CURRICULUM

MS Programme in Zoology

under the One Year Grading System
Sessions 2023-2024, 2024-2025 and 2025-2026

Department of Zoology
University of Dhaka

April 2025 **Dhaka**

CURRICULUM

MS Programme in Zoology

Prepared by
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Department of Zoology
University of Dhaka

Faculty Approval Date: 15th April, 2025

Academic Council Approval Date: 23rd April, 2025

Contents

Rules and Guidelines for MS Programme in Zoology
for the session 2023-2024, 2024-2025 and 2025-2026

1. Introduction to the Department of Zoology

The Department of Zoology, University of Dhaka is one of the oldest departments of the university and the pioneer institute to introduce teaching and research in animal sciences in the country, and therefore, played a commendable role in promoting zoological study in Bangladesh. Since its inception in 1954, the department has been the best learning seat for zoology education in the country and producing graduates of global competence, successfully serving the nation in various capacities. Besides, the department undertakes enormous research works to generate knowledge and insights into various fields of zoological sciences, including fisheries and food security, biodiversity conservation and management, genetics and biotechnology, epidemiology and public health, entomology and pest control, etc. The department also provides advisory and community services to government and private sectors, related to biodiversity conservation and environmental protection.

The department is housed in a large three-storied beautifully designed building located at a scenic place within the Curzon Hall Campus having infrastructural facilities for delivery of lectures, practical demonstrations and undertaking research activities.

Faculty members and non-academic staffs: The Department of Zoology has a globally competent faculty team consisting of 12 Professors (seven female and five male), 06 Associate Professors (four female and two male), 07 Assistant Professors (two female and five male) and 03 Lecturers (two female and one male) (April, 2025). All faculty members are highly qualified with brilliant academic results and research expertise. Most of them holds PhD degrees and Postdoc research experiences from renowned universities of the countries like Australia, Canada, Japan, Turkey, UK and USA. The department has supernumerary (2 posts) and honorary professors for retired professors who have proven themselves in university teaching and research. In addition to academic team, there are 18 non-academic staff (two female and sixteen male) who are involved in a wide range of administrative and managerial roles providing various student supports and ensuring the smooth operation of the department.

Research facilities: Research is also a major focus of the department and carried out in all disciplines of Zoology, particularly under five specialized branches of the department, viz. Fisheries, Entomology, Wildlife and Conservation Biology, Parasitology and Public Health, and Genetics and Molecular Biotchnology. The department is equipped with specialized research laboratories, representing all specialized branches. The departmental faculties and students publish a good number of research articles every year. Collaborative researches are carried out with different research institutions home and abroad.

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

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

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

Outdoor research facilities: The department maintains an animal garden as an outdoor research facility with experimental fields, fish hatchery, animal culture, rearing and experimental houses and wildlife captivity (aviary and serpentarium) covering an area of approximately 12000 square feet in the Curzon Hall campus. Moreover, the animal garden also houses specialized laboratories such as Animal Genetics Laboratory and Molecular Systematics, Ecology and Genotoxicity Laboratory. These research facilities in the animal garden are regularly utilized by the undergraduate, graduate, MPhil and PhD students, and faculties of the five branches of the department, viz. fisheries, entomology, wildlife and conservation biology, parasitology and public health, and genetics and molecular biotechnology. The department also has access to a pond (0.99 hectare), located within Curzon Hall Campus for aquatic research.

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

Mission and Vision of the Department:

Mission:

The Missions of the Department of Zoology are:

i) To bestow quality education to graduates in Zoology with theoretical and practical knowledge and research skills in various basic and applied areas of zoological sciences.
ii) To build partnership, student-faculty exchange programs and research collaborations with national and international organizations/universities to ensure quality education.
iii) To train students to become academics/professionals with a passion for research and scientific temperament in their mindsets.
iv) To prepare students for a wide range of career opportunities in the field of Zoology.

Vision:

As a leading center for zoological education and research, the vision of Department of Zoology is the holistic development of human resources making them able to contribute effectively for sustainable development of the country and to face the challenges of the modern world. The department is also committed to inhere amongst the students the highest values of life, respect for nature providing up to date knowledge of zoological sciences.

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

i. Bachelor of Science (Honours) in Zoology- BS (Honours) is a four year integrated degree programme comprising of theory and practical works.
ii. Master of Science (MS) in Zoology- a one year programme based either on practical and course works (Group A: Non-thesis Group) or research and course works (Group B: Thesis Group). MS degree courses are offered in five specialized branches of Zoology, as MS in Zoology (Entomology), MS in Zoology (Fisheries), MS in Zoology (Wildlife and Conservation Biology),

MS in Zoology (Parasitology and Public Health) and MS in Zoology (Genetics and Molecular Biotechnology). An MS student may choose any one of these branches for her/his study.

iii. MPhil in Zoology- is a two year degree, based on course work and research. Courses are offered in the above-mentioned specialized branches. Registered students need to successfully complete 8-credit course to be promoted from 1st year to 2nd year of the programme.

iv. PhD in Zoology- is normally a four year degree based on research, however, need to take 8-credit course to be promoted from 1st year to 2nd year of the programme, except for the students completed their 4 years BS and 1 year MS in Dhaka University.

2. Introduction to the Master of Science (MS) Programme

2.1 Programme Name

The MS in Zoology is a comprehensive programme and offered under five major branches of Zoology which are named as:

I) MS in Zoology (Fisheries)

II) MS in Zoology (Entomology)

III) MS in Zoology (Wildlife and Conservation Biology)

IV) MS in Zoology (Parasitology and Public Health) and

V) MS in Zoology (Genetics and Molecular Biotechnology)

A student may take up only one of these specialized programmes. After admission into the MS programme, the students will be asked to apply for his/her choice for a specialized branch with priority preferences. The department will then allocate the specialized branch of MS study to the students on a merit basis.

2.2 General Objectives of the Programme

MS programmes offer the opportunity to study the aforementioned core subjects of Zoology to produce graduates/professionals of global competence capable of contributing to national development. The MS program in Zoology is aligned to meet the expectations of country's policy for tertiary education.

2.3 Eligibility for Admission to the MS in Zoology Programme

(a) For Internal Students

All the successful students of the BS (Hons) programme of the department are eligible to get admission into the MS Program of the Department without having any screening or admission test. A student may seek admission to the immediate next batch of MS Programme following publication of BS (Hons) results. However, in a special circumstance, a student may seek admission within two years of the publication of his/her BS (Hons) results upon approval of the departmental Academic Committee and the Vice Chancellor of the University.

(b) For external students

Admissions for the one-year Master's program in the Department of Zoology will be conducted for available seats in accordance with established policies by the department. There will be no restrictions on the age or academic session of applicants. To be eligible for admission to the regular Master's (Thesis) program, candidates must have completed a four-year Bachelor's (Honors) degree in Zoology, Fisheries, Oceanography, Marine Sciences, Public Health, Environmental Science, Biochemistry, Microbiology, Genetic Engineering and Biotechnology, Botany, Natural Sciences, or hold an MBBS degree from a public university or a university recognized by the University Grants Commission of Bangladesh. Applicants must meet the minimum academic qualifications for secondary and higher secondary levels required for undergraduate admission, as specified by the Faculty of Biological Sciences and the Faculty of Sciences at the University of Dhaka. Furthermore, a

minimum CGPA of 3.25 (on a scale of 4) in the Bachelor's (Honors) program is required. The admission process includes both written and oral examinations, with evaluation and final results conducted in alignment with departmental policies.

2.4 Options for Thesis and Practical Group

The MS degree will be based on course and practical work (Non-thesis Group) or by course and thesis work (Thesis Group). Students having a CGPA 3.25 and above in BS level may opt for thesis work as a partial fulfilment of his/her MS degree. However, the department may refix the CGPA points time to time. A thesis student requires to perform his/ her research work under the supervision of a teacher of her/his specialized branch of study. The student needs to contact the teacher under whom he/she is willing do thesis work and once the teacher agrees to supervise the work, only then the student may embark on his/her thesis work. The students are also required to fill out a proforma mentioning the thesis title and the name of the supervisor.

3. Duration of the Programme

The MS Programme will be of 1 (one) academic year duration as distributed below:

Classes	28 weeks
Preparation time for course final examination	4 weeks
Course final examination (theory)	4 weeks
Time for submission of review article writing and seminar presentation after completion of last theoretical examination	2 weeks
Time for submission of thesis and thesis presentation after completion of last theoretical examination	12 weeks
Results	4 weeks
Total	52 weeks

Results would be published within 4 weeks from the date of last final examination (theory/ practical/viva-voce/thesis presentation, whichever is the latest).

4. Assignment of Credits

The entire Master of Science (MS) programme in Zoology will be covered by a set of theoretical courses, a thesis/practical course, a review and seminar course and a viva voce.

(a) A total of 30 credits, including 10 individual theory courses is assigned for the MS course without having any provision for options for courses.

(b) The distribution of credits is as follows:

Theory	Practical/Thesis	Review article writing and Seminar presentation	Viva-voce	**Total credit**
20	6	2	2	**30**

(c) Theoretical courses: A minimum of 15 class-hours will constitute 1 (one) credit and there will be 30 lecture-hours for a 2-credit course. 10 individual theory courses of the MS programme will carry 20 credits.

(d) Practical courses: 6-credits practical courses are only for the students of non-thesis group of each specialized branch of the MS Programme. Practical course will include 30 practical

classes, an assignment project and a number of field/laboratory visits to be organized by each branch.

(e) Thesis: The student will embark on his/her thesis research from the beginning of MS study and must submit thesis within 12 weeks after completion of the theoretical examination. Of the allocated 6 credits (150 marks) for thesis, 100 marks will be dedicated to thesis evaluation by external members and 50 marks will be allocated for thesis presentation or thesis defense.

(f) Review article writing and Seminar Presentation: For this two credits course, every student of the thesis and non-thesis groups of each specialized branch requires to write a review article on a specific published topic reviewing/assessing relevant scientific papers/articles. Students will select their review topics individually consulting with the teachers of respective branch. Students are required to prepare a project report/review paper on his/her reviewed topic and give a seminar presentation for evaluation.

5. Evaluation of Students' Performance

The total performance of a student in a given course will be evaluated on the basis of a scheme of continuous assessment, in-course and final examinations. The scheme and pattern of continuous assessment will be announced by the course teacher on the first day of classes.

(a) Assessment of theory courses will be made through a set of in-course examinations class attendance and final examination. In-course examination of one hour duration shall be conducted and evaluated by the course teacher. There will be a minimum of 2 (two) written examinations for 3 or 4 credit courses and a minimum of 1 (one) written examinations for 2 credit courses. Questions for in-course examination should preferably be of objective type. Additional assessment examinations may be made by the course teacher. In such cases the marks of all the examinations will be used to calculate average marks for the course. The course teacher will show the assessed in-course scripts to the students.

Distribution of marks for a theory course (2 credits- 50 marks)	
Class attendance	5% (2.5)
In-course examinations	35% (17.5)
Course final examination	60% (30)

(b) Assessment of practical courses will be made through a number of in-course examinations, homework assignments, observations of the students and viva-voce at the field, and also through an evaluation of assignment project report. There will be a minimum of 2 (two) in-course examinations for practical courses. The final examination on practical course will be evaluated by the course teacher along with the external examiner. A practical field/lab-based assignment project will be assigned to individual student by the concerned class teachers of respective branch. The assignment project will be evaluated by a group of class teachers.

Distribution of marks for a practical course (6 credits- 150 marks)	
In-course assessment 40 % (60 marks):	
i) Class attendance	7.5
ii) In-course examinations	27.5
iii) Assignment Project	25.0

Course final examination 60% (90 marks):	
i) Final examination	70.0
ii) Field Report	10.0
iii) Lab report/Notebook	10.0

(c) Assessment of thesis: The thesis course consists of two parts: theses writing and presentation of thesis. The thesis presentation/thesis defense (PowerPoint presentation) will be evaluated by all members of the examination committee. Thesis will be evaluated by two external examiners from outside of the department. If difference of marks of the internal and external examiners is more than 20%, there will be a third examiner to examine the thesis. Marks of the nearest two examiners will be used to get average marks as final marks.

Distribution of marks for thesis (6 credits- 150 marks)	
Thesis presentation/defense	50
Thesis evaluation by external members	100

(d) Assessment of review article writing and seminar presentation: Review article and Seminar presentation will be evaluated by internal members of the examination committee. Fifty percent marks will be allocated for the review project presentation, and the rest 50% marks for the project report.

Distribution of marks for review article writing and seminar presentation (2 credits-50 marks)	
Review paper presentation	25
Review paper evaluation	25

(e) Viva-voce/oral examination (2 credits-50 marks): Viva-voce/oral examination will be conducted by the Examination Committee.

(f) Basis for awarding marks for class attendance:

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

(g) Make-up examination (theory courses):

A student failing to appear in an in-course examination will not be allowed to sit for any make-up examination. Absence in any in-course examination will be counted as zero for calculating the average in in-course examination for that course. However, a student can

apply to the chairman of the department for make-up test provided he/she satisfies certain conditions. The Chairman will only place the application before the academic committee if the particular student had met an accident or his/her parent(s) had expired or he/she had gone through a surgical procedure one/two days before assessment examination date or any other such situation which the Academic Committee feels can be considered. The make-up examination must be held before the start date of the final examination.

(h) The course final examination (theory courses):

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

ii. Pattern of theory questions will be decided by the academic committee of the department. However, there will be no objective questions/part in the course final examination. There would be combination of broad and short questions.

iii. The course final examinations will be of two (2) hours for 2-credit courses.

iv. For the evaluation of course final examination there will be two examiners: the first examiner- course teacher and the second examiner- anyone other than the course teacher, preferably form the department.

v. Under double-examiner system if the difference of first and second examiners marks of a course is more than 20% of total marks, there will be a 3rd examiner. Marks of the nearest two examiners will be averaged out as final marks.

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

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

6. Grading description

The explanations of letter grades are described as follows:

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

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

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

satisfactorily.

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

F: Unacceptable performance; minimum required course objectives not met; objectives not met at a minimally acceptable level; no credit earned.

7. Earned Credits

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

8. Calculation of GPA

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

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

The Grade Point Average (GPA) is computed by dividing the total accumulated grade points earned during the MS programme by total credit points attempted. For successful completion of MS programme a student must earn 30 credits or more if approved with no F grade in any course. However, this minimum requirement may be raised by any department as per their programme and final GPA will be calculated using all the credits attempted.

9. Eligibility for Appearing in Course Final Examinations

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

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

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

10. Publication of Results

The results will be published within six weeks of completion of practical examination (for practical group) and after six weeks of submission of thesis paper (thesis group). Results will be published separately for non-thesis (practical group) and thesis group students.

11. Retake Examination

A student can appear in retake examination once only in one course to clear F grade within six weeks after announcement of the results. His/her in-course assessment marks will be retained.

12. Readmission

(a) A student failing to earn the degree may seek readmission once with the next batch. For readmission, a student will have to apply within one month after announcement of the result of the concerned year. Readmission will be allowed only after the approval of the departmental academic committee.

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

department will determine whether the re-admitted student can undertake any thesis work.

(c) If a student succeeds after taking readmission his/her transcript will bear "R" after GPA, with a foot note of mentioning "R means readmission"

13. Requirements for Successful Completion

A student must earn GPA of 2.50 on a 4.00 scale for obtaining MS degree.

14. Time Limit for Completion of Master's degree

A student must fulfill all the requirements for a master's degree within a maximum period of two academic years, starting from the year of enrolment, in case he/she appears and fails in the examination. In case the student is unable to participate he/she needs to inform the Chairman of the department. However, in case of continuing with the program for the second year he/she requires readmission upon approval of the department. In that case, his/her obtained marks obtained in the previous year will be discarded.

15. Other general regulations

(a) At the beginning of the session, a course teacher shall provide the students a course outline including the obvious, main topics, teaching approaches (e.g., labs, case studies, field work, etc.), schedule of exams, text books and other required materials.

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

(c) Tabulation work will start only after all the marks of the course final examinations for the year are received by the Chairman of Examination Committee. Marks received by the Chairman of the Examination Committee shall remain in the sealed envelopes as sent by the Examiner/Examiners until tabulation work is started. In case of thesis group tabulation starts only after thesis presentation.

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

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

16. Relevancy of Curriculum of the Department of Zoology, University of Dhaka to the SDGs (Sustainable Development Goals) in Bangladesh

SDGs	**Relevancy of Syllabus to the SDGs**
Goal 1: No poverty 	ZF 504; ZF 508; ZF 510; ZE 526; ZE 528; ZW 542; ZP 569; ZP 570; ZG 582; ZG 584; ZG 588; ZG 590.
Goal 2: Zero hunger 	ZF 504; ZF 506; ZF 507; ZF 508; ZE 526; ZE 527; ZE 528; ZW 542; ZP 565; ZP 566; ZP 569; ZP 570; ZG 582; ZG 584; ZG 588; ZG 590.
Goal 3: Good health and well-being for people 	ZF 504; ZF 506; ZF 507; ZF 508; ZE 528; ZE 530; ZP 564; ZP 565; ZP 566; ZP 569; ZP 570; ZW 542; ZW 544; ZG 583; ZG 584; ZG 588; ZG 589; ZG 590.
Goal 4: Quality education 	The department has adopted Outcome Based Education. The curriculum has been updated. The program will be regularly evaluated as per OBE principles and revised, as necessary, to ensure quality education.
Goal 6: Clean water and sanitation 	ZF 503; ZF 504; ZF 507; ZF 508; ZE 526; ZE 527; ZW 548; ZP 566; ZP 569; ZP 570; ZG 582; ZG 584; ZG 588; ZG 590.
Goal 9: Industry, Innovation, and Infrastructure 	ZF 504; ZF 505; ZF 508; ZE 526; ZE 527; ZE 528; ZE 530; ZW 547; ZW 550; ZP 564; ZP 565; ZP 564; ZP 569; ZP 570; ZG 581; ZG 582; ZG 583; ZG 584; ZG 587; ZG 588.
Goal 12: Responsible consumption and production 	ZF 504; ZF 505; ZF 508; ZE 526; ZE 527; ZE 529; ZW 542; ZW 543; ZP 564; ZP 565; ZP 564; ZP 569; ZP 570; ZG 582; ZG 588; ZG 589.

Goal 13: Climate action 	ZF 507; ZF 508; ZE 525; ZW 547; ZW 548; ZG 582; ZG 583; ZG 585; ZG 590.
Goal 14: Life below water 	ZF 501; ZF 510; ZW 541; ZW 542; ZW 543; ZW 544; ZW 545; ZP 562; ZP 564; ZP 565; ZP 566; ZP 569; ZP 570; ZG 581; ZG 582; ZG 583; ZG 585; ZG 586.
Goal 15: Life on land 	ZF 509; ZE 524; ZE 525; ZE 529; ZW 541; ZW 542; ZW 544; ZW 545; ZW 546; ZP 561; ZP 564; ZP 565; ZP 566; ZP 569; ZP 570; ZG 581; ZG 582; ZG 583; ZG 584; ZG 585; ZG 588; ZG 590.
Goal 16: Peace, justice and strong institutions 	ZF 510; ZE 529; ZW 549; ZP 569; ZG 587.
Goal 17: Partnerships for the goals 	The department has collaboration and partnership with a number foreign and national universities, research organizations and NGOs to achieve its goal.

17. MS Branch-Wise Distribution of Courses and Credits

17.1 MS in Zoology (Fisheries)

ZF 501	Fish Biology and Advanced Physiology	2 credits
ZF 502	Fish Population Dynamics and Fisheries Modelling	2 credits
ZF 503	Aquatic Resources, Biodiversity, Fisheries Management and Conservation	2 credits
ZF 504	Advanced Aquaculture, Fish Nutrition and Fish feed technology	2 credits
ZF 505	Fish Genetics, Biotechnology and Bioinformatics	2 credits
ZF 506	Fish Disease, Immunology, and Aquatic Health Management	2 credits
ZF 507	Aquatic Environment, Ecology and Limnology	2 credits
ZF 508	Marine Biology and Oceanography	2 credits
ZF 509	Post-harvest Technology and Quality Assurance	2 credits
ZF 510	Fisheries Extension, Marketing and Socio-economics	2 credits
ZF 511	Practical in Fisheries (Gr-A)	6 credits
ZF 512	Thesis in Fisheries (Gr-B)	6 credits
ZF 513	Review article writing and Seminar presentation	2 credits
ZF 514	Viva voce	2 credits
	Total:	**30 credits**

17.2 MS in Zoology (Entomology)

ZE 521	Insect Systematics and Nomenclature	2 credits
ZE 522	Insect Structure and Function	2 credits
ZE 523	Insect Developmental Biology, Endocrinology and Molecular Biology	2 credits
ZE 524	Insect Behavioural Adaptations and Insect-Plant interactions	2 credits
ZE 525	Insect Ecology and Biodiversity Management	2 credits
ZE 526	Insect Pest and Pest Management	2 credits
ZE 527	Toxicology and Impacts on Ecosystem	2 credits
ZE 528	Medical and Veterinary Entomology	2 credits
ZE 529	Insect Bioresources, Management and Conservation	2 credits
ZE 530	Insect Epizootiology and Disease Dynamics	2 credits
ZE 531	Practical in Entomology (Gr-A)	6 credits
ZE 532	Thesis in Entomology (Gr-B)	6 credits
ZE 533	Review article writing and Seminar presentation	2 credits
ZE 534	Viva voce	2 credits
	Total:	**30 credits**

17.3 MS in Zoology (Wildlife and Conservation Biology)

ZW 541	National and Global Wildlife	2 credits
ZW 542	Wildlife Resources and Protected Area Management	2 credits
ZW 543	Comprehensive Conservation Biology	2 credits
ZW 544	Wildlife Ecology and Biogeography	2 credits
ZW 545	Behavioral Ecology of Wildlife	2 credits
ZW 546	Human-Wildlife Interactions and Wildlife Diseases	2 credits
ZW 547	Restoration Ecology and Ecological modelling	2 credits
ZW 548	Climate Change Biology	2 credits

ZW 549	Wildlife Economics, Trades, Ethics, Laws and Legislations	2 credits
ZW 550	Field and Laboratory Techniques in Wildlife Studies	2 credits
ZW 551	Practical in Wildlife and Conservation Biology (Gr- A)	6 credits
ZW 552	Thesis in Wildlife and Conservation Biology (Gr-B)	6 credits
ZW 553	Review article writing and Seminar presentation	2 credits
ZW 554	Viva voce	2 credits
	Total:	**30 credits**

17.4 MS in Zoology (Parasitology and Public Health)

ZP 561	Parasite Systematics and Biology	2 credits
ZP 562	Parasite Physiology and Biochemistry	2 credits
ZP 563	Molecular Biology of Parasites	2 credits
ZP 564	Immunology	2 credits
ZP 565	Pathology and Medical Microbiology	2 credits
ZP 566	Parasite-Host Ecology and Behaviour	2 credits
ZP 567	Parasite Biodiversity and Population Dynamics	2 credits
ZP 568	Epidemiology and Disease Control	2 credits
ZP 569	Public Health Parasitology	2 credits
ZP 570	Veterinary Parasitology	2 credits
ZP 571	Practical in Parasitology and Public Health (Gr-A)	6 credits
ZP 572	Thesis in Parasitology and Public Health (Gr-B)	6 credits
ZP 573	Review article writing and Seminar presentation	2 credits
ZP 574	Viva voce	2 credits
	Total:	**30 credits**

17.5 MS in Zoology (Genetics and Molecular Biotechnology)

ZG 581	Cellular and Molecular Biology	2 credits
ZG 582	Animal Biotechnology	2 credits
ZG 583	Genetics of Development, Immunity, and Behavior	2 credits
ZG 584	Genetics of Human Diseases	2 credits
ZG 585	Functional Genomics and Bioinformatics	2 credits
ZG 586	Introduction to Proteomics and Metabolomics	2 credits
ZG 587	Genetic Engineering	2 credits
ZG 588	Industrial Biotechnology	2 credits
ZG 589	Molecular Ecology	2 credits
ZG 590	Conservation Genetics	2 credits
ZG 591	Practical in Genetics and Molecular Biotechnology (Gr-A)	6 credits
ZG 592	Thesis in Genetics and Molecular Biotechnology (Gr-B)	6 credits
ZG 593	Review article writing and Seminar presentation	2 credits
ZG 594	Viva voce	2 credits
	Total:	**30 credits**

MS in Zoology (Fisheries)

Course No.	Course Title	No. of Credits	Credit Hours
ZF 501	**Fish Biology and Advanced Physiology**	**2**	**30**

Introduction to the course

This course provides a comprehensive understanding of fish as the most diverse vertebrates in aquatic ecosystems. It covers the scope and history of fish biology, exploring fish diversity, phylogeny, and evolution. Students will learn about anatomy, morphology, and their functional significance, including locomotion, sensory systems, and communication. The course examines reproductive strategies, environmental influences on reproduction, life history, and spawning behaviors. Key aspects of fish behavior and migration are discussed, alongside advanced physiological processes such as digestion, respiration, circulation, osmoregulation, and thermoregulation. Special focus is given to bioluminescence and endocrine regulation. The course equips students with essential knowledge for careers in fisheries, aquaculture, conservation, and marine research.

Specific objectives of the course

- To provide comprehensive knowledge of fish biology, anatomy, and reproductive strategies.
- To explain physiological processes in fish such as digestion, circulation, respiration, and endocrine functions.
- To explore evolutionary adaptations, behaviors, and migration strategies in fish.
- To enable students in basic knowledge of ichthyology for fisheries management, conservation, and aquaculture.

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

Title/sub-titles of course contents	No. of classes
Fish Biology	**15**
Introduction to Fish Biology: Definition and scope of fish biology; History of ichthyology.	**1**
Overview of fish diversity and global distribution; Fish phylogeny and evolutionary history.	**2**
Anatomy and Morphology: External morphology and its functional significance – Skin and scales; Digestive, circulatory, and excretory systems; Skeletal system; Musculature and locomotion adaptations; Nervous system, Sensory organs and communication.	**6**
Reproductive Biology and Development: Reproductive strategies: oviparity, viviparity, ovoviviparity; environmental factors influencing the reproduction of fish.	**2**
Life history and development of selected fishes: Maturation and spawning, Spawning behaviors, developmental stages and parental care.	**2**
Fish Behavior and Migration: Schooling and social interactions - Migration types and mechanisms.	**2**
Advanced Physiology	**10**
Digestion and Circulation: Physiology of digestion and blood circulation in fish.	**2**
Respiration: Physiology and adaptations.	**2**

Osmoregulation in fishes: Osmoregulation and ion regulation of freshwater and marine fishes;	**2**
Fish adaptation: Physiological adaptation to diverse aquatic environments Thermoregulation in fishes - Bioluminescence and other unique adaptations.	**2**
Fish Endocrinology: Endocrine glands, origin and functions.	**2**

Course Learning Outcomes

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

- Describe the history of ichthyology, fish diversity, phylogeny, and evolutionary history.
- Explain fish anatomy, external morphology, and their functional significance, including locomotion and sensory systems.
- Discuss reproductive strategies, life history, and environmental influences on fish reproduction.
- Analyze fish behaviors such as schooling, social interactions, and migration mechanisms.
- Explain physiological processes: digestion, respiration, circulation, osmoregulation, thermoregulation, and bioluminescence.
- Illustrate the role and functions of endocrine glands in fish.

Instructional Strategies

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

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

Class/lecture types	No. of classes	Class/lecture types	No. of classes
Lecture and discussion	25	Review class	1
Students' group presentation	2	In-course exam	1
Feedback on In-course exam	1		

Assessment

There will be one In-course examination, consisting of 17.5 marks. Another 2.5 marks is reserved for class attendance. The students will be frequently asked questions in the classrooms to assess individual's performance. A course final examination, consisting of 30 marks will be conducted by the university.

References

Bone, Q. and Moore, R. 2008. *Biology of Fishes*. Taylor & Francis.Hoar, W.S., Evans, David H., Claiborne, James B., and Currie, Suzanne. 2013. *The Physiology of Fishes*, 4th edn., CRC Press, 491 pages.

Lagler, K.F., Bardach, J.E., Miller, R.R., and May, P.D.R. 1977. *Ichthyology*. John Wiley and Sons, New York.

Hart, Paul J.B and Reynolds, John D. edt. 2002. *Handbook of Fish Biology and Fisheries*. Vol.1. Blacwell Publ., USA. 412p.

Hart, Paul J.B and Reynolds, John D. edt. 2002. *Handbook of Fish Biology and Fisheries*. Vol.2. Blacwell Publ., USA. 410 p.

Randall, D.J., and Donaldson, E.M. (1983). *Fish Physiology*. Academic Press, Orlando, USA.

Course No.	Course Title	No. of Credits	Credit Hours
ZF 502	**Fish Population Dynamics and Fisheries Modelling**	**2**	**30**

Introduction to the course

Fish population dynamics and stock assessment are essential components of fisheries science, contributing to the sustainable management of fishery resources. This course explores the fundamental concepts of fish population structure, growth estimation, mortality rates, and stock assessment techniques. The course will also cover modern fisheries modeling approaches, including ecosystem-based models and predictive tools for stock assessment. Additionally, students will learn about fisheries data collection, management strategies, and decision-making processes necessary for sustainable fisheries management. This course aims to equip students with the necessary knowledge and technical skills for effective fishery resource assessment and management. By integrating theoretical understanding with practical applications, students will be prepared to address real-world fisheries challenges using data-driven and sustainable approaches.

Specific objectives of the course

- To understand the fundamental concepts of fish population dynamics and stock assessment.
- To identify different fishery stocks and analyze their abundance and distribution.
- To apply methods to estimate fish growth, mortality rates, and stock recruitment relationships.
- To utilize fisheries models, including conceptual, empirical, and mechanistic approaches, for stock assessment.
- To implement participatory and innovative data collection strategies for fisheries management.
- To develop skills to assess overfishing, underfishing, and exploitation levels for sustainable fisheries management.

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

Title/sub-titles of course contents	No. of classes
Fish Population Dynamics	**13**
Introduction to fish population dynamics: Concept of population and stock, unit stock, distribution and abundance, relative and absolute abundance, cohort and population structure.	**2**
Fish age and growth estimation: The von Bertalanffy growth equation; seasonal and non-seasonal growth equation. Growth parameters, K, L_∞, C, etc.	**2**
Estimation of mortality rates: Methods for estimation of total mortality (Z), fishing (F) and natural mortality (M); estimating survival and mortality rates.	**2**
Stock-Assessment: General aspects of fish stock assessment; stock-recruitment relationship; over-fishing and under fishing concept; by-catches and discards estimation of stock.	**3**
Fishery data collection for assessment and management: Issues and objectives of data collection, biological data, collection of length frequency data; catch assessment and fishing effort survey; estimation of CPUE and fish productivity and participatory data collection; species composition; distribution and abundance data; availability and gear selectivity; exploitation ratio; analysis of data; presentation of data for fishery management and decision making.	**4**

Fisheries Modelling	**12**
Concept and importance of modelling in fisheries science. Types of fisheries models: conceptual, empirical, and mechanistic. Prediction models: Surplus production model, Biomass model, Yield per Recruitment (Y/R); Biomass per Recruitment (B/R); Catch curve; Maximum Sustainable Yield (MSY), and Virtual Population Analysis (VPA).	**6**
Microcomputer programme packages: Graphical and computer-based analysis of growth - stock assessment based on length frequency analysis. LFDA (Length-Frequency Distribution Analysis), FISAT (FAO-ICLARM Stock Assessment Tools), ELEFAN I & II.	**6**

Course Learning Outcomes

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

- Explain key concepts in fish population dynamics, including population structure, recruitment, and stock assessment.
- Estimate fish age and growth parameters using von Bertalanffy and other growth models.
- Apply different mortality estimation methods and analyze fishing pressure.
- Conduct stock assessments using traditional and advanced modeling approaches.
- Interpret fisheries data for policy recommendations and sustainable management decisions.
- Use computer-based tools for analyzing fish stock assessments and evaluating management strategies.
- Contribute to sustainable fishery practices through innovative, evidence-based management approaches.

Instructional Strategies

To ensure effective learning, the course will incorporate innovative and interactive teaching methodologies. The course will be delivered through lecture and discussion, aided by power point presentations, models, video clips, etc. Classes will be made participatory and interactive through questions and answers, and group work exercises in the classroom. Demonstration of the use of prediction models will be made in the classroom.

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

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

Assessment

There will be one In-course examination, consisting of 17.5 marks and 2.5 marks are allocated for class attendance. Questions for In-course test will be objective and short answer types. A course final examination of 30 marks will be conducted centrally by the university. The students will be frequently asked questions in the classrooms to assess individual's performance.

References

Bagenal, T. 1978. *Methods for Assessment of Fish Production in Freshwaters.* IBP Handbook, No. 3. Blackwell Science, London.

Hart, P.J.B. and Reynolds, J.D. 2002. *Handbook of Fish Biology and Fisheries,* Vol. 1 and 2. Blackwell Publishing, London.

Jennings, S., Kaiser, J.M. and Reynolds J.D. 2001. *Marine Fisheries Ecology.* Blackwell Science, London.

King, M. 1995. *Fisheries Biology: Assessment and Management.* Fishing News Books, Oxford, UK.
Royce, W.F. 1984. *Introduction to the Practice of Fishery Science.* Academic Press, USA.
Sparre, P. and Yenema, S.C. 1992. *Introduction to Tropical Fish Stock Assessment.* FAO *Fisheries Technical Paper No. 306*. FAO, Rome.
Welcomme, R.L. 2001. *Inland Fisheries Ecology and Management.* FAO Fishing News Books, Oxford, UK.

Course No.	Course Title	No. of Credits	Credit Hours
ZF 503	**Aquatic Resources, Biodiversity, Fisheries Management and Conservation**	**2**	**30**

Introduction to the course

Fisheries resources are crucial for Bangladesh's national food security, livelihood, and foreign exchange earnings. Rapid declination in fisheries resources spurred a huge concern for its effective management in Bangladesh. To ensure the long-term sustainability, it is essential to understand the array of available fisheries resources, the issues and the driving forces responsible for Bangladesh's diminishing fisheries resources. The biological, ecological, social and legal premises of the sustainable management also play a crucial role in devising a legal framework that ensures both the abundance of the resources and human well-being. This course provides an information on the diversity of aquatic resources of the country and an exposure to all these basic principles, and different methods of fisheries management. It also offers a detail understanding of the existing legal instruments that are used to manage fisheries resources in Bangladesh. Students will be introduced to the processes of developing fisheries management plan under different management scenarios. The course is intended to produce professionals in fisheries management with necessary background knowledge and skills.

Specific objectives of the course

- To familiarize the students with country's fisheries resources, including fish habitats, species diversity, infra-structural facilities, support service, and existing legal instruments for management of Bangladesh fisheries.
- To understand the various components and levels of biodiversity including its measurement and estimation.
- To introduce the students with the methods and tools, and strategies for fisheries management.
- To enhance students' knowledge and skills in identifying, planning and designing fisheries management actions and preparing Fisheries Management Plan.

