marks	Methods of Assessment
Final Written Examination	Broad Questions	20	As mentioned in Zool.H.201 (Page No.)
	Short Questions	15	
Continuous Assessment	Attendance	5	
	Tutorial	10	

Course Title: Chemistry IV: Bio-physical and Bio-organic		
Course Code: Zool.R. 223	**Course Type:** Theory (Core Course, Mandatory)	**Credits:** 2
Full Marks: 50	**Total Lecture hours:** 30	**Exam Hours: 3**

Course Description

This course has been designed to introduce students to electrochemical cells, chemical and enzyme kinetics, spectrophotometry, carbohydrates and Lipids of chemical and biochemical processes. It will also provide knowledge on electrode potentials, the order and molecularity of reactions, the effect of pH and ionic strength, the kinetics of enzyme-catalyzed reactions, Spectrophotometric analysis, Nucleic acids, lipids and different aspect of biological membranes. Finally, it will capable students to apply their knowledge and skill for diagnosis of chemical and enzyme reactions, the effective control of those reactions and basic knowledge of bio-organic chemistry.

Course Learning Outcomes (CLOs)

After completion of this course, learners will be able to:

1. Define electrochemical cells, chemical and enzyme kinetics reactions with examples.
2. Compare the the Red-Ox processes, thermodynamics of reversible cells, half cells, electrode potentials, electrochemical cells, sign conventions, the Nernst equation, biochemical standard states, coupled red-ox processes.
3. Describe the pathway of reaction, order and molecularity of reaction, type of rate processes, determination of the order of reaction, rate expression for first and second order reaction, effect of temperature on the rate of reaction, Arrhenius equation, significance of parameters, simple treatment of transition state theory of reactions, effect of pH and ionic strength on the rate of reaction in solution, kinetics of enzyme catalyzed reactions, treatment of kinetic data, enzyme inhibition, effect of pH and temperature on enzyme reaction.
4. Explain the electromagnetic spectrum, Beer-Lambert law and determination of unknown concentration based on the Beer-Lambert law, appropriate concentration range, two absorbing compounds and isosbestics points.
5. Synthesize and give structures of different kinds of carbohydrates.
6. Convert one carbohydrate to another and know their uses.
7. Write RNA/DNA conformation and their functions
8. Discuss about genetic code.
9. Write structures and functions of different kinds of lipids.
10. Describe the component and functions of biological membranes.

Course contents, subject to the lecture and alignment of topic with CLOs

Course contents	**Subject to the lecture**	**Alignment of topic with CLOs**	**LH**
Electrochemical cells (Red-Ox Processes):			
Red-Ox processes, thermodynamics of reversible cells, half cells, electrode potentials, electrochemical cells, sign conventions, the Nernst equation, biochemical standard states, coupled red-ox processes	❖ Lecture will be used to define terms of redox processes with examples. ❖ Then, lecture will be applied to explain the comparative characteristics of Red-Ox processes, thermodynamics of reversible cells, half cells, electrode potentials, electrochemical cells, sign conventions, the Nernst equation, biochemical standard states, coupled red-ox processes.	CLO 1-2	6
❖ **Chemical and enzyme kinetics:**			
The pathway of reaction, order and molecularity of reaction, type of rate processes, determination of the order of reaction, rate expression for first and second order reaction,	❖ Lecture will be used to explain the different chemical kinetics.	CLO 1-3	8

effect of temperature on the rate of reaction, Arrhenius equation, significance of parameters, simple treatment of transition state theory of reactions, effect of pH and ionic strength on the rate of reaction in solution, kinetics of enzyme catalyzed reactions, treatment of kinetic data, enzyme inhibition, effect of pH and temperature on enzyme reaction.			
Spectrophotometry:			
The electromagnetic spectrum, Beer-Lambert law and determination of unknown concentration based on the Beer-Lambert law, appropriate	❖ Lecture is delivered to explain the electromagnetic spectrum, Beer-Lambert law and determination of unknown concentration based on the Beer-Lambert law, appropriate concentration range, two absorbing compounds and isosbestics points.	CLO 4	6
Carbohydrates:			
Monosaccharides, oligosaccharides and polysaccharides.	❖ Lecture will be used to provide definition of carbohydrates with examples. ❖ Then, monosaccharides, oligosaccharides and polysaccharides will be explained.	CLO 5-6	3
Nucleic acids			
Nucleotides/Polynucleotide, their conformations, DNA/RNA, genetic code.	❖ Lecture will be used to describe nucleic acids, RNA/DNA, their conformations and functions.	CLO 7-8	3
Lipids			
Fats and oils, biological membranes.	❖ Lecture will be used to provide definition of lipids with examples. ❖ Then, the component and functions of biological membranes will be described.	CLO 9-10	4

Learning Resources:

Peter W. Atkins and Julio de Paula: Atkins' Physical Chemistry (10th edition).
Nichilas C. Price and Raymond A. Dwek: Principles and Problems in Physical Chemistry for Biochemists; Claredon Press, Oxford (1979)
N. Kundu and S. K. Jain: Physical Chemistry
Samuel Glasstone: Textbook of Physical Chemistry
Bahl, B. S. Bahl and G. D. Tuli: Essentials of Physical Chemistry
A. Bahl and B. S. Bahl: Advanced Organic Chemistry
A. W. Lehninger: Principles of Bio-chemistry
A. Bahl and B. S. Bahl: A Text Book of Organic Chemistry
Robert C. Bohinski: Modern concepts in Biochemistry
R.T. Morrison and R.N. Boyd: Organic Chmistry

Assessment Strategy

Type of Assessment	Components	Marks	Methods of Assessment
Final Written Examination	Broad Questions	20	As mentioned in Zool.H.201 (Page No.)
	Short Questions	15	
Continuous Assessment	Attendance	5	
	Tutorial	10	

Course Title: Chemistry V: Bio-inorganic		
Course Code: Zool.R. 224	**Course Type:** Theory (Core Course, Mandatory)	**Credits:** 2
Full Marks: 50	**Total Lecture hours:** 30	**Exam Hours: 3**

Course Description

This course describes the concept of fundamental particles and radioactivity. The course also provides the students with the knowledge of group displacement law and laws of radioactive disintegration as well as the methods for the separation and identification of isotomes. This course is also aimed to provide information about the sources, requirements and functions of alkali alkaline metal. At the end of the course, students will enrich their knowledge about the structure and functions of different protein. The students can apply their achievements to keep healthy the living systems.

Course Learning Outcomes (CLOs)

After completing this course, the students will be able to:

1. Write fundamental particles and their nature.
2. Write radioactive elements and its' units.
3. Explain the terms decay constant, half-life period, average life period and their relationship.
4. State and explain the "group displacement law".
5. Explain the laws of radioactive disintegration.
6. Describe the methods for the separation and identification of isotopes.
7. Discuss the sources, requirements and functions of alkali and alkaline earth metals in living systems.
8. Write structure and functions of chlorophyll.
9. Write structure and functions of heme protein.
10. Write structure and functions of iron Sulphur protein.
11. Describe the source and functions of zinc and copper metalloenzymes.

Course contents, subject to the lecture and alignment of topic with CLOs

Course contents	**Subject to the lecture**	**Alignment of topic with CLOs**	**LH**
Nuclear Chemistry			
Fundamental particles, natural and artificial radioactivity, unit of radioactivity,	❖ Lecture is delivered on the fundamental particles and their nature. ❖ Then, definition of natural and artificial radioactive elements with examples will be discussed. ❖ After discussing unit of radioactivity, lecture will be finished.	CLO 1-2	3
group displacement law	❖ The "group displacement law" will be stated and explained.	CLO 3-4	3
laws of radioactive disintegration, radioactive equilibrium,	❖ The laws of radioactive disintegration are stated and explained. ❖ Then, radioactive equilibrium will be discussed.	CLO 5	2
isotopes, definition, separation and application	❖ Lecture is used to describe the methods for the separation and identification of isotopes.	CLO 6	2
Bio-Metal Chemistry			
Overview, the role of alkali and alkaline earth metals in living systems.	❖ Lecture is delivered on different types of alkali and alkaline earth metals in living systems. ❖ Then, the sources, requirements and functions of alkali and alkaline earth metals in living systems will be discussed.	CLO 7	4
Metalloporphyrin			
Chlorophyll,	❖ Structure of chlorophyll is shown. ❖ Then, its function will be discussed.	CLO 8	4
heme proteins,	❖ Structure of different type of heme proteins are shown.	CLO 9	4

haemoglobin and myoglobin, haemoglobin modeling, other heme proteins (cytochromes, cytochrome P-450, enzyme, catalase, peroxidases),	❖ Then, their functions will be discussed. ❖ Then, lecture will be finished to discuss the comparison among different heme protein.		
Iron sulphur proteins, rubredoxines, ferredoxines and high potential iron proteins, hemerythrin, iron supply and transport, bio-inorganic chemistry of cobalt, vitamin $B_{12.}$	❖ Structure of different type of iron sulphur proteins are shown. ❖ Then, their functions will be discussed. ❖ Then, lecture will be finished to discuss the functional mechanism of enzyme and vitamin B_{12}.	CLO 10	4
Metalloenzymes: Zinc and copper metalloenzymes.	❖ Lecture is used to describe the source and functions of zinc and copper metalloenzymes.	CLO 11	4

Learning Resources:

R.D. Madon, Modern Inorganic chemistry.

F.A. Cotton *et al*., Advanced Inorganic chemistry.

Assessment Strategy

Type of Assessment	Components	Marks	Methods of Assessment
Final Written Examination	Broad Questions	20	As mentioned in Zool.H.201 (Page No.)
	Short Questions	15	
Continuous Assessment	Attendance	5	
	Tutorial	10	

Course Title: Bio-Chemistry IV: Carbohydrate, Protein and Lipid metabolism		
Course Code: Zool.R. 225	**Course Type:** Theory (Core Course, Mandatory)	**Credits:** 2
Full Marks: 50	**Total Lecture hours:** 30	**Exam Hours: 3**

Sub-units	Content	LH
I	**Carbohydrates**: Nomenclature, classification and properties of carbohydrates; structure, configuration and ring size glucose and fructose including their interconversions; mutarotation; a brief idea of disaccharides, e.g. sucrose, inversion of sucrose.	**8**
II	**Proteins and enzymes**: Nomenclature and classification; building blocks, structural features (both primary, secondary, tertiary and quaternary structures) and functions; their general properties, e.g. denaturation, renaturation, activation, inhibition; biuret reaction, colour reaction, etc. and partial as well as complete hydrolysis by acid or alkali or by enzymes. Specificity of enzymes actions.	**10**
III	**Carbohydrates metabolism**: Glycolysis, citric acid cycle, alternate glycolytic pathways, photosynthesis, its mechanism and importance.	**6**
IV	**Lipid metabolism**: Oxidation of fatty acids, propionate metabolism, ketone bodies.	**2**
V	**Protein metabolism:** Outlines of metabolism of amino acids (deamination, transamination, decarboxylation, urea formation.	**4**

Assessment Strategy

Type of Assessment	Components	Marks	Methods of Assessment
Final Written Examination	Broad Questions	20	As mentioned in Zool.H.201 (Page No.)
	Short Questions	15	
Continuous Assessment	Attendance	5	
	Tutorial	10	

Course Title: Biochemistry-V: Nutrition and Digestion		
Course Code: Zool.R. 226	**Course Type:** Theory (Core Course, Mandatory)	**Credits:** 2
Full Marks: 50	**Total Lecture hours:** 30	**Exam Hours: 3**

Sub-units	Contents	LH
I	**Nutrition:** Classification of food-stuffs, role of protein, fat and carbohydrates in nutrition, vitamins, enzymes and minerals (source, chemistry and nutritional role), balanced diet, diet chart for children, pregnant and lactating mother. Nutritional diseases (cause and preventive measures), kweshiorkor and marasmus, diet therapy for diabetic and patients having cardiovascular diseases, food allergy.	**20**
II	**Digestion:** Digestion and absorption of protein, lipid and carbohydrates.	**10**

Assessment Strategy

Type of Assessment	Components	Marks	Methods of Assessment
Final Written Examination	Broad Questions	20	As mentioned in Zool.H.201 (Page No.)
	Short Questions	15	
Continuous Assessment	Attendance	5	
	Tutorial	10	

Course Title: Botany Practical II		
Course Code: Zool. RP. 231	**Course Type:** Practical (Core Course, Mandatory)	**Credits:** 2
Full Marks: 50	**Total Lecture hours:** 30	**Exam Hours:** 6 (6 hrs daily)

Course Learning Outcomes (CLOs)

After completion of this course, learners will be able to:

7. Identify the major groups of plants and lower plants.
8. Compare the characteristics of lower and higher plants.
9. Identify the cell, cell wall, tissue and tissue system, meristems, stomata, primary and secondary structure of stem and root.
10. Prepare the tissue culture processes.
11. Identify the different symptoms and causal agents of some plant diseases.
12. Identify different zoo-pathogenic fungi.
13. Collect, identify and use different microorganisms.

Course contents, teaching strategies and alignment of topic with CLOs

Contents	Alignment of topic with CLOs	LH
Laboratory and field observation and examination of major plant taxas and lower plants including their feature, classification, and economic importance in relation to topics included in the theoretical course Zool.-R-121.	CLO 1-2	6
Dissection and displaying of cell, cell wall, tissue and tissue system, meristems,	CLO 3-4	6

stomata, primary and secondary structure of stem and root and study of tissue culture system in relation to topics included in the theoretical course Zool.-R-122.		
Laboratory and field observation of diseases in relation to topics included in the theoretical course Zool.-R-123.	CLO 5	6
Laboratory and examination of zoo-pathogenic fungi in relation to topics included in the theoretical course Zool.-R-221.	CLO 6	6
Laboratory and examination of viruses, bacteria and plant diseases causing organisms in relation to topics included in the theoretical course Zool.-R-122.	CLO 7	6

Assessment Strategy

Type of Assessment	Marks	Methods of Assessment
Practical Examination	35	6-hrs practical exam on the above topics (6 hrs daily)
Continuous Assessment	5	As mentioned in Zool.H.201 (Page No.)
	5	Practical class records
	5	Laboratory assessment

Course Title: Chemistry Practical II

Course Code: Zool. RP. 232	**Course Type:** Practical (Core Course, Mandatory)	**Credits:** 2
Full Marks: 50	**Total Lecture hours:** 30	**Exam Hours:** 6 (6 hrs daily)

Course Learning Outcomes (CLOs)

After completion of this course, learners will be able to:

1. Prepare of different standard solution and standardization of supplied solutions.
2. Estimate of carbonate in a caustic soda solution.
3. Volumetic estimatie of chemical compound by complexometric titration with EDTA.
4. Determination of the molar volume of H_2 gas, the molar mass of a solute, the solubility product constant and special rotation in different method and condition.
5. Demonstrate the Kinetic study of an acid catalyzed hydrolysis of an ester by titrimetric and polarimetric method.
6. Demonstrate the conductometric titration of an acid by a base.
7. Verify of the Beer Lambert law and finding out unknown concentration of a solution.

Course contents, teaching strategies and alignment of topic with CLOs

Contents	Alignment of topic with CLOs	LH
Section A (Volumetric analysis, 50% marks)		
Preparation of standard sodium carbonate solution and standardization of supplied HCl and NaOH solutions.	CLO 1	3
Preparation of standard potassium dichromate solution and standardization of supplied sodium thiosulphate solution.	CLO 1	3
Preparation of standard sodium oxalate solution and standardization of supplied permanganate solution.	CLO 1	3
Estimation of carbonate in a caustic soda solution.	CLO 2	3
Volumetic estimation of (a) copper iodometrically, (b) Iron with permanganate and dichromate, (c) Iron, copper, nickel, zinc, calcium and magnesium by complexometric titration with EDTA.	CLO 3	3
Section B (Biophysical, 50% marks)		
Determination of the molar volume of H_2 gas at STP and evaluation of the gas law constant R.	CLO 4	2
Determination of the molar mass of a solute by Rast's method	CLO 4	2
Determination of the solubility product constant and study of common ion effect by titration method.	CLO 4	2
Determination of specific rotation and finding out unknown concentration of an	CLO 4	2

optically active organic compound.		
Determination of the heat capacity of a calorimeter and finding out heat of solution of NaOH in water and heat of neutralization of HCl with solid NaOH and with NaOH solution.	CLO 4	3
Kinetic study of an acid catalyzed hydrolysis of an ester by titrimetric and polarimetric method.	CLO 5	1
Conductometric titration of an acid by a base.	CLO 6	1
Verification of the Beer Lambert law and finding out unknown concentration of a solution.	CLO 7	2

Assessment Strategy

Type of Assessment	**Marks**	**Methods of Assessment**
Practical Examination	35	6-hrs practical exam on the above topics (6 hrs daily)
Continuous Assessment	5	As mentioned in Zool.H.201
	5	Practical class records
	5	Laboratory assessment

Course Title: Bio-Chemistry Practical II		
Course Code: Zool. RP. 233	**Course Type:** Practical (Core Course, Mandatory)	**Credits:** 2
Full Marks: 50	**Total Lecture hours:** 30	**Exam Hours:** 6 (6 hrs daily)

Sub-units	**Contents**	**LH**
I	Identification of organic compounds.	**4**
II	Colour test for carbohydrates and proteins.	**4**
III	Estimation of vitamin C from supplied sample and biological sources by dichlorophenol indophenol method.	**4**
IV	Chromatographic separation and identification of amino acids	**4**
V	Colorimetric estimation of protein and glucose	**3**
VI	Titrimetric analysis.	**2**
VII	Isolation and purification of microorganisms (i.e. bacteria, molds, and yeasts natural sources.	**4**
VIII	Morphological characterization of microorganisms, growth of bacteria in solid and liquid media.	**4**

Course Title: Bio-Chemistry Practical II		
Course Code: Zool. RP. 233	**Course Type:** Practical (Core Course, Mandatory)	**Credits:** 2
Full Marks: 50	**Total Lecture hours:** 30	**Exam Hours:** 6 (6 hrs daily)

Sub-units	Contents	LH
IX	Determination of saponification and iodine value of fats and oils.	**4**
X	Determination of SGPT and SGOT activity in blood; determination of creatinine in urine.	**4**
XI	Isolation and purification of DNA and RNA from bacteria and bacteriophages.	**4**
XII	Determination of M.W. of protein by SDS electrophoresis and gel filtration.	**4**

Assessment Strategy

Type of Assessment	Marks	Methods of Assessment
Practical Examination	35	6-hrs practical exam on the above topics (6 hrs daily)
Continuous Assessment	5	As mentioned in Zool.H.201 (Page No.)
	5	Practical class records
	5	Laboratory assessment

Detail curriculum

For Third Year Honours Degree

in Zoology

B.Sc. (Honours) Part-III Examination, 2022

Course Title: Cell Biology, Genetics & Animal Breeding		
Course Code: Zool.H.301	**Course Type:** Theory (Core Course, Mandatory)	**Credits:** 4
Full Marks: 100	**Total Lecture hours:** 60	**Exam Hours:** 4

Course Description:

Cell Biology: Cell biology course is intended for the students to introduce them with cell structure and function, and it revolves around the concept that the cell is the fundamental unit of life. Focusing on the cell biology permits a detailed understanding of the cell, cell theory, stem cell, cell division, cell organelles, growth and aging, differentiation, effect of radiation, pathological aspects and histology. It also includes cell ultrastructure and function, energy transfer, reproduction, migration, DNA replication and genetics. By understanding how cells work in healthy and diseased states, cell biologists working in animal and medical science will be able to develop new vaccines, more effective medicines, animals with improved qualities and through increased knowledge a better understanding of how all living things live.

Genetics and Animal Breeding: The course is designed to fortify the knowledge and understanding of the learners about various aspects of Genetics and Animal Breeding. The course will also help enrich the existing ideas of the students on the basic work of Mendel, his laws of inheritance and their deviations. In addition, types and mechanisms of linkage and crossing-over, sex-linked inheritance in man and *Drosophila*, gene and chromosomal mutations, ABO blood groups and their inheritance, various mechanisms of sex determination in animals, Hardy-Weinberg law and its uses in population genetic studies, extra-nuclear inheritance and types and applications of animal breeding for farm animals.

Course Learning Objectives:

1. To introduce the learners with cell structure and function, and it revolves around the concept that the cell is the fundamental unit of life.
2. To fortify the knowledge and understanding of the learners about various aspects of Genetics and Animal Breeding.