Course contents and number of classes by course sub-title

Title/sub-title of course content	No. of classes
Aquatic Resources	**8**
Habitats of fish, shellfish and other invertebrates: Types, extent and status. Physical resources in Bangladesh: Rivers, floodplains, haor, baors, beel, lake, estuary and sea.	**2**
Fish, shellfish and other invertebrates resources: Diversity and abundance of Freshwater fishes and marine finfishes (shark, sketes, rays and bonny fishes) and shellfishes (Shrimps, crabs, molluscs etc.) in Bangladesh. Exotic/Introduced and ornamental fish species: Status; roles/impacts of Alien Invasive Species	**2**
Sea weeds resources: Diversity, status and their ecological and economic importance.	**1**
Fish and shellfish production statistics of Bangladesh: Fisheries resources survey and monitoring system; habitat, area and species/group wise production statistics.	**1**
Fisheries resources of the major river systems, Sundarbans, Kaptai lake and major haors in Bangladesh.	**1**

Government and non-government national, regional and international organizations; Research and academic institutions.	**1**
Biodiversity	**5**
Components, types and levels of Biodiversity: Species, ecosystem and genetic diversity; alpha, beta and gamma level diversity; taxonomic, functional and phylogenetic diversity. Measures of biodiversity: Species identification, species richness, evenness, density, occurrence and composition; Diversity indices; Similarity and cluster analysis. Major threats to aquatic biodiversity in Bangladesh. Bangladesh's biodiversity conservation strategies and action plans. Biodiversity related conventions: CBD, CITIES, Ramsar convention, World heritage convention etc.	**2** **2** **1**
Fisheries Management and Conservation	**12**
Tragedy of the Commons in fisheries context. Concept, principles, objectives and aspects of fisheries management. Fisheries management approaches: Technical and regulatory approaches, restrictions and control; Biological: MSY, mortality, effort, breeding season and life-history information; Ecosystem based fisheries management approach; Right-based fisheries management approach; Criteria to evaluate fishery management tools/interventions. Fisheries Management Regime in Bangladesh: New Fisheries Management Policy (NFMP); Community Based Fisheries Management (CBFM) Policy; National Fisheries Policy; Hilsa Fisheries Management Action Plan (HFMAP) Concept and principles of fishery conservation; Conservation strategies for marine, inland and open water fishery: Fish sanctuaries, refuge, parks and reserves with special reference to hilsa and carps; Controlling ghost and poison fishing; Establishing protected areas (PAs), marine protected areas (MPAs) and no take zone. Conservation status of fish and shellfish fauna. Tools and Technologies in Fisheries Management: Fisheries monitoring and control technologies (e.g., VMS, e-logbooks); Remote sensing and GIS in habitat mapping. Use of mobile apps and AI in data collection; Citizen science initiatives in fisheries management. Legal frameworks for fisheries resources conservation in Bangladesh**:** Fish Protection and Conservation Acts and Rules of Bangladesh; The Marine Fisheries Act and Rules**;** The Fish and Fish Products (Inspection and Quality Control) Act etc.	**1** **2** **3** **2** **2** **2**

Course Learning Outcomes

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

- Recognise and assess the diversity and production outputs of fish, shellfish and other aquatic resources and their sustainable utilization.
- Identify and evaluate the roles of national and international organizations contributing fisheries resources.
- State and compare the levels, components and measures of biodiversity.
- Describe the biological, ecological, social and legal approaches of fisheries management;
- Apply methods and tools for designing and implementing fisheries management system.
- Identify and apply the policies, acts and rules related fisheries and aquatic biodiversity.

Instructional Strategies
To ensure effective learning, the course will incorporate innovative and interactive teaching methodologies. The course will be delivered through lecture and discussion, aided by power point presentations, models, video clips, etc. Classes will be made participatory and interactive through questions and answers, and group work exercises in the classroom. Demonstration of the use of prediction models will be made in the classroom.

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

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

Assessment
There will be one In-course examination, consisting of 17.5 marks and 2.5 marks are reserved for class attendance. A course final examination, consisting of 30 marks, will be conducted centrally by the university. The students will be frequently asked questions in the classroom to assess individual's performance.

References

Ali, M.Y. 1997. Fish, Water and People. The University Press Limited, Dhaka, Bangladesh.

Farooque, M. 1997. Regulatory Regime in Inland Fisheries in Bangladesh: Issues and Remedies. Bangladesh Environmental Lawyers Association (BELA), Dhaka.

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

Siddiqui, K.U., Islam, M.A., Kabir, S.M.H., Ahmad, M., Ahmed, A.T.A., Rahman, A.K.A., Haque, E.U., Ahmed, Z.U., Begum, Z.N.T., Hasan, M.A., Khondker, M. and Rahman, M.M. (ed.). Encyclopedia of Flora and Fauna of Bangladesh. Vol. 24. Marine Fishes. Asiatic Society of Bangladesh, Dhaka.

Sissenwine, M. P., & Kirkley, J. E. 1980. Fishery management techniques, a review. US Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Fisheries Center.

Tsai, C. and Ali, M.Y. 1997. Openwater Fisheries of Bangladesh. The University Press Limited, Dhaka,Bangladesh.

Course No.	Course Title	No. of Credits	Credit Hours
ZF 504	**Advanced Aquaculture, Fish Nutrition and Fish feed technology**	**2**	**30**

Introduction to the course
The contribution of culture fisheries to country's fish production is increasing overwhelmingly and its future prospects are also tremendous with the advancement in aquaculture technologies. The purpose of this course is to introduce and build skills of the students in the areas of aquaculture, both freshwater and marine. Specifically, the course will focus on the culture of different fish and shrimp species, different culture practices, modern techniques for intensification of fish productions and management of culture systems. The course will discuss also the induced breeding techniques and nursery techniques in detail and breeding stock improvement with highlights on hatchery design,

construction and its operation. The intent of this course is to produce fisheries professionals capable of dealing with the all aquaculture practices and its management.

Specific objectives of the course

- To enhance understanding and knowledge of the students on the principles, methods and techniques used for different types of aquaculture practices.
- To increase students' skills to undertake and operate culture programs in firm conditions and at individual level.
- To enhance students ability to design and operate fish hatcheries

Course contents and number of classes by course sub-title

Title/sub-titles of course contents	No. of classes
Advanced Aquaculture	
Introduction to aquaculture and its importance: History, definition, types, scope and significance of aquaculture, comparison of aquaculture with agriculture and commercial fisheries. Aquaculture - Global and Bangladesh Scenario.	**4**
GAP-Good Aquaculture Practices: Concept, applications and challenges. Role of exotic fishes in aquaculture production in Bangladesh.	**4**
Inland Aquaculture: Basis of inland aquaculture; Present practices of fish and shellfish culture in Bangladesh; Inland aquaculture with references to prawn, barbs, carps, tilapia, catfish (pungus) culture methods. Ornamental fish culture techniques. Hatchery and fish farm design: commercial fish seed production.	**4**
Coastal and marine aquaculture: Basis of coastal aquaculture; Coastal aquatic zonation and environmental process. Culture techniques and management of seaweed and *Spirulina*, mussels, scallops, mullets, milkfish and sea bass; Cage and pen culture techniques. Marine pearl and oyster culture. Intertidal farming and open water sea ranching. *Artemia* culture in salt pens.	**4**
Fish Nutrition and Fish feed technology	
Nutritional requirements: Qualitative and quantitative requirements of protein, fat and energy for fishes.	**2**
Feed preparation: Formulations, millings and bulk storage.	**2**
Farm made aquafeeds: On-farm feed preparation and feeding strategies for carps and shrimp. Fish meal, Fish silage.	**2**
Non-Conventional Feed Resources (NCFR): Definition, characteristics, availability, nutritive value and constraints to utilization.	**2**
Feeding of cultured fish: Appetite and satiation; factors influencing feeding behavior; feed types; handling and storage of feed; feeding methods. Fish feed Act and Rules.	
Selected Nutrient terms and analytical techniques: Proximate analysis (moisture, ash, crude protein, total lipids); apparent digestibility; Total Digestible Nutrients (TDN); Digestible Dry Matter (DDM); Net energy (NE); Relative feed value (RFV); Non-protein nitrogen (NPN); Nonfiber carbohydrates (NFC); energy utilization, bioavailability.	**5**
Nutritional bioassay: Hematological and histological parameters of a healthy herbivore (*Labeorohita*) and a carnivore (*Clarias batrachus*) fish.	**1**
Nutrient and Environment: Environmental issues on fish feed used for aquatic systems, Environmental issues related to high density fish culture in cages.	**1**
Fish feed Acts and rules: Salient features of Fish Feed and Animal Feed Acts 2010; Fish Feed Rules 2011.	**1**

Course Learning Outcomes

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

- explain the different types of aquaculture systems;
- know different methods and techniques of aquaculture of fish and shell fishes;

- identify conditioning factors of aquaculture and how they can be manipulated;
- describe water refinement mechanisms;
- describe basic culture methodologies, common problems and solutions of commercially important inland and coastal aquaculture species;
- understand the basis of Good Aquaculture Practice (GAP) & environmental impacts of aquaculture; and
- gain knowledge and skills on designing and operating fish hatcheries.

Instructional Strategies and tools

The course will be delivered through lecture and discussion, aided by power point presentations, providing reading material, etc. Classes will be made participatory and interactive through questions and answers, and group work exercises in the classrooms**.** Content/s of the upcoming class will be announced to the students. At the beginning of each class, there will be a brief review session on the previous lecture.

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

Class/lecture types	No. of classes
Lecture and discussion	26
Students' group presentation	1
In-course exam	1
Review class	1
Students' feedback on course contents and delivery	1

Assessment

There will be one in-course examinations, each consisting of 17.5 marks, and 2.5 marks are allocated for class attendance. The students will be frequently asked questions in the classroom to assess their individual performance.

References

FAO. 2011. Cultured Aquatic Species Information Programme. Cyprinus carpio (Linnaeus, 1758). Fisheries and Aquaculture Department. (available at: www.fao.org /fishery/ culturedspecies/ Cyprinus_carpio/en).

Huet, M. 1994. *Textbook of Fish Culture- Breeding and Cultivation of Fish.* 2nd edition. Fishing News Books, Oxford, UK.

Imai, T. 1977. *Aquaculture in Shallow Seas Progress in Shallow Sea Culture.* Amerind Publishing Co., Delhi, India.

Iversen, E.S. 1977. *Farming the Edge of the Sea.* 2nd edition. Fishing News Books Ltd., Oxford, UK.

Jhingran, V.G. 1975. *Fish and Fisheries of India*. Hindustan Publ. Corp., Delhi, India.

Milne, P.H. 1972. *Fish and Shellfish Farming in Coastal Waters.* West Byfleet. Fishing News Books, Oxford, UK.

Course No.	Course Title	No. of Credits	Credit Hours
ZF 505	**Fish Genetics, Biotechnology and Bioinformatics**	**2**	**30**

Introduction to the course

Genetical improvement of culture species and use of genetic engineering techniques for developing high yielding and disease resistant variety have led to the increased/boosting production of fish from minimum land. Application of genetic and molecular tools are being used to address various issues of modern fisheries and aquaculture. Moreover, Bioinformatics has become an integral part of genetic

and molecular studies. Therefore, this course is designed to familiarize the students with modern genetical techniques, biotechnological and bioinformatic applications in fisheries and aquaculture. In particular, the course focuses on the genetic basis for fish selection, breeding, hybridization, chromosomal engineering, ploidy production, cryopreservation and transgenic fish production. This course also covers the uses of genetic markers and DNA amplifications, sequencing and the processing of sequences using various bioinformatic tools.

Specific objectives of the course

- To provide conceptual understanding on the principles and genetical basis for breeding, sex determination, sex reversal, hybridization towards the improvement of culture fish.
- To enhance knowledge and skills of the students on the methods and techniques (e.g. chromosomal engineering, recombinant DNA technology, production of transgenic fish etc.) for genetically improved fish variety for aquaculture and maintenance of captive broodstocks.
- To acquire the basic biotechnological and bioinformatic knowledge to apply their various tools and approaches in fisheries and aquaculture.

Course contents and number of classes by course sub-title

Title/sub-titles of course contents	No. of classes
Fish Genetics and Breeding	**9**
Principles of fish genetics and breeding: natural and artificial breeding, inbreeding and outbreeding; Consequences of inbreeding depression; Genetic selection and breeding of fish; Cross breeding and genetic drift.; Heterosis and breeding.	2
Mutation and Chromosomal aberration.	1
Introduction to fish population genetics: Hardy-Weinberg law and its significance.	2
Sex determination in fish.	1
Genes, genetic codes, genome and genetic markers: Introduction to gene, genetic codes and genomes of fish; Types of molecular markers (allozymes, segments of particular gene, microsatellite and SNPs etc.); Uses of RELP, RAPD, AFLP in aquaculture.	2
Hybridization of fish: Principles, types techniques and applications	1
Biotechnology	**9**
Biotechnology in fisheries: Introduction, biotechnological techniques, role of biotechnology in improving aquaculture production and in fisheries resources conservation.	**1**
Chromosomal engineering: Induction of ploidy (polyploidy), gynogenesis, androgenesis.	**1**
Sex reversal techniques: Concept and techniques; Production of monosex population.	**1**
DNA Processing: DNA extraction, PCR amplification (principle, types, techniques and applications), Electrophoresis (general principles, classification and application) and DNA sequencing (Concept and techniques)	**2**
Recombinant DNA technology and Gene Cloning: General principles, tools, techniques and applications.	**1**
Transgenesis and GMOs: General concepts, methods for the production of transgenic fish, detection of transgenes and application; merits and demerits.	**1**
DNA fingerprinting and barcoding: Concepts and principles, techniques and applications.	**1**
Cryopreservation: General principles, preservation techniques of gametes and embryos and its application	**1**
Bioinformatics	**7**
Introduction to Bioinformatics: Concept and application.	**1**
Bioinformatics tools: Types, and applications in fisheries.	
Sequence Analysis: Introduction to raw sequence formats; handling of various sequence	**2**

formats, sequence conversion and alignments; measuring genetic distance; Phylogenetic tree construction. Sequence Analysis Tools: BLAST (Basic Local Alignment Search Tool), sequence alignment (ClustalW, Muscles), T-Coffee, MEGA, Phylogenetic tree building software. Introduction to Biological databases: Primary and secondary databases and its importance; Primary databases: GenBank; EMBL (European Molecular Biology Laboratory); DDBJ (DNA Data Bank of Japan), PDB (Protein Data Bank), BOLD etc.	2 2

Course Learning Outcomes

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

- State and explain different fish breeding approaches including their consequences.
- State and describe population genetics, chromosomal aberration, genetic or molecular markers.
- Compare and evaluate sex determination, sex reversal and practices of fish hybridization.
- Recognise and assess the scope and practices of different biotechnological tools in fisheries and aquacultures including ploidy induction, gynogenesis, androgenesis.
- Recall and explain DNA technology for the production of transgenic fishes and the DNA barcoding method including DNA processing protocols with PCR and gel electrophoresis etc.
- Describe and evaluate the cryopreservation techniques of gametes and embryos and its application in aquaculture.
- Recognise and apply different tools of bioinformatics for DNA sequence processing and analysis for measuring genetic distance, identification, taxonomy and evolutionary studies of fishes.
- State and evaluate the Genetic or DNA databases for taxonomic, ecological and phylogenetic studies of fishes.

Instructional Strategies

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

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

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

Assessment

There will be one In-course examination, consisting of 17.5 marks and class attendance will carry 2.5 marks. The students will be frequently asked questions in the classroom to assess individual's performance.

References

Colin, E.P. 1993. *Genetics and Fish Breeding.* Chapman and Hall, UK.

Das, P. and Jhingran, A.G. 1976. *Fish Genetics in India.* Today and Tomorrow Publishers, New Delhi.

Douglas, T. 2001. *Genetics for Fish Hatchery Managers.* 2nd edition. Kluwer Academic Publishers, Baton Rouge, USA.

Fingerman, M., Nagabhushanam, R. and Thompson, M.F. 1999. *Recent Advances in Marine Biotechnology* (Vol. 1-3). Oxford and IBH Publishing Co. Ltd., New Delhi.

Lakra, W.S. 2000. *Fish Genetics and Biotechnology*, CIFE, Mumbai, India.

Mackay, Trudy F. C. and Falconer, D. S. 2009. *An introduction to Quantitative Genetics* Pearson, Prentice Hall, New York.
Sinnot, E.W., Dunn, L.C. and Dobzhansky, T. 1989. *Principles of Genetics.* McGraw Hill Publishing Company Ltd., New Delhi.
Trygve Gjedrem, 2005. *Selection and Breeding Programs in Aquaculture*. Springer, Netherlands.

Course No.	Course Title	No. of Credits	Credit Hours
ZF 506	**Fish Diseases, Immunology and Aquatic Health Management**	**2**	**30**

Introduction to the course

Fish disease is a serious problem in modern aquaculture and in most cases, it is an important determinant of profitability in fish and shrimp farming. Recent advances in fish disease control are overwhelming and considered an integral part in fish farm management. The course offers a comprehensive package of learning opportunities with major focuses on stress and immune responses in fish, patho-physiological changes in fish diseases, methods and procedures for diagnosis and treatment of various fish diseases, including microbial, parasitic, environmental, nutritional and genetic diseases of fish. In addition, the course also highlights on prophylaxis, fish immunization/vaccination, fish quarantine and detection of pathogens in fish. The course is designed to enhance students' learning aiming at producing professionals in fish disease management in the country with adequate background knowledge in the subject area.

Specific objectives of the course

- To enhance students' knowledge and insight on various infectious and non-infectious diseases of fish including aetiology, transmission, epidemiology, pathogenicity and control measures.
- To promote critical thinking of students in understanding the conventional and modern disease diagnosis processes, and treatment measures.
- To foster the knowledge of aquatic pollution and their effects on fish health.
- To increase students' knowledge on immune organs, types of immunity and their functional mechanisms in fish.
- To provide students with a comprehensive understanding of stressors or factors related to fish immunity and fish diseases.
- To provide students with an insight of fish health management system addressing prophylactic and metaphylactic measures, fish vaccination, fish quarantine and certification considering public health issues.

Course contents and number of classes by course sub-title

Title/sub-titles of course contents	No. of classes
Fish Diseases	**15**
Concept of fish disease, terminologies related to diseases, environmental change and disease occurrence; Causes and types of diseases: Infectious and non-infection diseases of fishes.	**2**
Parasitic diseases of fish: Causes, aetiology, pathogenicity, and control measures of common protozoan, crustacean, helminth, acanthocephalan diseases of carps, catfishes and shrimps.	3
Microbial diseases of fish: Causes, symptoms, pathology, etiology and control measures for common bacterial, viral and fungal diseases of fishes and shrimps.	3
Non-pathogenic diseases: Causes, symptoms, control measures of environmental. nutritional, genetic diseases and diseases of unknown aetiology of fish diseases.	2
Toxicity of pesticides, fertilizers, heavy metals, antibiotics, and micro and nanoplastics in fish: Sources, extent and their impacts on fish health (Growth, behavior, dysbiosis, enzymatic, hematological, histopathological and genotoxic changes). Prevention and control strategies.	3
Disease diagnosis in fish**:** Conventional laboratory techniques for viral, bacterial and fungal identification; Molecular techniques for pathogen identifications. Clinical and pathological	2

Title/sub-titles of course contents	No. of classes
signs of diseased fish; histopathological techniques; Immunodiagnostic techniques: ELISA, PCR, Western blot etc.	
Immunology	**7**
General concepts and types of immunity in fish; immune systems in fish; Stress responses in fish: Concepts, definitions, types of stressors-physical, biological and chemicals; Stress and immune response, physiological outcomes of stress. Innate immune response: Nonspecific cellular and humoral immunity in fish. Adaptive immune response: Specific Cell mediated and humoral immunity. Antigen and antibody: General concepts of antigens and antibody; type and structure of antibody; antibody production and functions.	1 2 2 2
Aquatic Health Management	**3**
Management of fish diseases: Basis for fish disease management; Role of husbandry in controlling diseases in fish farms; Principles, concepts and different prophylactic and metaphylactic measures (therapeutic treatments, administration of vaccines and immunostimulants). Fish disease and public health issues; fish quarantine and certification. Fish vaccination: Concepts, types and vaccination methods of fish.	**3**

Course Learning Outcomes

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

- Recognise various types of fish diseases and describe their causes, mode of transmission, pathology, and control measures including therapeutic treatments.
- Assess the significance and implications of fish diseases affecting fish health and their production.
- Identify and evaluate the diseases diagnosis procedures in fishes including conventional and molecular techniques.
- Identify and assess the effects of various pollutants on fish health.
- State and describe the various stress factors related to fish diseases,
- Recognise and describe immune organs and immune responses in fish and compare their multi-layered defence mechanisms.
- Select aquatic health management approaches incorporating including prophylactic and metaphylactic measures and immunization, fish quarantine and certification.

Instructional Strategies

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

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

Class/lecture types	No. of classes	Class/lecture types	No. of classes
Lecture and discussion	25	Review class	1
Students' group presentation	2	In-course exam	1
Feedback on In-course exam	1		

Assessment

There will be one In-course examination, consisting of 17.5 marks and another 2.5 marks will be dedicated for students' class attendance. The students will be frequently asked questions in the classrooms to assess individual's performance. A course final examination, consisting of 30 marks will be conducted by the university.

References

Chemg, T.C. 1967. *The biology of animal parasites*. Saunders, London.
Dogiel, V.A.,, Petrusheveski, G.K. Polyanski, Y.I. 1961. *Parasitology of fishes*. Oliver, London.
Roberts, R.J. (ed.). 2001. Fish pathology, 3rd edition. Saunders. London, New York.
Schaperclaus, W. Kulow, H. and Schrecknbachy, K. 1991. *Fish diseases*, Vo. I & II. Oxonian Press (Pvt.) Ltd.
Shuzo, E. (1999). *Infectious diseses of fish*. Oxonian Press (Pvt.) Ltd.
Sinderman, C.J. 1970. Principal diseases of marine fish and shellfishes. Academic Press, London, New Yoerk. Van Duijn,C, 1966. Diseases of fishes, Iliffe Books, London.

Course No.	Course Title	No. of Credits	Credit Hours
ZF 507	**Aquatic Environment, Ecology and Limnology**	**2**	**30**

Introduction to the course

Knowledge on aquatic environment and its biodiversity is a pre-requisite for planning aquaculture development and fisheries management. Wetlands encompass a variety of forms and perform a wide array of functions, contribute enormously to economic productivity and support diverse ranges of biodiversity. The aquatic environment is thus viewed from the purview of the environment-productivity complexity for the sustainable management of its resources. The course is designed to enhance student's understanding on the wetland functions from ecological and productivity perspective for designing resource conservation or production programs. Specifically, the course focuses on the ecological and hydrological characters and dynamics, biodiversity of all ranges, and discusses its relation with fish production. The course also highlights the degradation to wetland services; conservation planning; and conducting environmental impact assessment. The course will allow the students to understand the volumes of community engagement in aquatic resource management.

Specific objectives of the course

- To provide students with a comprehensive conceptual understanding of the hydrodynamics and its relationship with fish production cycles; also the basis for the development of fisheries management strategies.
- To enhance students' knowledge of the aquatic biodiversity and the preparation of the biodiversity conservation action plans.
- To introduces the students to the threats to the wetlands and the preparation of the wetland management plans.

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

Title/sub-titles of course contents	No. of classes
Aquatic Environment	**13**
Classification of wetlands; characteristics, ecological and productivity functions, and importance of wetlands.	**2**
Water cycles and hydrodynamic patterns in Bangladesh; flood pulse and formation of fish production systems in aquatic environment and its relevance with life cycles of fish; adaptation strategies of fish with highly oscillating hydrodynamics and flood cycles.	**3**
Degradation to aquatic environment: natural causes; FCD/I; wetland conversion and reclamation, habitat fragmentation and its impacts on aquatic biodiversity; water pollution-pollutant types, sources and impacts on different life stages.	**3**
Water quality and its ranges, spatial and temporal fluctuations; and interrelationships between the major environmental factors affecting fish community. Limiting/biotic	**3**

factors and biological cycle in ponds. Environmental Impact Assessment (EIA) and Environmental Management Plan (EMP); strategy for protection of aquatic resources.	**2**
Fish Ecology	**7**
Aquatic organisms and global ecology: Ecology of freshwater column, coastal ecosystems, deep-water marine zones. The role of the oceans in global warming. Role of gases in sea level rise. Effects of climate change in world ocean and freshwaters.	**2**
Aquatic communities and Fish assemblages: Competition, predation and disturbances, coexistence and succession; effects of predation in communities, disturbances and patchy dynamic concepts. General patterns of species richness; species diversity and diversity indices.	**2**
Life-history strategy: Cost of reproduction and the consequences. Bioenergetics of life history patterns.	**1**
Impacts of man's activities on ecosystem: Harvesting natural product, ocean dumping and disposal, accidental discharge, ballast discharge and its ecological significance. Eutrophication: causes, process, impact and mitigation. Harmful algal blooms and bioactive marine products. Invasive alien fish and its impact on ecosystem. Freshwater, estuarine, marine fisheries ecosystems in Bangladesh.	**2**
Limnology	**5**
Water as a substance: Lentic and lotic water system. Hydrological cycle, global water balance.	**1**
Abiotic limnology: Physico-chemical parameters of freshwater system and their interrelationships.	**1**
Biotic limnology: Plankton: Phytoplankton, zooplankton and benthos and their types. Water quality criteria: Limnological basis for fish culture; limnological effects of fertilization and liming.	**2**
Water budgeting: Concepts. Water budgets for pond and polders; estimation methods of carrying capacity of water bodies; models and its interpretation. Eutrophication: Process and types, problems and remedial measures.	**2**

Course Learning Outcomes

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

- explain the hydrodynamic patterns of wetlands and its relation to fish production in Bangladesh;
- know the causes of wetland degradation and describe its impacts on biodiversity and wetland productivity;
- gain knowledge and skills for conducting EIA exercise;
- gain knowledge and skills for the preparation aquatic biodiversity conservation action plan;
- know about the acts, rules and policies of the country and international conventions and treaties relevant to biodiversity conservation and wetland protection.

Instructional Strategies

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

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

Class/lecture types	No. of classes	Class/lecture types	No. of classes
Lecture and discussion	25	Review class	1
Students' group presentation	2	In-course exam	1
Feedback on In-course exam	1		

Assessment

There will be one In-course examination, consisting of 17.5 marks. Another 2.5 marks is reserved for class attendance. The students will be frequently asked questions in the classrooms to assess individual's performance. A course final examination, consisting of 30 marks will be conducted by the university.

References

Barnes, R.S.K. and Mann, K.H. 1991. *Fundamentals of Aquatic Ecology.* Blackwell Scientific Publication, UK.

Charles, R.G., Michio, K. and Richard, D.R. 2012.*Climatic Change and Global Warming of Inland Waters*: *Impacts and Mitigation for Ecosystems and Societies.* Wiley-Blackwell, USA.

Payne, A.I. 1986. *The ecology of tropical lakes and rivers*. John Wiley & Sons., USA.

Ruttner, F.1984. *Fundamentals of Limnology.* University of Toronto Press, Canada.

Wetzel, R. 2001. *Limnology, Lake and River Ecosystem.* Academic Press, USA.

Wootton, R.J. 1999. *Ecology of Teleost Fishes.* Blackwell Scientific Publication, UK.

Course No.	Course Title	No. of Credits	Credit Hours
ZF 508	**Marine Biology and Oceanography**	**2**	**30**

Introduction to the course

The course Marine Biology and Oceanography provides an in-depth knowledge of marine ecosystems, biodiversity, and the physical, chemical, geological, and biological processes governing the ocean. Students will gain a comprehensive understanding of marine food webs, species interactions, and ecological dynamics in diverse marine habitats, including coral reefs, coastal zones, the open ocean, and the deep sea. The course also covers fundamental principles of oceanography, emphasizing ocean circulation, seawater chemistry, plate tectonics, and marine sediments. Additionally, this course addresses human-ocean interactions, exploring sustainable ocean resource management, marine pollution, and the role of the ocean in the global climate system. Through case studies and current research, students will analyze critical challenges such as ocean acidification, climate change, and marine renewable energy, fostering a holistic understanding of ocean science and conservation. This course provides a multidisciplinary approach to understanding marine systems, equipping students with the knowledge and skills necessary for research, conservation, and sustainable management of marine environments.

Specific objectives of the course

- To introduce students to marine ecosystems and their classification, including the physical and biological characteristics of oceans, seas, estuaries, coral reefs, and coastal habitats.
- To explore the principles of marine ecology, including food webs, species interactions, and biodiversity hotspots.
- To analyze the biological adaptations of marine organisms, including plankton, marine vertebrates, and invertebrates.
- To understand the fundamental concepts of oceanography, including physical, chemical,

geological, and biological aspects.

- To investigate human-ocean interactions, including fisheries management, marine pollution, and the blue economy.
- To equip students with the ability to critically assess conservation strategies and policy measures for sustainable ocean management.

Course contents and number of classes by course sub-title

Title/sub-titles of course contents	No. of classes
Marine Biology	**9**
Introduction to Marine Biology: Overview of Marine Ecosystems- Oceans, seas, and their types; History of Marine Biology- Key figures and milestones in marine science; Marine Environment and Habitat Types- Coastal zones, open ocean, deep-sea, estuaries, and coral reefs.	**2**
Marine Ecology and Biodiversity: Marine Food Webs; Species Interactions; Biodiversity Hotspots; Marine Invasions	**2**
Marine Organisms and Adaptations: Plankton- Phytoplankton, zooplankton, and their ecological roles; Fish and Marine Vertebrates-Adaptations in marine mammals, reptiles, and birds; Marine Invertebrates- Mollusks, Arthropods, Echinoderms, and Cnidarians.	**3**
Coral Reefs and Coastal Ecosystems: Coral Reef Ecology; Threats to Coral Reefs, Mangroves, Salt Marshes, and Seagrasses- Role in coastal protection, carbon sequestration, and biodiversity support.	**2**
Oceanography	**16**
Introduction to Oceanography and related sciences: Overview of ocean science disciplines (physical, chemical, biological, and geological oceanography). Key historical features and importance of ocean exploration.	**1**
Physical Oceanography: Ocean circulation. Waves and tides.	**2**
Chemical Oceanography: Composition and chemistry of seawater. Properties of seawater and its relation to temperature, salinity, density. Ocean acidification and its ecological impacts.	**2**
Geological Oceanography: Plate tectonics and the ocean basins. Marine sediments (classification, sources, and distribution).	**2**
Biological Oceanography: Marine plankton, nekton and benthos. Ecological zonation of the ocean floor.	**2**
Coastal Oceanography: Estuaries, deltas, and lagoons. Mixing process in the coastal and marine water.	**2**
Human-Ocean Interactions: Introduction to blue economy. Sustainable ocean resource management (fisheries, minerals, renewable energy). Marine pollution (plastic, oil spills, heavy metals).	**2**
Current Issues and Emerging Topics: Ocean Acidification- Causes, impacts on marine organisms, and mitigation strategies; Climate Change and the Marine Environment- Impact on biodiversity, distribution of species, and ecosystem services, Role of the ocean in the global climate system (El Niño/La Niña, heat transport), Impacts of climate change on oceans (sea level rise, coral bleaching); Marine Renewable Energy- Tidal, wave, and offshore wind energy and their effects on marine life; Ocean decades.	**3**

Course Learning Outcomes

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

- Demonstrate a foundational understanding of marine ecosystems and their significance to global biodiversity.
- Identify and describe key historical figures and milestones in marine science and ocean exploration.
- Explain marine ecological processes, including food webs, species interactions, and the role of biodiversity hotspots.
- Differentiate between various marine organisms and their physiological and behavioral adaptations to oceanic environments.
- Apply principles of oceanography to analyze physical, chemical, geological, and biological ocean processes.
- Assess human-induced impacts on marine ecosystems, including pollution, overfishing, and climate change.
- Evaluate conservation strategies and policy frameworks for sustainable marine resource management.
- Communicate scientific knowledge on marine biology and oceanography effectively through reports, discussions, and presentations.

Instructional Strategies

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

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

Class/lecture types	No. of classes	Class/lecture types	No. of classes
Lectures	26	Review class	1
Students' group presentation	1	In-course exam	1
Feedback on In-course exam `	1		

Assessment

There will be one In-course examination and a few home works on some selected course items. The In-course exam and class attendance will carry 17.5 marks and 2.5 marks, respectively. A course final examination, consisting of 30 marks will be conducted by the university.

References

Thurman, V.H. and Trujillo, A.P. 2004. Introductory Oceanography. 10th edit. Pearson Prentice Hall, NJ, USA.

Trujillo, A.P. and Thurman, H.V., 2017. Essentials of oceanography 12th edition.

Castro, P. and Huber, M., 2015. *Marine biology*. McGraw-Hill Higher Education.

Levinton, J.S., 2001. Marine biology: function, biodiversity, ecology. Oxford University Press.

Karleskint, G., 2006. Introduction to marine biology. Cengage Learning.

Knauss, J.A. and Garfield, N., 2016. *Introduction to physical oceanography*. Waveland Press.

Lalli, C. and Parsons, T.R., 1997. *Biological oceanography: an introduction*. Elsevier.

Course No.	Course Title	No. of Credits	Credit Hours
ZF 509	**Post-harvest Technology and Quality Assurance**	**2**	**30**

Introduction to the course

This course provides essential knowledge and practical skills in fish post-harvest handling and processing to ensure quality, safety, and value addition in fisheries products. It covers harvesting methods, grading, packaging, storage, and transportation for both freshwater and marine fish. Students will explore key post-harvest technologies, including freezing, chilling, drying, smoking, salting, fermenting, marinating, pickling, and canning, with a focus on principles, processes, and quality control. The course also addresses the utilization of fish by-products, such as fish meal, oils, silage, hydrolysates, and chitin. A significant component emphasizes quality control and assurance, covering quality assessment methods, microbial analysis, HACCP principles, BMP, and relevant quality certifications. It also familiarizes students with key fishery laws and regulations, including the Fish and Fish Products (Inspection and Quality Control) Ordinance and its updates. This course equips students for careers in fisheries processing, quality management, and value-added fishery product development.

Specific objectives of the course

- To understand post-harvest fish handling technologies and their importance in reducing losses.
- To analyze various preservation techniques (freezing, drying, curing, fermentation, canning) for maintaining fish quality.
- To evaluate the utilization of fish by-products for value addition.
- To apply quality control techniques and standards in fish and fishery products.
- To understand the legal frameworks and quality certifications associated with fishery products.