Course Learning Outcomes (CLOs):

After completion of **Cell Biology** course, learners will be able to**:**

1. Define cell, cell theory, cell cycle and cell processes, describe stem cell, history, characters and types of stem cells
2. Describe the culture and importance of stem cells in research
3. Define cell cycle and types of cell division: amitosis, mitosis, meiosis and explain the mechanism of cytokinesis
4. Discuss the structure, origin and function of cell organelles: internal membranes, compartmentalize the functions of a eukaryotic cell, endoplasmic reticulum, Golgi bodies, lysosomes and mitochondria
5. Describe the structure, types and function of endomembrane system: nucleus, ribosomes and vacuoles; Define peroxisomes with their structures and functions
6. Describe morphology, structure and function of cytoskeleton: microtubules, microfilaments and intermediate filaments
7. Describe the basic concept of chromosomes with detail structure, morphology, types and functions
8. Describe the structure and cytogenetic functions, polytene and lampbrush chromosomes
9. Define cell growth and explain how it is not to be confused with growth in the context of cell division, referred to as proliferation. Define aging and explain the factors that influence aging, describe genetic and environmental factors on aging
10. Explain the basic mechanism of sub-cellular changes due to aging as well as describe various theories of aging
11. Define cell differentiation in unicellular and multicellular animals; explain differentiation results from the interaction of the nucleus and cytoplasm, describe the influence of the nucleus on the cytoplasm and *vice versa*.
12. Explain the differential gene action, describe the mechanism of cell differentiation process, explain the role of DNA and RNA, control of gene expression as well as describe the environmental factors which affect cellular differentiation
13. Define radiation, types and sources; describe the effects of UV and ionizing radiations on cells and

unicellular organisms

14. Define pathology and pathological aspects of cells, describe different types of cellular adaptation, cell infiltration, degeneration and degenerative diseases, types of cell injury. Describe necrosis, apoptosis. Describe the stages of decomposition of corpse and explain the mechanism of post mortem changes due to *rigor mortis*.
15. Define histology, describe the detail procedure of histotechniques; describe the histological structure of different organs of vertebrates: such as esophagus, intestine, stomach, heart, liver, lungs, pancreas and kidney.

After completion of **Genetics and Animal Breeding** course, learners will be able to**:**

1. Describe the work of Johann Mendel, the father of Genetics, explain Mendelism, and define the common terminologies used in Genetics
2. Describe and explain with examples the Mendelian crosses and ratios in garden peas and animals
3. Explain allelic and non-allelic interactions, and deviations from Mendel's laws
4. Explain with examples deviations from Mendelian monohybrid and dihybrid ratios
5. Classify, explain and compare linkage and crossing-over along with their significance
6. Describe and compare sex-linked, sex-limited and sex-influenced traits particularly in man and *Drosophila*
7. Define, compare and explain multiple and pseudoalleles with special reference to the inheritance of ABO blood groups in man and their medico-legal applications
8. Describe and understand various mechanisms of sex determination in animals and their abnormalities
9. Describe types, mechanisms and detection of gene mutations
10. Describe types of chromosomal mutations along with their practical applications
11. Classify and explain chromosomal aberrations, their origin and frequencies in man
12. Interpret extra-nuclear inheritance in animals and compare it with nuclear inheritance
13. Define population genetics and describe Hardy-Weinberg law and its derivation
14. Describe inbreeding, outbreeding and cross breeding and their genetic effects
15. Apply animal breeding principles for improving farm animals

Course contents, subject to the lectures and alignment of topics with CLOs

Course contents	**Subject to the lectures**	**Alignment of the topic with CLOs**	**LH**
Cell: The cell theory; Stem cells, their types, culture and applications.	❖ Lecture is delivered on definition of cell, cell basic, cell cycle and cell processes. ❖ Then, the characteristics and types of stem cell will be explained. ❖ Then, the history of stem cells, their importance in research will be discussed. ❖ Finally, culture of stems cell and its application will be described.	CLO-1 CLO-2	2
Cell Division			
Amitosis, mitosis,	❖ Lecture is delivered on the description of the cell division: amitosis and mitosis in details with examples.	CLO-3	2
Meiosis and cytokinesis	❖ Lecture is delivered on the description of the process of meiosis cytokinesis as well with example	CLO-3	2
Cell organelles			
Structure, origin and functions: Plasma membrane; Structure, model and physiology: Endoplasmic	❖ Lecture is delivered on definition of cell organelles and their types and functions etc are mentioned. ❖ To be described the internal membranes compartmentalize the functions of a eukaryotic cell as well structure, origin and function of cell organelles: endoplasmic reticulum, Golgi, lysosomes.	CLO-4	2

reticulum; Golgi complex; lysosomes, mitochondria			
Structure, model and physiology: Mitochondria; Nucleus, ribosomes	❖ Lecture is delivered on the description of the structure, origin and function of cell organelles: mitochondria, nucleus, ribosomes and vacuoles. ❖ To be defined peroxisomes with structure and function.	CLO-5	2
Cytoskeleton: Morphology, structure and functions of microfilaments, microtubules and intermediate filaments	❖ Lecture is delivered on the description of the morphology, structure and function of cytoskeleton: microtubules, microfilaments and intermediate filaments. ❖ To be explained interactions of motor proteins and the cytoskeleton circulates materials within the cell.	CLO-6	2
Chromosome: Morphology, structure and cytogenetic functions.	❖ Lecture is delivered on the definition of chromosomes. ❖ To be discussed the basic concept of chromosomes with detail structure, morphology, types and cytogenetic function. ❖ To be showed comparison between the different types of chromosomes.	CLO-7	2
Chromosome: Polytene and lampbrush chromosomes.	❖ Lecture is delivered on the description of history, structure and function of Polytene and lampbrush chromosomes.	CLO-8	2
Cell growth and aging			
Process of aging; Sub-cellular changes due to aging; Causes and theories of aging.	❖ Lecture is delivered on the definition of cell growth and aging; explanation of the factors that influence on the aging. ❖ To be described genetic and environmental factors on aging.	CLO-9	2
Process of aging; Sub-cellular changes due to aging; Causes and theories of aging.	❖ Lecture is delivered on the explanation of the basic mechanism of sub-cellular changes due to aging as well as description of various theories of aging.	CLO-10	2
Cell differentiation			
Differentiation in unicellular and multicellular organisms; mechanism of differentiation	❖ Lecture is delivered on the explanation of the basic mechanism of cell differentiation in unicellular and multicellular animals. ❖ To be explained differentiation results from the interaction of the nucleus and cytoplasm. ❖ To be described the influence of the nucleus on the cytoplasm and *vice versa*.	CLO-11	2
Differentiation in unicellular and multicellular organisms; mechanism of differentiation	❖ Lecture is delivered on the explanation of the differential gene action. ❖ To be described the mechanism of cell differentiation process. ❖ To be explained the role of DNA and RNA, and control of gene expression as well as describe the environmental factors effect on cellular differentiation.	CLO-12	2

Effects of radiation on cells: Sources of radiation; effects of ultraviolet (UV) and ionizing radiations on cells	❖ Lecture is delivered on the definition of radiation, types and sources of radiation. ❖ To be described the effects of UV and ionizing radiations on cells and unicellular organisms.	CLO-13	2
Pathological aspects of cell: Cellular infiltration and degeneration; Necrosis and post mortem changes	❖ Lecture is delivered on the definition of pathology and pathological aspects of cells ❖ To be described different types of cellular adaptation, cell infiltration, degeneration and degenerative diseases, and types of cell injury. ❖ To be described necrosis, apoptosis, the stages of decomposition of corpse and explained the mechanism of post mortem changes due to rigor mortis.	CLO-14	2
Histology: Histotechniques; Study of histological structure of different organs of vertebrates: Oesophagus, intestine, stomach, heart, liver, lungs, pancreas and kidney.	❖ Lecture is delivered on the definition of histology with description of the detail procedure of histotechniques. ❖ To be described the histological structure of different organs of vertebrates: such as esophagus, intestine, stomach, heart, liver, lungs, pancreas and kidney.	CLO-15	2
Genetics			
A short life-sketch of Mendel; Common terminologies used in Genetics	**Lecture 1:** Introduction to Genetics; work of Mendel and common terminologies used in Genetics (2 LH)	CLO-1	2
Mendel's laws of inheritance	**Lecture 2:** Mendelian crosses and ratios in experimental organisms	CLO-2	2
Deviations from monohybrid and dihybrid cross ratios	**Lecture 3:** Deviations from Mendel's laws of inheritance and their explanations	CLO-3	2
Deviations from monohybrid and dihybrid cross ratios	**Lecture 4:** Allelic and non-allelic interactions; Deviations from monohybrid and dihybrid cross ratios	CLO-4	2
Linkage and crossing-over	**Lecture 5:** Linkage and crossing-over, their types, theories and significance	CLO-5	2
Sex-linked inheritance in *Drosophila* and man; Sex-limited and sex-influenced traits	**Lecture 6:** Sex-linked, sex-limited and sex-influences traits in man and other animals	CLO-6	2
Multiple alleles and inheritance of ABO blood groups in man; Pseudoalleles and Rh antigen	**Lecture 7:** Multiple and pseudoalleles in animals; inheritance of ABO blood groups in man and their medico-legal applications	CLO-7	2
Genetic mechanisms and chromosomal mutations			
Determination of sex	**Lecture 8:** Various mechanisms of sex determination in	CLO-8	2

in animals	animals and their abnormalities such as gynandromorphs, hermaphrodites and sex mosaics		
Gene *versus* chromosomal mutations; Classification of gene mutations; Detection of mutations by ClB and Muller-5 methods	**Lecture 9:** Mutation-1: Gene mutations, their types, mechanisms and detection by ClB and Muller-5 methods	CLO-9	2
Variations in chromosome number and structure	**Lecture 10:** Mutation-2: Structural and numerical chromosomal mutations, their origin and practical applications	CLO-10	2
Chromosomal abnormalities in man	**Lecture 11:** Chromosomal aberrations, their causal factors, origin and frequencies in man	CLO-11	2
Extra-chromosomal inheritance in *Paramecium* and *Drosophila*.	**Lecture 12:** Cytoplasmic or extra-nuclear inheritance in *Paramecium* and *Drosophila*; Differences between nuclear and extra-nuclear inheritance	CLO-12	2
Hardy-Weinberg law and its limiting factors	**Lecture 13:** Population genetics; Hardy-Weinberg law and its derivation, limiting factors and calculations of gene and genotype frequencies in a population	CLO-13	2
Animal Breeding			
Types of breeding and their genetic effects	**Lecture 14:** Animal breeding: Brief history, types of breeding and their genetic effects	CLO-14	2
Practical applications of breeding principles	**Lecture 15:** Applications of inbreeding, outbreeding and crossbreeding for improvement of farm animals like chicken, cattle, sheep and goat	CLO-15	2

Assessment Strategy

Type of Assessment	**Components**	**Marks**	**Methods of Assessment**
Final Written Examination	Broad Questions	35	Year-end final exam will be taken.
	Short Questions	35	
Continuous Assessment	Attendance	10	% of the assessment marks for attendance will be given as follows
	Tutorial	20	Class test, presentation in group, assignment

Attendance	Marks	Attendance	Marks	Attendance	Marks
95 -100%	20%	90 -<95%	18%	85 -<90%	16%
80 -<85%	14%	75 -<80%	12%	70 -<75%	10%
65 -<70%	8%	60 -<65%	6%	<60%	0%

Course Title: Developmental Biology		
Course Code: Zool.H.302	**Course Type:** Theory (Core Course, Mandatory)	**Credits:** 4
Full Marks: 100	**Total Lecture hours:** 60	**Exam Hours:** 4

Course Description:

Gametogenesis: The course has been designed aims to understand the processes that lead from the fertilization of an egg cell to the formation of a well-structured and functional multicellular organism. It will also provide knowledge to investigate how fertilized egg cells divide in regulated manners to grow into full-size bodies, how the cells formed in this process communicate in meaningful ways to become different from each other, migrate, change shape and attach to each other, thus assembling into tissues

and complex organs. This course is also aimed to provide information on different types of tissues, tissues culture and their applications. Finally, it will capable you to apply your knowledge and skill for biomedical research.

Developmental Biology: This course has been designed to introduce the students with the embryonic development, developmental theory, developmental events and embryonic development of such animals as examples. Finally, it will capable the students to apply their knowledge and skill for diagnosis of embryonic problem, planning for the effective care and basic treatment of that problem.

Course Learning Objectives:

1. To provide knowledge on the processes that lead from the fertilization of an egg cell to the formation of a well-structured and functional multicellular organism.
2. To apply knowledge and skill for biomedical research.
3. To introduce the students with the embryonic development, developmental theory, developmental events

Course Learning Outcomes (CLOs):

After completion of **gametogenesis** course, learners will be able to:

1. Define gametogenesis as well spermatogenesis with how does the sperm or acrosome develop?
2. Compare the spermatogenesis and spermiogenesis.
3. Describe the types of eggs and their characteristics with example and comparison spermatogenesis & oogenesis.
4. Describe natural and artificial parthenogenesis and their advantages and disadvantages.
5. Explain when parthenogenesis is occurred?
6. mention the different types of epithelial tissue and their characterization and functions.
7. describe types, location and functions of proper connective tissue.
8. explain component of blood and their functions and disorder.
9. classify cartilage and bones and compare compact bone & spongy bone.
10. describe types, location and functions of muscular tissue.
11. define and compare different types of muscular tissue.
12. explain the types and basic function of nervous tissue with example.
13. define neuroglia tissue as well as to compare their types.
14. explain the Basic components in the culture media, methods of tissue culture and their applications.
15. describe substrate and their types.

After completion of **developmental Biology** course, learners will be able to:

1. define embryonic development, embryology, developmental Biology
2. compare the embryology, developmental Biology, embryogenesis, blastogenesis.
3. name and discuss the events of development
4. describe the types of development and their control mechanisms
5. describe different theories of development
6. compare among different theories of development
7. define egg and egg types with examples
8. mention the types of cleavage and explain cleavage pattern
9. interpret the influence of yolk on cleavage
10. define gastrulation and mention types of gastrulation with explanation
11. define coelom, discuss different types of coelom and their significance
12. discuss Speaman's organizer
13. name the organizer in different chordate and discuss the theories of organizer
14. discuss determination of cell fate, fate map and cytoplasmic localization
15. describe different methods of fate map construction
16. describe fate map of an animal as example
17. describe the events of embryonic development of some animals *eg. Neanthes,* any arthropod, any echinoderm, *Branchiostoma,* chick as examples.
18. name the extra-embryonic membranes of chick and discuss their development
19. discuss the comparison of embryonic development of the above animals
20. define placenta and describe their types with significance and mention their evolutionary sequence

Course contents, subject to the lecture and alignment of topic with CLOs.

Course contents	Subject to the lecture	Alignment of topic	LH

		with CLOs	
Gametogenesis: spermatogenesis	❖ Lecture is delivered on description of spermatogenesis and spermeiogenesis. ❖ Then, the comparative study of spermatogenesis and spermeiogenesis will be explained.	CLO-1 CLO-2	4
Gametogenesis: Oogenesis	❖ Lecture is delivered on description of the process of oogenesis, the types of eggs, their characteristics and examples.	CLO-3	4
Fertilization: External and internal fertilization; Fertilizin and antifertilizin; Process of fertilization; Significance of fertilization	❖ Lecture is delivered on description of external and internal fertilization. ❖ Then, Fertilizin and antifertilizin are discussed. ❖ Then, the process of fertilization with significance will be explained.		4
Parthenogenesis: Natural and artificial parthenogenesis and their significance	❖ Lecture is delivered on explanation of natural and artificial parthenogenesis and their significance and also ❖ To be described when parthenogenesis is occurred?	CLO-4 CLO-5	4
Tissues			
Epithelial tissues	❖ Lecture is delivered on explanation of classification, characterization and function of epithelial tissue.	CLO-6	2
Connective tissues	❖ Lecture is delivered on definition and comparison among different types of proper connective tissues. ❖ To be described blood as special type of connective tissue with their components. ❖ To be showed comparison between the cartilage and bone.	CLO-7 CLO-8 CLO-9	2
Muscular tissues	❖ Lecture is delivered on explanation of classification, characterization and function of muscular tissue. ❖ To be described cardiac muscle as special type of involuntary striated muscle with their components and function.	CLO-10 CLO-11	2
Nervous tissues	❖ Lecture is delivered on components of nervous tissue. ❖ To be described the structure and function of a neuron with its types.	CLO-12	2
Nervous tissues	❖ Lecture is delivered on the functions, types and characterization of the supporting cells of the central nervous system (neuroglia).	CLO-13	2
Tissue culture	❖ Lecture is delivered on the Basic components in the culture media, methods of tissue culture and their applications.	CLO-14	2
Tissue culture	❖ Lecture is delivered on the substrate and their types.	CLO-15	2
Developmental Biology			
Types of development and their control mechanism	❖ Lecture is delivered on definition of embryonic development, embryology and developmental biology ❖ Then, the comparative features of the embryology, developmental biology, embryogenesis, blastogenesis will be exposed. ❖ Then, the events of development will be explained. ❖ Then, the types of development and their control mechanisms will be described	CLO-1 CLO-2 CLO-3 CLO-4	2
Theories of development	❖ Lecture is delivered on the description of different theories of development	CLO-5	2
Mosaic versus regulative	❖ Lecture is delivered on the comparative features of different theories of development	CLO-6	2

development			
Egg types and cleavage patterns	❖ Lecture is delivered on the definition of egg and egg types with examples ❖ Then, the types of cleavage and cleavage pattern will be mentioned with explanations ❖ Then, the influence of yolk on cleavage is interpreted	CLO-7 CLO-8 CLO-9	2
Types of gastrulation, coelom and their significance	❖ Gastrulation is defined and types of gastrulation are mentioned with explanation ❖ Then, coelom and types of coelom will be discussed with definition and mentioned their significance	CLO-10 CLO-11	2
Spemann's organizer	❖ Lecture is delivered on Speaman's organizer.	CLO-12	2
organizer in different chordates, Theories of organizer	❖ Lecture is delivered on the organizer in different chordate ❖ Then, different theories of organizer will be described	CLO-13	2
Determination of cell fate, fate map and cytoplasmic localization	❖ Lecture is delivered on the discussion of determination of cell fate, fate map and cytoplasmic localization ❖ Then, different methods of fate map construction will be described ❖ Then, fate map of an animal as example will be described	CLO-14 CLO-15 CLO-16	2
Embryonic development of *Neanthes*	❖ Lecture is delivered on the description of the events of embryonic development of *Neanthes*	CLO-17	2
Embryonic development of any arthropod	❖ Lecture is delivered on the description of the events of embryonic development of any arthropod	CLO-17	2
Embryonic development of any echinoderm	❖ Lecture is delivered on the description of the events of embryonic development of any echinoderm	CLO-17	2
Embryonic development of *Branchiostoma*	❖ Lecture is delivered on the description of the events of embryonic development of *Branchiostoma*	CLO-17	2
Embryonic development of chick	❖ Lecture is delivered on the description of the events of embryonic development of chick	CLO-17	2
Embryonic development of chick	❖ Lecture is delivered on the extra embryonic membranes of chick embryo and their development ❖ Then, the comparison of embryonic development of the above animals will be discuss	CLO-18 CLO-19	2
Placentation types, significance and evolutionary sequence	❖ Lecture is delivered on the description of types of placenta with definition, significance and their evolutionary sequence	CLO-20	2

Assessment Strategy

Type of Assessment	**Components**	**Marks**	**Methods of Assessment**
Final Written Examination	Broad Questions	35	As mentioned in Zool.H.301
	Short Questions	35	
Continuous Assessment	Attendance	10	
	Tutorial	20	

Course Title: Ecology, Ethology and Wildlife		
Course Code: Zool.H.303	**Course Type:** Theory (Core Course, Mandatory)	**Credits:** 4
Full Marks: 100	**Total Lecture hours:** 60	**Exam Hours:** 4

Course Description:

Ecology: Ecology course has been designed to introduce the students with the historical background of ecology, Environmental factors, Ecosystem, Biogeochemical cycles, Population and community, habitat ecology, ecological aspects of the Sundarbans.

Ethology: Ethology course has been designed to study the animal responses towards the stimuli which govern total biological mechanisms of the animals to successfully complete its life cycle and produce healthy generations. This course describes about the Inborn (or inherent or instinct) and Learnt (or acquired by learning and training) behaviors; process of memorization; process of intra- and inter-specific communication. The course also depicts interesting species-specific behavioral types; functions of nervous and endocrine systems in animal behavior; behaviors in social animals.

Wildlife: Wildlife course is aimed to focus on wildlife concepts and management activities in Bangladesh, in light of "Wildlife (conservation and security) Act 1973 of Bangladesh amended in 2012; list of important wildlife of world. Finally, it will capable the students to apply their knowledge and skill for the development of various aspects of the environment.

Course Learning Objectives:

1. To introduce the learners with different terms and aspects of ecology.
2. To fortify the knowledge and understanding of the learners about ethology
3. To provide knowledge and skills on wildlife

Course Learning Outcomes (CLOs):

After completion of **ecology** course, learners will be able to:

1. Define historical background of ecology
2. Define component and function of ecosystem
3. Explain energy flow in the ecosystem, concept of productivity; food chain, food web and food pyramid;
4. Illustrate Nitrogen, carbon, and phosphorus cycles;
5. Explain the concepts of population and community, properties of a population and classification of communities;
6. Describe different habitats of aquatic ecosystem: freshwater, marine, estuary.
7. Describe terrestrial ecosystem
8. Explain our mangrove forest Sundarbans.