Course contents and number of classes by course sub-title

Title/sub-titles of course contents	No. of classes
Post-harvest Technologies	**16**
Fish harvesting: Methods of harvesting freshwater and marine fishes; grading, packaging, storage, transportation of fish for consumers.	**2**
Post-harvest technologies: Principles and methods of freezing and chilling, changes during freezing fish; quality control during freezing and chilling.	**4**
Principles and techniques of fish drying, smoke and salt curing; fermentation, marinating and pickling of fish.	**3**
Introduction to fish canning, principles of thermal processing, changes during canning, problems related to fish canning.	**3**
Fishery products: Utilization of fishery products and by products - fish meal, fish body and liver oils, fish silage, fish hydrolysates and miscellaneous by products - fish maws and isinglass, pearl essence and chitin processing from shrimp and crab shell.	**4**
Quality Assurance	**9**
Quality determination and standard: Methods for determining quality of raw materials and fishery products. Factors affecting the quality of raw materials and finished products. Estimation of total viable bacteria in fish and fishery products. Determination of coliform and faecal coliforms in fish or fishery products.	**5**
Quality assurance: Introduction to HACCP, its principles and applications. Stages for	

developing a HACCP Plan. Best Manufacturing Practices (BMP). Quality Certifications. Fisheries products laws and rules: Salient features of Fish and Fish Products (Inspection and Quality control) Ordinance, 1983 and its updates (1997, 2008).	**4**

Course Learning Outcomes

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

- Explain methods of harvesting, grading, packaging, storage, and transportation of freshwater and marine fish.
- Describe principles and methods of freezing, chilling, drying, curing, fermentation, marinating, pickling, canning.
- Evaluate the changes and quality control issues in post-harvest handling and processing.
- Identify and describe fish by-products and their processing techniques.
- Demonstrate understanding of quality determination methods (microbiological and chemical) in fish products.
- Apply HACCP principles, BMP, and interpret fisheries product laws and regulations in post-harvest processing.

Instructional Strategies

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

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

Class/lecture types	No. of classes	Class/lecture types	No. of classes
Lecture and discussion	25	Review class	1
Students' group presentation	2	In-course exam	1
Feedback on In-course exam	1		

Assessment

There will be one In-course examination, consisting of 17.5 marks. Class attendance will carry 2.5 marks. A course final examination will be of 30 marks and be conducted by the university. The students will be frequently asked questions in the classrooms to assess individual's performance.

References

Alam, A.K.M.N. 2014. *Post harvest Fishery Losses and Mitigation Measures.* Department of Fish Technology, Faculty of Fisheries, Bangladesh Agricultural University, Mymensingh, Bangladesh.

Balachandran, K.K. 2001. *Post harvest technology of fish and fish products.* Daya Publishing House, New Delhi.

Clucas, I.J. and Ward, A.R. 1996. *Post Harvest Fisheries Development: A Guide to Handling. Preservation, Processing and Quality.* Natural Resources Institute, Overseas Development Administration, UK.

Connell, J.J. 1980/1990. *Control of Fish Quality.* 2nd Edition. Fishing News Books Ltd., Farnham, Surrey, England.

Cutting, C.L. 1999. *Fish Processing and Preservation.* Agro-botanical Publishers, India.

Govindan, T. K. 1985. *Fish Processing Technology.* Oxford & IBH Publ. Co. Pvt. Ltd., New Delhi.

Regenstein, J.M. and Regenstein, C.E. 1997. *Introduction to fish Technology.* 1st edition, CBS Publishers and Distributors. India.

Course No.	Course Title	No. of Credits	Credit Hours
ZF 510	**Fisheries Extension, Marketing and Socio-economics**	**2**	**30**

Introduction to the course

This course equips students with essential knowledge and skills in extension services, sustainable livelihoods, fish marketing, and fisheries economics, with a focus on Bangladesh's fisheries sector. It emphasizes the role of extension services in empowering fishing communities through knowledge transfer and capacity building. The Sustainable Livelihood Approach (SLA) provides a framework to enhance livelihood assets, reduce vulnerability, and promote resilience. Understanding fish marketing channels and market-led approaches, such as eco-label certifications, helps improve market access and encourage sustainable fishing practices. The course also covers fundamental economic concepts like scarcity, demand and supply, decision-making, and production, highlighting their relevance to fisheries management and aquaculture development. Overall, the course prepares students to design sustainable, inclusive, and economically viable strategies for the growth and sustainability of Bangladesh's fisheries sector.

Specific objectives of the course

- To explain the concepts, principles, and practices of fisheries extension and sustainable livelihood approaches (SLA).
- To analyze fish marketing systems, channels, and market-led approaches for sustainable fisheries.
- To understand fundamental economic concepts relevant to fisheries and aquaculture.
- To evaluate socio-economic factors influencing fisheries management and policy decision-making in Bangladesh.

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

Title/sub-titles of course contents	No. of classes
Extension Services	**5**
Concept of Extension services: for whom, how, and why? Sustainable livelihood Approach (SLA): Concept and approach; Framework, livelihood assets and strategies in SLA; Livelihood security and vulnerability context in SLA.	**5**
Fish Marketing	**6**
Market channels: Introduction and approach to assess fish marketing and its channels; Market channels for fish and fisheries products in Bangladesh; Case study: Shrimp/Hilsa/mud crab. Market-led approaches for sustainable fisheries: Eco-label certification schemes for seafood; Criteria to achieve certification for eco-label; Case study: Marine steward Council/Sea Choice/Ocean Wise.	**3** **3**
Fisheries Economics	**14**
Economics and decision making: Basic concept of scarcity and economics; Decision making (at individual, societal, and national level) in Economics; Case study: Decision making in the context of hilsa fisheries and its management in Bangladesh. Demand and supply of fish:–Concept of supply and demand; Elasticity of demand and supply; Implications of supply and demand in markets and fisheries sector. Production: Purpose of production and its function; Short-run and long-run production inputs factors, profit maximization; Government's role in aquaculture in Bangladesh; Growth of aquaculture and its role in the economic development of Bangladesh.	**14**

Course Learning Outcomes

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

- Explain the role, purpose, and processes of fisheries extension services and the sustainable livelihood approach (SLA).
- Describe the livelihood assets, strategies, security, and vulnerability context under SLA.
- Analyze fish marketing systems, market channels in Bangladesh, and case studies (Shrimp/Hilsa/Mud crab).
- Evaluate eco-label certification schemes and their criteria for sustainable seafood marketing (Marine Steward Council, etc.).
- Apply economic principles (scarcity, demand and supply, elasticity, production functions) to fisheries decision-making and management.
- Assess the role of aquaculture and fisheries in economic development and poverty alleviation in Bangladesh.

Instructional Strategies

The course will be delivered through lecture and discussion, aided by power point presentations, models, video clips, etc. Classes will be made participatory and interactive through questions and answers, and group work exercises in the classrooms. Reading materials will be supplied to students prior to each lecture so that students could participate in the discussion.

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

Class/lecture types	No. of classes	Class/lecture types	No. of classes
Lecture and discussion	25	Review class	1
Students' group presentation	2	In-course exam	1
Feedback on In-course exam	1		

Assessment

There will be one In-course examination, consisting of 17.5 marks and 2.5 marks will be allocated for class attendance. A course final examination will be conducted by the university and will carry 30 marks.

References

Cambell, J. and Salagrama, V. 2000. *New Approaches to Participation in Fisheries Research: A Discussion Document*. FAO and SIFAR.

CRS. 2002. *RRA and PRA manual*. Catholic Relief Support, USA.

IIRR. 2003. *Participatory Methods in Community-based Coastal Resource Management*. IIRR, The Philippines.

Kleih, U., Greenhalgh, P., & Oudwater, N. 2003. *A guide to the analysis of fish marketing systems using a combination of sub-sector analysis and the sustainable livelihoods approach*.

Mankiw, N. G. (2014). *Principles of macroeconomics*. Cengage Learning.

Phillip, T. 1996. *Rapid Rural Appraisal and Participatory Rural Appraisal and Aquaculture*. FAO Tech Paper 358. FAO, Rome.

Sen, A. 1986. *Poverty and Famines, an essay on entitlement and deprivation*. ELBS, Oxford University Press, UK.

Course No.	Course Title	No. of Credits	Credit Hours
ZF 511	Practical in Fisheries (Gr-A)	6	90

Introduction to the course

This course is designed to provide students with comprehensive hands-on experience and practical knowledge essential for careers in fisheries science, aquaculture, and aquatic resource management. Bangladesh, with its vast inland and marine water resources, relies heavily on fisheries for food security, livelihoods, and economic development. Therefore, developing technical expertise in the identification, management, and conservation of fishery resources is crucial for sustainable fisheries management and ensuring food security. This course bridges theoretical knowledge with real-world applications by training students in key areas such as taxonomy, age and growth analysis, feeding biology, reproduction, fish population dynamics, and fish health management. It also exposes students to the latest tools and techniques used in fish farming, hatchery operations, feed production, and fish processing industries through field visits and laboratory-based exercises. Furthermore, the course fosters analytical and research skills through project-based assignments, encouraging students to assess water quality, study aquatic biodiversity, conduct catch assessments, and perform proximate analyses. By integrating laboratory exercises, field observations, and research projects, students develop a holistic understanding of fisheries science that supports sustainable practices and innovations in the sector. This practical-oriented course is critical for equipping graduates with the necessary skills to meet the growing challenges of fisheries management, aquaculture development, and aquatic environmental conservation in Bangladesh and beyond.

Specific objectives of the course

- To develop practical skills in fish taxonomy, age determination, feeding habits, reproduction, health, fish parasite identification, fish health inspection and population dynamics.
- To provide hands-on exposure to fish farming, hatchery management, feed production, and fish processing.
- To conduct minor scientific investigations and project-based assignments related to fisheries.

Course contents and number of classes by course sub-title

Title/sub-title of course content	No. of classes
A. PRACTICAL CLASS BASED WORKS	**16**
I. Taxonomic study of finfish & shellfish: Commercially important finfishes (Osteichthyes and Chondrichthyes) and shellfishes (Shrimp, Crabs, Snails, Mussels and Cephalopods) of Bangladesh. **II. Determination of age of fish:** Different techniques (scale, otolith and vertebrae) for age determination of fishes. **III. Analysis of food and feeding habits of fish:** Relative gut length (RGL), Fullness of index (FI), Gut Index (Gastro Somatic Index); Comparative study of digestive system of fishes with different food and feeding habits; and analysis of gut contents. **IV. Reproduction and fecundity of fish:** Observing maturation stages of male and female fish; Observation on reproductive organs; Estimation of fecundity and GSI (Gonado Somatic Index). **V. Study of plankton and benthos:** Study of plankton and benthos community and their types; Collection and identification of planktons and benthos from an aquatic ecosystem; Analysis of planktonic and benthic composition. **VI. Induced breeding technique:** Dissection and display of reproductive system (male and female) of fish; Dissection and display of pituitary gland and preparation of pituitary gland extracts and its application in fish breeding. **VII. Water Quality Analysis:** Equipment used in water analysis; Water sampling and water quality parameters; Measurements of temperature, pH,	

conductivity, salinity, transparency, turbidity and solids; Analyses of dissolved oxygen, alkalinity and hardness, phosphorus, nitrogen; chlorophyll a; Application of fertilizers and pond liming. **VIII. Fish population dynamics & modelling:** Length-weight relationship and condition factors. Fish population estimation parameters and estimation methods (using LFDA and FiSAT). **IX. Fish health inspection and diseases diagnosis:** Techniques for disease diagnosis; Taxonomy and identification of fish parasites; Stress related study of fish and shellfish: counting of blood cells, estimation of glucose; histology of kidney, gills and liver and guts. **X. Fish nutrition analysis:** Practical Formulation and preparation of a balanced fish feed; Proximate analysis- moisture, crude protein, crude lipid, ash, acid insoluble ash content of feed; Estimation of crude fibre, nitrogen free extract, calcium and phosphorus content of feed; Estimation of protein and lipid quality; Determination of gross energy content of feed and feed ingredients; Determination of the digestibility of feed using markers; Estimation of FCR from feeding trials and preparation of feeding table; Estimation of growth parameters from feeding trials;	
B. EXPOSURE VISITS (MAXIMUM TWO VISITS):	**5**
Fish farm; Fish hatchery; Fish feed industry; Fish and Shrimp processing industry; and Specialized research organizations or laboratories.	
C. ASSIGNMENT PROJECT	**6**
Any fisheries related short-term project to be assigned by course teachers.	

Course Learning Outcomes

- Identify commercially important finfish and shellfish species of Bangladesh using taxonomic characteristics.
- Demonstrate techniques for determining the age of fish using scale, otolith, and vertebrae methods.
- Analyze food and feeding habits of fishes through gut content analysis and comparative digestive system studies.
- Examine reproductive organs, maturation stages, and estimate fecundity and GSI in fishes.
- Apply fish population dynamics models including length-weight relationships and condition factor assessments using LFDA and FiSAT software.
- Diagnose fish diseases, identify parasites, and conduct stress-related physiological studies (blood cells, glucose, histology).
- Evaluate practical fish farming operations, hatchery techniques, fish feed production, and fish/shrimp processing industry practices during field visits.
- Conduct independent project-based research on water quality, plankton/benthos analysis, induced breeding, proximate feed analysis, catch assessment, growth performance, or microplastic pollution.

Instructional Strategies

The course will be delivered by practical demonstrations in the laboratory, exposure visits to field and laboratory for hands-on training and experiences and also offering an assignment project to build a research foundation for non-thesis students. A number of teachers will demonstrate and guide the individual students in the practical classes and field visits. The practical classes will cover interactive and participatory lectures with PowerPoint and audiovisual systems, group works among students and hands on demonstrations by the teachers. Necessary equipment and logistics will be provided in the laboratory for use in the practical classes. Reference books will also available from the departmental seminar library.

Distribution of class lectures: Total number of classes- 33

Class/ lecture type	No. of classes
Lectures and Practical exercise	16
Exposure visit	5
In-course exam	2
Assignment project	6
Feedback on in-course exam, and students' feedback on course contents and delivery	1

Assessment

Assessment of practical course will be based on class attendance (5%), in-course assessment (35%) and a final examination (60%). In-course assessment will be done conducting in-course examinations and evaluating an assignment project. There will be at least two in-course examinations for the practical course. Assignment project will be allocated for each student individually and the project report will be evaluated by all course teachers of the branch. Other assessment components viz. report of field/laboratory/research organizations visits and Lab/Notebook will be evaluated with final examination.

References

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

Jhingran, V.G. 1983. *Fish and Fisheries of India*. Hindustan Publishing Corporation, Delhi, India

Jhingran, V.G. and Pullin, R.S.V. 1988. *A Hatchery Mannal for the Common, Chinese and Indian Major Carps*. ADB and ICLARM.

Nikerson, J.T. and Sinskey, A.J. 1977. *Microbiology of Foods and Food Processing*. 3rd edition. Elsevier, New York, Oxford, Amsterdam.

Rahman, A.K.A. 1989. *Freshwater Fishes of Bangladesh*. The Zoological Society of Bangladesh, Dhaka.

Siddiqui, K.U., Islam, M.A., Kabir, S.M.H., Ahmed, M., Ahmed, A.T.A., Rahman, A.K.A., Haque, E.U., Ahmed, Z.U., Begum, Z.N.T., Hassan, M.A., Khondker, M. and Rahman, M.M. 2007. *Encyclopedia of Flora and Fauna of Bangladesh*, Vol. 17, 23 and 24. Molluscs, Freshwater Fishes and Marine Fishes. Asiatic Society of Bangladesh, Dhaka.

Shafi, M. and Quddus, M.M.A. 1982. *Bangladesher Matsya Sampad* (in Bangla). Bangla Academy, Dhaka.

Welch, P.S. 1952. *Limnology*. McGraw-Hill Book Co., New York.

Wetzel, R.G. 1983. *Limnology*. CBS College Publishing. The Dryden Press, California.

Course No.	Course Title	No. of Credits	Credit Hours
ZF 512	**Thesis in Fisheries (Gr-B)**	**6**	**90**

Introduction to the course

Thesis is a research-based course that demonstrates a student's mastery of a specific field of study and their ability to conduct research project independently. This course is assigned to the thesis or research students who intends to complete the MS programme in Zoology with specialization in Fisheries. This course enables students to apply theoretical knowledge to address practical problems by conducting research works under the supervision of a faculty member of the branch. Students gain deeper insight into a specific aspect of fish biology, fisheries, aquaculture, aquatic biodiversity, fish

molecular biology, aquatic toxicology and so on. The course also fosters scientific writing and presentation skills, analytical thinking preparing students for future academic and research careers.

Specific objectives of the course

- To provide a research foundation for students assigning an independent research project related to fish biology, fisheries, aquaculture or any other project related to fisheries.
- To enhance analytical and critical thinking abilities through experimental design, data collection, interpretation, and problem-solving.
- To strengthen scientific communication by training students in writing research reports, presenting findings, and defending their work effectively.
- To enhance career prospects of the students who are interested in research-oriented careers or further higher academic degrees and professional work.

Course contents

Students have to choose a specific topic related to fisheries for conducting an individual research project for this thesis course. In this case, students may consult with his/her supervisor to select their research project concerning any basic or applied aspects of fish biology, aquaculture and fisheries, fish biodiversity, ecology and systematics, marine biology, fish diseases and nutrition, aquatic resources, fisheries management and economics, fish genetics, molecular biology and biotechnology. In addition to these, students have complete freedom to fix any topic related to fisheries branch. This course is divided into two parts firstly writing a thesis based on individual research project and secondly presentation of the thesis. Students must write their thesis following a standard MS thesis structure including a title, abstract, introduction, methodology, results, discussion, conclusion, and references with optional appendices. The front matters the thesis will includes title page, abstract, table of contents**,** dedication, declaration, and acknowledgements. In the main body, the introduction section will include background, review of existing research**,** research gaps, problem statement, rationale of the study, research hypothesis and questions, aims and objective of the research project. Likewise other sections will contain relevant components of a typical MS thesis. The maximum word limit for theses is 30,000 words that will include all text, figures, tables, and photographs, excluding references and appendices. No formal classes will be allocated for the thesis course, however pertinent knowledge and information shall be provided by the supervisors through lectures, meeting and group discussion etc.

Course Learning Outcomes

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

- Identify and describe different components and aspects of a research project and a thesis.
- Describe and apply laboratory and field techniques, statistical tools for data analysis, and interpretation related to specific research project.
- Employ critical thinking and problem-solving skills to address research questions and challenges.
- Review scientific literature, criticize research limitations/gaps and compose the overall outputs and outcomes of a research project.
- Reproduce scientific papers/publication and demonstrate presentation skills for communicating with scientific world.
- Design and conduct an independent research project in a specific field of fisheries and other subjects.

Instructional Strategies

The thesis course solely concerns the conducting a research project by every student individually under the direct supervision of a faculty member. Thesis work mainly includes selection of an individual research project, designing experimental/lab/field works, relevant data collection and analysis, and subsequently writing a thesis and its defense or presentation. Respective supervisor will supervise all of those steps involved in thesis works sharing knowledge, information and experiences

through lectures, weekly/monthly meeting, training programmes or workshops. Each thesis student will attend the monthly scientific seminar to organized by the department.

Assessment
This 6-credit course carries 150 marks of which 100 marks are allocated for thesis writing and 50 marks for thesis presentation or defense. The evaluation of thesis will be performed by two external members and thesis presentation will be assessed by examination committee.

Course No.	Course Title	No. of Credits	Credit Hours
ZF 513	**Review article writing and Seminar presentation**	**2**	**30**

Introduction to the course
This course is basically designed aiming to develop student's skills in writing comprehensive review articles after a critical evaluation of the results of existing studies on a particular topic or aspect. This course also includes a seminar presentation of review works for improving presentation skills encouraging students to confidently communicate to scientific world with current research findings, potential research areas, research gaps and new conclusions from the existing data. Therefore, this course will enhance students' abilities in scientific literature review, critical analysis, and writing different review papers on various aspects of fishery sciences.

Specific objectives to the course
- To provide a basic research knowledge on existing studies enabling students to critically review and synthesize scientific literature.
- To enhance skills in scientific writing in particular for structured and comprehensive scientific review articles.
- To enable students to search, review, and evaluate scientific information from various published sources.
- To prepare students for academic writing, public speaking, and professional communication.

Contents of the course
Students have to select a specific topic of review project related to fisheries for writing a review paper of any types such as narrative review, systematic review, and meta-analyses. In this case, students may consult with his/her supervisor to select their review project concerning published aspects of fish biology, aquaculture and fisheries, fish biodiversity, ecology and systematics, marine biology, fish diseases and nutrition, aquatic resources, fisheries management and economics, fish genetics, molecular biology and biotechnology. In addition to these, students have complete freedom to fix any topic related to fisheries branch. This course is divided into two parts firstly writing a review paper and secondly presentation of the reviewed article. Students must write their review paper following a standard structure including a title, abstract with keywords, introduction, methodology (if any), results, discussion, conclusion, and references. The maximum word limit for review article is 4,000 words that will include all text, figures, tables, and photographs, excluding references. No formal classes will be allocated for this course, however pertinent knowledge and information shall be provided by the branch teachers through special lectures, monthly group/lab meeting and group discussion etc.

Course Learning Outcomes
After completion of the course, the students will be able to-
- Recognise and explain the current state of knowledge on a particular issue or topic.
- Identify and describe knowledge gaps in existing studies for potential future research.
- Recognise and describe the current methodologies and research techniques.

- Demonstrate current research findings with critical analysis and interpretation of various issues of fishery sciences.

Instructional Strategies
The course will involve interactive lab/group meetings, discussions, and individual or group mentoring sessions to provide instructions for searching published articles, reviewing existing literature, and writing a review paper. All faculty members of the branch will guide the students in every stage of review project in particular to identify relevant as well as credible studies in the multiple databases or search engines.

Assessment
This 2-credit course carries 50 marks, where 25 marks will be allocated for review article and the remaining 25 marks will be for seminar presentation. Both the review article and seminar presentation will be assessed by the examination committee.

Course No.	Course title	No of Credits	Credit hours
ZF 514	**Viva voce**	**2 credits**	**30**

Introduction to the course
Viva voce or oral examination is an integral component of the MS programme in Zoology. This is a mandatory course for the students of both thesis and non-thesis group of all branches by which students demonstrate their secured knowledge, expertise, and understanding of theoretical, practical and thesis courses. It's also an opportunity for the examiners to evaluate the academic abilities of students, and ultimately for determining whether they have met the requirements of MS degree.

Specific objectives of the course
- To prepare students for presenting their in-depth knowledge of the broader field of study programme.
- To improve the ability of students to communicate to scientific world with secured skills and expertise
- To assess student's understanding of the programme.

Contents of the course
Course contents of the viva voce include all topics of theory, practical and thesis courses of the respective MS programme. Examination Committee has complete freedom to ask any question related to respective syllabus of the programme. No formal classes will be allocated for this course, however pertinent knowledge and information shall be provided by the course teachers through their routine lectures of theory courses, monthly group/lab meeting and group discussion etc.

Course Learning Outcomes
Upon completion of this course the students will be able to
- Demonstrate how their acquired knowledge, expertise and skills from the courses contribute to their field of study.
- Recognise and explain the current state of knowledge on a particular issue or topic of the programme.
- Demonstrate and assess their academic feats with critical analysis and interpretation of various aspects of the courses.

Instructional Strategies

The course will follow interactive lectures of all theoretical and practical courses and thesis works of the MS programme. Besides, regular lab/group meetings, discussions, and individual or group

mentoring sessions will also provide instructions for viva voce. All faculty members of the branch will instruct the students in this regard.

Assessment

This is a two-credit course that carries 50 marks. The respective Examination Committee including external members will assess overall student's knowledge asking questions from the contents of respective syllabus of the MS programme and student will answer questions accordingly.

MS in Zoology (Entomology)

Course No.	Course Title	No. of Credits	Credit Hours
ZE 521	**Insect Systematics and Nomenclature**	**2**	**30**

Introduction to the course

Insects are the most diverse group of animals on the planet with long history of evolution. Knowing the diversity of animals offers a fascinating challenge. The purpose of this course is to familiarize students with different orders and families of insects and enable them to study and identify the insects. The course specifically focuses on the methods and techniques of taxonomic study of insects, collection and preservation and identification of insects, rule governing the naming the species. The course will also highlight on the phylogenetic relationship of various groups of insects.

Specific objectives of the course

- To introduce the students with the detailed classification schemes of insects and familiarize them with insect orders and families with distinguishing characters.
  To enable the students to carry out taxonomic study of insects following the methods and identify insects.
- To introduce students with fossil insects, their depositories, time period, and phylogenetic relationship;
- Provide knowledge to interpret the rules of insect nomenclature.

Course contents and number of classes by course sub-title

Title/sub-titles of course contents	No. of classes
Insect systematics	**25**
Introduction to insect systematics: Introduction, definition of some terms used in insect systematics.	**1**
Fossil insects: Paleozoic and Mesozoic insects; localities of these fossil insects; phylogenetic development of insects (orders); evolution of insects.	**4**
An overview of the orders of insects: Diagnostic characters of all insect orders; important families of insect orders.	**4**
Insect collection, preservation, morphological and molecular identification, cataloguing, description, and publications; reference works in insect taxonomy.	**6**
Insect nomenclature	**5**
Interpretation of the rules of nomenclature in terms of the following aspects: Stability, priority, name changing, name given to hybrids, synonymy, date of publication, validity, formation of names, infra-specific names, authorship, homonymy, genus group names, the type methods, and ICZN.	**1** **2** **2**

Course Learning Outcomes

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

- describe the group of fossil insects existing in prehistoric localities and explain the phylogenetic relationship of insects;
- know the procedures and technique of taxonomic study;
- identify insects belonging to different groups through learning their diagnostic characteristics; and
- explain the rules of nomenclature.

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

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

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

Assessment
There will be an in-course examination, consisting of 17.5 marks and 2.5 marks will be allocated for students' attendance in the class. The students will be frequently asked questions in the classroom to assess individual's performance. A course final examination will be conducted by the university, which will carry 30 marks.

References

Johnson, N.F. and Triplehorn, C.A. 2004. *Borror and DeLong's Introduction to the study of Insects*. 7th edition. Belmont, CA: Thomson Brooks/Cole, Australia.

Gullan, P.J. and Cranston, P.S. 2010. *The insects: An outline of entomology.* 4th edition. Blackwell Publishing, Ltd., Malden, MA, USA.

ICZN. 1999. *International Code of Zoological Nomenclature*. Published by International Trust for Zoological Nomenclature in association with British Museum (Natural History), London, New York.

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

Mayr, E. 1991.*Principles of Systematic Zoology*. 2nd edition. McGraw-Hill Co., New York.

Richards, O.W. and Davies, R.G. (revised by Imm's, A.D.). 1997. *A General Text Book of Entomology.* The English Language Book Society and Mathuen & Co. Ltd., UK.

Course No.	Course Title	No. of Credits	Credit Hours
ZE 522	**Insect Structure and Function**	**2**	**30**

Introduction to the course
Insects are the most abundant and diverse invertebrates, show a great variety of modifications in their structural and functional systems. This course introduces the student with the diverse morphological and anatomical features of the insects. In particular the course focuses on detailed external structure of insects, viz. the integument and its derivatives and the internal structures and systems of the insects in relation to their functions. The course will also describe the modifications in different systems, and discusses how these systems allowed the insects group to adapt in different environment and different life stages.

Specific objectives of the course
- To introduce the students with morphological details of insect's organ systems and its modifications across different insect groups.
- To make students to appreciate how the morphology of a structure is related to its function.

Course contents and number of classes by course sub-title

Title/sub-titles of course contents	No. of classes
Insect structure	
Integument derivatives: Apodeme and apophysis, seta, tentorium. **Head**: Antenna; Mouthparts and feeding adaptations.	**3**
Thorax: General structure of the thorax. Wing: Wing structure, the wing muscle, wing coupling apparatus and mechanism of flight. Leg: Leg structure and modifications.	**3**
Abdomen: Segmentation and appendages; Genitalia and their modifications; Insect sense organs (mechano-, photo- and chemoreceptors). **Chitin:** Structure, formula, function. **Sound producing organs, light producing organs.**	**5**
Digestive system: Morphology and histology of the alimentary canal; modifications of the digestive tract. Filter chamber- structure, types and functions. **Respiratory system:** Structure and function; spiracles - structure and types. **Circulatory system:** Morphology, function and haemocytes. **Excretory system:** Morphology and types of Malpighian tubules; cryptonephridia. **Reproductive system:** Morphology, male and female reproductive organs; types of ovarioles. **Nervous system:** Morphology, central, peripheral and sympathetic nervous system.	**3** **3** **3** **2** **2** **2**

Course Learning Outcomes

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

- describe the morphological accounts of different organ systems;
- appreciate variations in the organs in different insects; and
- classify and tell about the function of different insect organ systems.

Instructional Strategies

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

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

Class/lecture types	No. of classes	Class/lecture types	No. of classes
Lecture and discussion	26	Review class	1
Students' group presentation	1	In-course exam	1
Student feedback on course contents and delivery	1		

Assessment

There will be one in-course examination, consisting of 17.5 marks and 2.5 marks will be allocated for students' attendance. Questions for In-course examination will be of objective and short answer types. The course final examination will carry 30 marks. The students will be frequently asked questions in the classrooms to assess individual's performance.

References

Chapman, R.F., Simpson, S.J. and Douglas, A.E. 2013. *The Insects: Structure and Function.* 5th edition. Cambridge University Press, New York.

Johnson, N.F. and Triplehorn, C.A. 2004. *Borror and DeLong's Introduction to the study of Insects*. 7th edition. Belmont, CA: Thomson Brooks/Cole, Australia.

Gullan, P.J. and Cranston, P.S. 2010. *The insects: An outline of entomology.* 4th edition. Blackwell Publishing, Ltd., Malden, MA, USA.

Richards, O.W. and Davies, R.G. (revised by Imm's, A.D.). 1997. *A General Text Book of Entomology.* The English Language Book Society and Mathuen & Co. Ltd., UK.

Ross, H.H. 1964. *A text book of entomology.* John Wiley and Sons, New York.

Snodgrass, R.E. 2004. *Principles of Insect Morphology.* Tata McGraw Hill Publ. Co. Ltd., New Delhi, India.

Course No.	Course Title	No. of Credits	Credit Hours
ZE 523	**Insect Development Biology, Endocrinology and Molecular Biology**	**2**	**30**

Introduction to the course

Insects are the most successful life form and they make up more than half of all living things on Earth. These are the first metazoan which resemble to the higher vertebrates. Insects show a range of fascinating morphological embryonic developmental and extra-embryonic events. The purpose of this course is to introduce the students with these morphogenetic events and the action of some genes in the formation of embryo. This course will also highlight the neuro-anatomy and hormonal regulation of insect development. Moreover, this course will offer to study Genes, Genome organization of insects as well as use of Molecular Biological Techniques in different Entomological Problems.

Specific objectives of the course

- To provide knowledge and detail understanding on the embryonic developmental events and metamorphic events in insects.
- To enhance students' knowledge and understanding on insect hormones and neuro-hormonal regulation of insect development and metamorphosis.
- To provide knowledge on Insect Molecular Biology.

Course contents and number of classes by course sub-title

Title/sub-titles of course contents	No. of classes
Insect embryology	**22**
General concept of developmental biology.	**1**
Development in Insects:	
Embryonic Development: Vitellogenesis and oogenesis; Insect egg and their types, fertilization, zygote formation, cleavage, formation of blastoderm and germ band; gastrulation; Germ band elongation and blastokinesis; organogenesis and hatching. Genetic control of embryogenesis.	**4**
Post Embryonic Development: Metamorphosis of insect**;** Types, larva and pupa; Histological changes in the metamorphic stages of insect.	**2**
Irregular development, parthenogenesis, paedogenesis, neoteny, hermaphroditism (mode of reproduction), viviparity.	**1**

Insect endocrinology	
Introduction to endocrinology: General concepts and branches of endocrinology; types and function of hormone; types and function of pheromone.	**3**
Endocrine system: Neurohaemal organ in insect; endocrine control of insect reproduction, development.	**2**
Role of hormone in insect development and metamorphosis.	**2**
Insect Molecular Biology	
Chromosomal and Extrachromosomal organisation of DNA in Insects.	**1**
Insect Genes and Genome organisation	**1**
Some basic tools of Molecular Biology: How to cut, copy, paste, measure and visualize DNA, Polymerase Chain Reaction, cDNA Cloning, DNA sequencing and Analyzing the Sequence Data.	**2**
Application of Molecular Biology in Entomological Problems: Application in insect identification, sex determination, Insect behavior, Insects systematics and Evolution, and for Pest Management Programs.	**3**

Course Learning Outcomes

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

- know about various developmental events and stages during embryonic development;
- describe explain the different larval and pupal developmental stages;
- learn about parthenogenesis, paedogenesis, neoteny, hermaphroditism, viviparity in insects;
- know about the insect hormones and pheromones; and
- explain the role of hormones and genes in insect development.
- know about different molecular biological tools used in insect molecular biology as well as learn about application of molecular biology in different entomological problems.

Instructional Strategies

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

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

Class/lecture types	Number of classes	Class/lecture types	Number of classes
Lecture and discussion	22	Review class	2
Students' group presentation	1	In-course exam	1
Feedback on In-course exam	1	Management / Action Plans development exercise	2
Student feedback on course contents and delivery	1		

Assessment

There will be one in-course examination, consisting of 17.5 marks 2.5 marks will be allocated for students' class attendance. The students will be frequently asked questions in the classrooms to assess individual's performance. A course final examination of this course will be conducted centrally by the university and will carry 30 marks.

References

Chapman, R.F., Simpson, S.J. and Douglas, A.E. 2013. *The Insects: Structure and Function.* 5th edition. Cambridge University Press, New York.

Hoy, M. A. 1994. *Insect Molecular Genetics: An Introduction to Principles and Applications*. Academic Press.

Kapoor, V.C. 1990. *Origin and evolution of insects*. Kalyani Publishers, New Delhi.

Klowden.M.J.2007. *Physiological systems in insects*. 2nd edition. Academic Press.

Nation, J.L. 2002. *Insect Biochemistry and Physiology.* 2nd edition. CRC Press, Florida, USA.

Course No.	Course Title	No. of Credits	Credit Hours
ZE 524	**Insect Behavioural Adaptations and Insect-Plant interactions**	**2**	**30**

Introduction to the course

Animal behaviour is always a matter of curiosity and insects are ideal subjects for basic behavioural studies. Insect behaviour has enormous economic implications. The successful management of both beneficial and harmful species depends on a thorough understanding of all aspects of their behavioural biology. Insect-plant relationship is also an important component in this regard. We may be able to avoid crop damage caused by an influx of pests thorough an understanding of their migratory behaviour. We may be able to suppress a pest population by disrupting a pattern of communication important to its reproduction. All these aspects are addressed in this course.

Specific objectives of the course

- To make the students to understand the basic responses and patterns of behaviour and the functional aspect of insect behaviour.
- To provide knowledge about the social behaviour of insects and their parental care.
- To enable the students to attain a thorough knowledge on plant-insect dynamics.