After completion of **Ethology** course, learners will be able to:

1. Define different terminologies used in ethological study with examples;
2. Explain ideas on ethological concepts and patterns of animal behaviors;
3. Mention the milestone literature especially which established the science of animal behavior;
4. Describe the types of stimuli and relevant responses;
5. Distinguish between types of orientation, *viz., taxes*, tropisms and kinesis with suitable examples;
6. Define and characterize different types of animal grouping (simple group, aggregation, colony) in animals; distinguish between merits and demerits of grouping and solitary living;
7. Describe different types of colony, characterize types of socialization in animals providing examples;
8. Define and describe different facets of social behavior with examples: altruism, dominance and hierarchy, courtship behavior, mating bonds, reproductive behavior of few interesting species, cast system in social insects (eusocial species);
9. Interpret all about territoriality;
10. Define and describe with examples about instinct (or inherent or inborn or innate) behavior and learnt or acquired behavior, types of memory and process of memorization;
11. Define and discuss animal communication with examples, ritual fights (metacommunication);
12. Discuss role of hormones and pheromones in animal behavior;

13. Discuss migratory behaviors in fish and birds.

After completion of **Wildlife** course, learners will be able to:

1. Define wildlife, provide scope and status of wildlife in Bangladesh;
2. Describe present status and role of wildlife and distribution of important wildlife species and their habitats in Bangladesh;
3. Mention key points provided in Bangladesh "Wildlife Act";
4. List wildlife species of Bangladesh and the world, providing their common English, scientific and Bangla names;
5. Define and categorize threatened and endangered species in Bangladesh and such important species of world, consulting current IUCN Red Data List;
6. Discuss role of wildlife in Bangladesh economy, and justify causes of wildlife Bangladesh, propose aspects for remedy;
7. Compare the international agencies working for conservation of nature and natural resources.
8. Describe methods or techniques taken for wildlife conservation and management, *in situ* and *ex situ* breeding of wildlife species.
9. Define present status of wild life.
9. Show awareness for wild life conservation and management with changing climate.

Course contents, subject to the lecture and alignment of topic with CLOs

Course contents	**Subject to the lecture**	**Alignment of topic with CLOs**	**LH**
Ecology			
Introduction to Ecology	❖ Lecture is delivered on definition of ecology, to describe historical background, modern concepts.	CLO 1	1
Introduction to Ecology	❖ Lecture is delivered on branches and scope of ecology, relationships of ecology with other disciplines.	CLO 1	1
Introduction to Ecology	❖ Lecture is delivered on different types **e**nvironmental factors and their impacts	CLO 1	2
Ecosystem	❖ Lecture is delivered on the component and function of ecosystem; food chain, food web and food pyramid	CLO 2	2
Ecosystem	❖ Lecture is delivered on the energy flow in the ecosystem, concept of productivity;	CLO 3	2
Biogeo-chemical cycles	❖ Lecture is delivered on the**:** types of biogeochemical cycle, Nitrogen cycle.	CLO 4	2
Biogeo-chemical cycles	❖ Lecture is delivered on description of carbon, and phosphorus cycles.	CLO 4	2
Population and community	❖ Lecture is delivered on concepts of population and community, properties of a population and classification of communities.	CLO 5	2
Habitat ecology	❖ Freshwater ecology; Limiting factors in freshwater environment; ecological classification of freshwater habitat;	CLO 6	2
Habitat ecology	❖ Lecture is delivered on; lotic and lentic communities; ecosystems of ponds and lakes;	CLO 6	2
Habitat ecology	❖ Lecture is delivered on Marine biota; Zonation of the sea;	CLO 6	2
Habitat ecology	❖ Lecture is delivered on communities in the marine environment;	CLO 6	2
Habitat ecology	❖ Lecture is delivered on Definition and types of estuaries; biota and productivity of estuary;	CLO 6	2
Habitat ecology	❖ Lecture is delivered on General structure of terrestrial communities	CLO 6	2

Habitat ecology	❖ Lecture is delivered on distribution of major biomes;	CLO 7	2
Habitat ecology	❖ Lecture is delivered on Ecological aspects of the Sundarbans.	CLO 8	2
Ethology			
Introductory information about the course	❖ Brain storming of students to assess prior knowledge about the course. ❖ Discussions on the background of the course assisted by video clipping to create learners' interest.	-	2
Definitions of terminologies on Ethology, concepts and patterns of animal behavior	❖ Lecture will be focused on defining ethological terminologies explaining those providing examples. ❖ Concepts and patterns of ethology will be discussed. ❖ How the animals behave and how – will be justified with examples.	CLO 1 CLO 2	2
Milestones literature on ethology	❖ Lecture will be delivered on milestone chronological literature, to explain what were the objectives and outcomes of those early researches. ❖ A chronological reference list will be asked to prepare by students and submit in next class.	CLO 3	2
Types of stimuli and orientations, and their relevant responses in different species	❖ Lecture will be delivered on the topics in detail with suitable examples. ❖ Lecture merit will be assessed by asking relevant questions.	CLO 4 CLO 5	2
Different types of animal groupings, social aggregation, merits and demerits of animal grouping and aggregation	❖ Students will be allowed to recollect some previous objectives, so that they will be able to understand ideas and information on present topic. ❖ Definition and examples will be given on types of animal grouping types. ❖ Advantages and disadvantages of different animal grouping types will be tabulated.	CLO 6 CLO 7	2
Different facets of social behavior in animals	❖ Lecture will include definitions and descriptions on different facets of social behavior providing suitable examples. ❖ After each day lecture open discussion will be held to assess the knowledge the students achieved on the topics.	CLO 8	2
Territoriality	❖ Lecture will be delivered on all aspects of territoriality in different animal species. ❖ Lectures will be supported by classical examples.	CLO 9	2
Instinct and learnt behavior, memory	❖ Definition and differentiations between instinct and learnt behavior will be focused. ❖ Characters of the two behaviors will be pointed out. ❖ Classical examples will be cited for instinct. ❖ Categories of learnt behavior will be discussed with classical examples. ❖ Learning theories will be discussed. ❖ All about memory will be discussed.	CLO 10	2
Communication, Hormones and Pheromones	❖ Lecture will be focused on what is animal communication and their types, metacommunication (ritual fights). ❖ Classical and interesting examples will be provided.	CLO 11 CLO 12	2
Animal migration, migratory behaviors in fish and bird	❖ Lecture will be focused on animal migration ant its causes; about great travelers. ❖ All about fish migration will be discussed giving examples. ❖ Detailed account of bird migration will be discussed with suitable examples.	CLO 13	2

Wild life			
Wildlife its scope, present status and distribution Bangladesh; brief discussion on world wildlife	❖ Lecture will include definition of wildlife. ❖ Scope, status and distribution of wildlife in Bangladesh will be discussed. ❖ Habitats of important wildlife of Bangladesh will be described. ❖ World wildlife will be discussed in brief.	CLO 1 CLO 2	1
Threatened wildlife species of world and Bangladesh	❖ Definition of different categories with examples will be provided. ❖ List of threatened species of Bangladesh will be tabulated with respective scientific, common English and Bangla names according to Red Data List published by IUCN. ❖ List of important threatened wildlife of world also be tabulated.	CLO 4 CLO 5	1
Role of wildlife in Bangladesh economy, causes of decline of wildlife and remedies	❖ Role of wildlife in economy of Bangladesh will be discussed. ❖ Causes of decline wildlife species in Bangladesh and strategies of remedies will be addressed.	CLO 6	1
Key Points in Bangladesh "wildlife Act"; agencies working for conservation of nature and natural resources	❖ Key points in Bangladesh "Wildlife Act" will be discussed. ❖ Amended Act 2012 will be discussed in brief. ❖ Role of different agencies working for conservation of nature and natural resources will be described.	CLO 3 CLO 7	1
Methods used for conservation and management of wildlife	❖ Lecture will be focused on different methods/techniques taken for conservation of wildlife. ❖ Different such techniques for conservation will be described with examples.	CLO 8	1
Wild life	❖ Concepts, definition and scope; present status and distribution of important wildlife species and their habitats;	CLO 9	1
Wild life	❖ Threatened and endangered species; causes of decline of wildlife; categories of rare species	CLO 9	1
Wild life Management conservation	❖ Problems and their remedies; Role of wildlife in Bangladesh economy.	CLO 10	1
Wild life Management conservation	❖ *Wildlife (Conservation and Security) Act 2012* of Bangladesh; Agencies like IUCN and WWF working for the conservation of natural resources.	CLO 10	1
Wild life Management conservation	❖ Protected areas: National park, wildlife sanctuary, safari, eco-park, ecologically critical area (ECA) and ecologically sensitive area (ESA); Forest types in Bangladesh; Fate of wild animals and threatened categories.	CLO 10	1

Assessment Strategy

Type of Assessment	**Components**	**Marks**	**Methods of Assessment**
Final Written Examination	Broad Questions	35	As mentioned in Zool.H.301 (Page No.)
	Short Questions	35	
Continuous Assessment	Attendance	10	
	Tutorial	20	

Course Title: Zoogeography, Palaeontology and Evolution		
Course Code: Zool.H.304	**Course Type:** Theory (Core Course, Mandatory)	**Credits:** 4
Full Marks: 100	**Total Lecture hours:** 60	**Exam Hours:** 4

Course Description:

Zoogeography is a sub-discipline of biogeography that examines the patterns of animal biodiversity over space and through time. The primary objective of the course is to study the geographic distribution patterns of animals, their origins and their significance for ecology and evolution. Using data and models from a variety of sources including zoology, ecology, evolutionary biology, paleontology, and geology, this course will allow the learner to examine the effects of isolation, elevation, and latitude to understand spatial patterns of animal biodiversity. Altogether, the focus of the course will be on the ecology of zoogeography and the application of zoogeography theory to conservation of species and biodiversity.

Palaeontology course has been designed to introduce you the palaeontology. It will provide knowledge on formation and different types of fossils, geological time scales, fossil dating methods, palaeontological history of major invertebrate and vertebrate groups. This course is also aimed to provide information on different types of fossils found in different animal groups and their age determination resulting to estimate the geological time scale. Altogether, you will learn about interesting history of ancient faunal and floral appearance and disappearance resulting from environmental changes. Finally, it will make capable you to apply your knowledge and skill for how the earth has been formed, how the animals were spread after division of total landmass Pangaea, how they have been extinct.

Evolution is the unifying concept and such a major tenet of modern biological theory that in 1973, evolutionary biologist Theodosius Dobzhansky penned that "Nothing in biology makes sense except in the light of evolution." Most people are familiar with evolution as the subject of controversy in elementary and high school education. But in reality, evolutionary ideas draw on the information you have gained in other courses and should also assist you to ascertain links between apparently contrasting fields of biology. This course designed to give the learners a broad introduction to evolutionary biology, including natural selection and microevolution, phylogeny, speciation, molecular evolution, macroevolution and the fossil records. Students will be introduced with both short-term and long-term evolutionary processes and they explore the patterns that result from those processes. It will cover topics like, the origin of life, the origin of animals, evidence for evolution, the history of evolutionary theory (i.e. Lamarckism, Darwinism, Synthetic theory, Neutral theory etc.), and the Cambrian explosion, genetic evolution, species concept and speciation, human evolution, and evolutionary issues in modern society.

Course Learning Objectives:

1. To fortify the knowledge and understanding of the learners about the geographic distribution patterns of animals, their origins and their significance for ecology and evolution.
2. To introduce the learners with the palaeontology.
3. To give the learners a broad introduction to evolutionary biology, including natural selection and microevolution, phylogeny, speciation, molecular evolution, macroevolution and the fossil records.

Course Learning Outcomes (CLOs)

After completion of **Zoogeography** course, learners will be able to -

1. Apply the scientific method in Zoogeography.
2. Demonstrate an understanding of evolution, environmental and zoogeographic patterns.
3. Describe climatic processes that changed animal distribution.
4. Establish an understanding of the internal and external factors governing and limiting a species' distribution.
5. Develop an understanding of speciation, dispersal, isolation, and extinction processes as they affect a taxon's distribution.
6. Examine, in detail, ecological zoogeography including the theory of island biogeography and the application of the theory to terrestrial islands and conservation.
7. Locate, characterize, and differentiate the major biomes of the planet.
8. Develop an understanding of the influence of earth history and basic zoogeographic processes on animals.
9. Explore the application of zoogeography to conservation which in turn prevent extinctions.

After completion of **Palaeontology** course, learners will be able to:

1. State Palaeontology and fossil.

2. Describe divisions of palaeontology.
3. Define living fossils and mentioning their examples in different animal groups.
4. Explain what is pangaea, panthalassa, geologic time of pangaea and its break up.
5. Interpret the drifting causing the formation of laurasia and gondwanaland and tethys sea.
6. Predict the shape of future world.
7. Describe fossil materials and the way by which one can learn prehistoric plants and animals.
8. Classify the different types of fossils with their description.
9. Interpret the importance of fossils.
10. Explain different conditions fossilization.
11. Explain three environments for fossilization.
12. Describe the different processes of fossilization.
13. Explain different types of fossil dating methods.
14. Define half life, isotope and to describe radioactive decay data.
15. Discuss criticisms regarding radioactive fossil dating methods.
16. Define geological time scale, to interpret geologic distribution of animals and to discuss on division of geological time scale.
17. Describe different periods of palaeozoic era.
18. Describe different periods of mesozoic and coenozoic era.
19. Describe fossils found in protozoa and Mollusca.
20. Describe fossils from arthropoda (trilobita).
21. Describe details of different fossil forms found in stegocephalia sub-class and seymouriamorpha order under Amphibia.
22. Describe ostracoderm and placoderm classes and their causes of extinction.
23. Describe *Archaeopteryx* mentioning its reptilian and avian characteristics.
24. Describe evolution of elephant and to show phylogeny of elephant evolution.
25. Interpret anthropoid apes from man.
26. Explain evolution of man mentioning different fossils recovered from Asia, Africa, Rhodensia and Europe.
27. Describe siwalik hills referring boundary, geology, prehistory and faunal distribution.
28. Describe siwalik rivers mentioning formation and boundary.
29. Disclose the information regarding present status of siwalic rivers.
30. Describe siwalik fossil park with boundary, purpose, establishment and museum.

After completion of **Evolution** course, learners will be able to:

1. Describe the study of Evolution as a science.
2. Explain how biologists reconstruct the evolutionary history of life on earth.
3. Interpret how an understanding of evolutionary patterns and processes is important to many disciplines of biology (including medicine and agriculture).
4. Describe how the forms, functions, and life histories of organisms have evolved.
5. Explain the interconnections among organisms and the environment.
6. Compare genetic differences between populations (used in medical genetics), and genetic relatedness of individuals (used in forensics).
7. Illustrate about phylogenetic trees (used in understanding the great diversity of medically important bacteria and viruses).
8. Classify organisms phylogenetically.
9. Describe the major modes of speciation, species concepts and patterns of macroevolution.
10. Explain that evolution is a significant part of understanding who we are as humans.
11. Explain that humans have evolved and how our actions effect the evolution of other organisms.

Course contents, subject to the lecture and alignment of topic with CLOs

Course contents	Subject to the Lecture	Alignment of topic with CLOs	LH
Zoogeography			
History of	❖ Lecture is delivered to provide the history of Zoogeography.	CLO 1-5	2

Zoogeography			
Zoogeographical Definitions	❖ Lecture is delivered on the definition of Zoogeographical terms.	CLO 1-5	2
Concept and Principles of Zoogeography	❖ Lecture is delivered to provide information on different concepts. ❖ Graphical illustration will be used to explain the topic and an outline summary will be delivered at the end.	CLO 1-5	2
Concepts and Principles of Zoogeography	❖ Lecture is delivered to explain and discuss different concept. ❖ Graphical diagrams/sketches will be used to explain the topic and an outline summary will be delivered at the end.	CLO 1-5	2
Concept and Principles of Zoogeography	❖ Lecture is delivered to indicate the gradual evolution of heart in different vertebrate classes.	CLO 1- 5	2
Continental drift and Plate tectonics	❖ Lecture is delivered to describe the continental drift. ❖ Then, information on the theory and mechanism of plate tectonics will be provided.	CLO 5-6	2
Palaearctic Region (Physiography, climate, vegetation and faunal distribution)	❖ Lecture is delivered to describe the physical features and faunal distribution on the realm.	CLO 5-8	2
Nearctic Region (Physiography, climate, vegetation and faunal distribution)	❖ Lecture is delivered to describe the physical features and faunal distribution on the realm.	CLO 5-8	2
Neotropical Region (Physiography, climate, vegetation and faunal distribution)	❖ Lecture is delivered to describe the physical features and faunal distribution on the realm. ❖ Then, information on different endemic fauna of the region will be provided.	CLO 5-8	2
Australian Region (Physiography, climate, vegetation and faunal distribution)	❖ Lecture is delivered to describe the physical features and faunal distribution on the realm.	CLO 5-8	2
Ethiopian Regions (Physiography, climate, vegetation and faunal distribution)	❖ Lecture is delivered to describe the physical features and faunal distribution on the realm.	CLO 5-8	2
Oriental Region (Physiography, climate, vegetation and	❖ Lecture is delivered to describe the physical features and faunal distribution on the realm.	CLO 5-8	2

faunal distribution)			
Transitional zones (Physical features and faunal distribution)	❖ Lecture is delivered to describe the physical features and faunal distribution of different transitional zones. ❖ Then, information on different endemic fauna of these region will be provided.	CLO 5-8	2
Island biogeography (Physical features and faunal distribution)	❖ Lecture is delivered to describe the physical features and faunal distribution of different islands. ❖ Then, information on different endemic fauna of these island biogeography will be provided.	CLO 5-8	2
Zoogeographical aspects of Bangladesh	❖ Lecture is delivered to describe the physical features and faunal distribution of Bangladesh. ❖ Then, information on different endemic fauna of the region will be provided.	CLO 8 CLO 9	2
Palaeontology			
Paleontology	❖ Lecture is delivered to provide definition of palaeontology and fossils and to give details of divisions of palaeontology. ❖ Then, the different living fossils found in different animal groups will be explained.	CLO 1-3	1
Pangaea	❖ Lecture is delivered to explain Pangaea and its break up and details of Laurasia, Gondwanaland and Tethys sea. ❖ Then, the future shape of world will be predicted.	CLO 4-6	1
Fossil	❖ Lecture is delivered to describe the materials could be fossil and the way by which students could be able to describe prehistoric plants and animals. ❖ Then, different types of fossils will be described.	CLO-7 CLO-8	1
Importance of fossils	❖ Lecture is delivered to interpret the importance of fossils.	CLO-9	1
Condition of fossilization	❖ Lecture is delivered to describe the essential conditions of fossilization and to mention the marine, terrestrial and desert environments. ❖ Then, another condition for fossilization *i.e.* amber, tar pits, oil seeps, lava, ash, ice and frozen soil will be interpreted.	CLO-10 CLO-11	1
Process of fossilization	❖ Lecture is delivered to describe the five fossilization processes *i.e.* entire organism preserved, skeleton almost unchanged, original hard part, altered hard part and traces of organisms. ❖ Then, different types of altering processes *i.e.* carbonization, petrifaction and replacement or mineralization of fossilization will be compared.	CLO-12	1
Fossil dating method	❖ Lecture is delivered to explore the information provided by fossils and to describe relative and absolute/radioactive fossil dating two methods, half-life and isotopes. ❖ Then, sedimentation, uranium-lead ratio fossil dating methods in detail will be described.	CLO-13 CLO-14	1
Fossil dating method	• Lecture is delivered to describe radio-carbon ratio, potassium-argon ratio and thermo-luminescence fossil dating methods and their criticisms.	CLO-15	1

Geological time scale	❖ Lecture is delivered to define geological time scale, arrangement of geologic time based on earth's crusts' age, distribution of animals, time units *i.e.* era, period and epochs. ❖ Then, archaeozoic and proterozoic era and mentioning different periods with epochs of palaezoic, mesozoic and coenozoic era will be interpreted.	CLO-16	1
Palaeozoic era	❖ Lecture is delivered to describe the different periods explaining climate and animals of palaeozoic era. ❖ Then, the time of ancient life, the age of fishes and the age of insects will be interpreted.	CLO-17	1
Mesozoic and coenozoic era	❖ Lecture is delivered to explain the mesozoic and coenozoic era with their periods and epochs mentioning climate and animals. ❖ Then the age of reptiles, the age of mammals, golden age of mammals and ice age will be interpreted.	CLO-18	1
Fossils of Protozoa and Mollusca	❖ Lecture is delivered to describe the fossil protozoa (foraminifera and radiolarian orders) mentioning formation of shell by components, habitat and examples from each. ❖ Then three different sub-classes of cephalopoda class under Mollusca will be explained.	CLO-19	1
Fossils of Arthropoda and Amphibia	❖ Lecture is delivered to describe trilobite with mentioning different orders containing trilobites' species, evolutionary trends and significance. ❖ Then the fossils found in sub-class stegocephalia and class seymouriomorpha under Amphibia will be explained.	CLO-20 CLO-21	1
Fish and bird	❖ Lecture is delivered to describe first vertebrate fossils under class ostracodermi and placodermi; causes of their extinction and also causes of extinction of freshwater fishes in Bangladesh. ❖ Then, *Archaeopteryx*, fossil bird of class aves with its reptilian and avian characteristics will be described.	CLO-22 CLO-23	1
Evolution of elephant	❖ Lecture is delivered to describe the proboscidean origin, archaic and spelialized characters, taxonomic position and ancestry of elephant mentioning characters (Oligocene stocks) and examples. ❖ Then, living genera and phylogeny of elephants will be described.	CLO-24	1
Evolution of man	❖ Lecture is delivered to describe taxonomic position of man, types of anthropoid apes under simiidae family, factors indicate men evolution from anthropoid apes, places and time of origin, evolutionary changes in man and geologic records. ❖ Then, asian, african, rhodensian and European fossils of man will be described.	CLO-25 CLO-26	1
Siwalic hill, river and fossil park	❖ Lecture is delivered to describe characteristics, boundaries, geology, prehistory and faunal distribution of siwalik hills. ❖ Then, formation, boundaries and present status of siwalik river and a short note of siwalic fossil park will be described.	CLO 27-30	1
Evolution			
Origin of Life (Historical account and theories)	❖ Lecture is delivered to describe the Historical account and theories of origin of life. ❖ Then, information on the most accepted theory of origin of life will be provided.	CLO 1-3	1

Evidence of Evolution (Comparative anatomy and Paleontology)	❖ Lecture is delivered to describe the evidences of evolution. ❖ Then, information on the evidence of Comparative anatomy and Paleontology in evolution will be provided.	CLO 1-3	1
Evidence of Evolution (Physiology & Biochemistry, and Embryology)	❖ Lecture is delivered to describe the evidences of evolution. ❖ Then, same above technique with the will be used to provide information on the evidence of Physiology & Biochemistry, and Embryology in evolution.	CLO 1-3	1
Theories of Evolution (Lamarckism)	❖ Lecture is delivered to describe different theories of evolution. ❖ Graphical diagrams/sketches will be used to explain the topic and an outline summary will be delivered at the end.	CLO 1 CLO 4 CLO 5	1
Theories of Evolution (Darwinism-Artificial Selection)	❖ Lecture is delivered to describe artificial selection theory of Darwin. ❖ Graphical diagrams/sketches will be used to explain the topic and an outline summary will be delivered at the end.	CLO 1 CLO 4-5	1
Theories of Evolution (Darwinism-Natural Selection)	❖ Lecture is delivered to describe natural selection theory of Darwin. ❖ Graphical diagrams/sketches will be used to explain the topic and an outline summary will be delivered at the end.	CLO 1 CLO 4-5	1
Theories of Evolution (Darwinism-Sexual Selection)	❖ Lecture is delivered to describe sexual selection theory of Darwin. ❖ Audiovisual aids will be used to elaborate the topic in question and an outline summary will be delivered at the end.	CLO 1 CLO 4-5	1
Theories of Evolution (Synthetic Theory)	❖ Lecture method using Multimedia projector as well as interactive question and answering technique will be used to describe synthetic theory of evolution. ❖ Graphical diagrams/sketches will be used to explain the topic and an outline summary will be delivered at the end.	CLO 1 CLO 4-6	1
Theories of Evolution (Neutral Theory)	❖ Lecture is delivered to describe neutral theory of molecular evolution. ❖ Graphical diagrams/sketches will be used to explain the topic and an outline summary will be delivered at the end.	CLO 1 CLO 4-6	1
Theories of Evolution (Punctuated equilibrium-Jumping Theory)	❖ Lecture is delivered to describe theory of punctuated equilibrium (Jumping Theory) of evolution. ❖ Graphical diagrams/sketches will be used to explain the topic and an outline summary will be delivered at the end.	CLO 1 CLO 4-6	1
Species Concept	❖ Lecture method using Multimedia projector as well as interactive question and answering technique will be used to explain different Species Concept. ❖ Graphical diagrams/sketches will be used to explain the topic and an outline summary will be delivered at the end.	CLO 1 CLO 7-9	1
Pattern of Speciation (Modes, causes and evidences)	❖ Lecture method using Multimedia projector as well as interactive question and answering technique will be used to explain different patterns of speciation. ❖ Graphical diagrams/sketches will be used to explain the topic	CLO 1 CLO 7-9	1

	and an outline summary will be delivered at the end.		
Evolution of man	❖ Lecture method using Multimedia projector as well as interactive question and answering technique will be used to explain different patterns of speciation. ❖ Graphical diagrams/sketches will be used to explain the topic and an outline summary will be delivered at the end.	CLO 10-11	1

Learning Resources:

A.S. Romer. 1965. Vertebrate Palaeontology. Chicago Univ. Press. Texas.
A.P. Tyagi. 1976. Introduction to Palaeontology.
P.S. Verma, V.K. Agarwal (1974). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology.
Dr. Md. Jalal Uddin Molla, Dr. Md. Ataur Rahman Khan, Prof. S.M. Rafiqul Islam. 2009. Evolution, Palaeontology, Zoogeography, Embryology and Ethology.
Muhammad Abul Kalam Azad. 2002. Evolution.

Assessment Strategy

Type of Assessment	Components	Marks	Methods of Assessment
Final Written Examination	Broad Questions	35	As mentioned in Zool.H.301 (Page No.)
	Short Questions	35	
Continuous Assessment	Attendance	10	
	Tutorial	20	

Course Title: Taxonomy, Biodiversity and Conservation Biology		
Course Code: Zool.H.305	**Course Type:** Theory (Core Course, Mandatory)	**Credits:** 4
Full Marks: 100	**Total Lecture hours:** 60	**Exam Hours:** 4

Course Description

Taxonomy and Conservation Biology: The course is aimed to form professionals in the area of 'Taxonomy & Conservation Biology'. Main objectives of the course are to know the classification and evolutionary relationship of animals and conservation philosophy of natural resources. The students will learn the concepts, history, scope and components of 'Taxonomy & Conservation Biology' especially in relation to Bangladesh.

Biodiversity has been designed to introduce the introduction, Etymology, definition, concept, levels, importance of biodiversity, growth forms, life forms, stratification of species, methods of diversity study, indices, and biodiversity calculation. Finally, it will capable the students to apply their knowledge and skill for biodiversity study, management and conservation of biodiversity.

Course Learning Objectives:

1. To give the learners a broad introduction to taxonomy and conservation biology
2. To fortify the knowledge and understanding of the learners about the biodiversity

Course Learning Outcomes (CLOs)

After completion of **Taxonomy** course, the students will be able to:

1. Define taxonomy and their related terms.
2. Describe the scope of taxonomy.
3. Mention the historical development of taxonomy.
4. Differentiate between taxonomy and systematics.
5. Describe the approaches in taxonomy.
6. Mention the types of classification.
7. Explain "species concept".
8. Illustrate the idea on type specimens.
9. Mention the kinds of taxonomic publications.
10. Describe the activities and regulations of ICZN.

11. Describe the status of taxonomical studies in Bangladesh.

After completion of **Biodiversity** course, learners will able to:

10. Define biodiversity.
11. Define Etymology of biodiversity.
12. Explain the concept of biodiversity.
13. Illustrate the levels of biodiversity.
14. Describe the importance of biodiversity.
15. Describe growth forms and life forms of biodiversity.
16. Describe stratification of species its indices.
17. Interpret the effect of biodiversity on ecosystem processes.
18. Describe the depletion of biodiversity.
19. Describe the methods of diversity.
20. Apply calculation of biodiversity study.

After completion of **Conservation Biology** course, the students will be able to:

1. Define conservation biology and their related term.
2. Describe the scope of conservation biology.
3. Mention the historical development of conservation biology.
4. Explain the anthropocentrism and biocentrism with types.
5. Illustrate the ecosystem services of natural resources.
6. Apply idea on the approaches of conservation.
7. Compare LEK and TEK.
8. Describe the Sundarbans.

Course contents, subject to the lecture and alignment of topic with CLOs

Course contents	**Subject to the Lecture**	**Alignment of topic with CLOs**	**LH**
Taxonomy			
Introduction and concept	❖ Lecture delivered to discuss the definition, scope and importance of taxonomy.	CLO 1 CLO 2	1
Historical development	❖ Lecture delivered to describe the historical development of taxonomy.	CLO 3	1
Difference between Taxonomy & Systematics	❖ Lecture delivered to differentiate between taxonomy & systematics.	CLO 4	2
Approaches in Taxonomy	❖ Lecture delivered to discuss the morphological, embryological, ecological, behavioural, genetical, biological and numerical approaches in taxonomy.	CLO 5	2
Types of classification	❖ Lecture delivered to discuss phenetic, natural and phylogenetic type of classification in taxonomy	CLO 6	2
Species concept	❖ Lecture delivered to discuss typological, nominalistic, biological and evolutionary concepts of species.	CLO 7	2
Types	❖ Lecture delivered to discuss holotype, paratype, allotype, neotype, syntype and lectotype.	CLO 8	2
Taxonomic publications	❖ Lecture delivered to describe the types of taxonomic publications, *viz* taxon/taxa, reviews, monographs, catalogues, checklists.	CLO 9	2
ICZN	❖ Lecture delivered to discuss an overview of the ICZN, commission and codes.	CLO 10	2
Status of taxonomy in Bangladesh	❖ Lecture delivered to describe status of taxonomy in Bangladesh.	CLO 11	2

Biodiversity			
Introduction: Etymology, definition and Concept of biodiversity	❖ Lecture is delivered on the definition of biodiversity, etymology of biodiversity. ❖ Lecture is delivered on the concept of biodiversity.	CLO 1-3	6
Levels of biodiversity, Importance of biodiversity, growth forms and life forms of biodiversity, stratification of species its indices.	❖ Lecture is delivered on level of biodiversity and importance of biodiversity. ❖ Lecture is delivered on growth and life forms of biodiversity. ❖ Lecture is delivered on the stratification of biodiversity. ❖ Lecture is delivered on the indices of biodiversity.	CLO 4-7	8
Effect of biodiversity on ecosystem processes. Depletion of biodiversity. Methods of diversity.	❖ Lecture is delivered on the effect of biodiversity on ecosystem. ❖ Lecture is delivered on the depletion of biodiversity. ❖ Lecture is delivered on the study of methods biodiversity.	CLO 8-10	8
Calculation of biodiversity study.	❖ Lecture is delivered on the measurement and calculation of biodiversity.	CLO 11	8
Conservation Biology			
Introduction: Definition, scope and importance	❖ To be discussed definition, scope and importance of CB	CLO 1 CLO 2	1
Historical development	❖ To be described the historical development of CB	CLO 3	1
Anthropocentrism and biocentrism with types	❖ To be described anthropocentrism and biocentrism with types	CLO 4	2
Ecosystem services	❖ To be explained the provisioning, regulating, supporting & cultural services of natural resources	CLO 5	2
Approaches of conservation	❖ To be described the key elements, examples, ecosystem management of natural resources	CLO 6	2
LEK and TEK	❖ To be discussed local ecological knowledge and traditional ecological knowledge for natural resources.	CLO 7	2
Case Study: Bangladesh Sundarbans	❖ To be discussed the natural resources and their constraints in the Bangladesh part of Sundarbans	CLO 8	2

Assessment Strategy

Type of Assessment	**Component**	**Marks**	**Methods of Assessment**
Final Written Examination	Broad Question	35	As mentioned in Zool.H.301 (Page No.)
	Short Question	35	
Continuous Assessment	Attendance	10	
	Tutorial	20	

Course Title: Environmental and Health Biology and Epidemiology		
Course Code: Zool.H.306	**Course Type:** Theory (Core Course, Mandatory)	**Credits:** 4
Full Marks: 100	**Total Lecture hours:** 60	**Exam Hours:** 4

Course Description

The course is designed to fortify the knowledge and understanding of the learners about various biological aspects of the environment. It will help them comprehend how environment maintain its balance, how the ecosystem works, how the biotic and abiotic factors maintain a reciprocal relationship between them. The course will also help enrich the existing ideas of the students on the exploitation of the natural resources by human being and its impact on the survivability of other species on this planet. In addition, how the human civilization could step up for the abatement and control towards conservation of nature.

Health Biology and Epidemiology Course is designed to introduce the first aid kits for human health. It will help the students to concern about the smoking hazards on human health including lung diseases and cancer. This course introduces the artificial kidney and familiarize with human neurological disorders; drugs and their effects on human health. This course will also help to enrich the knowledge of epidemiology and epidemiological diseases and apply the knowledge and skills in managing and planning health and environmental systems.

Course Learning Objectives:

1. To give the learners a broad introduction to environmental biology
2. To fortify the knowledge and understanding of the learners about health biology and epidemiology

Course Learning Outcomes (CLOs)

After completion of **Environmental Biology** course, learners will be able to:

1. Describe the reasons responsible for the deterioration of the environment.
2. Classify with examples the types of pollution.
3. Explain how the visible and invisible pollutants are being produced.
4. Explain how the air, water and soil get contamination.
5. Describe and explain the consequences of the contamination of the biosphere.
6. Describe and understand how developmental works are destroying the natural resources.
7. Describe how lifestyle influences contamination of the biosphere.
8. Describe how pollution control and abatement is possible.

After completion of **Health Biology and Epidemiology** course, learners will be able to:

1. Discuss the human health hazards.
2. Write the respiratory disorder and smoking hazards on human health.
3. Identify the important health problems including Lung, Kidney and Heart problems.
4. Describe the important neurological disorders of human.
5. Describe different drugs and their effects on human health.
6. Describe the First Aid Kits and its application.
7. Write the diagnostic procedures of health problems and tools used.
8. Describe circumstances under which disease occurs or health prevails in human populations.
9. Identify environmental health issues in local communities, society at large and in the world.
10. Apply experimental procedures to solve epidemiological problems.

Course contents, subject to the lecture and alignment of topic with CLOs

Course contents	**Subject to the Lecture**	**Alignment of the topic with CLOs**	**LH**
Environmental biology			
Pollution	**Lecture 1:** The blue planet and the environment	CLO 1	2
Concept, sources of pollution	**Lecture 2:** Concept and sources of pollution, pollutants	CLO 1	2
Types and costs of pollution	**Lecture 3:** Types and costs of pollution	CLO 2	2
Strategy of waste management and control	**Lecture 4:** Industrial wastes and raising of atmospheric temperature	CLO-8	2

Greenhouse effects	**Lecture 5:** Greenhouse effects **Lecture 6**: Greenhouse gases and climate change	CLO 3-4	4
Pollution monitoring	**Lecture 7:** Energy flow in the ecosystem, energy drain	CLO-5	2
Environmental laws and legislation	**Lecture 8:** Eutrophication, Relationship in between development and pollution	CLO-6	2
Biological magnification;	**Lecture 9:** Biogeochemical cycles, biological magnification **Lecture 10:** Photochemical reaction, BOD, COD and acid rain	CLO-5	4
Some problem areas: physical wastes (*e.g*. air, water, soil, solid waste, liquid waste)	**Lecture 11:** Some problem areas: physical wastes (*e.g*. air, water, soil, solid waste, liquid waste)	CLO-7	2
Wastes without weight (*e.g*. radioactive, thermal and noise)	**Lecture 12:** Wastes without weight (*e.g*. radioactive, thermal and noise)	CLO 3-4	2
Chemical, biological, social and electronic pollution	**Lecture 13:** Chemical, biological, social and electronic pollution	CLO 3-4	2
Toxicology: Introduction, classification, and sources of toxic substances; Pathways of toxic substances into ecosystem	**Lecture 14:** Toxicology: Introduction, classification, and sources of toxic substances; Pathways of toxic substances into ecosystem	CLO 1-5	2
Effects of toxic substances and mitigation mechanisms	**Lecture 15:** Effects of toxic substances and mitigation mechanisms	CLO 7	2
Health Biology			
Health hazards	**Lecture 1:** Health hazards	CLO 1	2
Smoking and respiratory system	**Lecture 2:** Respiratory system and smoking	CLO 2	2
Respiratory disorders: bronchitis, emphysema and lung cancer	**Lecture 3:** Respiratory disorders: bronchitis and emphysema **Lecture 4:** lung cancer	CLO 2	3
Circulatory and blood disorders; Haemodialysis (the artificial kidney) thalassemia and leukemia	**Lecture 5:** Circulatory disorders Haemodialysis (the artificial kidney) **Lecture 6:** thalassemia and leukemia	CLO 3	3
Effects of drugs on nervous system and sense organs	**Lecture 7:** Effects of drugs on nervous system and sense organs	CLO 4-5	2

Selected disorders of nervous system	**Lecture 8:** Nervous system disorders: meningitis, seizure and epilepsy **Lecture 9:** Nervous system disorders: multiple sclerosis **Lecture 10:** Nervous system disorders: Perkinson's disease **Lecture 11:** Nervous system disorders: Alzheimer's disease	CLO 5	6
First-aid kit and its applications	**Lecture 12:** First-aid kit and its applications	CLO 6	2
Epidemiology			
	Lecture 13: Introduction, definition, objectives, development of epidemiology, elements influencing epidemiological diseases, Environment: physical, biological and socio-cultural	CLO 7	2
	Lecture 14: Methods in epidemiology; Investigation of epidemics: field investigation, verification of disease by clinical and laboratory tests	CLO 8	2
	Lecture 15: Data analysis, calculation of rates, surveys and screening	CLO 9	2
	Lecture 16: Agents of diseases, reservoir of infection, host factors; Principles of control measures;	CLO 10	2
	Lecture 17: Epidemiological diseases: diarrhoea, hepatitis B, AIDS, Dengue fever, leishmaniasis, amoebiasis, elephantiasis and SARS	CLO-10	2

Assessment Strategy

Type of Assessment	Components	Marks	Methods of Assessment
Final Written Examination	Broad Questions	35	As mentioned in Zool.H.301 (Page No.)
	Short Questions	35	
Continuous Assessment	Attendance	10	
	Tutorial	20	

Course Title: Parasitology		
Course Code: Zool.H.307	**Course Type:** Theory (Core Course, Mandatory)	**Credits:** 4
Full Marks: 100	**Total Lecture hours:** 60	**Exam Hours:** 4

Course Description

Parasitology course has been designed to introduce the student the ecology, biology, biochemistry, physiology and immunology of animal parasites. It will also provide knowledge on causes of parasitic infections and their sign and symptom, control and treatment. This course is also aimed to provide information on different aspect of Zoonotic diseases. Altogether, student will learn about animal parasites, the factors and mechanism involved in interaction host-parasite interaction, and about different parasitic diseases in fish, livestock and human. Finally, it will capable them to apply their knowledge and skill for diagnosis of parasitic diseases, planning for the effective control of parasites and basic treatment of parasitic diseases.

Course Learning Objectives:

1. To give the learners a broad introduction to ecology and biology of parasites,
2. To provide knowledge on biochemistry, physiology and immunology of animal parasites,
3. To fortify the knowledge and understanding of the learners about fish, livestock and human parasitic diseases, zoonotic diseases and their control

Course Learning Outcomes (CLOs)

After completion of **Ecology and Biology of parasites; Biochemistry, physiology and immunology of animal parasites** course, learners will be able to:

1. Define parasite and host with example.
2. Compare the parasite, parasitoid, commensal, mutualistic organism and predator.
3. Describe the types of parasite and host with their characteristics and example.
4. Explain how a host act as an environment of a parasite.

5. Mention the types of host specificity.
6. Interpret the role of ecological, ethological and physiological factors on host specificity of parasites.
7. Describe types, mechanisms and routs of transmission of parasites.
8. Define infestation, hyperinfestation, pathogenesis and diseases.
9. Classify parasites depending on oxygen requirements.
10. Explain underlying mechanism of differential Oxygen sensitivity to growth and survival of parasites.
11. Define and compare different terms related to metabolism of carbohydrates, proteins and lipids.
12. Compare the aerobic and anaerobic respiration.
13. Explain as well as to illustrate flowchart of following catabolic pathways and chemical reaction: Glycolysis, Krebs cycle, Electron transport chain, Beta-Oxidation, Glycerol catabolism, Transamination and Oxidative deamination.
14. Interpret and locate nucleic acid distribution in cells.
15. Explain the types and basic mechanism of disturbances in hosts nucleic acid metabolism by parasites with example.
16. Define moulting and osmoregulation as well as to compare their types.
17. Explain basic physiology of host-parasite relationships.
18. Compare vitamin types and their roles in host-parasite relationships
19. Define and compare following terms: immunity, immunology, immune system, innate immunity, adaptive or acquired immunity, active immunity, passive immunity, cellular immunity and humeral immunity.
20. Describe basic components of immune system of parasite.
21. Interpret the different active and passive defense mechanisms mounted by parasites to evade hosts' immune system.
22. Explain as well as to illustrate flowchart of life cycle of following parasites: *Ichthyophthirius, Argulus, Dactylogyrus, Diphyllobothrium, Eimeria, Babesia, Toxoplasma, Taenia, Capillaria, Trichomonas, Giardia, Leishmania, Schistosoma, Clonorchis* and *Wuchereria.*

After completion of **Fish, livestock and human parasitic diseases, Zoonotic diseases and their control** course, learners would be able to:

1. Classify parasitic disease of fish.
2. Explain the causative agent as well as its morphological feature life cycle, mode of infestation, treatment of *Ichthyophthiriasis*, *Dactylogyrosis*, *Argulosis* and *Dibothriocephalopsis*.
3. Define livestock and its example.
4. Mention the causative agent, morphological feature, host, lifecycle, mode of infestation, controlling measures of *Emeriasis*, *Babeasis*, *Coccidiasis*, *Taeniarhynchosis* and *Capillariasis*.
5. Explain type of human disease.
6. Mention the causative agent, historical background of the diseases, habitat of the treatement of Trichomoniasis, Giardiasis, Leishmaniasis, Schistosomiasis, Clonorchiasis and Filariasis.
7. Describe zoonotic diseases, mode of its transmission, who are at the risk of transmission and how its control.
8. Define pathogen, parasite, host, carrier, pathogenic nonpathogenic parasite to man.
9. Describe viral zoonotic diseases of man eg. Rabies, Chikungunia etc.
10. Describe bacterial zoonotic diseases of man eg. Anthrax, Plague etc.
11. Describe fungal zoonotic diseases of man eg. Dermatophytosis, Coccidioidomycosis etc.
12. Explain Arthropodan diseases of man eg. Scabies, Acariasis etc.