Course contents and number of classes by course sub-title

Title/sub-titles of course contents	No. of classes
Basic responses and patterns of behaviour: Habituation; behavioural periodicity and clocks.	3
Functional aspects of behaviour: Displacement; orientation, navigation and homing.	4
Communications: Chemical, audio, visual, tactile and inter-specific communications.	4
Host selection and feeding: Phytophagous, blood feeding and entomophagous insects.	3
Defense: Behavioural, structural, chemical and defenses; colourational defenses (e.g. cryptic coloration, flash patterns, warning coloration, mimicry) and group defenses; Parental care and pre-social behaviour.	4
Eusocial Behaviour: Social wasps, bees, ants and termites.	3
Insect-plant Dynamics Plant-insect herbivore relationships; mutualistic associations; pollination and insects. Life histories and reproductive strategies.	 2 2

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

- understand and describe the basic responses and patterns of behavior,
- learn about the functional aspect of insect behavior and its their social behavior;
- explain insect-plant dynamics; and
- understand the life histories and reproductive strategies of insects.

Instructional Strategies
The course will be delivered through lecture and discussion, aided by power point presentations. At times, students will be engaged in group work in the classroom on selected topics. Classes will be made participatory and interactive through questions and answers.

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

Class/lecture types	Number of classes	Class/lecture types	Number of classes
Lecture and discussion	25	Review class	1
Students Groups discussion/presentation	3	In-course exam	1

Assessment
There will be one In-course examinations, consisting of 17.5 marks and 2.5 marks for class attendance. The students will be frequently asked questions in the classrooms to assess individual's performance.

References
Atkins, M.D.1980. *Introduction to insect behavior.* Macmillan Publishing Co. Inc., New York.
Matthews, R.W. and Matthews, J.R. 2009. *Insect behavior.* 2nd edition. Springer, New York.

Course No.	Course Title	No. of Credits	Credit Hours
ZE 525	**Insect Ecology and Biodiversity Management**	**2**	**30**

Introduction to the course
Insect ecology involves a wide range of aspects for study; in particular, it is concerned with the influences and interactions of insect populations and insect communities on ecosystem processes that affect landscape structure, function, and change. The level of focus is the ecosystem, the levels of explanation include populations and communities, and the level of interpretation is the landscape. Insects are affected by the climate and results of studies can tell us much about what is going on in the world around us. This course is designed to cover major aspects of insect ecology, highlighting on trophic relations, impacts of climate change on insect population, regulation of population, ecological genetics, interaction between species, photoperiodism, dispersal, migration, etc.

Specific objectives of the course

- To increase students conceptual understanding on the principles and functions of insect ecology.
- To introduce to ecological process and interactions at levels, species, population and community.
- To provide knowledge about the impacts of climate change on the life of insects and different theories on insect population regulation.

Course contents and number of classes by course sub-title

Title/sub-titles of course contents	No. of classes
Introduction	**1**
Trophic relationship: Trophic structure of community; coevolution of plants and herbivores; coevolution of prey and predator; energy flow.	**5**
Impact of climate change on the life of insects; Theories on population regulation.	**2**
Ecological genetics: Polymorphism, balanced and transient polymorphism, industrial melanism and insect under pesticide stress.	**2**
Insect interactions: Competition, predation and parasitoidism, and the models proposed on these.	**3**
Insect dispersal; Insect migration; Photoperiodism.	
Life budget: Concepts; life table on insects - construction and analysis.	**2**
Systems ecology: Concept; system measurement; system modelling.	**2**
Phase variations in insects, with particular emphasis on locust.	**2**
Insects of soil, litter, carrion and dung.	
Diversity and stability at community level: Relative abundance (commonness and rarity of species), species diversity [species richness, species evenness, measures of diversity].	**3** **2**

Course Learning Outcomes

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

- describe the trophic structure of a community and explain the flow of energy through it;
- explain competitive interactions between individuals of the same or between different species of animals;
- analyze and construct life table;
- understand the system ecology and perform modeling;
- understand population theories and prey-predator interactions; and
- know about impact of climate change on insect behaviour; explain role of gene in insect behaviour.

Instructional Strategies

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

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

Class/lecture types	Number of classes	Class/lecture types	Number of classes
Lecture and discussion	24	Review class	1
Students' group presentation	4	In-course exam	1

References

Begon, M. and Mortimer, M. 1981. *Population ecology - a unified study of animals and plants.* 3rd edition. Blackwell Science, Oxford, UK.

Krebs, C.J. 2009. Ecology - *The experimental analysis of distribution and abundance.* 6th edition. Pearson Benjamin Cummings, San Francisco.

Odum, E.P. 2004. *Fundamentals of Ecology*. 5th edition. Cengage Learning, Boston, MA, USA.

Price, P. W., Denno, R. F., Eubanks, M. D., Finke, D. L. and Kaplin, I. 2011. *Insect Ecology.* Cambridge University Press.

Riklefs, R.E. 1979. *Ecology*. Thomas Nelson and Sons Ltd., USA.

Varley, G.C., Gradwell, G.R. and Hassell, M.P. 1980. *Insect population ecology- an analytical approach.* Blackwell Scientific Publications, Oxford, UK.

Course No.	Course Title	No. of Credits	Credit Hours
ZE 526	**Insect Pest and Pest Management**	**2**	**30**

Introduction to the course

Insect pests cause great harm to our economy by destroying our crops, crop products, other commodities and our health. Pest control and management involves a wide range methods and techniques. This course introduces with different types of pests, pest control methods and bioassay techniques. The course also discusses the application of control techniques in environment friendly way.

Specific objectives of the course

- To familiarize the students with a range of pest and the nature of damage caused by them.
- To enhance students' knowledge and skills on methods and techniques for pest control and management,
- To make familiar with the sampling technique, bioassay technique and pesticide application methods.

Course contents and number of classes by course sub-title

Title/sub-titles of course contents	No. of classes
Status of pests and nature of damage.	**3**
Pest control methods: Physical, cultural, biological, and legal control.	**4**
Integrated Pest Management (IPM): Components and advantages; Cost-benefit analysis; How to design, develop and implement a practical IPM system. A successful case study of IPM. Methods of pesticide application.	**6**
Insect pest sampling techniques; Bioassay techniques.	**3**
Development of pest management programmes for certain pests and crops: Jute hairy caterpillar on jute plant, rice hispa on rice crops and sugarcane stem borer on sugarcane.	**4**
Biology, life history, nature of damage and control measures of the following pests: Jute pests- jute semilooper and jute mites; Sugarcane pests- sugarcane stem borer; Rice pests- rice ear-cutting caterpillar and rice hispa; Vegetable pests- potato tuber worm, epilachna beetle and mustard aphid; Fruit tree pests and fruit pests- mango stem and shoot borer, citrus leaf miner and palm beetle; Tea pests- flush pests and root pests.	**4**
Biology, nature of injury and control measures of major and minor insect pests of: Forest trees and vegetation; Stored grains- red flour beetle, rice meal moth and saw-toothed grain beetle.	**2**

Course Learning Outcomes

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

- know the pests and understand the nature of damage;
- learn about methods and techniques of pest control and management;
- learn about the sampling and bioassay techniques;
- develop pest management programme for pest of different plants; and
- gain knowledge on different control methods.

Instructional Strategies

The course will be delivered through lecture and discussion, aided by power point presentations. Group will be done on some selected lecture topics. Classes will be made participatory and interactive through questions and answers.

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

Class/lecture types	Number of classes	Class/lecture types	Number of classes
Lecture and discussion	26	Review class	1
Management / Action Plans development exercise	1	In-course exam	1
Student feedback on in-course exam	1		

Assessment

There will be an in-course examination, consisting of 17.5 marks and 2.5 marks will be allocated for students' attendance in the class. A course final examination, consisting of 30 marks, will be conducted by the university. The students will be frequently asked questions in the classrooms to assess individual's performance.

References

Kabir, A.K.M.F. 1975. *Jute pests of Bangladesh.* Bangladesh Jute Research Institute, Dhaka, Bangladesh.

Metcalf, C.L., Flint, W.P. and Metcalf, R.L. 1962. *Destructive and useful insects*. McGraw Hill Book company, New York.

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

Proceedings of the SAAR. *Workshop on Rice Hispa 28-29 December, 1986.* Organized jointly by BRRI & BARC, Bangladesh Rice Research Institute, Dhaka.

Sana, R.I. 1989. *Tea Science.* Ashrafia Boi Ghar, Bangla Bazar, Dhaka.

Van Driesche, R.G. and Bellows, T.S. 1996. *Biological Control*. Chapman and Hall, New York.

Course No.	Course Title	No. of Credits	Credit Hours
ZE 527	**Toxicology and Impacts on Ecosystem**	**2**	**30**

Introduction to the course

Expansion of agricultural activities, transportation and industrial development resulted in the environmental contamination of toxic substances with great threat to human, wildlife and our assets and created a great concern for its management and safe handling. This course is designed to enhance students' knowledge on inorganic and organic synthetic and natural insecticides including botanicals, their effects and its safe handling. The course will also discuss about the residual period and effects, effectiveness, doses, mode of action and insecticides resistance to insects.

Specific objectives of the course

- To classify toxic compounds according to their origin, hazardousness and doses and provide knowledge about residual period, method of use and mode of action of these compounds;
- To provide knowledge about the proper use of systemic, non-systemic natural and synthetic organic and inorganic insecticides and understand formulation, detoxification mechanism and general precaution;
- To enable students to understand the toxic effects of insecticides on environment as well as animal and human health.

Course contents and number of classes by course sub-title

Title/sub-titles of course contents	No. of classes
Definition, classification of toxic compounds: The WHO recommended classification of pesticides by hazards. Brief outlines of insecticides, acaricides, nematocides, rodenticides, fungicides, and herbicides Systemic insecticides for plants and animals.	**5**
Inorganic insecticides and Synthetic organic insecticides: Arsenic, fluorine, lead and sulphur compounds preparation – Residual period, doses, method of use and mode of action of these compounds. Phenolic compounds, chlorinated hydrocarbons, organophosphates, carbamates, cyclodiene compound and naphthalene derivatives. Residual period, doses, method of use and mode of action of these compounds. Persistant organic pollutants.	**5**
Organic insecticides of plant origin: Pyrethrines, nicotine, rotenone. Sources, use, doses, types and mode of action of these compounds	**3**
Fumigants: Methyl bromide, HCN, carbon bisulphides, sulphur dioxide, chloropicrin, carbon tetrachloride, ethyl dibromide, nicotin and phostoxin. Use, mode of action and general precautions to be followed in fumigation.	**5**
Miscellaneous	
Attractants, repellents, antifeedants, chemosterilants, insect growth regulators and synergistic compounds. Insecticide resistance including detoxification mechanisms. Formulation of insecticides. Appliances for dissemination of insecticides. Dose determination.	**4**
Insecticides are using to controls mosquito in Dhaka South City Corporation and Dhaka North City Corporation. Environmental pollutant's viz. Heavy metals and Plastics. Impact of toxic compound in insect's body and organs (viz. reproductive and nervous system).	

Course Learning Outcomes

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

- explain the chemical formula and structure, properties, sources and residual period of different types of pesticides;
- explain the toxic effect of different types of insecticides on human and animal health as well as plants;
- design action for safe use of toxic compounds as an insect control agent; and
- prepare proper management plan for pesticide use and its storage.

Instructional Strategies

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

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

Class/lecture types	Number of classes	Class/lecture types	Number of classes
Lecture and discussion	22	Review class	2
Students' group presentation	2	In-course exam	1
Feedback on In-course exam	1	Student feedback on course contents and delivery	2

Assessment

There will be one In-course examination, consisting of 17.5 marks and 2.5 marks will be allocated for students' class attendance. A course final examination on the course will be conducted by the university and will carry 30 marks. The students will be frequently asked questions in the classrooms to assess individual's performance.

References

FAO and WHO. 2002. *Manual on development and use of FAO and WHO specifications for pesticides.* FAO and WHO joint meeting on pesticide specifications. 255pp.

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

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

International programme on chemical safety, a cooperative agreement among FAO, ILO, UNEP, UNIDO, UNITAR, WHO and OECD. 2009. The WHO Recommended Classification of Pesticides by Hazard and Guidelines to Classification. 78pp.

Course No.	Course Title	No. of Credits	Credit Hours
ZE 528	**Medical and Veterinary Entomology**	**2**	**30**

Introduction to the course

Medical and veterinary entomology involves the study of insects and other arthropods, especially arachnids that cause and transmit diseases in human and livestocks. It is a broad science that includes studies on biology, ecology, morphology, taxonomy and many aspects related to disease and disease transmission. Veterinary entomology is included in this category, because many animal diseases become a human health threat. It is difficult to implement control measures of insects, without some knowledge of medical entomology. In addition, with increasing globalization, new and emerging vector borne diseases are becoming worldwide health priorities. The course focuses on these all aspects and intends to produce students capable of handling such parasites and vectors.

Specific objectives of the course

- To enhance the knowledge of pathogen- host- arthropod interactions, recognition and identification of vectors, and an understanding of epidemiology;
- To increase students learning about biology and control of disease vectors and the human pathogens they transmit;
- To introduce the students about recent global trends in insect borne diseases and impacts of emerging vector borne diseases.

Course contents and number of classes by course sub-title

Title/sub-titles of course contents	No. of classes
Medical entomology	
General introduction; Biology, life-history, host-parasite relationship and control measures of the following: General introduction; Biology, life-history, host-parasite relationship and control measures of the following: (a) mosquitoes; (b) sandflies; (c) fleas;	**5**

Title/sub-titles of course contents	No. of classes
and (d) ticks and mites. **Brief outline of the following insects and the diseases they carry:** (a) house flies; (b) horseflies and deerflies; (c) black flies; (d) tsetse flies; (e) bed bugs; and (f) lice. Myiasis: definition and types; **Epidemiology**: Including infection, dispersion, life cycle of pathogen and control measures of the following diseases: (a) malaria; (b) leishmaniasis; (c) filariasis; (d) arbovirus diseases (dengue and yellow fever). Maggot therapy. **Forensic entomology**: Concept; Insect in crime detection and significance.	**5** **5** **2**
Veterinary entomology	
General introduction; ectoparasites of cattle sheep, goats and birds: ticks, mites, flies, fleas and lice. (Clinical features, diagnosis and treatment). General introduction of zoonotic disease. Brief outline of following zoonotic diseases: a) Anthrax; b) Avian Influenza; c) Japanese encephalitis; and d) Nipah fever.	**5** **3**

Course Learning Outcomes

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

- identify existing public health problems related to arthropods;
- know the geographical distribution of important vector borne diseases and to explain the environmental factors determining such distribution;
- learn the impact of different insect species on human health and learn about potential control strategies; and
- design guidelines for a control program for a particular disease.

Instructional Strategies

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

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

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

Assessment

There will be one in-course examination, consisting of 17.5 marks and 2.5 marks will be allocated for students' attendance. The students will be frequently asked questions in the classrooms to assess individual's performance. A course final examination of 30 marks will be conducted by the university

References

Herms, W.B. and James, M.T. 1961. *Medical Entomology*. The Macmillan Company, New York.

Kettle, D.S. 1984. *Medical and Veterinary Entomology*. Croom and Helm Publishing, UK.

Lane, R.P. and Crosskey, R.W. 1993. *Medical insects and arachnids*. The Natural History Museum and Chapman & Hall, London.

Service, M.W. 1997. *Medical entomology*. Chapman and Hall, London.

Shearer, R.W. 1997. *Veterinary Entomology*. Chapman and Hall, London.

Course No.	Course Title	No. of Credits	Credit Hours
ZE 529	**Insect Bioresources, Management and Conservation**	**2**	**30**

Introduction to the course

This course provides an in-depth exploration of bioresources, focusing on their value, classification, and sustainable management. It emphasizes the importance of insects as bioresources, covering industries such as apiculture, sericulture, lac culture, and butterfly farming. The course also highlights conservation techniques, both in-situ and ex-situ, for preserving biodiversity and beneficial insects. Through this course, students will understand the ecological and economic significance of bioresources, and learn effective strategies for their management and conservation in the face of modern environmental challenges.

Specific objectives of the course

- To enhance conceptual understanding of students on bioresources, its value and service, and relationship with the environment.
- To introduce the student with the culture methods and techniques of some insects related commercial production of commodities.
- To enhance students' capacity in understanding bioresources management and conservation.

Course contents and number of classes by course sub-title

Title/sub-titles of course contents	No. of classes
Bioresources	
Introduction to bioresources: Definition, value of bioresources, category of bioresources, bioresource pool, classification of natural resources, insects as bioresource.	**4**
Apiculture: Introduction, scope, honey producing bees, bee colony, caste system, development of bee, relationship between the elements of a bee colony, swarming, methods of apiculture, seasonal management of honey bees, organization of work in apiculture, origin and importance of beekeeping, pests and diseases, royal jelly, pollination.	**3**
Sericulture: Introduction, scope, silk producing moths, rearing of silk worms, methods of sericulture, seasonal management of silk worms, organization of work in sericulture, pests and diseases.	**3**
Lac culture: Introduction, scope, lac producing insects, rearing of lac insects, methods of lac culture, seasonal management of lac insects, organization of work in lac culture, pests and diseases.	**3**
Colonization of butterflies: Introduction, scopes, colonizing materials, colonization process and a model of colonization system.	**2**
Butterfly farming: Introduction, scopes, brief history, farming process with examples.	**2**
Management and conservation	**7**
Management and conservation: Definition and concepts; conservation methods and techniques - *ex-situ* and *in-situ*. Conservation of beneficial insects. Prey-predator conservation. Diversity assessment; protected area management through insect conservation. Insect conservation for the twenty first century.	**1** **2** **2** **2**

Course Learning Outcomes

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

- explain bioresources, its types and conservation aspects;
- know about the methods and techniques related to apiculture, sericulture and lac culture;

- apply the knowledge on bee, silk worm and lac insect management design and maintain butterfly colonization center, farm and park; and
- tell about how to conserve biodiversity through bioresource management.

Instructional Strategies
The course will be delivered through lecture and discussion, aided by power point presentations. Classes will be made participatory through questions and answers and group work exercises in the classroom.

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

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

Assessment
There will be one in-course examination, consisting of 17.5 marks and 2.5 marks will be allocated for class attendance. There will be a course final examination, consisting of 30 marks on this course and will carry 30 marks to be conducted by the university. The students will be frequently asked questions in the classrooms to assess individual's performance.

References

Bashar, M. A. 2004. *Instant Basics of Environment.* Positron Publication, Dhaka, Bangladesh.

Bashar, M. A. 2013. *Butterfiles of Bangladesh.* Vols. 1 & 2. Biodiversity Conservation Trust Fund (BCTF) Publications, Dhaka, Bangladesh.

Ganga, G. and Chetty, J. S. 1991. *An Introduction to Sericulture*. Oxford & IBH Pub. Co. Pvt. Ltd., New Delhi, India.

Glover, P.M. 1937. *Lac Cultivation in India*. 2nd edition., Indian Lac Research Institute, Ranchi, India.

Jean-Prost, P. 1994. *Apiculture*. Oxford & IBH publishing Co. Pvt. Ltd., New Delhi, India.

Jordan, C.F. 1995. *Conservation.* John Wiley & Sons Inc., New York.

Primack, R. B. 2008. *A Primer of Conservation Biology*. 4th edition., Sinauer Associates, Inc., Sunderland, USA.

Course No.	Course Title	No. of Credits	Credit Hours
ZE 530	**Insect Epizootiology and Disease Dynamics**	**2**	**30**

Introduction to the course
Insect epizootiology is the study of disease patterns within insect populations. It deals with the character, ecology, and causes of diseases in insects, especially epizootic diseases. Insect are diseased by viral, bacterial, fungal, protozoan and nematode pathogens. To protect beneficial and economically important insects, it is necessary to know the nature of diseases, their transmission and prevention measures. This course is designed to introduce the students with diseases of economically important insects and its control measures.

Specific objectives of the course
- To make students understanding principle, concept and scope insect epizootiology and its relation with epidemiology;
- To introduce the students with various types of insect diseases, its patterns of spread, their pathogens, and the methods of diseases transmission through insect population;

- To enhance students' knowledge on methods and techniques of control of insect diseases, particularly maintenance of sanitation in culture stocks of insect**.**

Course contents and number of classes by course sub-title

Title/sub-titles of course contents	**No. of classes**
Definition, introduction, objectives and etiology. Causes of disease; Difference between epidemiology and epizootiology. Epizootic and enzootic infections;	**2**
Measurements: Basic measurements and observations in Epizootiology; Prevalence and Incidence.	**2**
Pathogen transmission in insects: Methods of pathogen transmission; dissemination in insects.	**3**
Insect diseases caused by viruses, bacteria, fungi, protozoans and nematodes: pathogenic families; route of entry of pathogen into insect host, dissemination of diseases into insects.	**14**
Prevention of insect diseases.	**2**
Applied Epizootiology: Microbial control of insects.	**2**

Course Learning Outcomes

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

- know about the insect diseases and its implication in insect culture system;
- tell about the measurements of epizootic insect diseases;
- learn about different insect diseases caused by virus, bacteria, protozoa, fungi and nematode;
- explain the route of entry of various pathogens into insect host body; and
- take preventive measure for insect rearing in the laboratory against insect diseases.

Instructional Strategies

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

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

Class/lecture types	Number of classes	Class/lecture types	Number of classes
Lecture and discussion	27	Review class	1
Students' group presentation	1	In-course exam	1
Student feedback on course contents and delivery	1		

Assessment

There will be an in-course examination, consisting of 17.5 marks and 2.5 marks will be allocated for students' attendance in the class. A course final examination will be taken by the university and will carry 30 marks. The students will be frequently asked questions in the classrooms to assess individual's performance.

References

James, R.F. and Tanada, Y. 1987. *Epizootiology of insect diseases*. John Wiley & Sons, New York.

Pelczar, M.J., Chan, E.C.S. and Krieg, N.R. 2006. *Microbiology.* Tata MacGraw Hill Co., New Delhi, India.

Course No.	Course Title	No. of Credits	Credit Hours
ZE 531	**Practical in Entomology (Gr-A)**	**6**	**90**

Introduction to the course

The course will cover the science of entomology by focusing on the basic principles of morphology (external and internal), development, behavior, ecology, and control of insects. Field trips provide opportunities to collect insects and study their adaptations to a wide variety of natural environments.

Specific objectives of the course

- Familiar students with comparative external structure and anatomical details of different systems (viz. digestive, circulatory, reproductive, nervous and endocrine systems) through dissection of common insects including muscular system (viz. flight muscle) of representative insects.
- Identify insects up to species level and also identify immature stages of different insects.
- Provide knowledge on understanding Insecticide formulations and mixtures, bioassay techniques and learning insect sampling and rearing technique.
- Identify medical and veterinary and economically important insects. Learning the whole mounts techniques of insects and their different body parts.
- Learning the preparation of histological techniques of slide preparation.
- Conduct a minor scientific study and project-based assignments related to insects and their environments.

Course contents and number of classes by course sub-title

Title/sub-titles of course contents	No. of classes
Comparative external structures of the common insects of following orders: Exopterygote orders - Odonata, Orthoptera, Hemiptera and Homoptera; Endopterygote orders - Coleoptera, Diptera, Lepidoptera and Hymenoptera.	**3**
a. Head: Including antennae and types; mouthparts - their types and modification due to feeding habits;	
b. Thorax: Including segments; legs and their functional modifications; wings - their articulation and venations;	
c. Abdomen: Segmentation; appendages, male and female genitalia, ovipositor, and aedeagus and associated structures.	
Mounting of mouth parts, Permanent mounting of wing, leg, and sex organs, mounting of economically important insects.	**2**
Study of the functional systems of insects through dissection of common insects of following orders: Orthoptera, Hemiptera, Diptera, Coleoptera and Hymenoptera:	**2**
a. Digestive system: Structural variations related to feeding habits;	
b. Circulatory and Endocrine system: Different types of haemocytes and neuro-haemal organs of insects.	
c. Reproductive system: Male and female systems- testis, ovary and ovariole;	
d. Nervous system: Nerve cord, ganglia and connectives.	
Study of the flight muscles of insects.	**1**
Identification of insects up to family, genus and species (including both exopterygote and endopterygote insects).	**2**
Insects, ticks, mites and spiders of medical and veterinary importance.	

Economically important insects (beneficial and harmful).	**1**
Types of larvae and pupae of insects; Preparation of whole mounts of larvae and pupae of insects; Preparation of histological slides of the larvae, pupae and adults of insect.	
Rearing of insects in the laboratory: Mosquitoes, fruit flies, potato tuber moth, and stored grain pests.	**1**
Insect sampling: Sampling methods; data collection, procedure of data analysis and concluding remarks.	**1**
Bioassay technique (Dose-Response Technique): Test procedure, data recording, data analysis and concluding remarks.	
FIELD VISIT	**1**
ASSIGNMENT PROJECT	**6**
Any entomology related short-term project to be assigned by course teachers.	

Course Learning Outcomes

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

- Understand economic importance of the insects as well as the morphological, anatomical and biological features of insects belong to different orders;
- Enhance their knowledge of insecticide formulation, application, data recording and data analysis technique and understand different insect sampling and rearing methods and its associated equipment;
- Differentiate between insect of medical and veterinary importance and state how they affect man;
- Classify insects into basic taxonomic categories and develop learning skills for further studies.By whole mount slide preparation students will capable to analyze the different body parts of insects.
- The histological slides examine different organs of insects; comparative analyze of the different organs helps to understand the structure and functions of different physiology and systems of insects.
- Capacity develops to conduct an independent project-based investigation on insects and their environment.

Instructional Strategies

The course will be delivered by practical demonstrations in the laboratory, exposure visits to field and laboratory for hands-on training and experiences and also offering an assignment project to build a research foundation for non-thesis students. A number of teachers will demonstrate and guide the individual students in the practical classes and field visits. The practical classes will cover interactive and participatory lectures with PowerPoint and audiovisual systems, group works among students and hands on demonstrations by the teachers. Necessary equipment and logistics will be provided in the laboratory for use in the practical classes. Reference books will also available from the departmental seminar library.

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

Distribution of class lectures: Total number of classes- 30

Class/ lecture type	No. of classes
Lectures and Practical exercise	20

Exposure visit	1
In-course exam	2
Assignment project	6
Feedback on in-course exam, and students' feedback on course contents and delivery	1

Assessment

Assessment of practical course will be based on class attendance (5%), in-course assessment (35%) and a final examination (60%). In-course assessment will be done conducting in-course examinations and evaluating an assignment project. There will be at least two in-course examinations for the practical course. Assignment project will be allocated for each student individually and the project report will be evaluated by all course teachers of the branch. Other assessment components viz. report of field/laboratory/research organizations visits and Lab/Notebook will be evaluated with final examination.

References

Chapman, R.F., Simpson, S.J. and Douglas, A.E. 2013. *The Insects: Structure and Function.* 5th edition. Cambridge University Press, New York.

Johnson, N.F. and Triplehorn, C.A. 2004. *Borror and DeLong's Introduction to the study of Insects*. 7th edition. Belmont, CA: Thomson Brooks/Cole, Australia.

Kettle, D.S. 1984. *Medical and Veterinary Entomology*. Croom and Helm Publishing, UK.

Metcalf, C.L., Flint, W.P. and Metcalf, R.L. 1962. *Destructive and useful insects.* McGraw Hill Book company, New York.

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

Service, M.W. 1997. *Medical entomology.* Chapman and Hall, London.

Snodgrass, R.E. 2004. *Principles of Insect Morphology.* Tata McGraw Hill Publ. Co. Ltd., New Delhi, India.

Course No.	Course Title	No. of Credits	Credit Hours
ZE 532	**Thesis in Entomology (Gr-B)**	**6**	**90**

Introduction to the course

The thesis course is a study on insects and their interactions with the environment, others animals and humans encompassing their biology, ecology, behaviour, evolution, conservation and management. The field research provides opportunities for the students to investigate the insects and their adaptations to a wide variety of natural environment. This course enables the students to learn how to conduct literature reviews, design experiments, analyze data and synthesize findings under the supervision of a faculty member. This course also enhances their ability to write thesis and the presentation skills will improve the ability to communicate ideas effectively. In addition, the thesis research work could lead to journal publications or conference presentations, which enhance academic and professional skills. Furthermore, enhance collaborative research work with different research organization and increase experience and capacity to conduct advance research, which can serve as a foundation for higher education. This course is divided into two parts firstly writing a thesis based on individual research project and secondly presentation of the thesis. Students must write their thesis following a standard MS thesis structure including a title, abstract, introduction, methodology, results, discussion, conclusion, and references with optional appendices. The front matters the thesis will includes title page, abstract, table of contents**,** dedication, declaration, and acknowledgements. In the main body, the introduction section will include background, review of existing research**,** research gaps, problem statement, rationale of the study, research hypothesis and questions, aims and objective

of the research project. Likewise other sections will contain relevant components of a typical MS thesis**.** The maximum word limit for theses is 30,000 words that will include all text, figures, tables, and photographs, excluding references and appendices. No formal classes will be allocated for the thesis course, however pertinent knowledge and information shall be provided by the supervisors through lectures, meeting and group discussion etc.

Specific objectives of the course

- To develop research skill in entomological research fields.
- To gain knowledge about insect biology, ecology, behaviour, adaptations with environmental changes, insect pest management and bio-diversity conservation.
- To enhance the ability to develop research design, collect data, analyze data and draw a meaningful conclusion.
- To develop lab and community-based communication skill.
- To equip students with skills in writing research work, presenting research findings, and defending their work effectively.
- To enhance experience and skills needed for further higher education, research jobs, or technical careers.

Course contents

Students have to choose a specific topic related to entomology for conducting an individual research project for this thesis course. In this case, students may consult with his/her supervisor to select their research project concerning any basic or applied aspects of insect biology, ecology, behaviour, adaptations with environmental changes, insect pest management and bio-diversity conservation management and economics, insect genetics, molecular biology and biotechnology. In addition to these, students have complete freedom to fix any topic related to entomology branch. This course is divided into two parts firstly writing a thesis based on individual research project and secondly presentation of the thesis. Students must write their thesis following a standard MS thesis structure including a title, abstract, introduction, methodology, results, discussion, conclusion, and references with optional appendices. The front matters the thesis will includes title page, abstract, table of contents**,** dedication, declaration, and acknowledgements. In the main body, the introduction section will include background, review of existing research**,** research gaps, problem statement, rationale of the study, research hypothesis and questions, aims and objective of the research project. Likewise other sections will contain relevant components of a typical MS thesis**.** The maximum word limit for theses is 30,000 words that will include all text, figures, tables, and photographs, excluding references and appendices. No formal classes will be allocated for the thesis course, however pertinent knowledge and information shall be provided by the supervisors through lectures, meeting and group discussion etc.

Course Learning Outcomes

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

- Learn how to develop hypothesis and design experiments in the field of entomology to test them.
- Learn how to conduct fieldwork, collect insect specimens, and analyze data and also develop laboratory skills.
- Learn to write a structured and well researched thesis as well as enhance presentation skills.
- Present findings in research papers, conferences, or scientific meetings.
- Provide insights that can improve pest management, conservation and vector borne disease control.

Instructional Strategies

The thesis course adopts independent research, supervised lab work, and regular faculty guidance. Students engage in experimental design, data analysis, and report writing. Progress seminars and discussions enhance critical thinking, scientific inquiry, and research skills, fostering self-directed

learning and problem-solving abilities essential for professional development in the field of entomology. Each thesis student will attend the monthly scientific seminar to organized by the department.

Assessment
The total marks for this 6-credit course are 150, with 100 marks allocated to thesis work and report writing, while the remaining 50 marks are reserved for thesis presentation and defense. Thesis will be evaluated by the external examiners while presentation will be evaluated by the examination committee.

Course No.	Course Title	No. of Credits	Credit Hours
ZE 533	**Review article writing and Seminar presentation**	**2**	**30**

Introduction to the course
The review article provided an overview of the current level of knowledge of a topic within a certain discipline. It is typically regarded as a secondary source because it may examine and evaluate the methodologies and findings of previously published research. This course is designed for the students to enhance their abilities for reviewing literature in the field of insect structure including physiology, morphology, development, behaviour, ecology, agricultural entomology, pest management, medical entomology and biological control. Furthermore, the course emphasizes the enhancement of presentation skills of review article seminars with confidence.

Specific objectives of the course
- To provide knowledge on understanding the different topics related with insects.
- To enhance skills in writing a scientific review article.
- To build capacities for seminar presentation.

Course contents
Students have to select a specific topic of review project related to entomology for writing a review paper of any types such as narrative review, systematic review, and meta-analyses. In this case, students may consult with his/her supervisor to select their review project. In addition to these, students have complete freedom to fix any topic related to entomology branch. This course is divided into two parts firstly writing a review paper and secondly presentation of the reviewed article. Students must write their review paper following a standard structure including a title, abstract with keywords, introduction, methodology (if any), results, discussion, conclusion, and references. The maximum word limit for review article is 4,000 words that will include all text, figures, tables, and photographs, excluding references. No formal classes will be allocated for this course, however pertinent knowledge and information shall be provided by the branch teachers through special lectures, monthly group/lab meeting and group discussion etc.

Course Learning Outcomes
- Enhance the knowledge of the scientific articles in the field of entomology.
- Develop analytical power and capacity to apply in different research activities in the entomological research field.
- Develop and enhance the skill to write and present a scientific article.

Instructional Strategies
The course will involve guided literature review, interactive discussions, and regular mentoring sessions. Students will receive training in scientific writing techniques and presentation skills. They will prepare review articles and deliver seminars on selected topics, followed by peer and faculty

feedback to improve their critical thinking and communication abilities. The maximum word limit is 4,000 words that will include all text, figures, tables, and photographs, excluding references and appendices.

Assessment
Out of the total 50 marks, 25 will be allocated for review writing and the remaining 25 for seminar presentation. Both the review work and seminar presentation will be assessed by the examination committee.

Course No.	Course title	No of Credits	Credit hours
ZE 534	**Viva voce**	**2 credits**	**30**

Introduction to the course
Viva voce or oral examination is an integral component of the MS programme in Zoology. This is a mandatory course for the students of both thesis and non-thesis group of all branches by which students demonstrate their secured knowledge, expertise, and understanding of theoretical, practical and thesis courses. It's also an opportunity for the examiners to evaluate the academic abilities of students, and ultimately for determining whether they have met the requirements of MS degree.

Specific objectives of the course
- To prepare students for presenting their in-depth knowledge of the broader field of study programme.
- To improve the ability of students to communicate to scientific world with secured skills and expertise
- To assess student's understanding of the programme.

Contents of the course
Course contents of the viva voce include all topics of theory, practical and thesis courses of the respective MS programme. Examination Committee has complete freedom to ask any question related to respective syllabus of the programme. No formal classes will be allocated for this course, however pertinent knowledge and information shall be provided by the course teachers through their routine lectures of theory courses, monthly group/lab meeting and group discussion etc.

Course Learning Outcomes
Upon completion of this course the students will be able to-
- Demonstrate how their acquired knowledge, expertise and skills from the courses contribute to their field of study.
- Recognise and explain the current state of knowledge on a particular issue or topic of the programme.
- Demonstrate and assess their academic feats with critical analysis and interpretation of various aspects of the courses.