Course contents, subject to the lecture and alignment of topic with CLOs

Course contents	**Subject to the lecture**	**Alignment of topic with CLOs**	**LH**
Ecology of parasites			
Range and characteristics of parasitic forms	❖ Lecture is delivered to provide definition parasite and host with example. ❖ Then, the comparative characteristics of parasite, parasitoid, commensal, mutualistic organism and predator will be explained.	CLO 1 CLO 2	1
Range and characteristics of	❖ Lecture is delivered to describe the types of parasite, their characteristics and examples	CLO 3	1

parasitic forms			
Range and characteristics of parasitic forms	❖ Lecture is delivered to describe the types of host, their characteristics and examples.	CLO 3	1
Host as an environment for parasites	❖ Lecture is delivered to explain how a host act as an environment of a parasite	CLO 4	1
Host specificity	❖ Lecture is delivered to mention the types of host specificity ❖ Then, the role of ecological, ethological and physiological factors on host specificity of parasites will be interpreted.	CLO 5 CLO 6	1
Transmission, hyper-infestation and diseases	❖ Lecture is delivered to describe types, mechanisms and routs of transmission of parasites. ❖ Then, definition of infestation, hyperinfestation, pathogenesis and diseases will be provided.	CLO 7 CLO 8	1
Biochemistry, physiology and immunology of animal parasites			
Oxygen requirements	❖ Lecture is delivered to explain classification of parasites depending on oxygen requirements ❖ Then, underlying mechanism of differential Oxygen sensitivity to growth and survival of parasites will be explained.	CLO 9 CLO 10	1
Metabolism of carbohydrates, proteins and lipids	❖ Lecture is delivered to define and compare different terms related to metabolism of carbohydrates, proteins and lipids ❖ Then, graphical overview of catabolism of carbohydrates, proteins and lipids will be described. ❖ Then comparison between the aerobic and anaerobic respiration will be showed.	CLO 11 CLO 12	1
Metabolism of carbohydrates, proteins and lipids	❖ Lecture is delivered to explain the pathway of Glycolysis and Krebs cycle. ❖ Then, one plus one cyclic recalling game will be played by leaners to mention stages of pathway of Glycolysis and Krebs cycle.	CLO-13	1
Metabolism of carbohydrates, proteins and lipids	❖ Lecture is delivered to explain electron transport chain.	CLO 13	1
Metabolism of carbohydrates, proteins and lipids	❖ Lecture is delivered to explain the pathway of catabolism of lipid: Beta-oxidation and Glycerol catabolism. ❖ Then, one plus one cyclic recalling game will be played by leaners to mention stages of pathway of Beta-oxidation and Glycerol catabolism.	CLO 13	1
Metabolism of carbohydrates, proteins and lipids	❖ Lecture is delivered to show the fate of different types of amino acid in protein catabolism. ❖ Then the chemical reaction involved in catabolism of protein: Transamination and Oxidative deamination will be explained.	CLO 13	1
Nucleic acid distribution	❖ Interactive question and answering technique will be used to define nucleic acid and their types. ❖ Then Lecture method using Multimedia projector will be applied to explain the distribution of nucleic acid in virus, bacteria and eukaryotic cells.	CLO 14	1
Types and disturbances in	❖ Interactive question and answering technique will be used to discuss on anabolism and catabolism of nucleic	CLO 15	1

hosts nucleic acid metabolism by parasites;	acid as well as type of nucleic acid disturbance by parasite. ❖ Then two flow charts on mechanisms of disturbance of nucleic acid metabolism by parasite will be explained using a Multimedia projector ❖ Then, different research results of parasitic disturbance of nucleic acid metabolism will be described to relate the practical examples to theoretical mechanism of flow charts.		
Osmoregulation and moulting	❖ Interactive question and answering technique using related pictures will be used to define Osmoregulation and their types. ❖ Then same technique using related video will be used to define moulting and their types.	CLO 16	1
Physiology of host-parasite relationships;	❖ Lecture method using Multimedia projector will be applied to describe basic concept on Physiology of host-parasite relationships.	CLO 17	1
Vitamin types and their roles in host-parasite relationships	❖ Interactive question and answering technique will be used to define vitamin and their types. ❖ Lecture method using Multimedia projector will be used to distinguish water soluble vitamin from fat soluble vitamin. ❖ Then, same method will be applied to explain the role of vitamin in host-parasite relationships.	CLO 18	1
Basic concepts of immunology	❖ Interactive question and answering technique will be used to define immunology, immunity, innate immunity, adaptive immunity, Humoral immunity, cellular immunity, active immunity, passive immunity and trained immunity. ❖ Then Lecture method will be used to distinguish innate immunity from adaptive immunity.	CLO 19	1
Defense mechanisms mounted by parasites to evade hosts' immune system.	❖ Lecture method will be used to describe the basic immune mechanism of parasites (invertebrate) ❖ Then, same method will be applied to explain passive and active mechanism of evasion of hosts' immune system by parasites	CLO 20-21	1
Biology of parasites			
Ichthyophthirius Argulus, Dactylogyrus, Diphyllobothrium, Eimeria, Babesia, Toxoplasma, Taenia, Capillaria,Trichomonas, Giardia, Leishmania, Schistosoma,Clonorchis and *Wuchereria.*	❖ Interactive question and answering technique will be used to describe the common name, morphology and clinical importance of a parasite (on each day class on one parasite will be taken). ❖ Then Lecture method using flow chart of life cycle of the parasite will be used to explain the biology (life cycle) of that parasite	CLO 22	15
Fish, livestock and human parasitic diseases			
Fish diseases	❖ Lecture is delivered to provide definition of parasite, type of fish parasites. ❖ Then the fish disease Ichthyophthiriasis and Argulosis will be described.	CLO 1 CLO 2	2
Fish diseases	❖ Lecture is delivered to describe the helmintic diseases, its characteristics and Dibothriocephalopsis and Dactylogyrosis.	CLO 2	2

Fish parasitic diseases.	❖ Lecture is delivered to describe the Ichthyphthiriasis and Argulosis ❖ Then about its parasite, geographical distribution, host, life cycle of parasite, symptoms and treatment of the disease will be described.	CLO 2	2
Livestock parasitic diseases	❖ Lecture is delivered to explain what is livestock and type of livestock disease.	CLO 3	2
Babesiasis and Coccidiasis	❖ Lecture is delivered to describe about Babesiasis and Coccidiasis.	CLO 4	2
Taeniarhychus and Capillariasis	❖ Lecture is delivered to describe characteristic of Platyhelminthes and Nemathelminthes.	CLO 4	2
Human parasitic diseases	❖ Lecture is delivered to explain classification of human parasites.	CLO 5 CLO 8	2
Human parasitic disease(Trichomoniasis, Giardiasis)	❖ Lecture is delivered to define pathogenic and none pathogenic protozoa.	CLO 5 CLO 6	2
Human parasitic disease	❖ Lecture is delivered to differentiate from Helminthes to Nematoda.	CLO 6	2
Zoonotic diseases and their control			
Zoonotic diseases and their control	❖ Lecture is delivered to explain zoonotic disease.	CLO 7	1
Zoonotic diseases and their control	❖ Lecture is delivered to define pathogen, parasite and describe about viral zoonotic disease.	CLO 7 CLO 9	1
Bacterial zoonotic diseases	❖ Lecture is delivered to show the different types of Bacterial zoonotic diseases. ❖ Then the Plague and Anthrux will be explained.	CLO 10	1
Fungal zoonotic diseases	❖ Lecture is delivered to show the different type of fungal zoonotic disease. ❖ Then the fungal disease Coccidioidomycosis and Blastomycosis will be explained.	CLO 11	1
Protozoan zoonotic disease	❖ Lecture is delivered to describe about the Protozoan zoonotic disease Giardiasis and Amoebiasis	CLO 6 CLO 7	1
Nematodes zoonotic disease	❖ Lecture is delivered to show the different type of Nematodes zoonotic disease. ❖ Then Nematodes zoonotic disease Capillariasis and Trichinellosis will be described.	CLO 4 CLO 7	1
Helminthic zoonotic disease	❖ Lecture is delivered to show the different type of Helminthic zoonotic disease. ❖ Then Helminthic zoonotic disease Taeniasis and Fascieloplopsiasis will be described.	CLO 7	1
Arthropodan Zoonotic diseases	❖ Lecture is delivered to show the different type of Arthropodan zoonotic disease. ❖ Then arthropods parasite and parasitic disease (Scabies) will be explained.	CLO 12	1

Assessment Strategy

Type of Assessment	**Components**	**Marks**	**Methods of Assessment**
Final Written Examination	Broad Questions	35	As mentioned in Zool.H.301 (Page No.)
	Short Questions	35	
Continuous Assessment	Attendance	10	
	Tutorial	20	

Course: Zool. H. 308

Field study/Excursion

Full Marks 50 (0.5 unit, 2 credits)

Preparation and submission of a report on the animals of any two bioecological/ agroecological zones of Bangladesh other than that studied earlier; acquaintance with zoogeography/biological realms of Bangladesh. (Distribution of marks: Field report/Excursion =25; Presentation/*viva-voce*=10; Assessment=10; Attendance=5).

Zoology Course: Zool.-HV-309

Viva-voce III

Full marks: 50 (0.5 unit, 2 credits)

Viva-voce on theoretical courses from Zool. H-301 to Zool. H. 308

Course Title: Zoology Practical III		
Course Code: Zool.HP.311	**Course Type:** Practical (Core Course, Mandatory)	**Credits:** 10
Full Marks: 250	**Total Lecture hours:** 150	**Exam Hours:** 24 (6 hours daily)

Course Learning Objectives

To provide practical experience on the topics covered by theoretical courses so that the learner can apply their knowledge in lab, workplace and in practical life.

Course Learning Outcomes (CLOs)

After completion of this course, learners will be able to:

1. Prepare and identify the permanent histological slides of chordates (Pisces-Mammalia);
2. Classify (with diagnostic characteristic) *Drosophila* mutants, sex-linked inheritance, linkage and crossing-over, human karyotypes, heterosis and inbreeding depression
3. Identify developmental stages in different groups of animals.
4. Demonstrate and explain the procedure of ecological samplings, estimation of biodiversity from a variety of habitats, and exploration of food chain in communities.
5. Prepare ethograms for representative group of animals
6. Evaluate positive versus negative taxes in *Tribolium castaneum*, and T-maze learning in laboratory mouse, *Mus* sp.
7. Explain and demonstrate zoogeographical realms, distribution of endemic and insular fauna of the world, and distribution of endemic fauna of Bangladesh.
8. Recognize and demonstrate the evidence and evolutionary sequences
9. Determine the taxonomic ranks (PCOFGS) for collected specimens following standard keys for vertebrates and invertebrates;
10. Prepare cladogram, hypothetical descriptions and type designation, reviews, monographs, catalogues and checklists
11. Prepare questionnaires and manuscript regarding the biodiversity.
12. Display the procedure of mapping biodiversity.
13. Prepare a report on current issues regarding environmental and health Biology and epidemiology.
14. Isolate and recognize the parasites from vertebrates and invertebrates host.

Course contents, teaching strategies and alignment of topic with CLOs

Contents	**Alignment of topic with CLOs**	**LH**
Cell Biology, Genetics and Animal Breeding: Preparation and identification of	CLO 1-2	30

permanent histological slides of chordates (Pisces-Mammalia); Identification of *Drosophila* mutants, and human karyotypes (with special reference to chromosomal abnormalities); Study of sex-linked inheritance in *Drosophila*. Estimates of linkage and crossing-over in *Drosophila*; Observation of heterosis and inbreeding depression on different quantitative traits.		
Gametogenesis and Developmental Biology: Identification of developmental stages in different groups of animals.	CLO 3	18
Ecology, Ethology and Wildlife: Ecological samplings from a variety of habitats, *e.g.* crop fields, grasslands, hedgerows and ponds; Ecosystem of ponds; Study of the food chain in communities; Estimation of different biodiversity; Ethology: Preparation of ethograms for representative group of animals with respect to irritability, stimulus, response, taxis and tropism; Estimates of positive versus negative taxes in *Tribolium castaneum*.; Evaluation of T-maze learning in laboratory mouse, *Mus* sp.	CLO 4-6	31
Zoogeography, Evolution and Paleontology: Demonstration and dynamics of zoogeographical realms; Identification and distribution of endemic and insular fauna of the world; Distribution of endemic fauna of Bangladesh. Evolution: evidence and evolutionary sequences: Homology, analogy and homoplasty; Vestigial organs: Hind limbs of python; nictitating membrane of human (diagrammatic); Secondary loses; atavism; Adaptive radiation in vertebrates; Evolutionary sequences of different organs/systems from preserved materials-models and drawings. Palaeontology: Identification of fossil fauna.	CLO 7-8	21
Taxonomy, Biodiversity and Conservation Biology: Determination of taxonomic ranks (PCOFGS) for collected specimens following standard keys for vertebrates and invertebrates; Construction of keys based on field collections; Preparation of cladogram based on supplied specimens; Preparation of hypothetical descriptions and type designation, reviews, monographs, catalogues and checklists; Morphological, cytogenetical and biochemical systematic of the anthropoid apes, manuscript preparation for new species; Mapping biodiversity, Shannon-Wiener and Simpson diversity calculations. Preparation of questionnaires for collecting local peoples' knowledge on various issues of conservation.	CLO 9-12	20
Environmental and Health Biology and Epidemiology:	CLO 13	15
Parasitology: Identification of parasites from vertebrates (farm animals, fishes etc.) and invertebrates (molluscs).	CLO 14	15

Assessment Strategy

Type of Assessment	**Marks**	**Methods of Assessment**
Practical Examination	175	24-hr practical exam on the above topics (6 hrs daily)
Continuous Assessment	25	Attendance (As mentioned in Zool.H.301) (Page No.)
	25	Practical class records
	25	Laboratory assessment

Learning Resources:

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ইসলাম, এম.সা, খান, হা.সা. ও রানা, মো. হা.তা. ২০১৭। জেনেটিক্স: মিল ও অমিলেরবিজ্ঞান। অন্যপ্রকাশ, বাংলাবাজার, ঢাকা।

Detail curriculum

For fourth Year Honours Degree

in Zoology

B.Sc. (Honours) Part-IV Examination, 2023

Course Title: Biometry & Research Methodology		
Course Code: Zool.H.401	**Course Type:** Theory (Core Course, Mandatory)	**Credits:** 4
Full Marks: 100	**Total Lecture hours:** 60	**Exam Hours:** 40

Course Description

Biometry course has been designed to introduce the students with the introduction, definition and scope of biometry; to study sample, sampling and data analysis. This will enable the students to describe and measure the central tendency and dispersion, probabilities, hypothesis, tests of significance, correlation & regression and to analysis of variance.

The course Biometry & Research Methodology has been designed to prepare a data sheet from any experiments, calculations, and prepare a ppt to presentation research findings in a scientific community. It will also provide knowledge on experiments set up and its methodology. Its aimed to teach learners to provide accurate ideas for written a complete research proposal. Finally, the course will help the learners to make them competent for a scientific research, assistant particularly on data arrangements, calculations and to write a scientific paper for a scientific journal. The students will earn the skill to be an expert for ppt preparatory, thesis writing and compilation of research output data.

Course Learning Objectives:

1. To introduce the students with the sample, sampling, tests, analysis and other aspects of biometry
2. To strengthen knowledge and experience on types, proposal, process, experimental designing, writing, presentation and other aspects of research

Course Learning Outcomes (CLOs)

After completion of **Biometry** course, learners will be able to:

1. Define the concept and scope of biometry
2. study population and sample: Populations, census and sample survey;
3. describe selection of sampling procedures; Characteristics for good sampling design;
4. describe different types of sampling design, their merits and demerits; Sampling and non-sampling errors;
5. describe the procedure of collection of data; Discrete and continuous variables; Frequency distribution and graphical presentation of data.
6. Describe arithmetic mean, median, mode and other measures of central tendency;
7. measure dispersion and variability: range; mean deviation; variance and standard deviation.
8. Have basic concepts, definition and meaning of probability; counting possible outcomes, permutations and combinations, sets, and laws of probability.
9. Describe the significance of hypothesis in research: Characters of a good hypothesis; Differences between hypothesis, theory, law and fact; Testing of hypothesis: Null hypothesis and alternative hypothesis; Types of errors: Type I and Type II Errors; Levels of significance; Controls in scientific experiments.
10. Describe the t-test, the chi-square test and test for goodness of fit and contingency tables; simple, rank, partial and multiple correlation; linear regression; relationship between co-efficient of correlation and regression co-efficient; probit analysis and its applications.

After completion **Research methodology** course, the learners will be able to:

1. Describe the criteria of a good research methodology
2. Explain the types of research methodology
3. Evaluate the problems of research to solve the problems
4. Interpret the problems and bottlenecks faced by researchers of Bangladesh.
5. Use a proper method of scientific citation procedure
6. Apply the procedures to find research problems
7. Use the processes to solve the problems or errors in methodology
8. Describe basic principal of experimental design
9. Define experiment
10. Calculate analysis of variance in excel sheet for biology
11. Formulate experimental design in biological science
12. Explain a Latin square design (LSD) and Duncun's multiple range test (DMRT) analysis
13. Write a research proposal

14. Write a scientific article for a journal
15. Write a report or a thesis paper
16. Evaluate good report writing
17. Explain the types of presentation
18. Demonstrate good oral presentation
19. Illustrate a research finding in poster presentation?
20. Communicate other researcher for research needs

Course contents, subject to the lecture and Alignment of topic with CLOs

Course contents	Subject to the lecture	Alignment of topic with CLOs	LH
Biometry			
Introduction, definition and scope	❖ Lecture is delivered on definition and scope of biometry	CLO 1	2
Population and sample	❖ Lecture is delivered on populations, census and sample survey	CLO 2	2
Population and sample	❖ Lecture is delivered on Selection of sampling procedures; Characteristics for good sampling design.	CLO 3	2
Population and sample	❖ Lecture is delivered on the Different types of sampling design, their merits and demerits; Sampling and non-sampling errors;	CLO 4	2
Population and sample	❖ Lecture is delivered on Collection of data; Discrete and continuous variables; Frequency distribution and graphical presentation of data.	CLO 5	2
Measures of central tendency	❖ Lecture is delivered on Arithmetic mean, median, mode and other measures of central tendency;	CLO 6	2
Measures of dispersion	❖ Lecture is delivered on Measures of dispersion and variability: Range; mean deviation; variance and standard deviation.	CLO 7	2
Probability	❖ Lecture is delivered on Basic concepts, definition and meaning of probability; counting possible outcomes, and community, properties of a population and classification of communities.	CLO 8	2
Probability	❖ Lecture is delivered permutations and combinations, sets, and laws of probability.	CLO 8	2
Hypothesis			
Hypothesis in research	❖ Lecture is delivered on significance of hypothesis in research & characters of a good hypothesis	CLO 9	2
Hypothesis in research	❖ Lecture is delivered on differences between hypothesis, theory, law and fact.	CLO 9	2
Testing of hypothesis	❖ Lecture is delivered on Testing of hypothesis: Null hypothesis and alternative hypothesis;	CLO 9	2
Testing of hypothesis	❖ Lecture is delivered on types of errors: type I and type II errors and levels of significance.	CLO 9	2
Testing of hypothesis	❖ Lecture is delivered on controls in scientific experiments.	CLO 9	2
Test of significance			
The t-test	❖ Lecture is delivered on t-test: Introduction & definition, calculation	CLO 10	2
The chi-square test	❖ Lecture is delivered on the chi-square test and test for goodness of fit and contingency tables.	CLO 10	2
Corelation & regression			

Simple, rank, partial and multiple correlation	❖ Lecture is delivered on simple, rank, partial and multiple correlation	CLO 10	2
Linear regression; Relationship between co-efficient of correlation and regression co-efficient	❖ Lecture is delivered on linear regression; and regression co-efficient and relationship between co-efficient of correlation	CLO 10	2
Probit analysis and its applications	❖ Lecture is delivered on Probit analysis and its applications	CLO 10	2
Research methodology:			
Introduction to research; Objectives, types and processes of research; Criteria for good research; Problems and bottlenecks faced by researchers of Bangladesh; Methods of scientific citations	❖ Lecture is delivered to understand the research, how to do a research. ❖ Classification of research, and it's significances will be discussed for researches ❖ Technique will be applied to explain Problems and bottlenecks faced by researchers of Bangladesh	CLO 1-5	4
Research topic: What is a research problem; How to find a research problem; Selection of a research topic.	❖ Lecture is delivered to understand research problem, and how to find and select a research topic	CLO 6 CLO 7	4
Experimental design Criteria for a good research design; Basic principles of experimental design; Formulation of experimental design in biological sciences. Analysis of variance in completely randomized design, randomized block design and Latin square design; LSD test, DMRT and non-parametric tests.	❖ Lecture is delivered to understand, how to set up an experiment and its applications. ❖ Classification of experiments, and it's significances will be discussed for researches ❖ Then same technique will be applied to explain the comparative methodologies of different experimental techniques and it's important.	CLO 8-12	6
Preparation of research project (RP) proposals: Preparation of RP proposals; Scientific writings; Scientific papers; Preparation of scientific reports or papers for publication and preparation of a thesis; Plagiarism.	❖ Lecture is delivered to understand, how to prepare a good research proposal. ❖ Classification of research proposals (MS, PhD theses, Dissertations etc.) and its' significances will be discussed for learners. ❖ Then same technique will be applied to explain the comparative methodologies of a good research proposal and its important.	CLO 13-16	4

Presentation: Principles and methods of oral and poster presentations of scientific findings; personal communication	❖ Lecture on multimedia projector will be used, how to Types of presentations (Conferences/seminar of a scientific community, MS/MPhil/PhD theses, business/marketing ppt etc) and it's significances will be discussed for learners. ❖ Then same technique will be applied to explain the comparative differences of presentation styles.	CLO 17-20	4

Assessment Strategy

Type of Assessment	Components	Marks	Methods of Assessment
Final Written Examination	Broad Questions	35	Year-end final exam will be taken.
	Short Questions	35	
Continuous Assessment	Attendance	10	% of the assessment marks for attendance will be given as follow
	Tutorial	20	Class test, presentation in group, assignment

Attendance	Marks	Attendance	Marks	Attendance	Marks
95 -100%	20%	90 -<95%	18%	85 -<90%	16%
80 -<85%	14%	75 -<80%	12%	70 -<75%	10%
65 -<70%	8%	60 -<65%	6%	<60%	0%

Course Title: Molecular Biology, Genetic Engineering & Biotechnology

Course Code: Zool.H.402	**Course Type:** Theory (Core Course, Mandatory)	**Credits:** 4
Full Marks: 100	**Total Lecture hours:** 60	**Exam Hours:** 40

Course Description

Molecular Biology, Genetic Engineering & Biotechnology course has been designed to introduce the students to basic molecular biological concepts and techniques used in the fields of biotechnology and genetic engineering. It will also provide knowledge to fulfill the requirement for jobs in public sectors and private enterprises involved in different biotechnology efforts and to face the challenges of new developments in this field. Finally, it will capable them to apply their knowledge and skill for Molecular Biology, Genetic Engineering & Biotechnology research.

Course Learning Objectives:

1. To introduce the students to basic concepts and techniques of molecular biological, genetic engineering & biotechnology
2. To fortify knowledge and experience of learners to apply their skills for Molecular Biology, Genetic Engineering & Biotechnology research.

Course Learning Outcomes (CLOs)

After completion of **Molecular Biology** course, learners will be able to:

1. Describe nucleic acids with example.
2. Explain the historical background and chemistry of nucleic acids.
3. Describe the forms of DNA, their structure and examples.
4. Describe the steps of DNA replication.
5. Explain the types of DNA replication and their molecular mechanisms.
6. Explain the role of polymerase enzymes in DNA replication and their types with example and functions.
7. Describe the properties of RNA, their structure and examples.
8. Describe types, mechanisms and functions of mRNA, rRNA and tRNA.
9. Explain the role of RNA polymerase enzymes in DNA replication and their types with example and functions.
10. Explain properties, classical and modern concept of gene.
11. Describe the characteristics of genetic code and their evolution.
12. Explain central dogma and central dogma reverse.
13. Explain the fidelity of transcription and the mechanisms of transcription.

14. Describe the main steps of translation and post translational modification.
15. Describe the types, characterization of the cancer cells.
16. Explain the historical background, concept of oncogene and their types and characterization.

After completion of Genetic **Engineering & Biotechnology** course, learners will be able to:

1. Explain the historical background and scope of genetic engineering and biotechnology.
2. Describe principles and techniques of gene CLOning with example.
3. Explain recombinant DNA technology.
4. Describe restriction enzymes and their mode of action and uses.
5. Describe the different types of plasmid and their characteristics.
6. Mention role of plasmids in biotechnology.
7. Explain agarose gel electrophoresis of DNA.
8. Describe the production of herbicide, virus and insects resistant plants through gene technology with example.
9. Describe the production of enzymes and vaccines using biotechnology
10. Describe production of human growth hormones and interferon with functions.
11. Describe the production of alcohol and alcoholic beverages, vinegar, lactic acid, wine, enzymes and amino acids with example.
12. Describe the techniques and production of transgenic animals and their advantages and disadvantages.
13. Explain the historical background, milestone and target of Human Genome Project.
14. Explain the methods of genome sequencing and comparison of human genome with other model organisms.
15. Describe the main steps of production of Genetic modified organisms (GMOs).
16. Describe the merits and demerits and use of GMOs.
17. Mention the controversy regarding GMOs and potential risks associated with GMOs.

Course contents, teaching strategies, assessment technique and Alignment of topic with CLOs

Course contents	**Teaching-learning strategies**	**Alignment of topic with CLOs**	**LH**
Molecular Biology			
Nucleic acids	❖ Lecture is delivered to provide definition nucleic acids with example ❖ Then, the historical background and chemistry of nucleic acids will be explained.	CLO-1 CLO-2	2
Deoxyribonucleic acid (DNA): occurrences and properties of DNA	❖ Lecture is delivered to describe the forms of DNA, their structure and examples	CLO-3	4
Replication of DNA and their significance	❖ Lecture is delivered to describe the steps of DNA replication. ❖ Then, the types of DNA replication and their molecular mechanisms will be explained.	CLO-4 CLO-5	2
DNA polymerase enzymes	❖ Lecture is delivered to explain the role of polymerase enzymes in DNA replication and their types with example and functions.	CLO-6	2
Ribonucleic acid (RNA): occurrences and properties of RNA	❖ Lecture is delivered to describe the properties of RNA, their structure and examples.	CLO-7	2
Ribonucleic acid (RNA): types of non-genetic RNA	❖ Lecture is delivered to describe types, mechanisms and functions of mRNA, rRNA and tRNA.	CLO-8	4
RNA polymerase enzymes	❖ Lecture is delivered to explain the role of RNA polymerase enzymes in DNA replication and their types with example and functions.	CLO-9	2
Gene			

Genes	❖ Lecture is delivered to explain properties, classical and modern concept of gene. ❖ Then, same technique will be applied to explain the comparative study of chromosome and gene.	CLO-10	2
Genetic code	❖ Lecture is delivered to describe the characteristics of genetic code and their evolution. ❖ Then, the comparative study of codon and anticodon will be explained.	CLO-11	2
Protein Synthesis			
Protein synthesis: central dogma and central dogma reverse	❖ Lecture is delivered to explain central dogma and central dogma reverse.	CLO-12	2
Protein synthesis: Transcription	❖ Lecture is delivered to explain the fidelity of transcription and the mechanisms of transcription.	CLO-13	2
Protein synthesis: Translation	❖ Lecture is delivered to describe the main steps of translation. ❖ Then, the post translational modification will be explained.	CLO-14	2
Cancer			
Cancer	❖ Lecture is delivered to describe the types, characterization of the cancer cells. ❖ Then, the possible causes of cancer will be explained.	CLO-15	2
Cancer: Oncogenes	❖ Lecture is delivered to explain the historical background, concept of oncogene and their types and characterization. ❖ Then, how proto-oncogene becomes oncogene will be described.	CLO-16	2
Genetic Engineering & Biotechnology			
Genetic engineering and biotechnology	❖ To be provided definition of genetic engineering and biotechnology with example. ❖ Then, the historical background and scope of genetic engineering and biotechnology will be discussed.	CLO-1 CLO-2	2
Genetic engineering and biotechnology	❖ Lecture is used to describe the principles and techniques of gene CLOning with example. ❖ Then, the restriction enzymes with their types and mode of action and uses will be described.	CLO-3 CLO-4	5
Plasmid	❖ To be described the types and characteristics of plasmids. ❖ Then, the role of plasmids in biotechnology will be explained.	CLO-5 CLO-6	3
Gel electrophoresis	❖ To be explained agarose gel electrophoresis of DNA.	CLO-7	2
Application of biotechnology: In agriculture	❖ Lecture is used to describe the production of herbicide, virus and insects resistant plants through gene technology with example.	CLO-8	3
Application of biotechnology: In medical science	❖ Lecture is used to describe the production of enzymes and vaccines using biotechnology. ❖ Then, teaching will be applied to explain production of human growth hormones and interferon with functions.	CLO-9 CLO-10	3
Application of biotechnology: In industry	❖ Lecture is used to explain the production of alcohol and alcoholic beverages, vinegar, lactic acid, wine, enzymes and amino acids with example.	CLO-11	3

Transgenic animal	❖ To be described the techniques and production of transgenic animals and their advantages and disadvantages.	CLO-12	3
Human Genome Project	❖ Lecture is used to explain the historical background, milestone and target of Human Genome Project. ❖ Then, teaching will be applied to explain the methods of genome sequencing and comparison of human genome with other model organisms.	CLO-13 CLO-14	2
GMOs	❖ Lecture is used to explain the main steps of production of Genetic modified organisms (GMOs). ❖ Then, the merits and demerits and use of GMOs will be described.	CLO-15 CLO-16	2
GMOs	❖ To be explained the controversy regarding GMOs and potential risks associated with GMOs.	CLO-17	2

Assessment Strategy

Type of Assessment	Components	Marks	Methods of Assessment
Final Written Examination	Broad Questions	35	As mentioned in Zool.H.401 (Page No.)
	Short Questions	35	
Continuous Assessment	Attendance	10	
	Tutorial	20	

Course Title: Applied, Medical and Veterinary Entomology		
Course Code: Zool.H.403	**Course Type:** Theory (Core Course, Mandatory)	**Credits:** 4
Full Marks: 100	**Total Lecture hours:** 60	**Exam Hours:** 40

Course Description

Lac culture and Sericulture course has been designed to introduce the students with the systematic position, geographical distribution, host plants, life cycle of different varieties and their salient features, techniques of rearing. It will also provide knowledge on diseases, parasites, predators and pests, their singn and symptoms, control and treatment. This course is also aimed to provide information on different aspect of economic of lac culture and significance of sericulture under the socio-economic condition of Bangladesh. Altogether students will learn about how to produces various type of lac and silk product and their uses. Finally, it will capable the students to apply their knowledge and skill for generate employment opportunity in the rural area, lac and silk industry and its related fields.

Apiculture; Medical Entomology; Veterinary Entomology: The overall objective of the course Apiculture is for the learner to understand the basic science of the honey bee and its environment and transform this knowledge in beekeeping practices with improved performance. This course is also aimed to provide information on different aspects of Medical and Veterinary entomology

Course Learning Objectives:

1. To introduce the students to basic concepts and techniques of lac culture, sericulture, apiculture, medical entomology and veterinary entomology
2. To strengthen skill and experience of learners on lac culture, sericulture, apiculture, medical entomology and veterinary entomology

Course Learning Outcomes (CLOs)

After completion of **Lac culture and Sericulture** course, learners will be able to:

1. Define lac culture and sericulture.
2. Classify lac insect and silkworm and their host plants.
3. Explains the life cycle of lac insect and silkworm, their diseases, parasites, predators, pests and their control and management.
4. Compare the techniques of silkworm and lac insect rearing.
5. Describe basic differences of egg, larva, pupa and adult moth of lac insect and silkworm.
6. Describe basic components of lac culture and silkworm rearing.

After completion of **Apiculture; Medical Entomology; Veterinary Entomology** course, the learners will

be able to:

1. Define Apiculture and Beekeeping with example.
2. Describe the history of beekeeping.
3. Assess the economic importance of bees.
4. Describe the systems of beekeeping.
5. Assess the role of pollination in ecosystem.
6. Identify the races of economic importance.
7. Distinguish African bee races.
8. Relate species diversity of bee with honey production.
9. Recognize distinctive morphological features of bees.
10. Distinguish between sexual and parthenogenetical reproduction of bees.
11. Explain sociality in organisms.
12. Trace caste development in bees.
13. Indicate age polytheism or temporal division of labour in bees.
14. Describe physical, hormonal and pheromonal communication in honey bees.
15. Interpret bee dancing.
16. Prepare bee floral calendar of a locality.
17. Demonstrate various bee keeping tools.
18. Describe handling and maintenance of bee keeping equipment.
19. Describe traditional and improved hives.
20. Select Apiary site.
21. Familiarize with the process of sighting and baiting swarms.
22. Manage routine apiary activities.
23. Distinguish between flow and lean season management strategies.
24. Identify bee pests, diseases and predators with prevention and control measures.
25. Identify honey, beeswax, propolis, ambrosia, slum gum and apitoxin.
26. Determine honey quality parameters.
27. Control the quality of bee products.
28. Identify prospective local and foreign markets.
29. Explore opportunities and address challenges towards sustainable bee keeping throughout Bangladesh.
30. Explain the role of insects in human health.
31. Identify the transmission cycles of some important vector- borne disease.
32. Identify specific medically important insects and explain their morphology, biology, ecology, behaviour, epidemiology, diagnosis, prevention, control measures and treatment strategies
33. Describe arthropod morphology, physiology and systematics.
34. Explain epidemiological fundamentals.
35. Interpret arthropod transmission of pathogens.
36. Do survey for arthropods and the transmission of diseases.
37. Find out the ways to reduce disease risk for poultry and livestock.

Course contents, subject to the lecture and Alignment of topic with CLOs

Course contents	**Subject to the lecture**	**Alignment of topic with CLOs**	**LH**
Lac culture			
Economic importance of lac culture; Systematic position and geographical distribution of lac insect	❖ Lecture is delivered to provide definition of lac and lac culture. ❖ Then, the systematic position and geographical distribution of lac insect, male lac insect, female lac insect, nymph, male lac cell and female lac cell will be explained.	CLO 1-6	2
Life-cycle of lac	❖ Lecture is delivered to describe the life cycle of lac insect and lac crops.	CLO 1-6	2

Host plants of lac insect	❖ Lecture is delivered to describe host plants of lac insect, economic importance of lac culture.	CLO 1-6	2
Lac crops	❖ Lecture is delivered to describe the cultivation of lac.	CLO 1-6	2
Lac crops	❖ Lecture is delivered to describe the composition of lac and properties of lac.	CLO 1-6	2
Parasites and predators of lac insect and their control	❖ Lecture is delivered to describe the parasites and predators of lac insect and their control.	CLO 1-6	2
Significance of sericulture under the socio-economic conditions of Bangladesh	❖ Lecture is delivered to describe the significance of sericulture under the socio-economic conditions of Bangladesh		2
Systematic position of mulberry and non-mulberry silkworms in the Animal Kingdom with salient features	❖ Lecture is delivered to provide definition of sericulture and silk. ❖ Then, the systematic position of mulberry and non-mulberry silkworm in animal kingdom with salient features will be explained.	CLO 1-6	2
Different varieties of silkworms and their host plants	❖ Lecture is delivered to describe the history of sericulture and different verities of silkworm and their host plants.	CLO 1-6	2
Techniques of silkworm rearing	❖ Lecture is delivered to describe the disinfection methods of rearing house. ❖ To be described the appliances use for silkworm rearing. ❖ To be described the chawki or young age rearing methods. ❖ To be described the late age rearing methods.	CLO 1-6	8
Silkworm diseases and pests and their management practices	❖ Lecture is delivered to describe the silkworm diseases and pests.	CLO 1-6	4
Apiculture			
Scope (Notes on Pollination)	❖ To be defined apiculture and beekeeping with example. ❖ Students will come to know about the ancient history of beekeeping. ❖ Then, the significance of apiculture and system of bee keeping will be discussed.	CLO 1-5	2
Species diversity in relation to honey production	❖ To be presented the economic importance of the Identified races. ❖ Then African bee races will be distinguished. ❖ Then to be related species diversity of bee with honey production ❖ Then to be recognized distinctive morphological features of bees	CLO 6-9	2
Life cycle of honey bee	❖ To be discussed the life cycle and caste of bees. ❖ Then the sociality in organisms will be explained.	CLO10-13	2
Communication in bees	❖ To be described physical, hormonal and pheromonal communication in honey bees. ❖ Then bee dancing will be interpreted.	CLO14-15	2
Bee keeping equipments	❖ To be prepared bee floral calendar of a locality. ❖ Then to be demonstrated various bee keeping tools with	CLO 16-19	2

	handling and maintenance. ❖ Then to be described traditional and improved hives.		
Apiary management	❖ To be discussed the management of apiary. ❖ Then to be Identified bee pests, diseases and predators with prevention and control measures	CLO 20-24	2
Bee/Hive products/ Byproducts	❖ To be discussed honey, beeswax, propolis, ambrosia, slum gum and apitoxin with quality control.	CLO 25-27	2
Marketing of bee and bee products	❖ Lecture is delivered to describe marketing of bee and bee products.	CLO 28-29	2
Medical Entomology			
Biology and nature of damage of insect vectors and carriers of human disease such as yellow fever, sleeping sickness and myiasis along with their control measures.	❖ Lecture is delivered to provide information on medically important insects. ❖ Then the morphology, biology, ecology, behaviour, epidemiology, diagnosis, control measures, prevention and treatment stratebies of myiasis, yellow fever and trypanosomiasis will be explained.	CLO 30-32	8
Veterinary Entomology			
Biology and nature of damage of insect vectors and carriers of poultry and livestock and their control measures.	❖ Lecture is delivered to provide information on poultry and livestock pests. ❖ Then the arthropod transmission of pathogens will be explained.	CLO 33-37	6

Assessment Strategy

Type of Assessment	Components	Marks	Methods of Assessment
Final Written Examination	Broad Questions	35	As mentioned in Zool.H.401 (Page No.)
	Short Questions	35	
Continuous Assessment	Attendance	10	
	Tutorial	20	

Course Title: Fisheries		
Course Code: Zool.H.404	**Course Type:** Theory (Core Course, Mandatory)	**Credits:** 4
Full Marks: 100	**Total Lecture hours:** 60	**Exam Hours:** 40

Course Description

Fisheries course has been designed to introduce students the fisheries resources, fish technology, biological limnology, fisheries management and aquaculture. It will also provide knowledge on all sector of fish fin fish, shell fish, fisheries and their technology and management. This course is also aimed to provide information on different aspect of fisheries sector. Altogether they will learn about fish, fisheries, fisheries resources fisheries items of Bangladesh, fishing gear and crofts, fish handling, processing, preservation and quality control. Finally, it will capable them to apply their knowledge and skill for fisheries resources, aquaculture practices and water qualities of fish culture method and their management and plankton and benthos their type distribution and role of plankton.

Management of different types of waterbody like lakes, reservoirs, rivers and other waterbody. It will also provide knowledge about river and different fisheries item of river. This course is also aimed to provide information about fishing regulation. You will learn about different types of fish hatcheries and their

management. Also you will learn about different types of bacterial, viral, fungal diseases of fishes and their control Aquaculture topics has been designed to provide knowledge about different types of aquaculture, construction of fish farm, culture techniques for carp and cat fishes; different types of aquatic weeds and their control. You also know about the scope and approach of aquaculture.

Course Learning Objectives:

1. To introduce the students to fisheries resources, fish technology, biological limnology, fisheries management and aquaculture
2. To fortify skills and experience of learners on fish technology, fisheries management and aquaculture

Course Learning Outcomes (CLOs)

After completion of **Fisheries** course, learners will be able to:

1. Define fish, fishery, fisheries and aquaculture with example.
2. Describe the types of fishes with example.
3. Define fresh water and marine water fishes.
4. Compare fin fish, shell fish, fresh water fish and marine water fish.
5. Describe fisheries resources and types of fisheries resource and types of fisheries resources.
6. Compare freshwater, brackish water and marine water characters and their significance.
7. Explain phylum wise enlisted fisheries resource.
8. Describe present status of fin fish and shell fish of Bangladesh.
9. Define fishing gear and crofts.
10. Describe the types of fishing gear and crafts and their uses.
11. Explain how done fish handling processing preservation and quality control.
12. Mention the principles of fish processing.
13. Describe types and mechanism of fish processing.
14. Explain P^H, DO and CO_2
15. Describe the P^H, DO and CO_2 and their requirements importance of pond water.
16. Explain advantage and disadvantage of P^H, DO and CO_2
17. Define the plankton and benthos.
18. Clarify types of plankton with example.
19. Interpret the distribution and role of plankton in fish culture.
20. Classify the types of benthos with example
21. Explain the distribution and role of benthos in the production of fisheries items.
22. Mention the production of fisheries item in plankton and benthos.