Instructional Strategies
The course will follow interactive lectures of all theoretical and practical courses and thesis works of the MS programme. Besides, regular lab/group meetings, discussions, and individual or group mentoring sessions will also provide instructions for viva voce. All faculty members of the branch will instruct the students in this regard.

Assessment
This is a two-credit course that carries 50 marks. The respective Examination Committee including external members will assess overall student's knowledge asking questions from the contents of respective syllabus of the MS programme and student will answer questions accordingly.

MS in Zoology (Wildlife and Conservation Biology)

Course No.	Course Title	No. of Credits	Credit Hours
ZW 541	**National and Global Wildlife**	**2**	**30**

Introduction to the course

Wildlife and wildlife diversity is an integral component of global ecosystems, playing a critical role in maintaining ecological balance and providing invaluable resources and services to humanity. This course offers a comprehensive exploration of wildlife diversity from both national and global perspectives, emphasizing the unique biodiversity of Bangladesh within its global context. Students will gain a deep understanding of the importance of wildlife diversity, its patterns, and the threats it faces due to natural and anthropogenic factors. By examining case studies, students will learn about the ecological, cultural, and economic significance of wildlife. This course will equip students with the knowledge and skills to address the pressing challenges of wildlife conservation in the 21st century.

Specific objectives of the course

- To provide an in-depth understanding of wildlife diversity at national and global levels, including patterns, distribution, and significance.
- To analyze the status and distribution of wildlife in Bangladesh, including endemic and threatened species.
- To study the role of protected areas, wetlands, urban environments, and human-dominated landscapes in supporting wildlife diversity.
- To examine the various natural and anthropogenic threats to wildlife populations, including habitat destruction, climate change, and illegal wildlife trade.

Course contents and number of classes by course sub-title

Title/sub-titles of course contents	No. of classes
Introduction to Wildlife Definition and importance of wildlife and wildlife diversity; Global Biodiversity Hotspots – Amazon rainforest and Madagascar, and their significance; Overview of Bangladesh's wildlife diversity and its global context.	3
Wildlife of Bangladesh Amphibians, reptiles, birds and mammals at species and subspecies level; Past and present status and distribution of wildlife; Endemic and threatened species; Exclusive wildlife in Protected Areas; Case studies: Bengal tigers, Asian Elephants, migratory birds, and Ganges River Dolphins.	12
Global Wildlife Diversity Overview of global biodiversity patterns and distribution; Comparative analysis of wildlife diversity across Southeast Asian countries.	**3**
Wildlife diversity in (i) Urban areas including cities and towns; (ii) Wetlands such as rivers, streams, lakes, beels, haors, and baors; (iii) Human-dominated landscapes like homestead forests, jungles, bushes, village common forests, bazaars, roads and highways; (d) areas of religious, cultural beliefs and sacred sites.	**4**

Threats and their consequences to wildlife Natural and anthropogenic threats, threat categorization, threat assessment and mitigation Emerging threats: Microplastics, pollution, and diseases.	**3**

Course Learning Outcomes

By the end of this course, students will be able to:

- Define and articulate the importance of wildlife diversity and its significance.
- Identify and compare patterns of wildlife diversity at national and global scales, including biodiversity hotspots and their importance.
- Analyze the past and present status of wildlife in Bangladesh, with a focus on endemic and threatened species.
- Evaluate the role of protected areas and other habitats in conserving wildlife diversity, using case studies such as the Sundarbans, Tanguar Haor, and Ganges river dolphins.
- Assess the major threats to wildlife populations, categorize these threats, and propose mitigation strategies for habitat destruction, climate change, and invasive species.
- Demonstrate knowledge of emerging threats, such as microplastics and wildlife diseases, and advocate for education and community involvement in conservation efforts.

Instructional Strategies

All courses will be delivered through lectures and discussions, aided by power-point presentations, video, films, etc. Classes will be made participatory and interactive through questions and answers, and individual/group work presentations/exercises/assignments in the classroom.

Distribution of class lectures:

Total number of classes/lectures- 30

Class/lecture types	Number of classes	Class/lecture types	Number of classes
Lecture and discussion	25	presentation (individual/group)/ surprise test/ quiz/ assignment	3
Review and feedback class	1	In-course exam	1

Assessment

There will be one in-course examination comprising 15 marks, 2.5 marks for presentation (individual/group)/ surprise test/ quiz/ assignment; 2.5 marks are allocated for students' attendance in classes. The questions for in-course examinations will be of objective and/or short questions and/or creative types. A course final examination of 30 marks will be conducted by the university after the completion of the course.

References

Grimmett, R., Inskipp, C., & Inskipp, T. (1999). A guide to the birds of India, Pakistan, Nepal, Bangladesh, Bhutan, Sri Lanka, and the Maldives (p. 888). Princeton, New Jersey: Princeton University Press.

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

Hasan, M.K., Khan, M.M.H., Feeroz, M.M. 2014. *Amphibians and Reptiles of Bangladesh: A Field Guide*. Dhaka, Bangladesh, Arannayk Foundation.

IUCN Bangladesh. 2015a. *Red List of Bangladesh: A Brief on Assessment Result*. Volume 1: IUCN, International Union for Conservation of Nature, Bangladesh Country Office, Dhaka, Bangladesh, pp. 24.

IUCN Bangladesh. 2015b. *Red List of Bangladesh Volume 2: Mammals*. IUCN, International Union for Conservation of Nature, Bangladesh Country Office, Dhaka, Bangladesh, pp. xvi+232.
IUCN Bangladesh. 2015c. *Red List of Bangladesh Volume 3: Birds.* IUCN, International Union for Conservation of Nature, Bangladesh Country Office, Dhaka, Bangladesh, pp. xvi+676.
IUCN Bangladesh. 2015d. *Red List of Bangladesh Volume 4: Reptiles and Amphibians.* IUCN, International Union for Conservation of Nature, Bangladesh Country Office, Dhaka, Bangladesh, pp. xvi+320.
Khan, M.A.R. 1982. *Wildlife of Bangladesh*. The University of Dhaka, Dhaka, 174 pp.
Khan, M.A.R. 2010. *Wildlife of Bangladesh from Amphibia to Mammalia- a Checklist*. Shahitya Prakash, Dhaka, Bangladesh
Khan, M.A.R. 2015. *Wildlife of Bangladesh*: *Checklist and Guide*. Dhaka, Chayabithi publication.

Course No.	Course Title	No. of Credits	Credit Hours
ZW 542	**Wildlife Resources and Protected Area Management**	**2**	**30**

Introduction to the course

Wildlife and protected areas are a natural renewable resource. Therefore, proper management of this resource is important. To do this, knowledge development is necessary for better understanding about management plan of wildlife resources and protected areas in the country. Study of this course will help to elucidate better understanding of the values of wildlife, management strategies of threatened wildlife species, protected area management, and captive breeding programs.

Specific objectives of the course

- To know the importance of wildlife management and to acquire knowledge about the management.
- To increase knowledge about the management of urban wildlife.
- To increase knowledge about the proper management of wildlife and habitats.
- To enhance knowledge of the student about the captive breeding and re-introduction of wildlife.

Course contents and number of classes by course sub-title

Title/sub-titles of course contents	No. of classes
Introduction to wildlife and wildlife resources management Defining wildlife resources and management; Wildlife Resource Management: past and present perspective.	**3**
Urban wildlife and ecosystem s management Ecological principles in urban context; Urban aquatic ecosystem; Urban habitats and hazards; Invasive species management.	**5**
Wildlife resource management strategies Wildlife control; Management of wildlife habitats; Threatened species management; Managing landscapes and modified habitats (e.g., fragmentation and corridors); Use of satellite imagery and mapping in assessing modified habitats.	**7**
Protected area management Coverage, spatial distribution, and management of Protected Areas – National Parks,	**7**

Wildlife Sanctuaries, Ramsar Sites, Key Biodiversity Areas, World Heritage Sites, Ecologically Critical Areas, Important Bird Areas (IBAs) in Bangladesh; Threats assessment and management of Protected Areas.	
Captive breeding and re-introduction Role of zoological garden and safari park in wildlife management; Developing and maintenance of captive habitat and their management; Role of captive breeding in re-introduction of threatened species.	**3**

Course Learning Outcomes:

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

- understanding and evaluating the significance of wildlife management.
- acquiring knowledge about the wildlife resource management strategies.
- develop skills about the preparation of management plan of wildlife and their habitats.
- understand captive breeding techniques and introduction programs.
- develop skills about wildlife disease management.
- acquire knowledge about the wildlife conservation laws and acts.

Instructional Strategies

All courses will be delivered through lectures and discussions, aided by power-point presentations, video, films, etc. Classes will be made participatory and interactive through questions and answers, and individual/group work presentations/exercises/assignments in the classroom.

Distribution of class lectures:

Total number of classes/lectures- 30

Class/lecture types	Number of classes	Class/lecture types	Number of classes
Lecture and discussion	25	presentation (individual/group)/ surprise test/ quiz/ assignment	3
Review and feedback class	1	In-course exam	1

Assessment

There will be one in-course examination comprising 15 marks, 2.5 marks for presentation (individual/group)/ surprise test/ quiz/ assignment; 2.5 marks are allocated for students' attendance in classes. The questions for in-course examinations will be of objective and/or short questions and/or creative types. A course final examination of 30 marks will be conducted by the university after the completion of the course.

References

Bolen, E. G. and Robinson. W. L. 2003. *Wildlife Ecology and Management*, (5th edition). Prentice Hall, Upper Saddle River, New Jersey. 505pp.

Fryxell, J.M., Sinclair, A. R. E., and Cavghley, G. 2006. *Wildlife Ecology, Conservation and Management*. Blackwell Publishing Ltd.

Hobbs, R. J. (ed.). 2000. *Invasive species in a changing world*. Island Press. Washington DC, USA.

Hosetti, B. B. 2005. *Concepts in Wildlife Management*, 2nd Revised and Enlarge Edition. Daya Publishing House, Delhi.

IUCN. 2008. *Guidelines for Applying Protected Area Management Categories*.

Primack, R.B. 2014. Essentials of Conservation Biology. 6th Edition. Sinauer Associates, Inc., USA.

Wobeser, G. A. 2007. *Disease in Wild Animals – Investigation and Management*. Springer-Verlag Berlin Heidelberg, Germany. 389 pp.

Course No.	Course Title	No. of Credits	Credit Hours
ZW 543	**Comprehensive Conservation Biology**	**2**	**30**

Introduction to the course

Conservation of biodiversity, wildlife in particular, primarily requires a comprehensive understanding of the root causes of the problem, appreciating the conservation priority and conservation methods in practice, and biological and social factors that affects the success of conservation efforts. This course offers a comprehensive package of learning opportunities aiming at protecting and maintaining the genes, species, communities, habitats, ecosystems from extinction and erosion of biotic interactions with emphasis on principles, methods and tools of conservation that integrates biological, ecological and social factors. The course also introduces the students with emerging issues in conservation sector, including effects of climate change and application of genetics in conserving wildlife, and aspects of protected area management. This course is not only a fascinating one, but also essential to people willing to build career as a wildlife biologist.

Specific objectives of the course

- To elucidate the theories and principles of conservation biology.
- To develop students' skills for conserving wild species, population and habitats.
- To make the students aware of the conservation in changing world with the application of new innovations.

Course contents and number of classes by course sub-title

Title/sub-titles of course contents	No. of classes
Conservation Biology History, concepts and scopes; Emergence of conservation biology; Setting conservation priorities-distinctiveness, endangerment and utility; Concepts of sustainable development, measures for conservation and sustainable use of wildlife resources.	5
Conservation genetics and genetic management Genetics in wildlife conservation; Genetic drift; Genetic consequences of small population; Inbreeding and species extinction; Genetical problem of endangered species in the wild.	5
Conservation of populations Effective population size; Metapopulations and population fragmentation; Population viability analysis and minimum viable population; Management of small population; Recovery strategies for threatened species.	5
Conservation of habitat and landscape Concept and importance of habitat heterogeneity; Landscape gradients and patch dynamics; Problem of habitat loss isolation and fragmentation; Managing habitat connectivity and role of corridors; Management and action plan for threatened species; Management and action plan of protected areas. Community-based conservation awareness, role of relevant governmental departments and NGOs in wildlife conservation.	10

Course Learning Outcomes

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

- Explain the principles and theories in conservation of wildlife.
- Perform threat analysis and set conservation priorities.
- Describe and apply the methods and tools for conservation of small populations.
- Develop skills for conservation and management of ecosystems and habitats.
- Understand the application of genetics in conserving wildlife populations.

Instructional Strategies

All courses will be delivered through lectures and discussions, aided by power-point presentations, video, films, etc. Classes will be made participatory and interactive through questions and answers, and individual/group work presentations/exercises/assignments in the classroom.

Distribution of class lectures:

Total number of classes/lectures- 30

Class/lecture types	Number of classes	Class/lecture types	Number of classes
Lecture and discussion	25	presentation (individual/group)/ surprise test/ quiz/ assignment	3
Review and feedback class	1	In-course exam	1

Assessment

There will be one in-course examination comprising 15 marks, 2.5 marks for presentation (individual/group)/ surprise test/ quiz/ assignment; 2.5 marks are allocated for students' attendance in classes. The questions for in-course examinations will be of objective and/or short questions and/or creative types. A course final examination of 30 marks will be conducted by the university after the completion of the course.

References

Dyke, F.V. 2008. *Conservation Biology- Foundations, Concepts and Applications.* Springer Science-Business Media, New York.

Ferriere, R., Dieckmann, U. and Couvet, D. 2004. *Evolutionary Conservation Biology.* Cambridge University Press, Cambridge, UK.

Macdonald, D.W. and Service, K. 2007. *Key Topics in Conservation Biology.* Blackwell Publishing Ltd., UK.

Miffe, O.K. and Carroll, C.R. 1997. *Principles of Conservation Biology.* Sinauer Associates. Inc. Publ., Sunderland, Massachusetts, USA.

Mills, L.S. 2007. *Conservation of Wildlife Populations: Demography, Genetics and Management*. Blackwell Publishing Ltd., UK.

Myers, N., Mittermeier, R.A., Mittermeier, C.G., Fonseca, G.A. and Kent, J. 2000. *Biodiversity hotspots for conservation priorities.* Nature 403 (6772): 853-858.

Primack, R.B. 2014. *Essentials of Conservation Biology*. 6th Edition. Sinauer Associates, Inc., USA.

Course No.	Course Title	No. of Credits	Credit Hours
ZW 544	**Wildlife Ecology and Biogeography**	**2**	**30**

Introduction to the course

The life processes are fundamentally linked to ecological processes in which wildlife is a part of it. Knowledge on interactions of animals within its ecosystem and understanding the ecological requirements of animals provide the fundamental basis for designing conservation strategies and to make action plan. For management purpose, wildlife should be viewed from its organization at the level of species, population and community. All these aspects are addressed in this course and designed to provide students with conceptual understanding of the principles, methods and ecological processes that apply to wildlife conservation and management. Specifically, the course focuses the fundamental ecological processes, the limiting factors and barriers that affect wildlife, habitat assessment, structure and functions of communities. The course is very useful to the students willing to develop skills about wildlife that ultimately help to develop career as a wildlife biologist.

Specific objectives of the course

- To provide the students with the fundamental understanding of the relationship between ecological processes
- To provide knowledge of the types of interactions, limiting factors and barriers that affect wildlife population and understand the wildlife from population and community perspectives.
- To provide insights into the ecological and historical foundations for understanding the distribution and abundance of species, and the changes in distribution pattern and abundance over time.

Course contents and number of classes by course sub-title

Title/sub-titles of course contents	No. of classes
Ecosystem and population process Concept and types of biomes and ecosystems; Edge, ecotones, and interspersion; Population dynamics; Population regulation and fluctuation; Competition within and between species; Predation ecology.	**7**
Wildlife and habitat surveys Census, total counts, estimates, and indices; Methods and logic of sampled counts; Indirect estimates of population size; Acoustic ecology; Point and quadrat sampling of habitats; EIA with special focus on ecological baseline and interview survey, critical habitat assessment and impact assessment of wildlife and their habitats.	**8**
Community ecology Community structure, resource partitioning, niche and competitive exclusion; Successional changes in the wildlife community.	**2**
Biogeographic patterns and process Status and distribution of species at individual and population levels; Dispersal, dispersion, distribution and range extension; Mechanism of movement and nature of barriers.	**3**

Geography of diversification Endemism, cosmopolitanism and disjunction; Barriers between biogeographic realms and biotic interchange; Divergence and convergence of isolated biotas.	**3**
Island biogeography Patterns of species richness in islands; Island biogeography theory; Assembly and evolution of insular communities.	**2**

Course Learning Outcomes

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

- understand the ecological principles and processes, such as succession, competition, adaptation, and predation that affect wildlife populations.
- know and apply the methods, techniques and tools for wildlife survey and habitat assessment.
- describe the methods and techniques for environmental impact assessment.
- demonstrate an ability to analyze wildlife population dynamics and structure.
- learn about the distribution pattern of wildlife and factors affecting the distribution.
- know about the insular fauna and its adaptation.
- understand the processes that affect how biota responds to a changing climate and the challenges.

Instructional Strategies

All courses will be delivered through lectures and discussions, aided by power-point presentations, video, films, etc. Classes will be made participatory and interactive through questions and answers, and individual/group work presentations/exercises/assignments in the classroom.

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

Class/lecture types	Number of classes	Class/lecture types	Number of classes
Lecture and discussion	25	presentation (individual/group)/ surprise test/ quiz/ assignment	3
Review and feedback class	1	In-course exam	1

Assessment

There will be one in-course examination comprising 15 marks, 2.5 marks for presentation (individual/group)/ surprise test/ quiz/ assignment; 2.5 marks are allocated for students' attendance in classes. The questions for in-course examinations will be of objective and/or short questions and/or creative types. A course final examination of 30 marks will be conducted by the university after the completion of the course.

References

Bolen, E.G. and Robinson, W.L. 2003. *Wildlife Ecology and Management*, 5th edition. Prentice Hall, Upper Saddle River, New Jersey, USA.

Chapman, J.L. and Reiss, M.J. 1998. *Ecology: Principles and Applications*. Cambridge University Press, Cambridge, UK.

Lomolino, M.V., Riddle, B.R and Brown, J.H. 2006. *Biogeography*. 3rd edition. Sinauer Associates, Inc. Blackwell Publishing Ltd., UK.

Maurer, B.A. 1994. *Geographical population analysis: Tools for the analysis of biodiversity. Methods in ecology*. Blackwell Scientific, Oxford, U.K.

Sinclair, A.R.E., John, M.F. and Cavghley, G. 2006. *Wildlife Ecology, Conservation and Management*. Sunderland, USA.

Course No.	Course Title	No. of Credits	Credit Hours
ZW 545	**Behavioral Ecology of Wildlife**	**2**	**30**

Introduction to the course

Animal behaviour has been always an interesting subject for zoologists and wildlife biologists. This course aims to elucidate understandings of the behavioural aspects of wildlife. The course mainly deals with various important aspects of behavioural ecology such as inter and intra-specific interactions, breeding activities, feeding, grooming and social behaviour of all the groups of wildlife.

Specific objectives of the course

- To enhance students' understanding about the scientific study of animal behaviour involving a variety of approaches.
- To give a comprehensive understanding of the various aspects of intra and inter specific interactions.

Course contents and number of classes by course sub-title

Title/sub-titles of course contents	No. of classes
Behaviour, ecology and evolution Principles of evolutionary theories; Questions about behaviour; Genes and behaviour; Phenotypic plasticity; Environmental influences on behaviour.	**4**
Testing hypotheses in behavioural ecology Breeding behaviour in relation to predation risk; Social organizations in birds and mammals; Comparative approach to ecology and behaviour.	**3**
Economic decisions The economics of carrying capacity and prey choice; The risk of starvation; Environmental variability, body reserves and food storing; The cognitive decisions; Feeding and danger: a trade-off; Social learning.	**4**
Interspecies interactions Symbiosis; Predator versus prey: anti-predatory adaptations; Evolutionary arms race.	**3**
Intraspecies interaction Group living – benefits and costs; Optimal group size; Sexual selection and conflicts; Parental care and family conflicts; Mating system and sex allocation; Kin selection; Altruism, Selfishness and Spiteful; Cooperation.	**11**

Course Learning Outcomes

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

- understand evolutionary basis for the development of animal behaviour.
- learn about the testing hypotheis and economic decisions of wild animals.
- learn about feeding behaviour, reproductive behaviour, social behaviour, parental care, inter- and intra-specific interactions, etc.

Instructional Strategies

All courses will be delivered through lectures and discussions, aided by power-point presentations, video, films, etc. Classes will be made participatory and interactive through questions and answers, and individual/group work presentations/exercises/assignments in the classroom.

Distribution of class lectures:

Total number of classes/lectures- 30

Class/lecture types	Number of classes	Class/lecture types	Number of classes
Lecture and discussion	25	presentation (individual/group)/ surprise test/ quiz/ assignment	3
Review and feedback class	1	In-course exam	1

Assessment

There will be one in-course examination comprising 15 marks, 2.5 marks for presentation (individual/group)/ surprise test/ quiz/ assignment; 2.5 marks are allocated for students' attendance in classes. The questions for in-course examinations will be of objective and/or short questions and/or creative types. A course final examination of 30 marks will be conducted by the university after the completion of the course.

References

Bateson, M., and P. Martin. 2021. *Measuring behaviour: an introductory guide*. 4th edition. Cambridge university press.

Davies, N., J. R. Krebs, and S. A. West. 2012. *An introduction to behavioural ecology.* 4th edition. Wiley Blackwell Scientific.

Krebs, J. R. and Davies, N. 1997. *Behavioural Ecology: An Evolutionary Approach.* 4th Edition. Wiley-Blackwell Scientific.

Tinbergen, N. 1963. *On aims and methods of ethology. Zeitchrift fur tierpsychologie* 20:410-433.

Course No.	Course Title	No. of Credits	Credit Hours
ZW 546	**Human-Wildlife Interactions and Wildlife Diseases**	**2**	**30**

Introduction to the course

Human-wildlife interactions play a significant role in shaping ecosystems and human livelihoods, yet they often result in conflicts and pose challenges to coexistence. This course explores the dynamics of human-wildlife conflicts, focusing on their causes, impacts, and mitigation strategies, with special emphasis on cases from Bangladesh, such as human-tiger, human-elephant, and human-primate interactions. Additionally, the course delves into wildlife diseases, including zoonoses and their effects on wildlife populations and human health. By integrating principles of conflict resolution,

disease management, and the One Health approach, this course aims to equip students with the skills and knowledge to address the complex challenges arising from human-wildlife interactions and wildlife diseases.

Specific objectives of the course

- To analyze the causes and levels of human-wildlife conflicts and their implications for safety and livelihoods.
- To study human-wildlife conflicts in Bangladesh, focusing on key species such as tigers, elephants, and primates.
- To evaluate economic impacts of wildlife conflicts and explore mitigation strategies through behavioral change, education, and policy development.
- To understand the principles of wildlife diseases, including infectious and non-infectious diseases, and their impacts on populations.
- To examine tools and strategies for investigating and managing wildlife diseases, incorporating the One Health approach.

Course contents and number of classes by course sub-title

Title/sub-titles of course contents	No. of classes
Human-wildlife conflicts and coexistence Conflicts and coexistence; Threats to human safety; Levels of conflicts over wildlife; Anthropogenic and natural factors influencing human-wildlife conflicts; Human-tiger, human-elephant and human-primate conflicts and coexistence in Bangladesh.	**7**
Economics of human-wildlife conflicts Measuring damage caused by wildlife; Stakeholders' perceptions of wildlife damage; Resolving human-wildlife conflicts through changing human behaviour, environmental education and compensation; Governing human-wildlife conflicts; Working with stakeholders and communities; Compensation policies for casualties caused by wildlife in Bangladesh; Human-wildlife conflict mitigation strategies.	**6**
Wildlife Diseases Basic principles of wildlife diseases; Zoonoses and anthroponoses; Wildlife diseases including parasitic (protozoa and helminth), mycotic (chytridiomycosis, ophidiomycosis), bacterial and viral (avian influenza, ranavirus, hantavirus) diseases; Transmission and perpetuation of infectious diseases; Non-infectious diseases: nutrients and toxicants; Effects of diseases on individual animal and wildlife populations; Diseases investigation and management tools and strategies; Role of One health in wildlife disease management.	**12**

Course Learning Outcomes

By the end of this course, students will be able to:

- Explain the factors influencing human-wildlife conflicts and propose sustainable coexistence strategies.
- Assess the economic and ecological consequences of human-wildlife conflicts and recommend mitigation measures.

- Analyze the principles, transmission, and impacts of wildlife diseases on both individual animals and populations.
- Apply investigative and management tools for addressing wildlife diseases, including zoonoses and emerging health threats.
- Critically evaluate compensation policies and stakeholder engagement approaches to resolve conflicts in Bangladesh.
- Advocate for integrated conservation strategies that address both human-wildlife interactions and wildlife disease management.

Instructional Strategies
All courses will be delivered through lectures and discussions, aided by power-point presentations, video, films, etc. Classes will be made participatory and interactive through questions and answers, and individual/group work presentations/exercises/assignments in the classroom.

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

Class/lecture types	Number of classes	Class/lecture types	Number of classes
Lecture and discussion	25	presentation (individual/group)/ surprise test/ quiz/ assignment	3
Review and feedback class	1	In-course exam	1

Assessment
There will be one in-course examination comprising 15 marks, 2.5 marks for presentation (individual/group)/ surprise test/ quiz/ assignment; 2.5 marks are allocated for students' attendance in classes. The questions for in-course examinations will be of objective and/or short questions and/or creative types. A course final examination of 30 marks will be conducted by the university after the completion of the course.

References

Conover, M. R., and D. O. Conover. 2022. *Human-wildlife interactions: from conflict to coexistence.* 2nd edition. CRC Press.

Hernandez, S. M., Barron, H. W., Miller, E. A., Aguilar, R. F., & Yabsley, M. J. (Eds.). (2019). *Medical management of wildlife species: a guide for practitioners*. John Wiley & Sons.

IUCN Resolution WCC. 2020. Res-101 *Addressing human-wildlife conflict: fostering a safe and beneficial coexistence of people and wildlife*. iucncongress2020.org/motion/117

IUCN. 2023. *IUCN SSC guidelines on human-wildlife conflict and co-existence*. 1st edition. Gland, Switzerland.

Wobeser, G. A. 2007. *Disease in wild animals.* Berlin, Germany: Springer.

Course No.	Course Title	No. of Credits	Credit Hours
ZW 547	**Restoration Ecology and Ecological modelling**	**2**	**30**

Introduction to the course
Restoration ecology focuses on rehabilitating degraded ecosystems and wildlife habitats, making it a crucial field for addressing biodiversity loss and ecosystem impairment. This course provides students with foundational knowledge and practical skills in ecological restoration and modelling, emphasizing

their significance for sustainable ecosystem management. Students will explore key concepts, techniques, and guidelines for restoring damaged ecosystems, alongside advanced ecological modelling tools like species distribution modelling, GIS, and statistical analysis. With a special focus on applications in Bangladesh, this course highlights the role of restoration and modelling in achieving ecological balance and conservation goals.

Specific objectives of the course

- To understand the key terms, concepts, and significance of ecological restoration.
- To study techniques and approaches for restoring damaged ecosystems and wildlife habitats.
- To learn practical applications of species distribution modelling and habitat suitability modelling.
- To gain proficiency in tools like GIS, PAST and statistical software (R, SPSS).

Course contents and number of classes by course sub-title

Title/sub-titles of course contents	No. of classes
Restoration Ecology Terms and concepts of ecological restoration; Ecological restoration techniques for damaged ecosystems and wildlife habitats; Significance and future of ecological restoration; Disturbance and impairment; Ecological theories of restoration ecology; Ecological attributes of restored ecosystems; Ecological references; Approaches and Guidelines for restoration; Restoration in urban and wetland areas.	**8**
Ecological restoration: Bangladesh perspective Definition, concepts and impacts of social forestry in ecological restoration Application of plantation program in ecological restoration Significance of Community Conserved Area (CCA) in restoration ecology	**2**
Ecological Modelling Introduction to ecological model; Types of models- analytical and simulation; Empirical and process-based models in climate change applications; Population viability models: risk analysis; Modelling infectious diseases: outbreak dynamics; Vegetation model: biomass to gap dynamics; Habitat suitability modelling: adaptive behaviour; Species distribution modelling; GIS in ecological modelling; Statistical tools – R, SPSS with special focus on ecological data; Diversity analysis using PAST; Modelling application in Bangladesh.	**15**

Course Learning Outcomes

By the end of this course, students will be able to:

- Define the principles and importance of ecological restoration and apply restoration techniques to impaired ecosystems.
- Assess ecological attributes of restored ecosystems and develop guidelines for restoration based on ecological references.
- Utilize GIS, remote sensing, and statistical tools to create ecological models for species distribution and habitat suitability.

- Apply ecological modelling techniques to restoration projects in Bangladesh, addressing local conservation needs.
- Analyze the impact of disturbances and propose effective restoration strategies informed by ecological theories.
- Design and evaluate restoration initiatives with consideration for future sustainability and global ecological challenges.

Instructional Strategies
All courses will be delivered through lectures and discussions, aided by power-point presentations, video, films, etc. Classes will be made participatory and interactive through questions and answers, and individual/group work presentations/exercises/assignments in the classroom.

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

Class/lecture types	Number of classes	Class/lecture types	Number of classes
Lecture and discussion	25	presentation (individual/group)/ surprise test/ quiz/ assignment	3
Review and feedback class	1	In-course exam	1

Assessment
There will be one in-course examination comprising 15 marks, 2.5 marks for presentation (individual/group)/ surprise test/ quiz/ assignment; 2.5 marks are allocated for students' attendance in classes. The questions for in-course examinations will be of objective and/or short questions and/or creative types. A course final examination of 30 marks will be conducted by the university after the completion of the course.

References

Clewell, A.F. and Aronson, J. 2013. *Ecological restoration: Principles, values, and structure of an emerging profession*. 2nd Edition. Island press, Washington.

Khan, M., Aziz, M., Uddin, M., Saif, S., Chowdhury, S., Chakma, S., ... & Mohsanin, S. 2012. *Community conserved areas in Chittagong Hill Tracts of Bangladesh.* Wildlife Trust of Bangladesh, Dhaka, Bangladesh.

Owen-Smith, N. 2009. *Introduction to modeling in wildlife and resource conservation*. John Wiley & Sons.

Primack, R.B. 2014. *Essentials of Conservation Biology*. 6th Edition. Sinauer Associates, Inc., USA.

Course No.	Course Title	No. of Credits	Credit Hours
ZW 548	**Climate Change Biology**	**2**	**30**

Introduction to the course
Climate change is one of the most pressing global challenges, profoundly impacting ecosystems, species, and human societies. This course provides an in-depth understanding of the biological implications of climate change, focusing on its drivers, impacts, and solutions. Students will explore topics such as the evolution of Earth's climate, human-induced changes, species range shifts, and ecosystem transformations. By integrating theoretical knowledge with practical applications, this course emphasizes the need for adaptive solutions, wildlife conservation strategies, and policy initiatives to address climate change's impact on biodiversity. Through real-world examples, students will gain insights into the complex relationship between climate change and biological systems.

Specific objectives of the course

- To understand the climate system and the natural and anthropogenic drivers of climate change.
- To analyze the impacts of human-induced climate change on species, ecosystems, and biological events.
- To explore methods for assessing or estimating risks and designing adaptive solutions for climate change impacts.
- To develop conservation strategies and policy initiatives for mitigating climate change effects on wildlife and ecosystems.

Course contents and number of classes by course sub-title

Title/sub-titles of course contents	No. of classes
The climate system and climate change Evolution of earth's climate; Natural drivers of climate change; Human-driven change: rising CO_2; Modelling the climate system; The velocity of climate change.	**6**
Impacts of human-induced climate change Species range shifts; Changes in the timing of biological events; Ecosystem change; Estimating extinction risk from climate change.	**4**
Assessing risks and designing a solution Impacts risks and adaptation; The risk assessment process; Design of adaptation solutions with examples; Wildlife Toxicology and climate change; Toxicological stressors, including pesticides, environmental contaminants, and other emerging chemical threats; The complex impact of climate and stressors on wildlife.	**9**
Wildlife conservation and climate change Global fingerprint of climate change on biodiversity; Climate change in ecosystems-species loss and system degradation; Conservation planning and policy initiatives for climate change; Emerging wildlife diseases and climate change.	**6**

Course Learning Outcomes

By the end of this course, students will be able to:

- Explain the components of the climate system and the factors driving natural and human-induced climate change.
- Assess the impacts of climate change on species range shifts, timing of biological events, and ecosystem dynamics.
- Analyze climate-related risks to biodiversity, including extinction risks and ecosystem degradation.
- Design adaptive solutions for mitigating climate change impacts, using biological assessments and case studies.
- Evaluate the complex interactions between climate change and toxicological stressors on wildlife populations.
- Critically assess global and national conservation planning efforts, with a focus on emerging threats like microplastics, pollution, and wildlife diseases.

- Advocate for the integration of climate change biology into policy and conservation efforts, emphasizing the importance of education and community engagement.

Instructional Strategies
All courses will be delivered through lectures and discussions, aided by power-point presentations, video, films, etc. Classes will be made participatory and interactive through questions and answers, and individual/group work presentations/exercises/assignments in the classroom.

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

Class/lecture types	Number of classes	Class/lecture types	Number of classes
Lecture and discussion	25	presentation (individual/group)/ surprise test/ quiz/ assignment	3
Review and feedback class	1	In-course exam	1

Assessment
There will be one in-course examination comprising 15 marks, 2.5 marks for presentation (individual/group)/ surprise test/ quiz/ assignment; 2.5 marks are allocated for students' attendance in classes. The questions for in-course examinations will be of objective and/or short questions and/or creative types. A course final examination of 30 marks will be conducted by the university after the completion of the course.

References

Abate, R. S. 2019. *Climate change and the voiceless: Protecting future generations, wildlife, and natural resources*. Cambridge University Press.

Hannah, L. 2014. *Climate Change Biology.* 2nd Edition. Academic Press, USA.

Post, E. 2013. *Ecology of climate change: the importance of biotic interactions*. Princeton University Press.

Van Putten, M. 2013. *Wildlife responses to climate change: North American case studies*. Island Press.

Course No.	Course Title	No. of Credits	Credit Hours
ZW 549	**Wildlife Economics, Trades, Ethics, Laws and Legislations**	**2**	**30**

Introduction to the course
Wildlife plays a vital role in maintaining ecological balance and contributes significantly to cultural, economic, and environmental well-being. This course explores the intricate relationship between wildlife and economics, focusing on the direct and indirect economic values of wildlife, its contributions to rural livelihoods, and its potential for sustainable development. Students will examine the dynamics of wildlife trade, including its legal and illegal aspects, and assess the economic, ecological, and public health implications. The course also emphasizes ethical considerations, policy frameworks, and laws governing wildlife conservation. Students will gain a comprehensive understanding of wildlife economics, trade, and the ethical and legal principles essential for sustainable conservation.