After completion of **Fisheries Management** course, learners will be able to:

1. Explain the management measure of lake, reservoir and other water body.
2. Define riverine fisheries.
3. Explain the fishing regulation.
4. Explain different types of fish hatcheries and their management.
5. Explain fish parasite and parasitic diseases of fish and their control measure.
6. Explain bacterial, fungal, viral diseases of fish and their control.
7. Define different types of aquaculture.
8. Explain the scope and approach of aquaculture.
9. Explain how to construction of a fish farm.
10. Explain fish culture technique.
11. Identify aquatic weeds and explain how to control aquatic weeds.
12. Define induce breeding.
13. Explain induce breeding techniques for carp and cat fishes.

Course contents, subject to the lecture and Alignment of topic with CLOs

Course contents	Subject to the lecture	Alignment of topic with CLOs	LH
Fisheries Resource			
Open and Close water fisheries resources of Bangladesh	❖ Lecture is delivered to provide definition fish, fishery and fisheries with example. ❖ Then, the comparatively aquaculture fish, non-fish, shell fish will be explained.	CLO 1-7	8

	❖ Then, Lecture is delivered to provide definition of open water and Close water with example. ❖ Then to be described the types of fisheries resource. ❖ Then to be enlisted fresh water brackish water and marine water characters and their significance.		
Fin fish and shell fish of Bangladesh	❖ Lecture is delivered to describe the present status of fin fish and shell fish of Bangladesh.	CLO-8	2
Fish Technology			
Fishing gears and crafts	❖ Lecture is delivered to describe the types of fishing gear and crafts and their uses.	CLO 9-10	4
Fish handling, processing, preservation and quality control	❖ Lecture is delivered to define and how done fish handling, processing, preservation and quality control. ❖ Then, to be mentioned the principles of fish processing. ❖ Then, to be described the types and mechanism of fish processing.	CLO 11-13	6
Biological limnology			
Dynamics of physical and chemical factors of inland waters, sediments and their influences	❖ Lecture is delivered to explain water qualities/ P^H, DO and CO^2 ❖ Lecture is delivered to describe the P^H, DO and CO^2 and their requirements importance's of pond water.	CLO 14-15	2
Factors affecting growth, distribution and abundance of biota of inland waters	❖ Lecture is delivered to explain advantage and disadvantage of P^H, DO and CO^2.	CLO 16	2
Composition, Classification distribution and role of plankton	❖ Lecture is delivered to define plankton and benthos. ❖ Lecture is delivered to classify types of plankton and benthos with example. ❖ Lecture is delivered to interpret the distribution and role to plankton and benthos in the production of fish and fisheries items.	CLO 17-22	6
Fisheries Management			
Management measures and approaches	❖ Lecture is delivered to provide definition of fisheries, management, and culture. ❖ Then, the management methods of water body will be explained.	CLO-1	2
Management of lakes and reservoirs; River fisheries	❖ Lecture is delivered to describe the river and riverine fisheries and fisheries item with their maintenance.	CLO-2	2
Fishing regulations	❖ Lecture is delivered to describe what fisheries regulation is and explain Act for fisheries sector for Bangladesh.	CLO-3	2
Hatcheries and their management	❖ Lecture is delivered to explain different types of hatchery.	CLO-4	2
Hatcheries and their management	❖ Lecture is delivered on fish hatchery. ❖ Then, different types of hatchery and management of hatchery will be explained.	CLO-4	2
fish parasite	❖ Lecture is delivered to describe types, of fish parasites. ❖ Then, fish parasitic diseases and their control will be explained.	CLO-5	2
diseases and their control	❖ Lecture is delivered to define bacteria. ❖ Then bacterial fish diseases and their control measure will be	CLO-6	2

	discussed.		
diseases and their control	❖ Lecture is delivered to define virus. ❖ Then the viral and fish diseases and their control will be explained.	CLO-6	2
Aquaculture			
Definition, scope and approach; Types of aquaculture	❖ Lecture is delivered to explain the scope of aquaculture. ❖ Then the approaches of aquaculture will be explained. ❖ Then, the types of aquaculture will be explained.	CLO 7-8	2
construction of Fish Farm	❖ Lecture is delivered to define different types fish farm. ❖ Then the construction of fish farm will be explained.	CLO-9	2
Selection of sites for fish culture	❖ Lecture is delivered on the description on sites selection for fish culture.	CLO 10	2
Culture techniques of carps and catfishes	❖ Lecture is delivered on the description of techniques of different type of carp culture.	CLO 10	2
Culture techniques of carps and catfishes	❖ Lecture is delivered on the description of techniques of different type of catfish culture.	CLO 10	2
Weed control	❖ Lecture is delivered to explain of weeds and their control.	CLO 11	2
Induced breeding techniques for carps and catfishes	❖ Lecture is delivered to describe the techniques of induced breeding for carps and catfishes.	CLO 12-3	2

Assessment Strategy

Type of Assessment	Components	Marks	Methods of Assessment
Final Written Examination	Broad Questions	35	As mentioned in Zool.H.401 (Page No.)
	Short Questions	35	
Continuous Assessment	Attendance	10	
	Tutorial	20	

Course Title: Animals for Farming, Industry and Trade; Zoo-keeping, Animal Ethics and Ethnozoology		
Course Code: Zool.H.405	**Course Type:** Theory (Core Course, Mandatory)	**Credits:** 4
Full Marks: 100	**Total Lecture hours:** 60	**Exam Hours:** 40

Course Description

The course Animals for Farming, Industry and Trade has been designed to introduce the students with the animal for farming and industry, animal husbandry, laboratory, pet and ornamental animals. It will also provide knowledge on variety of fowl and duck and different system of poultry farming with their diseases and control. This course is also aimed to provide information on different aspect of farming of domesticated animals (cattle and goat) with their diseases and control. Altogether, students will learn about the laboratory, pet and ornamental animals. Finally, it will capable them to understand about the present status of laboratory animals, specific diseases free (SPF) animals, gnotobiotic animals, different types of pet and ornamental animals.

This course has been designed to introduce the students with the conservation of wild animals through ex-situ and captive breeding and re-introducing the zoo animals in their natural habitat. It will capable the students to raise the awareness, knowledge and respect to the wild animals among the people.

Course Learning Objectives:

1. To introduce the students with the animal for Farming, Industry and Trade
2. To provide information on Zoo-keeping, Animal Ethics and Ethnozoology
3. To strengthen skills and experience of learners on Zoo-keeping and captive breeding

Course Learning Outcomes (CLOs)

After completion of **Animals for Farming, Industry and Trade** course, learners will be able to:

1. Describe the economic importance of poultry farming;
2. Compare the varieties/ breeds of fowl;
3. Compare the varieties/ breeds of duck;
4. Illustrate the different system of poultry farming;
5. Discuss the management of brooding system in poultry farming;
6. Differentiate between the broiler and layer poultry;
7. Describe different poultry farming system of broiler and layer with advantages and disadvantages.
8. Explain the duck farming in Bangladesh;
9. Interpret the diseases of poultry and their control;
10. Explain the economic importance of farm animals with examples;
11. Explain the farming of domesticated animals especially cattle;
12. Compare the various types of breeds of cattle;
13. Discuss the farming system of cattle/ cow;
14. Interpret the diseases of cattle/ cow with their control;
15. Mention the laboratory animals;
16. Elucidate the selection and supply of laboratory animals;
17. Compare the specific disease free (SPF) and gnotobiotic animals;
18. Discuss the specific disease free (SPF) animals;
19. Describe gnotobiotic animals;
20. Compare the pet and ornamental animals;
21. Discuss some pet animals;
22. Recognize the ornamental animals of some group.

After completion of **Zoo-keeping, Animal Ethics and Ethnozoology** course, learners will be able to:

1. Describe zoos in relation to society and environments.
2. Describe the differing views, within society, relating to the scientific uses of animals and recognize the need to respect these.
3. Describe the responsibility of humans when working with research animals and recognize the importance of having a respectful and humane attitude towards working with animals in research.
4. Identify ethical and animal welfare issues in their own work and be aware and able to reflect on the consequences of their own actions.
5. Recognize that compliance with ethical principles may contribute to the long-term trust and acceptance in scientific research from the general public.
6. Describe how the law is based on an ethical framework which requires 1) weighing the harms and benefits of projects (the harm/benefit assessment) 2) applying the Three Rs to minimize the harm, maximize benefits and 3) promote good animal welfare practices.
7. Describe and discuss the importance of the Three Rs as a guiding principle in the use of animals in scientific procedures.
8. Explain the Five Freedoms and how these apply to laboratory species.
9. Describe the concept of harms to animals including avoidable and unavoidable suffering, direct, contingent and cumulative suffering.
10. Describe the severity classification system, and give examples of each category. Describe cumulative severity and the effect this may have on the severity classification.
11. Describe the regulations regarding re-use of animals.
12. Describe the importance of good animal welfare including its effect on scientific outcomes as well as for societal and moral reasons.
13. Describe the need for a culture of care and the individual’s role in contributing to this.
14. Describe relevant sources of information relating to ethics, animal welfare and the implementation of the Three Rs.
15. Synthesize the wide-ranging relationships between humans, other animals and plants.
16. Describe the effect of plants and other animals on human history and the contribution to the

structure of contemporary societies around the world.

17. Discuss the utilitarian, welfare and rights-based perspectives, among others, that affect our contemporary relationships with plants and other animals.
18. Describe the symbolic, mythological and religious perspectives of animals and plants.
19. Describe the development of legal, political and social institutions that manage plants and animals.
20. Describe the basic theories of how plants and animals are named, identified and classified by different peoples, including scientists.

Course contents, subject to the lecture and Alignment of topic with CLOs

Course contents	**Subject to the lecture**	**Alignment of topic with CLOs**	**LH**
Animal for farming and industry			
Economic importance of poultry farming	❖ Lecture is used to provide definition of poultry with example. ❖ Then, the economic importance of poultry farming will be explained.	CLO-1	2
Varieties/ breeds of fowl	❖ Lecture is used to explain the Zoological Classification of fowl and duck. ❖ Then, to be introduced the varieties/ breeds of fowl.	CLO-2	2
Varieties/ breeds of duck	❖ Lecture is used to describe the varieties/ breeds of duck.	CLO-3	2
System of poultry farming: brooding	❖ Lecture is used to illustrate the different system of poultry farming. ❖ Then, the management of brooding system in poultry farming will be discussed.	CLO-4 CLO-5	2
System of poultry farming: broiler and layer farming	❖ Lecture is used to differentiate between the broiler and layer poultry. ❖ Then, different poultry farming system of broiler and layer will be described with advantages and disadvantages.	CLO-6 CLO-7	2
System of poultry farming: duck farming in Bangladesh	❖ Lecture is used to explain the duck farming in Bangladesh.	CLO-8	2
Diseases of poultry and their control	❖ Lecture is used to understand the diseases of poultry and their control.	CLO-9	2
Animal husbandry			
Economic importance of farm animals	❖ Lecture is used to learn about the economic importance of farm animals with examples.	CLO-10	2
Farming of domesticated animals: breed of cattle	❖ Lecture is used to explain the farming of domesticated animals especially cattle. ❖ Then, the various types of breeds of cattle will be described.	CLO-11 CLO-12	2
Farming of domesticated animals: farming system of cattle/ cow	❖ Lecture is used to discuss the farming system of cattle/ cow.	CLO-13	2
Farming of domesticated animals: their diseases and control	❖ Then, lecture method using Multimedia projector as well as interactive question and answering technique will be used to understand the diseases of cattle/ cow with their control.	CLO-14	2
Laboratory, pet and ornamental animals			
Selection and supply of laboratory animals	❖ lecture is used to mention the laboratory animals. ❖ Then, the selection and supply of laboratory animals will be elucidated.	CLO-15 CLO-16	2
Specific disease free (SPF)	❖ Lecture is used to compare the specific disease	CLO-17	2

animals and gnotobiotic animals	free (SPF) and gnotobiotic animals. ❖ Then, the specific disease free (SPF) animals will be discussed. ❖ Then, to be described gnotobiotic animals.	CLO-18 CLO-19	
Pet animals	❖ Lecture is used to compare the pet and ornamental animals. ❖ Then, some pet animals will be discussed.	CLO-20 CLO-21	2
Ornamental animals	❖ Lecture is used to know the ornamental animals of some group.	CLO-22	2
Zoo-keeping			
History and types of zoos; General principles and objectives of modern zoos;	❖ History and types of zoos; General principles and objectives of modern zoos	CLO-1	2
Principles of importation of animals to zoos; Construction and equipment of animal houses and outdoor enCLOsures;	❖ Principles of importation of animals to zoos ❖ Construction and equipment of animal houses and outdoor enCLOsures;	CLO-1	2
Capital investment and income generation;	❖ Capital investment and income generation	CLO-1	2
Feeding and nutrition of zoo animals; Hygiene and parasitic control of zoo animals;	❖ Feeding and nutrition of zoo animals; Hygiene and parasitic control of zoo animals	CLO-1	2
Importance of zoos: Environmental education and awareness; *ex-situ* conservation and captivity.	❖ Importance of Zoos: Environmental education and awareness; *ex-situ* conservation and captivity.	CLO-2	2
Animal ethics and ethnozoology			
Legislation relevant to the keeping of laboratory animals	❖ Legislation relevant to the keeping of laboratory animals;	CLO 4-5	2
Anaesthesia, euthanasia and prevention of cruelty to animals	❖ Anaesthesia, euthanasia and prevention of cruelty to animals	CLO 6-10	2
Regulations relevant to protect juveniles, individuals and reproducing habitats for the conservation of species	❖ Regulations relevant to protect juveniles, individual and reproducing habitat for the conservation of species	CLO 11	2
Ethnozoology and commercialization	❖ Ethnozoology and commercialization;	CLO 12	2
Animal sources of oil, fibre, drugs and medicines, perfumes	❖ Animal sources of oil, fibre, drugs and medicines, perfumes	CLO 13	2
Animal-based folk-cottage industries; Local markets and produces	❖ Animal-based folk-cottage industries; local markets and produces;	CLO 14	2
Conventions on biodiversity (CBD)and ethnozoology	❖ CBD (conventions on biodiversity) and ethnozoology.	CLO 15	2
Museology (The science of museum)			
Definition, collection, documentation and research	❖ Lecture on definition, collection, documentation and research	CLO 16	2

Museum education; Museum exhibition, conservation and preservation	❖ Lecture on museum education, museum exhibition, conservation and preservation	CLO 17-18	2
Museum architecture, marketing, publication, security and administration	❖ Lecture on museum architecture, marketing, publication, security and administration	CLO 19-20	2

Assessment Strategy

Type of Assessment	Components	Marks	Methods of Assessment
Final Written Examination	Broad Questions	35	As mentioned in Zool.H.401 (Page No.)
	Short Questions	35	
Continuous Assessment	Attendance	10	
	Tutorial	20	

Course Title: Pest Biology		
Course Code: Zool.H.406	**Course Type:** Theory (Core Course, Mandatory)	**Credits:** 4
Full Marks: 100	**Total Lecture hours:** 60	**Exam Hours:** 40

Course Description

Pest Biology and Nematology: Pest biology course has been designed to introduce students with the pest, their biology, nature of damage, sign and symptom, and their control. It will also provide knowledge on economic crops and causes of their losses. This course is also aimed to provide information on different aspect of insect pests of stored products and their control. Altogether, students will learn about the nematode pests of economic crops such as rice, cereal, banana, potato, sugarcane, vegetables. Finally, it will capable the students to apply their knowledge and skill for control the pests through physical, cultural, chemical and biological management.

Insect Control: The Pest Management & Nematology is a core course for 4th year honours students has been designed to focus on identification, biology, ecology, behaviour, economic impact and management of agricultural and stored products pests, weeds and plant diseases. Majority of them are insect pests, some are arachnids, plant parasitic nematodes, molluscs, pathogens and vertebrates. Pest management will emphasize the principles and practices of integrating the cultural, physical & mechanical, ecological, biological, behavioural, genetic and other control tactics to suppress pest populations below damaging levels, and the issues related to pesticides and the environment. This course is to provide a holistic view of pest management with more workable knowledge to deliver effective and cost-efficient integrated pest management to improve the agricultural and environmental quality and sustainability as well as human well-being. During study period the students will be knowledged about important species of pest insects in agriculture and stored products, and will be acquainted with the techniques for controlling each species.

Course Learning Objectives:

1. To introduce the students with the different aspects of Pest biology and Nematology
2. To strengthen knowledge, skills and experience of learners for different approaches of insect control

Course Learning Outcomes (CLOs)

After completion of **Pest Biology and Nematology** course, learners will be able to:

1. Define pest and host with example
2. Recite the pest scientific name, common name, order name, family name of specific crop.
3. Describe the types of pest and host with their characteristics and example on different crop.
4. Classify pest depending on order, family, genus and sp.
5. Explain when a pest attack as an environment or seasonal pest on crop
6. Mention the total life cycle of pest
7. Interpret the role of ecological and physiological factors on host specificity of pest
8. Describe biology, nature of damage of insect pest of economic crops
9. Define management, damage, treatment of stored products pest and their control
10. Explain damage, symptom, treatment underlying mechanism of differential growth and survival of pest
11. Describe historical background of plant parasite namatodes and characterstiche

12. Mention the types of nematode depending on feeding strategy
13. Interpret the types and adaptation of parasitic nematodes
14. Describe nematode pests of crops and plants.
15. Describe the biology, distribution economic importance and control of root-knot nematode, cyst nematode, gall forming nematode.
16. Explain the entomopathogenic nematode.
17. Define physical, cultural, chemical and biological management of plant parasite nematodes.
18. Explain different types control measure of pest management.
19. Compare the nematode pests of crop rice, cereal, banana, potato, sugercane vegetables and fruits.

After completing **Insect Control** course, students will be able to:

1. Define and describe of pest, pest status and types of pest; Pest organisms and their impacts; Concepts involved in pest population regulation.
2. Define the terminology related to pest management and describe the principles of pest management; Pest management strategies and tactics.
3. Describe Non-Chemical Control Methods - Physical & Mechanical Control Methods, Ecological Management (Cultural Control Methods), Management with Natural Enemies (Biological Control Methods), Resistant Plant Varieties (Varietal Control Methods), Management by modifying insect behaviour and development, Chemical Control Methods; Integrated Pest Management (IPM)
4. Define and describe historical development, principles and its Components; Benefits, requirements and steps of IPM.
5. Describe Arsenal of Methods for Manipulating Pest Populations in Integrated Pest Management.

Course contents, subject to the lecture and Alignment of topic with CLOs

Course contents	Subject to the lecture	Alignment of topic with CLOs	LH
Pest biology			
Biology of specific crop pest	❖ Lecture is delivered to provide definition pest and host with example. ❖ Then, the pest scientific name, common name, order name, family name of specific crop will be explained.	CLO-1 CLO-2	2
Biology of specific crop pest	❖ Lecture is delivered to describe the types of pest and host with their characteristics and example on different crop.	CLO-3	2
Biology of specific crop pest	❖ Lecture is delivered to describe classify pest depending on order, family, genus and sp.	CLO-4	2
Damage of insect pest of economic crops	❖ Lecture is delivered to explain when a pest attack as an environment or seasonal pest on crop	CLO-5	2
Biology and nature of damage	❖ Lecture is delivered to mention the types of host specificity the role of ecological and physiological factors on host specificity of pest	CLO 5-7	2
Stored product pest and their control	❖ Lecture is delivered to management, damage, treatment of stored products pest and their control ❖ Then, biology, nature of control will be described.	CLO-8 CLO-9	2
Stored product pest	❖ Lecture is used to describe damage, symptom, treatment underlying mechanism of differential growth and survival of pest.	CLO-9 CLO-10	2
Nematology			
Historical background of PPN	❖ Lecture is used to describe historical background of plant parasite nematodes and characteristics. ❖ Then, to be mentioned the types of nematode depend on feeding strategy.	CLO-11 CLO-12	2
Types and Adaptation of plant parasite	❖ Lecture is delivered on the types and adaptation of parasitic nematodes. ❖ Then, survival through arrested development of unfavorable condition will be discussed.	CLO-13	2

Brief descriptions of nematode pest of crop and plants	❖ Lecture is used to brief describe the nematode pests of crops and plants.	CLO-14	2
Biology, distribution, economic importance and control of root-knot nematode, cyst nematode, gall forming nematode	❖ Lecture is used to describe the biology, distribution, economic importance and control of root-knot nematode, cyst nematode, gall forming nematode. ❖ Then, the entomopathogenic nematode is explained.	CLO 15-16	2
Management of plant parasitic nematodes: Physical, cultural, chemical, biological	❖ Lecture is used to show the fate of define physical, cultural, chemical and biological management of plant parasite nematodes. ❖ To be explained different types of control measure of pest management.	CLO 17-19	2
Insect control			
Introduction to Pest	**Lecture 1.** Definition of pest, factors for determining the status of pest and categories of pest	CLO 1	2
Pest organisms and their impacts	**Lecture 2.** Pest organisms - Introduction, Plant pathogens, weeds, Invertebrates and vertebrates,	CLO 1	2
Concepts involved in pest population regulation	**Lecture 3.** Introduction, Description of factors- reproduction, fecundity & fertility, generation time, cycles per season, longevity & mortality, Quiescence & dormancy, Temperature & humidity, Molting & metamorphosis, Dissemination, invasion & colonization process	CLO 1	2
Pest Management in General	**Lecture 4.** Definition and historical development of pest management, Terms related to pest management	CLO 2	2
Pest Management in General	**Lecture 5.** Principles of pest management - Concept, Decision, and Pest management strategies and tactics	CLO 2	2
Tools of Pest Management: Non-Chemical Control Methods	**Lecture 6.** Physical & Mechanical Control Methods: Definition, Basis of Management, Categories of Management Procedures, Advantages and Disadvantages of this methods **Lecture 7.** Ecological Management (Cultural Control Methods) Definition, Basis of Ecological Management, Categories of Ecological Management Procedures, Advantages and Disadvantages of Ecological Management	CLO 3 CLO 5	4
Tools of Pest Management: Non-Chemical Control Methods (Biological Control)	**Lecture 8.** Definition, History, principles and scope of biological control; Basis of Biological Control **Lecture 9.** Strategies of biological control- importation, augmentation and conservation. **Lecture 10.** Agents of Biological Control, Practice of Biological Control, Advantages and Disadvantages of Biological Control.	CLO 3 CLO 5	6
Tools of Pest Management: Non-Chemical Control Methods	**Lecture 11.** Managing Insects with Resistant Plants (Varietal Control Methods) Definition, Insect and Host-Plant Relationships, Mechanisms of Host Plant Resistance, Genetic Nature of Host Plant Resistance, Factors Mediating the Expression of Resistance, Biotechnology and Resistance Development, Advantages and Disadvantages of Host Plant Resistance **Lecture 12.** Management by Modifying Insect Behaviour and Development Using Pheromones and IGRs: Modifying Behaviour Patterns, Disrupting Normal Growth and Development, Advantages and Disadvantages of Using Pheromones and IGRs in Pest Management	CLO 3 CLO 5	4

Tools of Pest Management: Chemical Control Methods	**Lecture 13.** Definiton, Pesticide Development History; Nomenclature; Drawbacks and benefits of Pesticides; Classification of pesticides based on target pest and effect on pest	CLO 3 CLO 5	2
Tools of Pest Management: Chemical Control Methods	**Lecture 14.** Classification of Pesticides based on mode of entry and mode of action **Lecture 15.** Classification of Pesticides based on chemical nature: Inorganic, Organic and Biopesticides; Organic - natural organics and synthetic organics; Natural organics - Oils and Plant origin (Botanicals**)** **Lecture 16.** Synthetic Organics: Introduction, Organochlorins and Organophosphates - Structure, Physico-Chemical Characteristics and Uses, Mode of action **Lecture 17.** Synthetic Organic Pesticides: Carbamates and Synthetic Pyrethroids - Introduction, Structure, Physico-Chemical Characteristics and Uses, Mode of action; Biopesticides - Introduction and types of biopesticides	CLO 3 CLO 5	8
Tools of Pest Management: Non-Chemical Control Methods (Biological Control)	**Lecture 18.** Definition, Historical development of IPM; Practicing IPM; Principles, objectives & benefits of IPM; Essential requirments and steps of IPM implementation	CLO 3 CLO 5	2

Assessment Strategy

Type of Assessment	**Components**	**Marks**	**Methods of Assessment**
Final Written Examination	Broad Questions	35	As mentioned in Zool.H.401 (Page No.)
	Short Questions	35	
Continuous Assessment	Attendance	10	
	Tutorial	20	

Course Title: Microbiology, Animal Pathology and Immunology		
Course Code: Zool.H.407	**Course Type:** Theory (Core Course, Mandatory)	**Credits:** 4
Full Marks: 100	**Total Lecture hours:** 60	**Exam Hours:** 40

Course Description

The course Microbiology is the study of microorganisms or microbes, a diverse group which are unicellular or cell cluster organisms that include bacteria, viruses, archaea, algae, fungi and protozoa. The populations in microbial communities interact our life in various ways by both harmful and beneficial activities. We can use them for agriculture, industry, preparation of vaccine, antibiotic and many more. They are also harmful for human health. In many cases microbial populations interact and cooperate. Ecosystems are controlled to a significant extent by microbial activities. Therefore, study of microbiology is very important to impart knowledge about history, sources, nature of pathogenic and beneficial microbes, pathogenesis, laboratory diagnosis, transmission, prevention, spread and control of diseases common in the living and non-living organisms in the earth. The course will provide the information how to use and control the microbes for comfortable human life,

Immunology course has been designed to introduce you the history of immunology by which, small pox, a dreadful disease is eliminated from the face of the earth. It will provide knowledge about Expanded Program on Immunization (EPI) in Bangladesh by which a person can be prevented from six infectious diseases by vaccines. It will also give knowledge about antigen, antibody and their structures. This course is also aimed to provide information about different immune disorders. Altogether, you will learn about successful transplantation of kidney and many other organs. Finally, it will capable you to apply your knowledge and skill for diagnosis of diseases by different serological reactions in the laboratory conditions.

Course Learning Objectives:

1. To introduce the students with the different aspects of Microbiology, Animal pathology and

Immunology
2. To strengthen knowledge, skills and experience of learners for application of different methods of Microbiology, Animal pathology and Immunology

Course Learning Outcomes (CLOs)

After completion of **Microbiology and Animal Pathology** course, learners will be able to:

1. Describe the microbial world, history and development of microscope
2. Explain the scope of microbiology
3. Classify the microbes
4. Define the characteristics of various microbes.
5. Describe the morphology and characteristics of various bacteria.
6. Use the culture media and culture techniques of bacteria.
7. Apply the techniques for isolation, identification and preservation of bacteria.
8. Describe bacterial reproduction and growth, bacterial growth curve
9. Explain the bacterial enumeration from various sources (eg, water, soil, fish etc.)
10. Describe the bacteria in natural environment and common bacterial diseases in human
11. Define virus and describe their properties, morphology, classification etc.
12. Describe common viral diseases in human.
13. Control the microbes by physical and chemical agents.
14. Explain the microbiota (microfauna and microflora) in human body as well as their origin, nature and distribution.
15. Interpret the effects of microbiota on host body
16. Describe the significance of the study of microbiota
17. Explain the host-microbe relationships (commensalism, mutualism opportunistic pathogen and pathogen and their transmission.
18. Define the pathogen, pathogenicity and virulence factors
19. Interpret the host defense against microbial invasions
20. Define the first line and second line defense systems of host.
21. Define the third line of defense
22. Describe the bacterial, viral, protozoan, fungal and helminth diseases in animals and their mode of transmission,
23. Explain the principles and mechanisms of chemotherapeutic drug actions and their clinical uses (antibacterial, antiviral, antifungal etc.).

After completion of **Immunology** course, learners will be able to:

1. Define immunology and immunity.
2. Explain the history and major milestone in immunology.
3. Interpret the application and branches of immunology.
4. Classify immunity according to different criteria.
5. Classify the antigen according to their different criteria.
6. Describe the structure and types of antibody, CMI and AMI, diversity of antibody and antigen-antibody reactions.
7. Describe the mechanism of complement pathways and complement Components deficiency diseases.
8. Explain the serological reactions to diagnosis diseases.
9. Compare the different types of hypersensitivities.
10. Describe the synthesis of monoclonal antibodies.
11. Describe the vaccines and vaccination.
12. Explain transplantation and graft rejection.

Course contents, subject to the lecture and Alignment of topic with CLOs

Course contents	Subject to the lecture	Alignment of topic with CLOs	LH
Microbiology			
Introduction to microbial world; progressive development of microscopes; advancement and scope of microbiology	❖ Lecture is used to provide information on microbial world as well as the history of development of microscope and importance of the study of	CLO 1-4	3

Classification and salient features of microbes, prokaryotes VS eukaryotes	microbiology. ❖ Then, the definition, classification of microbes will be explained.		
Bacteria: Morphology, classification and characteristics: Culture media and methods; Preservation of cultures; Reproduction and growth; Bacterial growth curve; Bacterial enumeration method Bacteria in natural environment Common bacterial diseases	❖ Lecture is used to describe the morphology and characteristics of bacteria with their growth, culture, preservation, enumeration techniques etc.	CLO 5-10	8
Viruses: Properties, morphology and classification; Viroid and prions Common viral diseases	❖ Lecture is used to describe the definition, properties, morphology, classification of virus. ❖ Then, the common viral diseases in animals will be explained.	CLO 11-12	3
Control of microbes: Physical agents-heat, filtration, radiations and ultrasonic vibrations; Chemical agents-halogens, phenolics, heavy metals, alcohols, soaps and detergents, miscellaneous chemicals, dyes and acids.	❖ Lecture is used to explain different types control methods of microbes.	CLO 13	1
Normal microbiota: Microfauna and microflora of human body; Effects of microbiota on host body, Significance of the study of microbiota.	❖ Lecture is used to describe microbial populations in human body with their effects.	CLO 14-16	2
Host-microbe relationships: Commensals, mutualists, opportunists and pathogens; sources and transmission of pathogens; pathogenicity and virulence factors; host factors affecting pathogenicity and virulence.	❖ Lecture is used to discuss about host-microbe's relationships. ❖ Then, the pathogen, pathogenicity and virulence factors will be described.	CLO 17-18	3
Non-specific defense: Host-defense against microbial invasions; first line of defense; -skin, mucus membranes and cilia, chemical barriers enzymes, fatty acids, gastric juice, acids, bile and defensive chemicals; Second line of defense; - biological barriers-inflammatory response, phagocytosis, fever, NK cells, histamine and cytokines. Third line of defense; -brief introduction to specific (acquired) defense-B and T lymphocytes and their roles in host defense.	❖ Lecture is used to explain host-defense against invasions. ❖ Then, first, second and third line of defense will be described.	CLO 19-21	4
Animal pathology			
Bacterial, viral, protozoan, fungal and helminth diseases in animals and their mode of transmission;	❖ Lecture is used to discuss about bacteria, viral, protozoan, fungal and helminth diseases in animals.	CLO 22-23	6

Antimicrobial therapy; principles and mechanisms of chemotherapeutic drug actions; Antiviral, antibacterial, antifungal, antiprotozoan and antihelminth drugs and their clinical uses.	Discussions will be taken place on disease transmissions, antimicrobial therapy.		
Immunology			
Immunology	❖ Lecture is used to define immunology and immunity. ❖ Then, the history and major milestone in immunology, application and branches of immunology will be described.	CLO-1 CLO-2 CLO-3	2
Immunity	❖ Lecture is used to classify the immunity. ❖ Then, comparison between active and passive immunity, innate and acquired immunity, non- specific and specific immunity will be discussed.	CLO-4	2
Antigen	❖ Lecture is used to classify the antigen according to their different criteria.	CLO-5	2
Antibody	❖ Lecture is used to describe the structure and types of antibody. ❖ Then, the mechanism of cell mediated immunity (CMI) will be to described.	CLO-6	2
Antibody	❖ Lecture is used to describe the mechanism of antibody mediated immunity (AMI) and CLOnal selection theory.	CLO-6	2
Antibody	❖ Lecture is used to describe the diversity of antigen. ❖ Then, how antibodies interact with antigens in such a way that the antigen is altered will be discussed.	CLO-6	2
Complement	❖ Lecture is used to describe the complement pathways and complement Components deficiency diseases.	CLO-7	2
Serological reaction	❖ Lecture is used to explain the serological reactions in the laboratory condition.	CLO-8	2
Serological reaction	❖ Lecture is used to explain the serological reactions in the laboratory condition.	CLO-8	2
Hypersensitivities	❖ Lecture is used to describe the mechanism of type-1 and type- 2 hypersensitivities.	CLO-9	2
Hypersensitivities	❖ Lecture is used to describe the mechanism of type- 3, type- 4 and type- 5 hypersensitivities.	CLO-9	2
MonoCLOnal antibody	❖ Lecture is used to describe the synthesis of monoCLOnal antibodies.	CLO-10	2
Vaccine and Vaccination	❖ Lecture is used to describe the different types of vaccines and the mechanism of vaccination.	CLO-11	2
Transplantation and Graft rejection	❖ Lecture is used to differentiate the transplantation and transfusion with examples. ❖ Then, the different types of transplantation barriers and hypothesis of transplantation will be described.	CLO-12	2
Transplantation and Graft rejection	❖ Lecture is used to explain how the grafts are rejected and the role of T- lymphocytes in graft rejection. ❖ Then, the tempo of rejection and the prevention of rejection will be described.	CLO-12	2

Assessment Strategy

Type of Assessment	**Components**	**Marks**	**Methods of Assessment**
Final Written Examination	Broad Questions	35	As mentioned in Zool.H.401 (Page No.)
	Short Questions	35	
Continuous Assessment	Attendance	10	
	Tutorial	20	

Course: Zool. H. 408

Field study/Excursion

Full Marks 50 (0.5 unit)

Preparation and submission of reports on industry, farm, zoo, museum and local study tours (Distribution of marks: (Distribution of marks: Field report/Excursion =25; Presentation/*viva-voce*=10; Assessment=10; Attendance=5).

Course: Zool. HV. 409

***Viva-voce* IV**

Full Marks 50 (0.5 unit)

Viva-voce on theoretical courses from Zool. H. 401 to Zool. H. 407.

Course Title: Zoology Practical IV		
Course Code: Zool.HP.411	**Course Type:** Practical (Core Course, Mandatory)	**Credits:** 8
Full Marks: 200	**Total Lecture hours:** 120	**Exam Hours:** 24 (6 hours daily)

Course Learning Objectives

To provide practical experience on the topics covered by theoretical courses so that the learner can apply their knowledge in lab, workplace and in practical life.

Course Learning Outcomes (CLOs)

After completion of this course, learners will be able to:

1. Calculate the Mean ± SE from the supplied materials and comment on your findings and draw a graph.
2. Calculate the Student's t-value from supplied samples and to justify if the two samples differ significantly.
3. Calculate, comment and draw a graph on the Coefficient of correlation (r) from the supplied materials.
4. Calculate and comment on the F-value from the number of insects caught from your common habitats (in three replicates each).
5. Write bibliographies by searching literature, genetic information and other information.
6. Demonstrate some techniques of molecular biology and biotechnology.
7. Identify the developmental stages of prawn or bird/ zooplanktons/ fish parasites and to mention their diagnostic characters.
8. Identify and demonstrate the application of the IPM tools and mention the target pest for which the IPM is to be conducted.
9. Write a brief report on the IPM procedure.
10. Describe and demonstrate following techniques; (a) Cage fish culture; (b) Poultry farming; and (c) Dairy farming.
11. Identify and characterize the breeds of animals and mention their origin.
12. Identify and characterize the supplied specimens from cattle and poultry feed/ food products/ bi-products/ medicines), and to mention their uses/ economic importance.
13. Describe and demonstrate the following zoo techniques: (a) Apiculture; (b) Lac culture; and (c) Sericulture.
14. Isolate the bacteria from the supplied discrete colony by streaking method.
15. Perform a sensitivity test of the supplied antibiotic discs and make a comment on it.

Course contents, teaching strategies and Alignment of topic with CLOs

Contents	Alignment of topic with CLOs	LH
Biometry and Research Methodology: Analyses of raw data and measurement of central tendency and dispersion (Mean ± SD/SE); t-tests; Chi-square tests; ANOVA (Analysis of variance); Correlation and regression; Data input, analyses and presentation; Uses of mathematical formulae and functions in Microsoft Excel spreadsheets. **Bioinformatics:** Searching of literature and information from books, dissertations, abstracts, journals and periodicals, and for writing up of bibliographies using standard methods of citation; Compilation of an inventory of the following faunal groups of Bangladesh: Annelida, Arachnida, Mollusca, Pisces (freshwater) Amphibia, Reptilia, Aves and Mammalia; Submission of a report on literature search; Searching of genomic information from databases and e-sources.	CLO 1-5	30
Molecular biology, genetic engineering and biotechnology: Extraction and estimation of protein, nucleic acids (DNA and RNA) and plasmid; Identification of amino acids of proteins by paper chromatography.	CLO 6	24
Applied, Medical and Veterinary Entomology: Identification of developmental stages of silkworm, lac insect and honeybee; IPM: Methods and applications; Identification of vectors of medical and veterinary interest.	CLO 7-9	15
Fisheries and Aquaculture: Study and identification of freshwater planktons; Study of parasites of fishes; Pituitary glands of carps.	CLO 10	9
Animals for farming, industry and trade: Identification of different races, strains and varieties of economically important animals; Cultural and farming methodologies for poultry, dairy and fishes.	CLO 10-13	12
Crop pest management and Nematology: Identification of parasites and diagnosis of their effect on the hosts.	CLO 7	9
Microbiology, Animal Pathology and Immunology: Culturing, isolation and purification of bacteria; Antibiotic sensitivity tests.	CLO 14-15	21

Assessment Strategy

Type of Assessment	Marks	Methods of Assessment
Practical Examination	140	24-hr practical exam on the above topics (6 hrs daily)
Continuous Assessment	20	Attendance (As mentioned in Zool.H.401 (Page No.))
	20	Practical class records
	20	Laboratory assessment

Course: Zool. HR. 421

Thesis/Dissertation

Full Marks 50 (0.5 unit)

Each student will be attached to a teacher(s) for conducting research work. At the end of theoretical examination, he/she is required to submit his/her research work in the form of a thesis/dissertation, the format of which will be designed by the Academic Committee of the Department. Two (5) copies of the thesis/ dissertation (type-written/printed and bound) duly signed by the concerned supervisor(s) shall have to be submitted to the Chairman of the relevant examination committee within the schedule date of submission [Distribution of marks: Thesis/Dissertation=35; Assessment=10; Attendance=5].

Learning Resources:

Barth, FG. 1985. Insects and Flowers: The Biology of a Partnership. Princeton University Press, New Jersey.

Clark, BFC. 1984. The Genetic Code and Protein Biosynthesis (2nd edn). Edward Arnold Ltd. London.

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Geddws, AMW and Ilez, M. 1991. The Relative Importance of Crop Pests in South Asia. NRI Bull. No. 39.

Gillott, C. 2005. Entomology (3rd edn). Springer, Germany.

Heinz-Georgklos and Lang, EM. 1976. Handbook of Zoo Medicine. Van Nortrand Reinhold Co., London, New York.

Hume, CW. 1976. The UFAW Handbook on the Care and Management of Laboratory Animals. Churchill Livingstone, Edinburgh, London and New York.

Islam, MA. 1988. A Textbook on Parasitology (in Bengali). Bangla Academy, Dhaka.

Molles, MC Jr. 2002. Ecology: Concepts and Applications. McGraw-Hill, NY.

Mukhopadhyaya, B. and Muhthana, MS. 1962. A Monograph of Lac. Indian Lac Research Institute.

Nicholl, DST. 1996. An Introduction to Genetic Engineering. Cambridge Univ. Press, UK.

Rao VP., Ghani MA., Sankaran T. and Mathur KC. 1971. A Review of the Biological Control of Insects of other pests in South East Asia of the Pacific Region. Commonwealth Agricultural Bureaux, England.

Smith, JE. 1996. Biotechnology (3rd edn). Cambridge Univ. Press, UK.

Zethner, O.; Koustrup, R.; Reza, A.M.S.; Subba, D.K.; Barooah, D.; Barooah, N.; Win, M.M.; Tiwari, S.; Dhoj, Y.; Bajwa, G.A.; Bajwa, R.A.; Ahangama, D. 2015. *South Asian Ways of Silk: A Patchwork of Biology, Manufacture, Culture and History.* Bookbell, Guahati, Asam, India.

Abrose *et al*. Museum Basics.

Edson *et al*. The handbook of Museum.

Elizabeth, O. Information Handlings of Museum.

Gairola, T.R. Handbook of Chemical Conservation of Museum Objects.

Harper et al. Museums of the shaping of knowledge.

Light et al. Museum Documentation System.

Nigam, M.L. Fundamentals of Museology.

UNESCO. Organization of Museums: Practical Advice.

Zethner *et al*. 2015. *South Asian Ways of Silk: A Patchwork of Biology, Manufacture, Culture and History.* Bookbell, Guahati, Asam, India. 251pp.

খান, হা.সা. ও ইসলাম, এম.সা. ২০১১। জৈবপ্রযুক্তি এবং জীন প্রকৌশল। আগামী প্রকাশনী, বাংলাবাজার, ঢাকা।

[The Curriculum was approved by the Committee of Courses Meeting No. 02/17; dated: 25.07.2019]