Specific objectives of the course
- To understand the concepts, principles, and scope of wildlife economics and its applications.

- To evaluate the impacts of wildlife trade, including biodiversity loss, public health risks, and economic costs.
- To examine the ethical theories and moral considerations in wildlife management and conservation.
- To study the laws, acts, conventions, and treaties related to wildlife conservation, with a focus on Bangladesh.

Course contents and number of classes by course sub-title

Title/sub-titles of course contents	No. of classes
Wildlife Economics Concepts, scopes and Principles of Wildlife Economics; Economic value of wildlife: direct, indirect, and intrinsic values; Role of wildlife in Bangladesh's culture, religion, and folklore; Ecotourism as a sustainable economic model; Economic valuation techniques: contingent valuation, cost-benefit analysis; Payment for Ecosystem Services (PES) initiatives; Scopes, prospects, feasibility and farming of economically important species such as frogs, crocodilians, turtles, snakes and deer; Vertebrate pest and pest management- chemical, mechanical and biological.	**10**
Wildlife Trades Overview of legal and illegal wildlife trade in Bangladesh; CITES; National and Global scenarios of wildlife trade and wildlife crime; Key traded species and their economic drivers; Impacts of wildlife crimes and wildlife trade; Tools and Techniques for Trade Analysis; Trade monitoring tools: TRAFFIC, seizure databases, and market surveys.	**5**
Wildlife Ethics Theory of wildlife ethics; Role of ethical theories in wildlife management; Moral disagreement about wildlife; Specialized equipment for wildlife care.	**3**
Wildlife Laws and Legislations Principles, overview of wildlife laws and legislations; Roles of laws, acts, conventions and treaties relating to wildlife conservation; Bangladesh Biodiversity Act, 2017 Wildlife (Conservation and Security) Act, 2012 Bangladesh Environment Conservation Act, 1995 Forest Act, 1927	**7**

Course Learning Outcomes

By the end of this course, students will be able to:

- Explain the economic value of wildlife, including direct, indirect, and intrinsic values, and its role in livelihoods and ecotourism.
- Assess the impacts of legal and illegal wildlife trade on biodiversity, ecosystems, and public health.
- Apply tools and techniques for wildlife trade analysis, including economic valuation and market surveys.
- Critically evaluate ethical theories and their application in wildlife management and conservation.
- Demonstrate knowledge of key wildlife-related laws, including the Bangladesh Biodiversity Act, 2017, and Wildlife (Conservation and Security) Act, 2012.

- Propose sustainable conservation strategies based on economic insights, ethical considerations, and legal frameworks.
- Advocate for the integration of wildlife economics and ethics into policy and community-based conservation efforts.

Instructional Strategies
All courses will be delivered through lectures and discussions, aided by power-point presentations, video, films, etc. Classes will be made participatory and interactive through questions and answers, and individual/group work presentations/exercises/assignments in the classroom.

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

Class/lecture types	Number of classes	Class/lecture types	Number of classes
Lecture and discussion	25	presentation (individual/group)/ surprise test/ quiz/ assignment	3
Review and feedback class	1	In-course exam	1

Assessment
There will be one in-course examination comprising 15 marks, 2.5 marks for presentation (individual/group)/ surprise test/ quiz/ assignment; 2.5 marks are allocated for students' attendance in classes. The questions for in-course examinations will be of objective and/or short questions and/or creative types. A course final examination of 30 marks will be conducted by the university after the completion of the course.

References

Laws of Bangladesh. 2019. Legislative and Parliamentary Affairs Division, Ministry of Law, Justice and Parliamentary Affairs. Available at- http://bdlaws.minlaw.gov.bd/act-1203.html

Palmer C, Fischer B, Gamborg C, Hampton J, Sandoe P. 2023. Wildlife Ethics: The Ethics of Wildlife Management and Conservation. Willey and sons.

Roth, H. H., & Merz, G. (Eds.). 2013. *Wildlife resources: a global account of economic use*. Springer Science & Business Media.

Tisdell, C. A. 2002. *The economics of conserving wildlife and natural areas* (pp. x+-308). Cheltenham, UK: Edward Elgar.

van Uhm, D. P. 2016. *The illegal wildlife trade: Inside the world of poachers, smugglers and traders* (Vol. 15). Springer.

van Uhm, D. P. 2019. *The Illegal Wildlife Trade*. Springer.

Wildlife (Conservation and Security) Act. 2012. Government of Bangladesh. Gazette no. 30(25).

Course No.	Course Title	No. of Credits	Credit Hours
ZW 550	**Field and Laboratory Techniques in Wildlife Studies**	**2**	**30**

Introduction to the course
Field and laboratory techniques are essential components of wildlife research, enabling scientists to study animal behavior, ecology, and conservation needs with precision and accuracy. This course introduces students to a range of tools and methodologies used in wildlife studies, from field-based techniques such as camera trapping, bird ringing, and radiotelemetry to advanced laboratory methods including PCR, eDNA analysis, and wildlife forensics. Emphasis is placed on both the theoretical and

practical applications of these techniques, ensuring students gain hands-on experience in data collection, analysis, and interpretation. The course highlights cutting-edge technologies like drones, artificial intelligence (AI), and citizen science data to enhance wildlife research in diverse ecosystems.

Specific objectives of the course

- To provide an understanding of the structure, types, and applications of field equipment such as camera traps, drones, tranquilizer guns, and radiotelemetry systems.
- To introduce advanced laboratory techniques, including ELISA, PCR, eDNA, and nutritional analysis, for studying wildlife samples.
- To explore the use of AI and citizen science data in wildlife research and conservation.

Course contents and number of classes by course sub-title

Title/sub-titles of course contents	No. of classes
Camera trap Structure and types; Deployment strategies, surveys, monitoring and data recording; Application in wildlife studies.	**3**
Drones, Telescope and GPS Structure, types and function; Application in wildlife studies.	**4**
Tranquilizer gun Structure, types and function; Chemical bullets and calculation of doses for different animals; Application of tranquilizer gun.	**1**
Radiotelemetry and radio transmitters Basic concepts and structure; Types of radio transmitters and collars for different animals; Basic operations; data recording and analysis; real-time locating system (RTLS).	**3**
Bird ringing Terminology and techniques of bird ringing; Wing tags, and leg-flags.	**2**
Other approaches Night vision binoculars and cameras, different types of cameras and balance	**2**
Laboratory techniques Types, sources, and utilization of citizen science data; Application of Artificial Intelligence (AI) in wildlife research; Scats, stool, swab sample collection procedures and analysis; ELISA, PCR and eDNA technology in wildlife research; Nutritional analysis; Wildlife forensics.	**9**

Course Learning Outcomes

By the end of this course, students will be able to:

- Demonstrate proficiency in using field equipment like camera traps, GPS, drones, and night vision tools for wildlife research.
- Apply tranquilization techniques, including dose calculations and handling chemical bullets, for animal management and study.
- Implement bird ringing techniques, including the use of wing tags and leg flags, for monitoring avian populations.
- Utilize radiotelemetry systems to track animal movement and analyze spatial data.

- Conduct laboratory analyses using advanced techniques such as PCR, eDNA, and ELISA for studying wildlife genetics and health.
- Integrate citizen science data and AI tools into wildlife research to enhance data collection and interpretation.
- Apply wildlife forensic methods to investigate illegal activities and support conservation efforts.
- Plan and execute comprehensive wildlife research projects combining field and laboratory techniques.

Instructional Strategies

All courses will be delivered through lectures and discussions, aided by power-point presentations, video, films, etc. Classes will be made participatory and interactive through questions and answers, and individual/group work presentations/exercises/assignments in the classroom.

Distribution of class lectures:

Total number of classes/lectures- 30

Class/lecture types	Number of classes	Class/lecture types	Number of classes
Lecture and discussion	25	presentation (individual/group)/ surprise test/ quiz/ assignment	3
Review and feedback class	1	In-course exam	1

Assessment

There will be one in-course examination comprising 15 marks, 2.5 marks for presentation (individual/group)/ surprise test/ quiz/ assignment; 2.5 marks are allocated for students' attendance in classes. The questions for in-course examinations will be of objective and/or short questions and/or creative types. A course final examination of 30 marks will be conducted by the university after the completion of the course.

References

Abbasi, A. and Chari, K.B. 2005. *Application of GIS and Remote Sensing in Environmental Management.* Discovery, New Delhi, India.

Agarwal, S. and Rana, M.S. 1995. *Application of Telemetry in Wildlife Conservation.* Wildlife Institute if India, Dehra Dun, India.

DeMers, M.N. 2005. *Fundamentals of Geographic Information Systems.* John Wiley & Sons, USA.

Gordon, I.J. (ed.). 2009. *The Theory and Practice of Community Based Wildlife Management.* Springer Science – Business Media, New York.

Course No.	Course Title	No. of Credits	Credit Hours
ZW 551	**Practical in Wildlife and Conservation Biology (Gr- A)**	**6**	**150**

Introduction of the course

This course offers students to assess wildlife ecology, management policies and practices in Bangladesh. The aim of this course is to provide an environmental analysis toolkit to students; a toolkit that contains skills and abilities to measure and evaluate observations of wildlife made within the diverse and challenging ecosystems of Bangladesh that can be used in other global environmental contexts.

Specific objectives of the course

- To provide students with a strong practical background in wildlife management and research techniques and to be professional to study wildlife;
- To expose students to various techniques and methods in wildlife study with their contribution to the conservation issues;
- To enhance students' capacity in understanding and applying the instruments for wildlife study.

Course contents and number of classes by course sub-title

Title/subtitles of the course contents	No. of classes
Morphometric and meristic study Study of morphological structures, i.e. skulls, toes, claws, feathers and measurements; Species profiling.	**5**
Wildlife survey techniques Quadrat/plot sampling; Transect sampling; Point sampling; Tracks and sign surveys; Questionnaire surveys; Ecological assignments and Field exercises.	**6**
Designing and performing a behavioural study Types of study designs; Categorizing behaviours; Behavioural metrics; Recording methods; Data processing and analysis; Behavioural assignments and Field exercises.	**4**
Animal preservation techniques Wet preservation; Dry preservation (taxidermy).	**2**
Bioinstrumentation Camera trapping; Aerial survey/ UAV methods; GPS, telescope; Animal handling tools; Bird ringing.	**3**
Assignment project Designing a project, Collecting and analysing data (minimum 20 days of on-field/lab/desk data), Writing and submission of a report	

Course Learning Outcomes

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

- know how to prepare a GIS map by using GPS coordinates for animal distribution, ranging, habitat demarcation, etc.
- use different instrument for sampling wildlife and vegetation.
- capture, handle and mark the different groups of wildlife.
- determine the age, sex and estimation of population size of wildlife by using best methods.
- preserve different wild animals (including herpetofauna, birds and mammals) following proper preservation techniques (wet and dry preservation).

Instructional Strategies

All courses will be delivered through lectures and discussions, aided by power-point presentations, video, films, etc. Classes will be made participatory and interactive through questions and answers, and individual/group work presentations/exercises/assignments in the classroom.

Distribution of class lectures:

Total number of classes/lectures- 35

Class/lecture types	Number of classes	Class/lecture types	Number of classes
Preliminary class on course contents, code of conduct, mode of class and what to learn from the class	1	Local field visits	6
Lecture and discussion	20	Assignments	5
Review and feedback class	1	In-course exam	2

Assessment

There will be one/two in-course examinations comprising 27.5 marks, for class attendance 7.5 and 25 marks for the short-term research projects. The questions for in-course examinations will be short questions and/or demonstrative and/or laboratory application types. A course final examination of 90 marks will be conducted by the university after the completion of the course. This 90 marks will be broken down as: field visit and report, 10 marks; laboratory notebook 10 marks and final exam, 70 marks.

Assignment project will be allocated for each student individually and the research project report will be evaluated by all course teachers of the branch. Other assessment components viz. report of field/laboratory/research organizations visits and Lab/Notebook will be evaluated with final examination.

References

Altman, J. 1974. *Observational study of behavior: Sampling methods*. Behaviour. 49: 227-267. Martin, P. and Bateson, M., and P. Martin. 2021. Measuring behaviour: an introductory guide. 4th edition. Cambridge university press.

Rabinowitz, A. 1997. *Wildlife Field Research and Conservation Training Manual*. Wildlife Conservation Society, USA.

Khan M.A.R. 1982. *Wildlife of Bangladesh*. The University of Dhaka, Dhaka, 174 pp.

Khan, M.A.R. 2010. *Wildlife of Bangladesh from Amphibia to Mammalia- a Checklist*. Shahitya Prakash, Dhaka, Bangladesh

Khan, M.A.R. 2015. *Wildlife of Bangladesh*: *Checklist and Guide*. Dhaka, Chayabithi publication.

Course No.	Course Title	No. of Credits	Credit Hours
ZW 552	**Thesis in Wildlife and Conservation Biology (Gr-B)**	**6**	**90**

Introduction

The Thesis is an integral component of the Wildlife and Conservation Biology curriculum, designed to provide students with hands-on research experience and enhance their scientific inquiry skills. This course enables students to apply theoretical knowledge to practical problems by conducting independent research under the supervision of a faculty member. Through experimental design, data

analysis, and critical interpretation, students gain deeper insights into advanced topics in wildlife ecology, animal behaviour, human-wildlife conflicts and co-existence and wildlife conservation. The course also fosters scientific writing and presentation skills, preparing students for future academic or professional research pursuits. Ultimately, this experience nurtures innovation, analytical thinking, and a strong foundation for higher studies or careers in research and development.

Specific objectives of the course

- To develop research skills by engaging students in independent scientific investigation related to animal behaviour, behavioural ecology, human-wildlife conflicts and coexistence, and wildlife conservation etc.
- To enhance analytical and critical thinking abilities through experimental design, data collection, interpretation, and problem-solving.
- To strengthen scientific communication by training students in writing research reports, presenting findings, and defending their work effectively.

Course contents

Students have to choose a specific topic related to entomology for conducting an individual research project for this thesis course. In this case, students may consult with his/her supervisor to select their research project concerning any basic or applied aspects of wildlife ecology, animal behaviour, human-wildlife conflicts and co-existence and wildlife conservation, animal genetics and biotechnology. In addition to these, students have complete freedom to fix any topic related to wildlife and conservation Biology branch. This course is divided into two parts firstly writing a thesis based on individual research project and secondly presentation of the thesis. Students must write their thesis following a standard MS thesis structure including a title, abstract, introduction, methodology, results, discussion, conclusion, and references with optional appendices. The front matters the thesis will includes title page, abstract, table of contents**,** dedication, declaration, and acknowledgements. In the main body, the introduction section will include background, review of existing research**,** research gaps, problem statement, rationale of the study, research hypothesis and questions, aims and objective of the research project. Likewise other sections will contain relevant components of a typical MS thesis**.** The maximum word limit for theses is 30,000 words that will include all text, figures, tables, and photographs, excluding references and appendices. No formal classes will be allocated for the thesis course, however pertinent knowledge and information shall be provided by the supervisors through lectures, meeting and group discussion etc.

Course Learning Outcomes

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

- Ability to design and conduct independent research in the fields of wildlife and conservation biology.
- Proficiency in field data collection and subsequent laboratory analysis (if required) and interpretation of these data in the light of wildlife research.
- Enhanced critical thinking and problem-solving skills to address scientific questions and challenges.
- Capacity to review scientific literature and apply relevant knowledge to research projects.
- Improved scientific writing and presentation skills for preparing a thesis and communicating research outcomes effectively.
- Experience in working ethically and responsibly in a research environment, adhering to scientific and biosafety standards.

Instructional Strategies

The thesis adopts independent research, supervised field and laboratory work, and regular faculty guidance. Students engage in experimental design, data analysis, and report writing. Progress

seminars and discussions enhance critical thinking, scientific inquiry, and research skills, fostering self-directed learning and problem-solving abilities which is essential for professional development in wildlife and conservation biology related fields. Each thesis student will attend the monthly scientific seminar to organized by the department.

Assessment

The total marks for this 6-credit course are 150, with 100 marks allocated to thesis work and report writing, while the remaining 50 marks are reserved for thesis presentation and defense. Thesis will be evaluated by the external examiners while presentation will be evaluated by the examination committee.

Course No.	Course Title	No. of Credits	Credit Hours
ZW 553	**Review article writing and Seminar presentation**	**2**	**30**

Introduction to the course

This course is designed to enhance students' abilities in scientific literature review, critical analysis, and effective communication. It aims to develop skills in writing comprehensive review articles on current topics in wildlife and conservation biology related disciplines. Students will learn to search, evaluate, and synthesize scientific information from various sources. In addition, the course focuses on improving presentation skills through structured seminars, encouraging students to confidently communicate scientific ideas and research findings. This course prepares students for academic writing, public speaking, and professional communication, which are essential for future careers in research, teaching, and conservation sectors.

Specific objectives of the course

- To develop the ability to critically review and synthesize scientific literature.
- To enhance skills in writing structured and comprehensive scientific review articles.
- To build confidence and competence in delivering effective seminar presentations.

Course contents

Students have to select a specific topic of review project related to wildlife and conservation biology for writing a review paper of any types such as narrative review, systematic review, and meta-analyses. In this case, students may consult with his/her supervisor to select their review project. In addition to these, students have complete freedom to fix any topic related to wildlife branch. This course is divided into two parts firstly writing a review paper and secondly presentation of the reviewed article. Students must write their review paper following a standard structure including a title, abstract with keywords, introduction, methodology (if any), results, discussion, conclusion, and references. The maximum word limit for review article is 4,000 words that will include all text, figures, tables, and photographs, excluding references. No formal classes will be allocated for this course, however pertinent knowledge and information shall be provided by the branch teachers through special lectures, monthly group/lab meeting and group discussion etc.

Course Learning Outcomes

- Ability to critically analyze and interpret scientific literature in wildlife and conservation biology related fields.
- Proficiency in writing well-structured and coherent scientific review articles.
- Improved oral communication and presentation skills for academic and professional settings.
- Enhanced confidence in presenting scientific concepts and engaging in scholarly discussions.

Instructional Strategies

The course will involve guided literature review, interactive discussions, and regular mentoring sessions. Students will receive training in scientific writing techniques and presentation skills. They will prepare review articles and deliver seminars on selected topics, followed by peer and faculty feedback to improve their critical thinking and communication abilities. The maximum word limit is 4,000 words that will include all text, figures, tables, and photographs, excluding references and appendices.

Assessment

Out of the total 50 marks, 25 will be allocated for review writing and the remaining 25 for seminar presentation. Both the review work and seminar presentation will be assessed by the examination committee.

Course No.	Course title	No of Credits	Credit hours
ZW 554	**Viva voce**	**2 credits**	**30**

Introduction to the course

Viva voce or oral examination is an integral component of the MS programme in Zoology. This is a mandatory course for the students of both thesis and non-thesis group of all branches by which students demonstrate their secured knowledge, expertise, and understanding of theoretical, practical and thesis courses. It's also an opportunity for the examiners to evaluate the academic abilities of students, and ultimately for determining whether they have met the requirements of MS degree.

Specific objectives of the course

- To prepare students for presenting their in-depth knowledge of the broader field of study programme.
- To improve the ability of students to communicate to scientific world with secured skills and expertise
- To assess student's understanding of the programme.

Contents of the course

Course contents of the viva voce include all topics of theory, practical and thesis courses of the respective MS programme. Examination Committee has complete freedom to ask any question related to respective syllabus of the programme. No formal classes will be allocated for this course, however pertinent knowledge and information shall be provided by the course teachers through their routine lectures of theory courses, monthly group/lab meeting and group discussion etc.

Course Learning Outcomes

Upon completion of this course the students will be able to

- Demonstrate how their acquired knowledge, expertise and skills from the courses contribute to their field of study.
- Recognise and explain the current state of knowledge on a particular issue or topic of the programme.
- Demonstrate and assess their academic feats with critical analysis and interpretation of various aspects of the courses.

Instructional Strategies

The course will follow interactive lectures of all theoretical and practical courses and thesis works of the MS programme. Besides, regular lab/group meetings, discussions, and individual or group mentoring sessions will also provide instructions for viva voce. All faculty members of the branch will instruct the students in this regard.

Assessment

This is a two-credit course that carries 50 marks. The respective Examination Committee including external members will assess overall student's knowledge asking questions from the contents of respective syllabus of the MS programme and student will answer questions accordingly.

MS in Zoology (Parasitology and Public Health)

Course No.	Course Title	No. of Credits	Credit Hours
ZP 561	**Parasite Systematics and Biology**	**2**	**30**

Introduction to the course

This course comprises two distinct disciplines of biological sciences. Taxonomic names and phylogenetic hypotheses are essential tools for modern biological research, both basic and applied. This course concentrates on the systematic position and general biology of the parasites of medical, veterinary, environmental and economic significance. In particular students have the opportunities to learn the classification schemes of major group of parasites and taxonomic procedures for identifying parasites. The course also high lights on reproduction, development, adaptation and transmission of parasites. The course is intended to provide a good foundation for students aiming at developing parasitology-based career.

Specific objectives of the course

- to provide basic knowledge on systematics of parasites;
- to provide foundation knowledge on parasitic life stages and overall biology;
- to familiarize them with parasitic adaptation and parasite transmission.

Course contents and number of classes

Sub-title of the course contents	No. of classes
Parasite Systematics Parasite systematics: Classification and phylogenetic relationship within taxa and among different taxa of parasitic animals from Protista to Arthropoda; Parasite systematics in twenty first century: Opportunities and obstacles.	**9**
Parasite Biology	**18**
Parasite life cycle and development stages: From protista to arthropoda; historical perspective of parasite life cycle; an overiew of parasite life cycle; the establishment of infection: a) parasite entry into the host organism, b) resistant and dormant forms, c) active entry; site selection within the host: entry into specific organs and cells, maintenance and establishment in the host. **Parasite adaptation**: Morphological, physiological/biochemical, life history, behavioural and immunological; Reproduction strategies in different groups of parasites. **Transmission of parasites:** Effective transmission; strategies other than high fecundity to achieve transmission; mathematical models to provide a useful tool to predict transmission rates'; common pathways of transmission, strategies to reduce parasite transmission.	

Course Learning Outcomes

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

- learn the detail classification scheme of different parasite groups and procedures for identification of parasites;
- determine the taxonomic position of parasites;
- describe and explain the life cycle and developmental stages of parasites;
- describe different types of parasitic adaptation;
- explain transmission strategies and probable pathways of infection; and
- design preventive measures to avoid transmission.

Instructional Strategies
The course will be delivered through lectures and open discussion after each lecture. An introductory class will be dedicated to explain how teaching-learning will proceed for the course. Classes will be made participatory and interactive through questions and answers, group and individual work exercises in the classroom. Tools, like power point presentations, video shows will be used for delivering some special topics.

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

Class/ lecture type	Number of classes	Class/ lecture type	Number of classes
Lecture with discussion	27	In-course exam	1
Review class	1	Feedback on In-course exam.	1

Assessment
One In-course examination, consisting of 15 marks and one hour duration will be taken for this course. Some 2.5 mark is allocated for class attendance. Another 2.5 marks will be allocated for surprise test/oral presentation/assignment. A course final examination, consisting of 30 marks will be conducted centrally by the university.

References

Bush, A.O., Fernandez, J.C., Esch, G.W. and Seed, R. 2001. *Parasitism: the diversity and ecology of animal parasites.* University Press. Cambridge, UK.

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

Kennedy, C.R. 1975. *Ecological Animal Parasitology.* Blackwell Scientific Publication, Oxford, UK.

Lewis, E.E., Campbell, J.F. and Sukhdeo, M.V.K. 2002. *The behavioral ecology of Parasites.* CABI Publishing, UK.

Nobel, E.R. and Nobel, G.A. 1971. *Parasitology, The biology of animal Parasites.* Henry Kimpton, London.

Schmidt, G.D. and Roberts, L.S. 2000. *Foundations of Parasitology.* Wm. C. Brown Publishers, USA.

Course No.	Course Title	No. of Credits	Credit Hours
ZP 562	**Parasite Physiology and Biochemistry**	**2**	**30**

Introduction to the course
The major focus of this course is to study the complex and dynamic physiological relationships between parasites and their hosts. It presents an overview of the biological and physiological bases of important parasite group and an understanding of the metabolic processes of the parasites. The course describes by which mechanisms a parasite survives in the host body or also in the habitat peculiar to it. In the course of their lives, parasites undergo significant metabolic alternations. For these reasons, parasitic organisms have become model systems for the study of biochemistry. The phenomena of metabolic shifts to accompany morphological changes, compartmentalization of enzyme system, rapid alterations in membrane chemistry, and genetic changes associated with adaptation to the host have recommended parasites to be the attention of scientists of many disciplines.

Specific objectives of the course
- to provide basic knowledge on parasitic nutrition;
- to make understand of the students about the metabolic processes in parasites;
- to provide knowledge on host-parasite interactions and its impacts;
- to provide students with basic knowledge on biochemistry of parasitic organisms and its application in parasitology.

Course contents and number of classes by course sub-title

Sub-titles of course contents	No. of classes
Parasite Physiology	**16**
Feeding and Nutritional Physiology Structure of helminths aid in obtaining nutrition, ultrastructure of tegument and its role in feeding; Alimentary canal as biotope for parasites, Surface enzymes in parasites; Transtegumentary absorption of nutrients, mechanisms of solute entry and transport of molecules into parasites. Oxygen consumption in helminths; requirements and utilization, O_2 as a terminal electron acceptor. **Carbohydrate, Protein, Lipid Metabolism and energy production** Carbohydrate, protein and energy metabolism in helminths, end-products of carbohydrate catabolism. Role of oxygen in parasite energy metabolism; Homolactate fermentation; Malate dismutation; Electron transport in helminths. **Excretory System, Nitrogen Excretion, Water and Ionic Regulation** End-products of nitrogen metabolism; Ionic regulation and water balance. **Reproduction** Synchronization of parasite and host reproduction. **Parasite Transmission** Physiological mechanisms for locating the host; Physiological mechanisms for penetrating the host. **Establishment and growth of parasites** Physiological aspects of hatching mechanisms; Physiological aspects of migration and site selection.	
Biochemistry	**11**
Biochemical Aspects of Developmental Processes Egg shell formation in cestode, trematode and nematode; Transformation of larval stages; Hormones influencing development (Pheromones and other reproductive cues); In-Vitro development in cestode, trematode and nematode. **Invasion Mechanism** Cellular invasion by protozoa and helminths; Specific steps and pathways of invasion by helminths.	

Course Learning Outcomes

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

- explain the structures involved with obtaining food in helminths;
- tell about the oxygen consumption and utilization in parasites;
- explain the function of the cells, tissues, organs and organ systems of parasites;
- appraise the metabolic processes of parasites;
- explain the physiological differences among the different group of parasites;
- understand the biochemical components involved in developmental processes of parasitic organisms;
- explain different mechanisms for egg shell formation and egg hatching;
- explain the role of hormones in parasite development; describe mechanism of parasites and in vitro development of these organisms.

Instructional Strategies
An introductory class will be taken to explain the method of teaching and how teaching-learning of the course will advance. The course will be delivered through lectures and discussion, Teaching tools like power point presentation, flip chart and video films will also be used to aid lecture delivery. Classes will be made participatory and interactive through questions and answers, group and individual work exercises in the classroom.

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

Class/ lecture type	Number of classes	Class/ lecture type	Number of classes
Lecture with discussion	27	In-course exam	1
Review class	1	Feedback on In-course exam.	1

Assessment
One In-course examination, consisting of 15 marks and one hour duration will be taken for this course. Some 2.5 mark is allocated for class attendance. Another 2.5 marks will be allocated for surprise test/oral presentation/assignment. A course final examination, consisting of 30 marks will be conducted centrally by the university.

References

Smyth, J.D. 1969. The Physiology of Cestodes. Oliver and Boyd.
Smyth, J.D. 1966. The Physiology of Trematodes. Oliver and Boyd.
Smyth, J.D. 1994. Introduction to Animal Parasitology. Cambridge University Press.
Lee, D.L. 1965. The Physiology of Nematodes. Oliver and Boyd.
Marr, J. J. and Mukker, M. 1995. *Biochemistry and molecular biology of Parasites*. Academic Press, Harcourt Brace and Company, New York.
Saleuddin, A.S.M. and Fenton, M.B. 2004. Canadian Journal of Zoology. Vol. 82 (2). Chappell, L.H. Physiology of Parasites.

Course No.	Course Title	No. of Credits	Credit Hours
ZP 563	**Molecular Biology of Parasites**	**2**	**30**

Introduction to the course
The molecular biology of parasites which has been presented as it relates to the cell biology of parasitic organisms. The course is designed to introduce students with the basics of molecular facts having relevance to parasitological study and will better allow the parasitologists to plan quality researches.

Specific objective of the course
- to enhance students' knowledge to appreciate the relevance of molecular biology in parasitological study.

Course Contents and Number of Classes by Course Sub-title

Sub-titles of Course Contents	Number of Classes
Molecular Biology of Parasites	
Molecular Phylogeny Molecular phylogeny of helminths. The importance of phylogenetic study in the evolution of Parasites.	**5**
Molecular Biology Molecular biology of protozoa and helminth parasites. Genetics and Gene expression.	**20**

Advantages and launching of genetics investigations. Transcription in *Trypanosomes* and Nematodes. Trans-splicing mechanism; Parasite genomics; RNA processing in parasitic organisms: trans-splicing and RNA editing; Transcription; Post-transcriptional regulation; Antigenic variation in African trypanosomes and malaria; Genetic and genomic approaches to the analysis of *Leishmania* virulence. **Molecular interaction of transmission** Molecular aspects of an intimate association between trematode and snails.	**2**

Course Learning Outcomes

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

- explain molecular phylogenetic tree and its application in parasite study; and
- explain molecular interactions between host and parasites.

Instructional Strategies

The course will be delivered through lectures and discussions, power point presentations, video films etc. In the introductory class the students will be informed how the course will proceed. Classes will be made participatory and interactive through questions and answers, group and individual work exercises in the classroom.

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

Class/ lecture type	Number of classes	Class/ lecture type	Number of classes
Lecture with discussion	27	In-course exam	1
Review class	1	Feedback on In-course exam.	1

Assessment

One In-course examination, consisting of 15 marks and one hour duration will be taken for this course. Some 2.5 mark is allocated for class attendance. Another 2.5 marks will be allocated for surprise test/oral presentation/assignment. A course final examination, consisting of 30 marks will be conducted centrally by the university.

References

Molecular Medical Parasitology, J. Joseph Marr, M.D., Timothy W. Nilsen, Richard W. Komuniecki
Boothroyd, J. C. and Komuniecki, R. 1995. *Molecular approaches to parasitology.* Vol. 2.
Lee, D. L. *The Physiology of Nematodes.* 1965. Oliver and Boyd.
Marr, J. J. and Mukker, M. 1995. *Biochemistry and molecular biology of parasites.* Academic Press, Harcourt Brace and Company, New York.
Saleuddin, A. S. M. and Fenton, M. B. 2004. *Canadian Journal of Zoology.* 82 (2).
Smyth, J. D. *Introduction to Animal Parasitology.* 1994. Cambridge University Press.
Smyth, J. D. *The Physiology of Cestodes.* 1969. Oliver and Boyd.
Smyth, J. D. *The Physiology of Trematodes.* 1966. Oliver and Boyd.

Course No.	Course Title	No. of Credits	Credit Hours
ZP 564	**Immunology**	**2**	**30**

Introduction to the course

A highly discriminatory immune system is fundamental to survival. How the immune system accomplishes this level of discrimination remains deeply enigmatic, but such questions are among the many that make immunology a fascinating discipline. Immunology as a distinctive subject developed in the 20th century as researchers started to understand how the adaptive immune system aids in defense against pathogens. The course will allow the students to learn how the immune system in the body is organised and how it works to provide protection against pathogens and foreign molecules.

Specific objectives of the course

- To provide conceptual understanding on immunity, its types and, the make up of the immune system.
- To increase students' knowledge on the mechanism of different type of immune responses in vertebrates.
- To introduce the students with some immunological techniques.

Course Contents and Number of Classes by Course Sub-title

Sub-titles of course contents	Number of classes
Components of Immune System Introduction to the Immune System; Cells, tissues and organs of the Immune system; Antibodies and Immunoglobulins; Complement; T cell receptors and MHC molecules	**6**
Modes of Immune Response Mechanisms of Innate Immunity; Antigen Presentation and Processing; T cell Maturation, Activation and Differentiation; B- cell Generation; Activation and Differentiation; Immune responses in tissues.	**6**
Defence Against Infectous agents Immunity to viruses; Immunity to bacteria and fungi; Immunity to protozoa and worms; Primary Immunodefeciency; AIDS and secondary Immunodeficiency; Vaccination	**5**
Immune Responses against tissues Immunological tolerance; Autoimmunity and autoimmune diseases; Transplantation and rejection; Immunity to cancers	**4**
Hypersensitivity Immediate hypersensitivity type I; Hypersensitivity type II; Type IV hypersensitivity	**3**
Immunological Techniques	**2**

Course Learning Outcomes

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

- compare and contrast innate vs. acquired immunity and cell mediated and humoral immunity;
- differentiate the recognition and effectors functions of T cells and B cells;
- distinguish primary and secondary immune responses and primary and secondary immune organs;
- name the major lymphoid organs and describe their functions;
- describe the basic structures of immunoglobulin molecules and its functions; and
- learn about a variety of immunological techniques.

Instructional Strategies
The course will be delivered through lectures and discussions, power point presentations, video films etc. In the introductory class the students will be informed how the course will proceed. Classes will be made participatory and interactive through questions and answers, group and individual work exercises in the classroom.

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

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

Assessment
One In-course examination, consisting of 15 marks and one hour duration will be taken for this course. Some 2.5 mark is allocated for class attendance. Another 2.5 marks will be allocated for surprise test/oral presentation/assignment. A course final examination, consisting of 30 marks will be conducted centrally by the university.

References

Roitt, I., Brostoff, J. and Male, D. 2001. Immunology. 6th edition. The University of Wisconsin Press, Medison, Wisconsin, USA.

Osborne, B.A. and Kuby, J. 2000. Immunology. 7th edition. Macmillan International Publication, USA.

Course No.	Course Title	No. of Credits	Credit Hours
ZP 565	**Pathology and Medical Microbiology**	**2**	**30**

Introduction to the course
Parasites cause a wide array of pathological changes in host body, many of which are manifested as disease symptoms and helps pathologist to understand the background and significance of diseases and provides basis for its treatment. Medical microbiology deals with the morphology and pathogenesis of various microbes, virus and fungus. This course deals with the study of pathological mechanisms common to all tissue-cell pathology with emphasis on cellular changes, inflammation, healing, laboratory techniques and many more. The course is intended to provide students with a solid foundation in pathological study and commonly encountered pathogenic microbes with a view to developing future career in this area, capable of monitoring health status, and designing and conducting researches in this area of biological sciences.

Specific objectives of the course
- to enable the students to understand basic pathologic processes and responses;
- to familiarize the students with the ranges of pathological changes in hosts' body brought about by parasitic diseases;
- to enhance learning and skills of students on the methods and techniques used in clinical pathology;
- to understand the clinical manifestations, pathogenesis and control of various pathogenic microbes, virus and fungi.

Course contents and number of classes by course sub-title

Sub-titles of course contents	Number of classes
General pathology Aetiology of diseases. Histopathology of infected host tissues; Types of cellular changes. Inflammation and its types. Healing processes. Tumors, ulcers and anaemia. Pathology of parasitic diseases of fish, birds and mammals.	**15**
Clinical pathology Planning a clinical chemistry laboratory. Collection and transport of specimens. Biochemical analysis; constituents of blood and urine. Techniques for examination of- stool, urine and blood.	**5**
Medical Microbiology Clinical manifestation, Pathogenesis, virulence factors and control of the following pathogenic microbes**:** *Mycobacterium tuberculosis, Vibrio cholerae, Escherichia coli, Salmonella typhi*. Virus: Influenza, measles, mumps, chicken pox. Fungi: *Tinea versicolor, Candida*.	**6**

Course Learning Outcomes

Upon completion of this course the student should be able to-

- understand the pathogenesis of the common and important diseases;
- recognize and describe the major cell and tissue alterations associated with parasitic diseases;
- learn about the methods and techniques used for measuring pathological changes in body caused by diseases;
- describe how pathological analysis and techniques are used to recognize the abnormalities; and
- provide knowledge on the techniques used in clinical pathology;
- describe current understanding of the clinical manifestations, pathogenesis and control of the common and important microbes, virus and fungi.

Instructional Strategies

The course will be delivered through lecture and discussions. An introductory class will taken to guide the students on teaching-learning strategy to be followed in the subsequent class. Classes will be made participatory and interactive through questions and answers, group and individual work exercises in the classrooms.

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

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

Assessment

One In-course examination, consisting of 15 marks and one hour duration will be taken for this course. Some 2.5 mark is allocated for class attendance. Another 2.5 marks will be allocated for

surprise test/oral presentation/assignment. A course final examination, consisting of 30 marks will be conducted centrally by the university.

References

Abigall A. Salyers and Dixie D. Whitt. 2002. Bacterial Pathogenesis: A Molecular Approach. ASM Press, 2nd ed.

Cheesbrough, M. 1987. *Medical Laboratory Manual for Tropical Countries.* ELBS Publishing, UK.

Chester W, Chapman H., and Kwon-Chung. Medical mycology. 3rd ed.

Jawed, E., Melnik J.L. and Edward, A. 1980. *Review of Medical Microbiology*. Adel berg, Lange Medical Publications, California, USA.

Jawetz, Melnick and Adelberg's Medical Microbiology / Edited by Karen C. Carroll, Stephen A. Morse, Timothy Mietzner, Steve Miller – McGraw Hill Education, 2016 (27th Ed.).

Khaleque, K.A. and Mannan, K.Z. 2001. *Practical Pathology and Microbiology.*Aleya House, Dhaka, Bangladesh.

Ribulin, W.E. and Migaki, G. 1975. *Pathology of fishes.* The University of Wisconsin Press, Wisconsin, USA.

S. Jane Flint, Lynn W. Enquist, Vincent R. Racaniello, Anna Marie Skalka. 2008. Principles of Virology 2 Vol., ASM Press, 3rd ed.

Course No.	Course Title	No. of Credits	Credit Hours
ZP 566	**Parasite-Host Ecology and Behaviour**	**2**	**30**

Introduction to the course

Ecological parasitology is concerned with the factors for establishment of parasites in or on the host. This course highlights on parasite and its abundance in space, in time and in different hosts, and involves consideration of the factors regulating host-parasite interactions at both the individual and the population levels. Parasites of all kinds are known to modify the behaviour of their hosts in ways that appear to enhance the chances of completing its life cycle. This course provides some powerful conceptual tools allowing rigorous, quantitative predictions to be made when a parasite should manipulate its host.

Specific objectives of the course

- to enhance students conceptual understanding on parasite ecology;
- to provide knowledge on behavioural aspects of parasite and its significance;
- to increase students' knowledge about host specificity in parasitic organism;
- to enhance students understanding on behaviour of the infected host and parasite.

Course contents and number of classes by course sub-title

Sub-titles of course contents	No. of classes
Parasite-Host Ecology **Introduction to parasite ecology**: Definition; host as an environment; existence of parasites in the host as a milieu; Factors favoring the establishment of ecto-and endo-parasite; The role of parasites in the food web and ecosystem. Parasite effects on host ecology. Parasites as bioindicators of ecosystem health. **Communities and determinants of parasites**: The kinds of communities of parasites; the kinds of parasites found in communities; the composition of parasite communities- species richness; parasite characteristics as determinants of species richness; ecological determinants of parasite species richness **Host specificity**: Definition; kinds of parasite-host specificity; establishment of host-	**6**

Sub-titles of course contents	No. of classes
parasite system; phylogenetic aspects and factors responsible for host specificity. Comparative host specificity to genus and species levels. Ecological consequences of specificity. **Inter- and intra-specific relationships within a host**: Intra-specific competition and crowding effects; Inter-specific relationships and ecological consequences of inter-specific reactions. **Dispersion of parasites within a host-parasite system**: Definition; types of host-parasite system; Dispersion of parasites throughout a host population concerning age, behavior, movement, and sex of host.	**5** **5**
Parasite-Host Behavior **Introduction to Behavioral Ecology**: Causation of behavioral ecology: Host finding, host acceptance and infection. Behavior of infected host/ modified host behavior owing to parasites; Behavior of parasites within their host. **Behavioral interactions of parasite-host**: Parasite manipulation of host behavior; Functional role of manipulation of behavior; Phylogenetic evolution of manipulation; Mechanisms of manipulation. **Parasite manipulation of vector behavior**: Introduction, model of blood-feeding behavior-Haematophagy; steps of blood-feeding: The appetitive search, the activation and orientation, attraction and landing & probing. **Behavioral alterations and parasite transmission**: Introduction, transmission by intermediate hosts, transmission by arthropod vectors, behavior enhances host-parasite survival, parasitic castration & host behavior, and fecundity reduction & altered behaviors.	**5** **5**

Course Learning Outcomes

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

- explain the factors responsible for the existence of parasite;
- compare host specificity in generic and specific level;
- explain the reasons that parasite alter the behaviour of its host; and
- explain the factors of dispersion of parasite in a host population.

Instructional Strategies

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

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

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

Assessment

One In-course examination, consisting of 15 marks and one hour duration will be taken for this course. Some 2.5 mark is allocated for class attendance. Another 2.5 marks will be allocated for

surprise test/oral presentation/assignment. A course final examination, consisting of 30 marks will be conducted centrally by the university.

References

Bush, A.O., Fernandez, J.C., Esch, G.W. and Seed, R. 2001. *Parasitism: the diversity and ecology of animal parasites.* University Press. Cambridge, UK.

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

Kennedy, C.R. 1975. *Ecological Animal Parasitology.* Blackwell Scientific Publication, Oxford, UK.

Lewis, E.E., Campbell, J.F. and Sukhdeo, M.V.K. 2002. *The behavioral ecology of Parasites.* CABI Publishing, UK.

Nobel, E.R. and Nobel, G.A. 1971. *Parasitology, The biology of animal Parasites.* Henry Kimpton, London.

Schmidt, G.D. and Roberts, L.S. 2000. *Foundations of Parasitology.* Wm. C. Brown Publishers. USA.

Janice Moore 2002. Parasites and the behavior of animals. Oxford University Press.

Goater T.M, Goater C.P, and Esch G.W 2014. Parasitism, the diversity and ecology of animal parasites. Cambridge University press.

Course No.	Course Title	No. of Credits	Credit Hours
ZP 567	**Parasite diversity and Population dynamics**	**2**	**30**

Introduction to the course

This comprises of two essential aspects of Parasitology. Variations within and among the parasite species and its abundances within a host are often expressed in various quantitative terms. Parasites are also natural selection agents influencing a variety of host attributes. These effects ultimately drive biological diversification, through influencing host reproductive isolation and speciation. Recent discussions of the importance of parasites in food webs as modulators of host behavior, drivers of community composition, competitive interactions and biological invasions; and as selective agents, provide multiple lines of evidence for the ecological and evolutionary relevance of parasitic biodiversity. Parasites show fluctuations in their abundances and occurrences within the host body and show dynamism in their population parameters, including birth, mortality, immigration and emigration etc. This course provides an opportunity for developing a foundation for professionalism in this area of parasitology.

Specific objectives of the course

- to enhance students' knowledge on diversity of parasites and understand why they are important;
- to enhance skills of students to estimate parasite diversity of a particular host population;
- to make students ability to appreciate parasite diversity for conservation and maintaining ecosystem integrity.
- To enhance students' understanding on the dynamic aspects of a parasite population

Course contents and number of classes by course sub-title

Sub-titles of course contents	Number of classes
Parasite diversity **Basic concepts**: Origins and known diversity of parasites; A primer in parasite ecology. **Estimating parasite diversity**: Recognizing parasite diversity; sampling effects and extrapolating diversity; Extrapolation of global parasite species richness; The	**10**

Sub-titles of course contents	Number of classes
parasites basic reproductive number, Ro; Host features and Parasite species richness; Epidemiological Models and Parasite Ecology.	
Host and parasite diversity **Hosts as drivers of parasite diversity**: Host Parasite co evolution: Association by descent and colonization; Hosts as islands; Host traits and parasite species richness; Relationship between parasite diversity and host diversity. **Parasite features and parasite diversification**: Intra host speciation and congeneric parasites; Parasite body size and parasite diversification; Other parasite features and parasite diversification. **Parasite biogeography and phylogeography**: Historical biogeography and parasite diversity; Parasites are where the hosts are; Latitudinal gradients in parasite diversity; other gradients in parasite diversity; Host introductions and parasite species richness. **Parasite extinctions**: Causes of parasite extinctions; Dynamics of local parasite extinctions; Estimated rate of global parasite extinctions. **Parasite diversity driving host evolution**: Parasites and host life history traits; Host metabolism and parasites; Parasites and Host investment in immune functions; Parasites and evolution of the MHC; Parasites, host sex and host sexual selection. **Study and value of biodiversity**: Parasite biodiversity- past, present and future; Why bother about parasite diversity; Parasite diversity as a conservation target.	**10**
Population Dynamics **Basic concepts**: Speciality of parasite population dynamics; factors governing parasite population dynamics; models of parasite population dynamics. Transmission thresholds: Direct and indirect transmission in microparasite and macro parasites. Breakpoints in parasite transmission, population dynamics of malaria.	**6**

Course Learning Outcomes

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

- understand what parasite biodiversity is and why it is an important part of learning;
- understand parasite biogeography, speciation and extinction;
- understand history of parasite biodiversity and its relationship with host evolution.
- design and implement survey works for inventorying of parasites.
- understand the population dynamics of parasites.

Instructional Strategies

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

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

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

Assessment
One In-course examination, consisting of 15 marks and one hour duration will be taken for this course. Some 2.5 mark is allocated for class attendance. Another 2.5 marks will be allocated for surprise test/oral presentation/assignment. A course final examination, consisting of 30 marks will be conducted centrally by the university.

References

Bush, A.O., Fernandez, J.C., Esch, G.W. and Seed, R. 2001. *Parasitism: the diversity and ecology of animal parasites.* University Press. Cambridge, UK.
Poulin, R. and Morand, S. 2004. *Parasite Biodiversity*. Smithsonian Books, Washington DC, USA.

Course No.	Course Title	No. of Credits	Credit Hours
ZP 568	**Epidemiology and Disease control**	**2**	**30**

Introduction to the course
Epidemiology is the study and analysis of the distribution and determinants of health and disease conditions in defined populations. Many parasitic diseases are fatal as well as take the epidemiological manifestations. The control of such parasitic epidemic diseases requires a wide array of information including transmission across the population, pattern of distribution, etc. to plan a control programme. This course will introduce with the epidemiological factors and their measurements. The course will be very useful for students willing to develop career in parasitology.

Specific objectives of the course
- To provide conceptual understanding on the epidemiological factors and their study of parasite mediated epidemic diseases.
- To provide students with the knowledge and skills on the techniques for the measurement of epidemiological parameters.
- To familiar students with different types of distribution of parasites.

Course contents and number of classes by course sub-title

Sub title of contents	No. of classes
Epidemiology	
Introduction and basic concept, Scope of Epidemiology in Parasitology, Modes and dynamics of disease transmission. Measuring the occurrence of disease – mortality, morbidity, proportion, standardization, rates and ratios. Measures of disease occurrence and measures of association. Transmission and exposure status. Epidemiological analysis and biological monitoring. Natural history of disease, types of epidemiological studies, environmental epidemiology. Association and causation, Case control study, Cohort study. Estimating risk, estimating the potential of prevention. Epidemiology, health services and health policy, ethical and professional issues in epidemiology.	**18**
Disease Control Concept and history of disease control. Geo-medical aspects of parasitic diseases. Parasite control – principles, designs and case studies; challenges of parasite control. Vector control – principles, designs and case studies.	**8**

Course Learning Outcomes
At the end of this course, the students will be able to-

- understand the basic principles and concepts epidemic diseases and the epidemiology;
- describe methods and techniques for measuring the epidemiological parameters; the
- conduct epidemiological research;
- understand distribution of parasites in space and time; and
- learn about how to control both parasites and vectors.

Instructional Strategies
Classes will be of interactive type. Students will be asked to have an idea about their presupposition on the tropic at the very beginning of the lecture. Students will take part in discussion after lecture hours. Lectures will be aided by multimedia, video clips and web browsing etc.

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

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

Assessment
One In-course examination, consisting of 15 marks and one hour duration will be taken for this course. Some 2.5 mark is allocated for class attendance. Another 2.5 marks will be allocated for surprise test/oral presentation/assignment. A course final examination, consisting of 30 marks will be conducted centrally by the university.

References
Gordis, L. Epidemiology. 4th Edition. Saunders, an imprint of Elsevier Inc. PP- 375.
Basheer, A. 1995. Environmental Epidemiology. Rawat Publications. New Delhi. India. PP-174.
Fletcher, R. H. and Fletcher, S. W. 2005. Clinical Epidemiology – The Essentials. 4th Edition. Lippincott Williams & Wilkins, USA. Pp- 252.
Rothman, K. J., Greenland, S. and Lash, L. T. 2008. Modern Epidemiology. 3rd Edition. Lippincott Williams & Wilkins, USA. Pp- 758.
Nelson, K. E. and Williams, C. M. Infectious Disease Epidemiology: Theory and Practice. 2nd Edition. Jones and Bartlett Publishers. London/Toronto. PP-1207.
Cox, F.E.G. 1993. *Modern Parasitology.* 2nd edition. Blackwell Science, UK.

Course No.	Course Title	No. of Credits	Credit Hours
ZP 569	**Public Health Parasitology**	**2**	**30**

Introduction to the course
A great variety of parasites infect human, both externally and internally, causing a health concern of considerable magnitude worldwide, some of which cause fatal diseases. Having poor sanitation and medical services the problems of parasitic diseases are more prevalent in Bangladesh.
Some societal change influences the infectious diseases by increasing international traffic, ecological changes, microbial adaptation, changing contact patterns and societal breakdown. Bangladesh has experienced a variety of diseases caused by natural dissemination of an array of pathogenic organisms into the environment. Specifically, the course focuses on the communicable diseases, methods and

techniques for controlling such diseases, knowledge about primary health care and learning different health indicators. The course will be useful for tose willing to build career in public health.

Specific objectives of the course

- to provide students understanding on community health care;
- to enhance students' knowledge on procedures for examining and determining the public health status from the perspective of parasitic diseases;
- to enhance students understanding about relation between disease and community behaviour; and
- to increase students' capability to assess the impact of diseases.

Course contents and number of classes by course sub-title

Sub-titles of course contents	No. of classes
Public health: Basic concept, significance, history and evolution of public and community health, terms related to public health. **One Health:** Concept of one health, principles of one health application, one health in Bangladesh.	**4**
Concept of health and disease: Definition of health, concept of health, changing concept of health, dimensions of health, determinants of health, health indicators, indicators selected to monitor the progress of health for all, health care of the community, comprehensive health care, primary health care (PHC). Definition of disease, concept of disease, theories of disease causation, factors, surveillance, prevention of diseases.	**5**
Public health management: Principles of public health management, laws and ethics. **Public health biology**: Definition and classification of diseases of public health interest, epidemiology of communicable diseases (respiratory infections, intestinal infections, arthropod-borne infections, zoonosis, etc.), epidemiology of non-communicable diseases, emerging and re-emerging diseases. Modern travel and transmittable diseases.	**4**
Public health and nutrition: Nutritional status and problem in Bangladesh, nutritional diseases and their prevention, food safety, and hygiene.	**2**
Environment and health: Definition of environment, environmental factors on public health, water and water-borne diseases, air pollution and airborne diseases, noise and factors related to its harmful effects, radiation and effects of radiation, meteorological environment and green-house effects, humidity, housing, disposal of wastes and excreta, soil pollution, risk assessment of environmental health and climate health.	**4**
Health programs in Bangladesh: Introduction**,** Sustainable developmental goals (SDG), Millennium Developmental Goals (MDG), Health and population sector programs (HPSP), Health nutrition and population sector programs (HNPSP), and Residential field site training (RFST).	**4**
International health organizations and NGOs International organizations working with health in Bangladesh: World Health Organization (WHO), United Nations Development Programme (UNDP), United Nations Fund for Population Activities (UNFPA), International Red Cross & Red Crescent Movement, International Centre for Diarrheal Disease Research Bangladesh (ICDDR'B), United Nations International Children's Emergency Fund	**3**

(UNICEF), United Nations Environment Programme (UNEP), World Bank, Food and Agriculture Organization (FAO), United States Agency for International Development (USAID), and Asian development Bank (ADB). Some international NGOs include Helen Killer International, CARE, The Asia Bangladesh, and Save the Children Fund. Local/National GOs/NGOs: DPH (Department of Public Health), Bangladesh Rural Development Committee, Gonoshasthya Kendra, Community Health Research Association, Bangladesh National Society for the Blind, Bangladesh Red Crescent Society, Rotary and Lions Club in Bangladesh, Bangladesh Rural Advancement Committee (BRAC). Merits and demerits of non-govt. organization.	

Course Learning Outcomes

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

- explain how to protect and improve the health of the population;
- identify current public health problems all around the community;
- assess different health indicators and determinants.
- understand the mode of transmission of communicable diseases across population and across a country; and
- know about the emerging diseases in public health sector.

Instructional Strategies

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

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

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

Assessment

One In-course examination, consisting of 15 marks and one hour duration will be taken for this course. Some 2.5 mark is allocated for class attendance. Another 2.5 marks will be allocated for surprise test/oral presentation/assignment. A course final examination, consisting of 30 marks will be conducted centrally by the university.

References

Park, K. 2014. *Park's Text Book Preventive and Social Medicine.* 22nd edition. M/s BanarsidasBhanot Publishers, India.

Rahman, M., Alamgir, A.K.M and Hafez, A. (ed.). 2012. *Rashid, Kabir, Hyders' Text book of Community Medicine and Public Health.* 5th edition, MAP Publishers, Dhaka, Bangladesh.

Rashid, K.M. Rahman, M. and Hyder, S. 2004. *Community Medicine and Public Health*. 4th edition. RHM Publishers, Dhaka, Bangladesh.

Reza, S. 2014 -2015. *The Essential of Community Medicine.* 12th Edition. Media Plex Medical Publisher and Distributor, Dhaka, Bangladesh.

Roger D., J. Mcewen, R. Beaglehole., and H. Tanaka. 2002. *Oxford textbook of Public Health Ed.* Oxford University Press (OUP) 4th Edition: 28.

Course No.	Course Title	No. of Credits	Credit Hours
ZP 570	**Veterinary Parasitology**	**2**	**30**

Introduction to the course

Veterinary health management is very important for production of dairy and food products of a country. It is an integral part of animal health and one health approaches. A wide variety of animals are parasitic to our livestock and pet animals. In addition to damages made to our live stocks, there are good numbers of animal diseases with zoonotic potential. This course focuses on the diagnosis, pathology and treatment of various common parasitic veterinary diseases. So the scope of Veterinary Parasitology is wide for students of animal science. Students of MS in Parasitology should have detail idea about parasites of veterinary importance.

Specific objectives of the course

- to provide basic idea to students about importance of veterinary parasites;
- to enhance learning about biology, importance, injury and control of common veterinary parasites;
- to enhance students' knowledge on distribution of veterinary parasite.

Course contents and number of classes by course sub-title

Sub title of contents	No. of classes
General introduction: parasites of livestock and companion animals. Opportunities and importance of veterinary parasitology.	**2**
Protozoology: Brief biology, distribution, veterinary importance and control of following parasites: *Eimeria tenella, Sarcocystis neurona, Trypanosoma equiperdum, T. evansi, Cytauxyzoonosis felis, Babesia divergens, Haemoproteus columbae, Histomonas meleagridis, Leucocytozoon symondi, Plasmodium gallinaceum.*	**7**
Helminthology: Brief biology, distribution, veterinary importance and control of following parasites: *Ascaridia galli, Ascaris suum, Capillaria hepatica, Haemonchus contortus, Ancylostoma canium, Dicrocoelium dendriticum, Dictyocaulus viviparous, Dipylidium caninum, Dirofilaria immitis, Echinococcus granulosus, E. laeophorapoeli, E. schneideri, Fasciola giganticus, Fascioloides magna.*	**8**
Entomology: Brief biology, distribution, veterinary importance and control of following parasites: *Haematomyzuse ephantis, Goniocotes gallinae, Columbicola columbae, Haematopinus suis, Comex lectularius, Nosopsyllus fasciatus, Ctenocephalides* spp., *Xenopsylla cheopis, Tabanus atratus, Musca domestica, Gasterophilus intestinalis, Ixodes* spp., *Dermacenter andersoni, Argas* spp.	**6**
Zoonosis: Basic concept, types, factors and potential zoonotic diseases.	**2**
Sustainable food production through livestock health management.	**1**

Course Learning Outcomes

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

- understand the importance of veterinary parasitology;
- assess the damage caused by veterinary parasites;
- understand distribution of parasites in space and time;
- learn about how to control both parasites and vectors of veterinary diseases.

Instructional Strategies

Classes will be of interactive type. Students will be asked to have an idea about their presupposition on the tropic at the very beginning of the lecture. Students will take part in discussion after lecture hours. Lectures will be added by multimedia, video clips and web browsing etc.

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

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

Assessment

One In-course examination, consisting of 15 marks and one hour duration will be taken for this course. Some 2.5 mark is allocated for class attendance. Another 2.5 marks will be allocated for surprise test/oral presentation/assignment. A course final examination, consisting of 30 marks will be conducted centrally by the university.

References

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

Reinecke, R. K. 1983. Veterinary Helminthology. Butterworths Professional Publishers, South Africa.

Schmidt, G.D. and Roberts, L.S. 2000. *Foundations of Parasitology.* Wm. C. Brown Publishers, USA.

Soulsby, E.J.L. 1982. *Helminths, Arthropods and Protozoa of Domesticated Animals.* Bailliere Tindall Publishers, UK.

Williams, R. E. 2010. Veterinary Entomology Livestock and Companion Animals. CRC Press, USA.

Wobeser, G. A.1994. Investigation and Management of Disease in Wild Animals. Plenum Press, New York and London.

Course No.	Course Title	No. of Credits	Credit Hours
ZP 571	**Practical in Parasitology and Public Health (Gr-A)**	**6**	**90**

Introduction to the course

The purpose of this course is to enhance students practical skills in carrying out a range of activities aligned with the theoretical courses of the MS in Zoology (Parasitology and Public Health) programme. The course will be based on practical demonstration classes in the laboratory, hands-on training, experimental trails, and filed work. This will allow the student to equip with knowledge and skills required in ones research and professional career.

Specific objectives of the course

- to make students capable of identifying parasites from blood and other body fluids of various hosts;
- to demonstrate students' standard protocols of parasitological works;
- to increase students' capacity of understanding and applying the molecular methods for parasitological works;
- to investigate histopathological changes caused due to parasitic infestation;
- to enhance their capability to prepare inventory, reports, scientific papers etc.
- to make them capable of developing experimental design.

Course contents and number of classes

Sub-titles of course contents	Number of Classes
Collection and preparation of blood and other body fluids for parasitological studies.	**2**

Sub-titles of course contents	Number of Classes
Examination of parasites from intestinal tracts of invertebrate and vertebrate hosts.	**2**
Collection and preparation of blood and other body fluids for parasitological studies.	**2**
Examination of different living animal hosts (domestic and wild fish) for collection, preservation, mounting and identification of ecto- and endo- parasites.	**2**
Necropsy and inventory of parasites: case study.	**1**
Microscopic examination of blood smears for protozoan parasites.	**1**
Study of blood smears for differential count and cell morphology.	**2**
Parasitological examination of faecal samples.	**2**
Preparation and study of protozoan culture. Survey of parasitic diseases: Recording data for parasitological research: Epidemiological analysis of parasitic infection.	**2**
Histopathological preparation and observation of parasite infected tissues.	**3**
Demonstration of molecular techniques: DNA extraction, PCR, gel electrophoresis, ELISA.	**2**
Research article and review article writing practices.	**2**
Designing plan for parasite control: case studies.	**2**
Field visit **Assignment Project** Any parasitology and public health related short-term project to be assigned by course teachers	

Course Learning Outcomes

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

- collect and prepare parasites for study and identification;
- record data properly;
- learn standard protocols to make inventory of parasites of any host;
- learn molecular techniques; culture and histopathology.
- learn culture techniques of parasites; and
- develop experimental design and write up reports.

Instructional Strategies

The course will be delivered by practical demonstrations in the laboratory, exposure visits to field and laboratory for hands-on training and experiences and also offering an assignment project to build a research foundation for non-thesis students. A number of teachers will demonstrate and guide the individual students in the practical classes and field visits. The practical classes will cover interactive and participatory lectures with PowerPoint and audiovisual systems, group works among students and hands on demonstrations by the teachers. Necessary equipment and logistics will be provided in the laboratory for use in the practical classes. Reference books will also available from the departmental seminar library.

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

Class/lecture types	Number of classes	Class/lecture types	Number of classes
Demonstration and discussion	25	Review class	1
Students group assignments	1	In-course exam	2
Students feedback on course contents and delivery	1		

Assessment

Assessment of practical course will be based on class attendance (5%), in-course assessment (35%) and a final examination (60%). In-course assessment will be done conducting in-course examinations and evaluating an assignment project. There will be at least two in-course examinations for the practical course. Assignment project will be allocated for each student individually and the project report will be evaluated by all course teachers of the branch. Other assessment components viz. report of field/laboratory/research organizations visits and Lab/Notebook will be evaluated with final examination.

References

Garcia, L.S. and Ash, L.R. 1975. *Diagnostic Parasitology Clinical Laboratory Manual*. The C.V. Mosby Company, USA.

Soulsby, E.J.L. 1982. *Helminths, Arthropods and Protozoa of Domesticated Animals*. Bailliere Tindall Publishers, UK.

Svobodova, Z. and Vykusova, B. (ed.). 1991. *Diagnostics, preservation and therapy of fish diseases and intoxications.* Research Institute of Fish Culture and Hydrobiology, Vondnany, Czechoslovakia.

Tonguthai, K., Chinabut, S., Somsiri, T., Chanratchakool, P. and Kanchanakhan, S. 1999. *Diagnostic procedures and finfish diseases.* Aquatic Animal Health Institute, Bangkok, Thailand.

Yamaguti, S. 1959. *SystemaHelminthum. Vol. II. The cestodes of vertebrates.*Interscience Publishers Inc., New York.

Yamaguti, S. 1961. *SystemaHelminthum***.** *Vol III. The nematodes of vertebrates.*Interscience Publishers Inc., New York.

Yamaguti, S.1958. *SystemaHelminthum*. *Vol I. The trematodes of vertebrates.*Interscience Publishers Inc., New York.

Course No.	Course Title	No. of Credits	Credit Hours
ZP 572	**Thesis in Parasitology and Public Health (Gr-B)**	**6**	**90**

Introduction to the course

Under the Thesis course the students will perform a brief original research on Parasitology and Public Health issues. This will also be the first exposure to research work for the student. They will choose a plot of research feasible to complete within stipulated time allocated for his/her MS programme. This course is designed to train the students to develop research proposal with appropriate experimental design; writing skill on various chapters of a thesis. They will learn to follow research methodology to perform a research properly. They will also learn how to prepare a presentation of his research and present it before audience. All activities of a student under this course will be guided by faculty member/s. It will be of great help for them in future to do independent research in his/her career.

Specific objectives of the course

- To orient the students with research work in various fields of Parasitology and Public Health issues.
- To enhance analytical and critical thinking abilities through experimental design, data collection, interpretation, and problem-solving.
- To strengthen scientific communication by training students in writing research reports, presenting findings, and defending their work effectively.

Course contents

Students have to choose a specific topic related to parasitology and public health for conducting an individual research project for this thesis course. In this case, students may consult with his/her supervisor to select their research project concerning any basic or applied aspects of Parasitology and Public Health issues. In addition to these, students have complete freedom to fix any topic related to Parasitology and Public Health branch. This course is divided into two parts firstly writing a thesis based on individual research project and secondly presentation of the thesis. Students must write their thesis following a standard MS thesis structure including a title, abstract, introduction, methodology, results, discussion, conclusion, and references with optional appendices. The front matters the thesis will includes title page, abstract, table of contents**,** dedication, declaration, and acknowledgements. In the main body, the introduction section will include background, review of existing research**,** research gaps, problem statement, rationale of the study, research hypothesis and questions, aims and objective of the research project. Likewise other sections will contain relevant components of a typical MS thesis**.** The maximum word limit for theses is 30,000 words that will include all text, figures, tables, and photographs, excluding references and appendices. No formal classes will be allocated for the thesis course, however pertinent knowledge and information shall be provided by the supervisors through lectures, meeting and group discussion etc.

Course Learning Outcomes

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

- Ability to organize, plane and execute a research work in the various fields of Parasitology and Public Health.
- Proficiency in laboratory techniques, data analysis, and interpretation relevant to Parasitology and Public Health.
- Enhance critical thinking and problem-solving skills to address scientific questions and challenges.
- Capacity to review scientific literature and apply relevant knowledge to research projects.
- Improve scientific writing and presentation skills for preparing a thesis and communicating research outcomes effectively.
- Experience in working ethically and responsibly in a research environment, adhering to scientific and biosafety standards.

Instructional Strategies

Research problem and tentative title will be fixed after rigorous discussion and review of relevant literatures. A synopsis with appropriate experimental design will be developed by the student in consultation with respective supervisor/s. Intermittent meetings will be held between supervisor/s and student on progress and problems facing. The supervisor/s will observe the student at work regularly. Each thesis student will attend the monthly scientific seminar organized by the department.

Assessment

Out of 150 marks 100 marks will be for thesis and rest 50 marks for presentation with defense. Thesis will be evaluated by the external examiners while presentation will be evaluated by the examination committee.

Course No	Course title	No of Credits	Credit hours
ZP 573	**Review article writing and Seminar presentation**	**2**	**30**

Introduction to the course

This course is designed to enhance students' abilities in scientific literature review, critical analysis, and effective communication. It aims to develop skills in writing comprehensive review articles on current topics in Parasitology and Public Health. Students will learn to search, evaluate, and synthesize scientific information from various sources. In addition, the course focuses on improving presentation skills through structured seminars. This course will develop students' presentation skill which is essential for their careers in research, teaching and/or any profession.

Specific objectives of the course

- To develop the ability to critically review and synthesize scientific literature.
- To enhance skills in writing structured and comprehensive scientific review articles.
- To build confidence and competence in delivering effective seminar presentations.

Course contents

Students have to select a specific topic of review project related to parasitology and public health for writing a review paper of any types such as narrative review, systematic review, and meta-analyses. In this case, students may consult with his/her supervisor to select their review project. In addition to these, students have complete freedom to fix any topic related to parasitology and public health branch. This course is divided into two parts firstly writing a review paper and secondly presentation of the reviewed article. Students must write their review paper following a standard structure including a title, abstract with keywords, introduction, methodology (if any), results, discussion, conclusion, and references. The maximum word limit for review article is 4,000 words that will include all text, figures, tables, and photographs, excluding references. No formal classes will be allocated for this course, however pertinent knowledge and information shall be provided by the branch teachers through special lectures, monthly group/lab meeting and group discussion etc.

Course Learning Outcomes

- Ability to critically analyse and interpret scientific literature in once related fields.
- Proficiency in writing well-structured and coherent scientific review articles.
- Improve oral communication and presentation skills for academic and professional settings.
- Enhance confidence in presenting scientific concepts and engaging in scholarly discussions.

Instructional Strategies

The course will involve guided literature review, interactive discussions, and regular mentoring sessions. Students will receive training in scientific review writing techniques and presentation skills. They will prepare review articles and deliver seminars on selected topic. The maximum word limit is 4,000 words that will include all text, figures, tables, and photographs, excluding references and appendices. Department will provide a guild line to follow during preparation and writing of the review.

Assessment
Out of the total 50 marks, 25 will be allocated for review write up and the remaining 25 for seminar presentation. Both the review work and seminar presentation will be assessed by the examination committee.

Course No.	Course title	No of Credits	Credit hours
ZP 574	**Viva voce**	**2 credits**	**30**

Introduction to the course
Viva voce or oral examination is an integral component of the MS programme in Zoology. This is a mandatory course for the students of both thesis and non-thesis group of all branches by which students demonstrate their secured knowledge, expertise, and understanding of theoretical, practical and thesis courses. It's also an opportunity for the examiners to evaluate the academic abilities of students, and ultimately for determining whether they have met the requirements of MS degree.

Specific objectives of the course
- To prepare students for presenting their in-depth knowledge of the broader field of study programme.
- To improve the ability of students to communicate to scientific world with secured skills and expertise
- To assess student's understanding of the programme.

Contents of the course
Course contents of the viva voce include all topics of theory, practical and thesis courses of the respective MS programme. Examination Committee has complete freedom to ask any question related to respective syllabus of the programme. No formal classes will be allocated for this course, however pertinent knowledge and information shall be provided by the course teachers through their routine lectures of theory courses, monthly group/lab meeting and group discussion etc.

Course Learning Outcomes
Upon completion of this course the students will be able to
- Demonstrate how their acquired knowledge, expertise and skills from the courses contribute to their field of study.
- Recognise and explain the current state of knowledge on a particular issue or topic of the programme.
- Demonstrate and assess their academic feats with critical analysis and interpretation of various aspects of the courses.

Instructional Strategies

The course will follow interactive lectures of all theoretical and practical courses and thesis works of the MS programme. Besides, regular lab/group meetings, discussions, and individual or group mentoring sessions will also provide instructions for viva voce. All faculty members of the branch will instruct the students in this regard.

Assessment
This is a two-credit course that carries 50 marks. The respective Examination Committee including external members will assess overall student's knowledge asking questions from the contents of respective syllabus of the MS programme and student will answer questions accordingly.

MS in Zoology (Genetics and Molecular Biotechnology)

Course No.	Course Title	No. of Credits	Credit Hours
ZG 581	Cellular and Molecular Biology	2	30

Introduction to the course

This course explores the fundamental principles of life at the molecular and cellular levels. It covers the molecular basis of life, including bio-elements, energy dynamics, enzymatic reactions, and biosynthesis. Students will study biomolecules such as carbohydrates, lipids, proteins, and nucleic acids, along with key molecular biology concepts like DNA replication, mutation, repair, transcription, translation, and gene regulation. Additionally, the course examines epigenetics, cell cycle regulation, and mechanisms of cell division. It also delves into signal transduction pathways, cellular communication, and the molecular basis of cell death and survival, including apoptosis, autophagy, and necrosis. By integrating these topics, the course provides a comprehensive understanding of cellular and molecular processes essential for life.

Specific objectives of the course

- To Understand Molecular Mechanisms of Life – Exploring the structure, function, and interactions of biomolecules, along with the principles of bioenergetics, enzymatic reactions, and biosynthesis.
- To Analyze Genetic and Cellular Processes – Gaining in-depth knowledge of DNA replication, mutation, repair, transcription, translation, gene regulation, epigenetics, and cell cycle control.
- To Examine Cellular Communication and Survival Mechanisms – Studying signal transduction pathways, cell-cell interactions, apoptosis, autophagy, and other processes that regulate cell fate and homeostasis.

Course contents and number of classes by course sub-title

Title/sub-titles of course contents	No. of classes
Molecular Basis of Life	
Concepts on matter and energy, essential bio-elements and metal ions, enthalpy vs entropy, laws of thermodynamics, free energy, activation energy, energy coupling, principles of enzymatic reactions, reaction vs interactions, energy careers, and biosynthesis.	**2**
Structure and function of biomolecules: carbohydrates, lipids, amino acids, proteins, nucleic acids and DNA.	**2**
Molecular Biology	
DNA mutation and repair: Types and causes of mutation, molecular mechanism of mutagenesis, molecular mechanism of DNA repair systems;	**2**
DNA replication in prokaryotes and eukaryotes: origin and initiation, chemistry of DNA synthesis, major enzymes, elongation, and end replication problem;	**1**
Transcription in prokaryotes and eukaryotes: Gene and regulatory elements; mechanism of transcription; pre-mRNA modifications, mechanism of splicing; RNA export.	**2**
Gene regulation: Concept of gene expression, control of gene expression via DNA binding chemistry- activator-repressor competition, ligand binding, inhibitory proteins; epigenetic control-circadian clock, hormonal/metabolic control; control via RNAs (RNAi, microRNAs).	**2**

Title/sub-titles of course contents	No. of classes
Translation: genetic code and protein synthesis chemistry, control of translation via antibiotics, nonsense, and nonstop mediated decay, proteolysis. Epigenetics: histone modification, DNA methylation, and chromatin remodeling.	**2** **1**
Control of cell cycle and division Cyclin, Cyclin-dependent Kinases (Cdks), APC complex, Mechanisms of cell cycle regulation, cell division response to damage.	**3**
Signal Transduction and Cellular Communication Principles of signal transduction, receptors, and Secondary messengers (e.g., cAMP, Ca^{2+}); Signal transduction pathways (e.g., GPCRs, RTKs, MAPK pathways); Cell-cell communication, cell adhesion-junction, and role of extracellular matrix.	**3** **2**
Cell Death and Survival Concept of programmed cell death (apoptosis), necrosis/inflammatory cell death and senescence; Molecular pathways of apoptosis (caspase cascade, Bcl-2 family), autophagic cell death, survival mTOR and NF-κB Signaling, molecular mechanisms of cellular aging.	**2** **2**

Course Learning Outcomes

After completing this course, students will be able to:

- Understand the Molecular Basis of Life – Explain the roles of biomolecules, bio-elements, enzymatic reactions, and bioenergetics in cellular functions.
- Analyze Genetic and Cellular Processes – Describe DNA replication, mutation, repair, transcription, translation, gene regulation, and cell cycle control.
- Evaluate Signal Transduction and Cellular Communication – Understand key signaling pathways, secondary messengers, and mechanisms of cell-cell communication.
- Interpret Cell Fate Decisions – Differentiate between apoptosis, autophagy, necrosis, and survival mechanisms in cellular aging and disease.

Instructional Strategies

The course will be delivered through lecture and discussion, aided by power point presentations, flip charts, video films, etc. Classes will be made participatory and interactive through questions and answers, and group work exercises in the classroom. Students will be encouraged and guided for eLearning assessments based on lecture material and other reading materials.

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

Class/lecture types	Number of classes	Class/lecture types	Number of classes
Lecture, discussion and review classes	26	In-course exam	2
Feedback on in-course exam Plus group presentation	4	eLearning and assessments	2

Assessment

There will have at least one In-course test. A total of 17.5 marks will be allocated for In-course exams and 2.5 marks for class attendance. The students will be frequently asked questions in the classrooms to assess individual performance. A course final examination, consisting of 30 marks, will be conducted by the university.

References

Alberts B., Johnson A., Lewis J., Raff M., Roberts K. and Walter, P. 2004. Molecular Biology of the Cell 4th edt. Garland Science Publisher, UK.

Brown, T. 2012. Introduction to Genetics: A Molecular Approach. Garland Science Publisher, UK.

Hartl, Daniel L. and Ruvolo Maryellen. 2012. Genetics: Analysis of Genes and Genomes. 8th edition. Jones and Barlett Pvt. Ltd., India.

Klug, W.S. and Cummings, M.R. 2017. Concepts of Genetics. 11th edition. Pearson Education, Inc., New Jersey, USA. (e-Book available: https://smtebooks.com/book/7787/concepts-genetics-11th-edition-pdf)

Lehninger, A.L., Nelson. D.L. and Cox, M.M. 1993. Principles of Biochemistry. CBS Publishers and distributors, Delhi, India.

Snustad and M.J. Simmons. 2015. Principles of Genetics. 7th Ed. John Willey and Sons. Inc. New York, USA.

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

Course No.	Course Title	No. of Credits	Credit Hours
ZG 582	**Animal Biotechnology**	**2**	**30**

Introduction to the course

Animal Biotechnology is an advanced field that applies molecular and cellular techniques to enhance animal health, productivity, and conservation. This course explores genetic manipulation tools, including genome editing, mutagenesis, and transgenic animal production. It covers animal cell culture and tissue engineering principles, along with stem cell biotechnology and regenerative medicine. Students will also learn about cloning and reproductive technologies such as somatic cell nuclear transfer (SCNT), in vitro fertilization (IVF), and embryo cryopreservation for species conservation. Additionally, the course examines livestock and aquaculture biotechnology, focusing on disease-resistant breeds, biotech feeds, and reproductive enhancements. Insect biotechnology applications, including sterile insect technique (SIT) and genetic control methods, will also be discussed. By integrating these topics, the course provides a strong foundation in modern biotechnological approaches for animal research, agriculture, and conservation.

Specific objectives of the course

- To Understand Genetic Manipulation Techniques – Exploring genome editing tools, mutagenesis methods, gene delivery systems, and transgenic animal production.
- To Learn Cell Culture and Reproductive Biotechnology – Studying principles of animal cell culture, tissue engineering, cloning, and assisted reproductive technologies (ART) for genetic improvement and conservation.
- To Apply Biotechnology in Livestock, Aquaculture, and Insect Control – Developing knowledge of disease-resistant breeds, biotech feed production, reproductive enhancements, and genetic control of insect pests.

Course contents and number of classes by course sub-title

Title/sub-titles of course contents	No. of classes
Introduction to Animal Biotechnology Scope, significance and ethics of animal biotechnology.	**1**
Genetic manipulation in Animals Genome editing tools and techniques; Mutagenesis (eg. site-specific, In-vitro, random); Mutant production through gene deletion, recombination, transformation and overexpression; Gene delivery systems, Production of transgenic animals; Genetic modification, transposons, hybridization and variety creation.	**3** **2** **3**
Animal Cell Culture and Tissue Engineering Principles of animal cell culture: Types, Media preparation and culture techniques; Tissue engineering-scaffold, bioreactors and regenerative medicine.	**3**
Stem Cell Biotechnology Types, applications, and challenges; genetic mechanisms of tissue regeneration: examples of regenerative capacity in animals (e.g., salamanders, planarians etc.); Genetic control of stem cells in regenerative processes.	**3**
Cloning and Reproductive Biotechnology Methods of animal cloning: Somatic cell nuclear transfer (SCNT); Assisted reproductive technologies (ART): IVF, embryo transfer, and artificial insemination. Conservation of endangered species; gamete and embryo cryopreservation.	**3**
Livestock and Aquaculture Biotechnology Development of disease-resistant breeds; Biotech feed production and nutrient enhancement, probiotics and prebiotics feeds; sex reversal techniques in fishes.	**3**
Insect Biotechnology SIT, chemical, physical and biocontrol, Genetically engineered mosquitoes.	**3**

Course Learning Outcomes

After completing this course, students will be able to:

- Explain Genetic Manipulation Techniques – Describe genome editing tools, mutagenesis, transgenic animal production, and gene delivery systems.
- Understand Cell Culture and Reproductive Biotechnology – Demonstrate knowledge of animal cell culture, tissue engineering, cloning, and assisted reproductive technologies (ART).
- Apply Biotechnology in Livestock, Aquaculture, and Conservation – Analyze strategies for disease-resistant breed development, biotech feed production, and species conservation.
- Explore Insect Biotechnology for Pest Control – Understand genetic and biotechnological approaches, including SIT and genetically engineered insects, for pest management.

Instructional Strategies

The course will be delivered through lecture and discussion, aided by power point presentations, flip charts, video films, etc. Classes will be made participatory and interactive through questions and answers, and group work exercises in the classroom. Students will be encouraged and guided for eLearning assessments based on lecture material and other reading materials.

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

Class/lecture types	Number of classes	Class/lecture types	Number of classes
Lecture, discussion and review classes	26	In-course exam	2
Feedback on in-course exam Plus group presentation	4	eLearning and assessments	2

Assessment

There will have at least one In-course test. A total of 17.5 marks will be allocated for In-course exams and 2.5 marks for class attendance. The students will be frequently asked questions in the classrooms to assess individual performance. A course final examination, consisting of 30 marks, will be conducted by the university.

References

National Research Council. (2002). *Animal Biotechnology: Science-Based Concerns.* National Academies Press.

Masters, J. R. W. (2000). *Animal Cell Culture: A Practical Approach.* Oxford University Press.

Cibelli, J., Lanza, R. P., Campbell, K. H. S., & West, M. D. (2002). *Principles of Cloning.* Academic Press.

Glick, B. R., & Patten, C. L. (2017). *Molecular Biotechnology: Principles and Applications of Recombinant DNA.* ASM Press.

Meyers, R. A. (2013). *Stem Cells: From Biology to Therapy.* Wiley-VCH.

Course No.	Course Title	No. of Credits	Credit Hours
ZG 583	**Genetics of Development, Immunity, and Behavior**	**2**	**30**

Introduction to the course

Genetics of Development, Immunity, and Behavior is an advanced course designed to explore the genetic principles underlying key biological processes in development, immune function, and behavior. By integrating knowledge from developmental genetics, immunogenetics, and neurogenetics, the course provides insights into the genetic and molecular mechanisms that govern organismal growth, adaptation, and interaction with the environment. Through the study of model organisms, genetic pathways, and molecular techniques, students will develop a comprehensive understanding of the roles genes play in shaping developmental outcomes, immune responses, and behavioral traits.

Specific objectives of the course

- To introduce the core principles of developmental genetics, immunogenetics, and neurogenetics to understand how genetic mechanisms regulate development, immunity, and behavior.
- To develop the ability to analyze and interpret genetic pathways, mechanisms, and disorders associated with development, immune responses, and neural function.
- To highlight the interconnectedness of genetic principles across developmental biology, immunology, and neuroscience to foster a multidisciplinary perspective.
- To equip students with knowledge of model organisms and experimental techniques to explore practical applications in regenerative medicine, immune system modulation, and behavioral genetics.

Course contents and number of classes by course sub-title

Title/subtitle of the course contents	No. of classes
Foundations of Developmental Genetics	
Introduction and Overview of Developmental Genetics and its importance	**2**
Model organisms in developmental genetics	**1**
Developmental Mechanisms and Disorders	
Key developmental pathways and genes	**2**
Pattern formation and morphogenesis	**2**
Impact of genetic mutations on development; Examples of developmental disorders	**2**
Developmental Plasticity	
Regenerative capacity in animals	**1**
Genetic mechanisms underlying neural repair and regeneration – insights from regenerative models like zebrafish and planarians	**2**
Immunogenetics	
Molecular and Cellular Basis of Immune Responses: Humoral and cell-mediated immune responses	**1**
Clonal theory of immune response; Mechanism of adaptive immune response;	**1**
Antibodies: structure, diversity, function, and mechanism of action; Complement activation, mechanism and function;	**3**
Recognition of antigens by T cells, Major Histocompatibility Proteins: Structure and function in immune recognition.	**2**
Neurogenetics and Behavior	
Genetic Basis of Neural Development, Mutations affecting neural development, Genetic factors contributing to neurodevelopmental and neurodegenerative disorders	**2**
Influence of genetic factors on behavior	**1**
Model organisms for studying behavioral genetics (*Drosophila*, *C. elegans*, rodents); Circadian rhythms, courtship, and social behavior in *Drosophila*	**2**
Role of epigenetic modifications (e.g., DNA methylation, histone modification) in brain function and behavior	**2**
Mechanisms of neural plasticity: processes of learning and memory	**2**

Course Learning Outcomes

By the end of this course, students will be able to:

- Explain the importance of developmental genetics and the utility of model organisms in research.
- Describe key pathways and genes involved in pattern formation, morphogenesis, and regenerative capacity.
- Evaluate the impact of genetic mutations on developmental outcomes and identify examples of developmental disorders.
- Analyze the role of epigenetic modifications and neural plasticity in brain function, learning, and memory.
- Utilize insights from model organisms to address questions in developmental, immune, and behavioral genetics.
- Critically evaluate recent research and advancements in regenerative genetics, immunogenetics, and behavioral genetics.

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

Class/lecture types	Number of classes	Class/lecture types	Number of classes
Lecture, discussion and review classes	26	In-course exam	2
Feedback on in-course exam Plus group presentation	4	eLearning and assessments	2

Assessment

There will have at least one In-course test. A total of 17.5 marks will be allocated for In-course exams and 2.5 marks for class attendance. The students will be frequently asked questions in the classrooms to assess individual performance. A course final examination, consisting of 30 marks, will be conducted by the university.

References

Abbas, A. K., Lichtman, A. H. and Pillai, S. 2014. Cellular and Molecular Immunology. 5th edition.

Alberts, B. 2017. Molecular Biology of the Cell. 6th edition. Garland Science, USA.

Nelson, D. L., and Cox, M.M. 2016. Lehninger Principles of Biochemistry. Sixth Edition. W.H. Freeman
and company, New York, USA.

Klug, W.S. and Cummings, M.R. 2017. Concepts of Genetics. 11th edition. Pearson Education, Inc., New Jersey, USA.

Snustad and M.J. Simmons. 2015. Principles of Genetics. 7th Ed. John Willey and Sons. Inc. New York,USA.

Course No.	Course Title	No. of Credits	Credit Hours
ZG 584	**Genetics of Human Diseases**	**2**	**30**

Introduction to the course

This course explores the intricate interplay between genetics and human health, emphasizing the molecular underpinnings of various diseases and their broader implications. By bridging foundational concepts and cutting-edge research, it provides students with a comprehensive understanding of the genetic basis of neuronal, oncological, immunological, metabolic, and zoonotic diseases. Students will delve into mechanisms of disease development, diagnostic approaches, and therapeutic interventions, highlighting the role of genetics in addressing complex health challenges.

Specific objectives of the course

The primary objectives of this course are to:

- Provide an in-depth understanding of the genetic and molecular mechanisms underlying human diseases.
- Explore the connection between genetic mutations, cellular processes, and the manifestation of neuronal, oncological, immunological, and metabolic disorders.
- Introduce students to the One Health approach, emphasizing zoonotic diseases, antimicrobial resistance, and the integration of genetic tools in global health.
- Develop critical thinking skills to evaluate genetic research and its application in disease diagnostics, therapeutics, and management.

Course contents and number of classes by course sub-title

Title/subtitle of the course contents	No. of classes
Neuronal Disorders in Humans	
Genetic basis of neuronal disorders	**1**
Neurodevelopmental Disorders: Autism spectrum disorder (ASD), Attention-deficit/hyperactivity disorder (ADHD), Intellectual disabilities and fragile X syndrome	**2**
Neurodegenerative Disorders: Alzheimer's disease, Parkinson's disease, Huntington's disease	**3**
Neuropsychiatric Disorders: Schizophrenia, Bipolar disorder and anxiety disorders	**2**
Cancer biology and Oncogenetics	
Introduction to Cancer Biology: Hallmarks of Cancer, Basic Mechanisms of Cancer Development, Cancer Classification	**2**
Oncogenes and Tumor Suppressors; Molecular Pathways in Cancer; Cell Cycle Dysregulation in Cancer	**2**
Genetic and Epigenetic Alterations in Cancer	**1**
Tumor Microenvironment and Metastasis; Cancer Therapeutics	**1**
Immunodeficiency Diseases	
Overview of Immunodeficiency Diseases: Types and Mechanisms of Immunodeficiency Diseases, Acquired Immunodeficiency Syndrome (AIDS)	**2**
HIV: Transmission and Lifecycle of HIV, Mechanism of Immunosuppression; Diagnosis and treatment of HIV and AIDS	**2**
Metabolic Diseases	
Overview of Metabolic Diseases: Common Features and Types of Metabolic Diseases	**1**
Diabetes Mellitus: Types and pathophysiology of Diabetes; symptoms and diagnosis of Diabetes; complications of Diabetes	**3**
Insulin gene, biosynthesis and secretion of insulin, mechanism of Insulin action; Management and Treatment of Diabetes	**2**
One Health Genetics	
Overview of the One Health concept	**1**
Zoonotic Diseases (SARS-COV-2)	**1**
Antimicrobial Resistance (AMR)	**1**
Genetic Tools and Technologies in One Health	**1**

Course Learning Outcomes

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

- Uncover the genetic underpinnings of complex neuronal disorders, such as autism spectrum disorder, Alzheimer's disease, and schizophrenia, to understand their biological roots.
- Investigate how genetic mutations and epigenetic modifications influence the onset and progression of diseases like cancer and metabolic disorders.
- Examine the molecular pathways involved in tumor development and metabolic imbalances, identifying key points of dysregulation.
- Assess cutting-edge diagnostic tools and therapeutic approaches used to manage genetic and metabolic diseases effectively.
- Discover groundbreaking genetic technologies revolutionizing disease research and treatment, within the holistic One Health framework.

- Engage in collaborative, cross-disciplinary efforts to integrate genetic knowledge into broader health and environmental strategies for a sustainable future.

References

Abbas, A.K. *et al.* (2022) *Cellular and molecular immunology*. Philadelphia, PA: Elsevier.

Holt, R.I.G. and Flyvbjerg, A. (2024) *Textbook of diabetes*. Hoboken, NJ: Wiley-Blackwell.

Kandel, E.R. *et al.* (2021) *Principles of Neural Science*. New York: McGraw Hill.

Paul, W.E. (1989) *Fundamental immunology*. New York: Raven Pr.

Weinberg, R.A. *et al.* (2023) *The Biology of Cancer*. New York, N.Y: W. W. Norton & Company, Inc.

Zinsstag, J. (2021) *One health: The theory and practice of integrated health approaches*. Wallingford, Oxfordshire, UK: CAB International.

Course No.	Course Title	No. of Credits	Credit Hours
ZG 585	**Functional Genomics and Bioinformatics**	**2**	**30**

Introduction to the course

One of the recent innovations and developments in molecular biology relates to "omic" technologies surrounding the genomics and use of bioinformatics. In fact, Omic technologies are regularly applied in medical research and throughout the drug-development process. High throughput technologies are being used to study gene stucture, gene regulation and epigenomic processes within an organism. Rather investigating single genes, omic methods simultaneously investigate large numbers of genes in one single experiment. This course will focus on these technologies to provide an exposure to the key applications, techniques and recent advances in this field and is useful for career build up in this area of molecular biology.

Specific objectives of the course

- To provide an in-depth conceptual understanding on the genomcs and technologies used in genomics
- To familiarize the students with the omic techniques used in medical sciences and drug development
- To enhance students skills in applying bioinformatics in researches and studies

Course contents and number of classes by course sub-title

Title/sub-titles of course contents	No. of Classes
Basic Understanding of Genomics: Gene; genome; genomics; classification of genomics; structure and different sites of DNA (regulatory sequences, coding and non coding sequences, repitative sequences, transposable eliment, terminal region); gene structure in DNA (Identification marks of regular sequence, promoter region, initiation site, transcription factor binding site, Exon-Intron boundaries, termination site); Comparetive study of viral, prokaryotic and eukaryotic gene structure in DNA.	**4**
Microbial genomics and Genome epidemiology: Basic knowledge on microbial genomics; structure of a typical bacterial and viral DNA/RNA; brief study on replication, transcription (operon, post transcriptional modification), translation processes; antibiotic resistance pathway (with a typical example); bacterial and viral gene mapping process; genome epidemiology.	**3**

Mitochondrial genomics: Evolution of mitochondrial genome: Diversity of mitochondrial genome in different group of living organisms; human mitochondrial DNA (structure, gene arrangement, d-loop region, gene function); role of mitochondrial genome in apoptosis and aging; replication, transcription and translation processes of mitochondrial genome.	**3**
Epigenomics: Basic principle and methods of epigenomics.	**3**
Metagenomics: Basic principle and methods of metagenomics.	**3**
Nutritional genomics: Basic concepts on nutritional genomics.	**2**
Genome sequencing methods: Next generation sequencing vs shot-gun approach; Pyro seq, Mi seq, Hi seq, Nova seq, RNA seq, Oxford Nanopore, Bisulfide sequencing; genome-wide association study (GWAS), Foot printing; microarray; qPCR.	**3**
Genomic databases and Bioinformatic tools: Introducing major data bases (NCBI, retrieving gene sequence from GenBank, FASTA file, BLAST, Multiple sequence alignment); Designing PCR Primer, Finding Protein-coding regions; Phylogenetic tree construction and analysis; Genotyping, Mutation Identification, typing; Use of MEGA software, gene annotation.	**5**

Course Learning Outcomes

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

- understand the basics of genomics and bioinformatics;
- gain skills in applied bioinformatics and functional genomics; and
- get familiarity with omic techniques, particularly related to drug development process.

Instructional Strategies

The course will be delivered through lecture and discussion, aided by power point presentations, flip charts, video films, etc. Classes will be made participatory and interactive through questions and answers, and group work exercises in the classroom. Students will be made engaged with eLearning assessments based on lecture material and supplementary lecture-related materials.

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

Class/lecture types	Number of classes	Class/lecture types	Number of Classes
Lecture, discussion and review classes	26	In-course exam	1
Feedback on in-course exam and group presentation	2	Learning and assessment	1

Assessment

There will be one In-course examinations, consisting of 17.5 marks and 2.5 marks will be allocated for class attendance. The students will be frequently asked questions in the classrooms to assess individual's performance.

References

Abbas, A. K., Lichtman, A. H. and Pillai, S. 2014. Cellular and Molecular Immunology. 5th edition.

Alberts, B. 2017. Molecular Biology of the Cell. 6th edition. Garland Science, USA.

Klug, W.S. and Cummings, M.R. 2017. Concepts of Genetics. 11th edition. Pearson Education, Inc., New Jersey, USA. (e-Book available: https://smtebooks.com/book/7787/concepts-genetics-11th-edition-pdf)

Lehninger, A.L., Nelson. D.L. and Cox, M.M. 1993. Principles of Biochemistry. CBS Publishers and distributors, Delhi, India.

Pierce, B.A. 2005. Genetics: A Conceptual Approach. 2nd edition. W.H. Freeman and Company, New York, USA.

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

Course No.	Course Title	No. of Credits	Credit Hours
ZG 586	**Introduction to Proteomics and Metabolomics**	**2**	**30**

Introduction to the course

One of the recent innovations and developments in molecular biology relates to "omic" technologies surrounding proteomics and bioinformatics. Omic technologies are regularly applied in medical research and throughout the drug development process. High throughput technologies are being used to study gene regulation, protein function, and quantification of metabolites and metabolic networks within an organism. Rather than investigating single proteins or single metabolites, omic methods simultaneously investigate large numbers of proteins or metabolites in one single experiment. This course will focus on these technologies to provide exposure to the key applications, techniques and recent advances in this field and is useful for career build up in this area of molecular biology.

Specific objectives of the course

- To provide an in-depth conceptual understanding of proteomic and metabolomics technologies.
- To familiarize the students with the omic techniques used in medical sciences, clinical diagnostic, and drug development process.
- To enhance student's skills in applying bioinformatics in research and studies.

Course contents and number of classes by course subtitle

Title/sub-titles of course contents	No. of classes
Functional Proteomics	
Basic concepts of Proteomics; chemical structure of proteins;	**2**
Conformation of the polypeptide chain;	**2**
Protein folding types and patterns;	**2**
Concept of binding and docking; post-translational modifications;	**2**
Metabolomics	
Metabolites: types and concepts, Metabolic profiling;	**2**
Metabolic pathways and engineering.	**2**
Proteomic techniques	
Principles and applications of 2D PAGE, Protein localization technology, Protein-Protein interaction (Yeast-2-hybrid system), polysome profiling;	**4**
Different chromatographic techniques (gel filtration, ion exchange, affinity, HPLC, Gas chromatography);	**2**

MS/MS Spectrometry, Protein identification by peptide mass fingerprinting, and Capillary electrophoresis; FTIR, X-ray crystallography, Tomography, Electron microscopy, NMR, ELISA; **Bioinformatic tools**	**3**
Bioinformatic tools for proteomics: NCBI, PDB database, nucleotide to amino acid sequence, prediction of secondary structure of a protein, etc.	**7**
Application of Proteomic techniques in pharmacology, pathology, toxicology, and cell biology.	**4**

Course Learning Outcomes

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

- understand the basics of proteomics, metabolomics, and bioinformatic tools;
- gain skills in applied bioinformatics and functional proteomics like clinical diagnostic, understanding disease mechanisms;
- Gain proficiency in bioinformatic tools for analyzing protein data;
- get familiarity with omic techniques, particularly related to drug development, disease research and personalized medicine.

Instructional Strategies

The course will be delivered through lectures and discussion, aided by powerpoint presentations, flip charts, video films, etc. Classes will be made participatory and interactive through questions and answers, and group work exercises in the classroom. Students will be made engaged with eLearning assessments based on lecture material and supplementary lecture-related materials.

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

Class/lecture types	Number of classes	Class/lecture types	Number of classes
Lecture, discussion and review classes	27	In-course exam	1
Feedback on in-course exam and group presentation	1	Learning and assessment	1

Assessment

There will be at least one In-course test. A total of 15 marks will be allocated for In-course exams and 2.5 marks for class attendance. Another 2.5 marks will be allocated for surprise test/oral presentation/assignment. The students will be frequently asked questions in the classrooms to assess individual performance. A course final examination, consisting of 60 marks, will be conducted by the university.

References

Alberts, B. 2017. *Molecular Biology of the Cell*. 6th edition. Garland Science, USA.

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Bino RJ, Hall RD, Fiehn O, Kopka J, Saito K, Draper J, Nikolau BJ, Mendes P, Roessner-Tunali U, Beale MH, Trethewey RN, Lange BM, Wurtele ES, Sumner LW. 2004. *Potential of metabolomics as a functional genomics tool. Trends in Plant Science 9*: 418-425.

Campbell, A.M. and Heyer, L.J. 2009. *Discovering Genomics, Proteomics, and Bioinformatics.* 2nd edition. Pearson Education, Inc., UK.

Dan, E.K. and Michael, L.R. 2003. *Fundamental Concepts of Bioinformatics.* Pearson Education Inc., UK.

Dunn WB, Ellis DI. 2005. Metabolomics: current analytical platforms and methodologies. *Trends in Analytical Chemistry 24*: 285-294.

Klug, W.S. and Cummings, M.R. 2003. *Concepts of Genetics.* 7th edition. Pearson Education Pvt. Ltd., Singapore.

Nelson, D. L., and Cox, M.M. 2016. *Lehninger Principles of Biochemistry*. Sixth Edition. W.H. Freeman and company, New York, USA.

Course No.	Course Title	No. of Credits	Credit Hours
ZG 587	**Genetic Engineering**	**2**	**30**

Introduction to the course

The tremendous development in molecular biology, genetic engineering in particular, has resulted in the wider applications of molecular techniques sectors. This course focuses on the basic techniques required for the study of genetic engineering This course provides a comprehensive understanding of molecular biology techniques, focusing on restriction enzymes and vectors for DNA manipulation. It covers gene cloning strategies in *Escherichia*, *Saccharomyces*, and other organisms, along with the construction of DNA libraries. Key topics include marker genes, gel electrophoresis, PCR, blotting techniques, primer design, and DNA sequencing methods like Sanger and Next-Generation Sequencing. The course also explores DNA fingerprinting applications in forensics and paternity testing. Finally, it addresses ethical and environmental issues, including biosafety regulations and the responsible use of genetic technologies in medicine, industry, and agriculture.

Specific objectives of the course

- Explain the types, nomenclature, and applications of restriction enzymes and their role in DNA cutting and joining.
- Describe various vectors (plasmids, cosmids, phasmids, YACs) and their significance in gene cloning.
- Demonstrate gene cloning strategies in *E. coli*, *Saccharomyces cerevisiae*, and other organisms.
- Explain the construction and importance of genomic DNA and cDNA libraries for genetic research.
- Apply gel electrophoresis, PCR, blotting techniques, and primer design for DNA/RNA analysis.
- Compare sequencing methods such as Sanger sequencing, RNA sequencing, and Next-Generation Sequencing (NGS).
- Explain DNA fingerprinting principles and its applications in forensics, paternity testing, and identification.
- Assess biosafety regulations, ethical issues, and environmental concerns in gene manipulation and biotechnology.

Course contents and number of classes by course sub-title

Title/sub-titles of course contents	No. of classes
Restriction enzymes and Vectors Types, nomenclature and applications of restriction enzymes; Cutting and joining DNA molecules; Plasmid, cosmids, phasmids; Yeast Artificial Chromosomes (YAC) and other advanced vectors.	**4**
Gene cloning Strategies Cloning in *Escherichia coli* and other bacteria; Cloning in *Saccharomyces cerevisae* and other fungi.	**2**
DNA Library Construction of genomic DNA and cDNA libraries.	**2**
Marker genes Selectable markers, screenable markers, other markers.	**2**
Fundamental Molecular techniques Introduction, Fundamental techniques of gene manipulation;	**6**

Title/sub-titles of course contents	No. of classes
Principle, type and application of Poly acrylamide and Agarose Gel Electrophoresis; Key component, steps and application of Polymerase Chain Reaction Technique; Principle, steps and application of Southern, Northern, Western and other blotting techniques; Key considerations and process of Primer design.	
Sequencing methods Maxam Gilbert, Sanger sequencing; RNA-sequencing; Next Generation Sequencing and other techniques.	**3**
DNA fingerprinting Principles of DNA fingerprinting; Application of DNA fingerprinting in criminal investigation (person identification), paternity dispute, immigration, identification of missing children or bodies found in accidents.	**3**
Ethical and Environmental issues Biosafety regulations to protect producers, consumers and nature; Ethical and environmental issues concerning use of cloned gene in medicine, industry and agriculture.	**4**

Course Learning Outcomes

By the end of this course, students will be able to:

- Explain the classification, mechanism, and applications of restriction enzymes and their role in DNA manipulation.
- Identify different types of vectors and their functions in gene cloning.
- Perform gene cloning in *E. coli*, *Saccharomyces cerevisiae*, and other host organisms.
- Construct and utilize genomic DNA and cDNA libraries for genetic research.
- Conduct gel electrophoresis, PCR, and blotting techniques for DNA/RNA analysis.
- Design primers for gene amplification and analyze sequencing data.
- Differentiate between Sanger sequencing, RNA sequencing, and Next-Generation Sequencing (NGS).
- Apply DNA fingerprinting techniques in forensic science, paternity testing, and genetic identification.
- Evaluate the impact of biosafety regulations, ethical concerns, and environmental risks in genetic engineering.
- Discuss the responsible use of genetic technologies in medicine, industry, and agriculture.

Instructional Strategies

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

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

Class/lecture types	Number of classes	Class/lecture types	Number of classes
Lecture and discussion	26	Review and Questionnaire survey	1
Students' group presentation	2	In-course exam	1

Assessment

There will have at least one In-course tests. A total of 15 marks will be allocated for In-course exams and 2.5 marks for class attendance. Another 2.5 marks will be allocated for surprise test/oral presentation/assignment. A course final examination, consisting of 30 marks will be conducted centrally by the university. The students will be frequently asked questions in the classrooms to assess individual's performance.

References

Brown, T. 2012. Introduction to Genetics: A Molecular Approach. Garland Science Publisher, UK.

Glick, B.R and Pasterniak, J.J. 2003. *Molecular Biotechnology- Principles and Applications of Recombinant DNA*. 4th edition. ASM Press, Washington, DC, USA. (https://www.academia.edu/28272521/Molecular_BiochemistryBernard_R_Glick_Jack_J_Pasternak_Cheryl_L_Patten_pdf)

Primrose, S.B. and Twyman, R.M. 2010. *Principles of Gene Manipulation and Genomics.* 7th edition. Blackwell Publishing, UK.

Sambrook, J. and Russell, D.W. 2001. *Molecular Cloning (A Laboratory Manual)*, Vol. 1, 2 & 3, 3rd edition. Cold Spring Harbor Laboratory Press, USA.

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

Course No.	Course Title	No. of Credits	Credit Hours
ZG 588	**Industrial Biotechnology**	**2**	**30**

Introduction to the course

Biotechnology plays a crucial role in various industries, including medicine, food, agriculture, and environmental management. This course explores key aspects of pharmaceutical biotechnology, including disease diagnosis, gene medicine, DNA/RNA vaccines, and gene editing technologies like CRISPR-Cas9. It also covers food and beverage biotechnology, focusing on traditional and industrial fermentation processes. Bioprocess engineering topics include insulin, growth hormone, antibody production, and enzyme applications. Additionally, the course examines agricultural biotechnology, discussing GMOs, antimicrobials, and antibiotics, and highlights environmental biotechnology, addressing plastic degradation and wastewater treatment using genetically engineered microbes.

Specific objectives of the course

- Explain diagnostic techniques such as karyotyping, FISH, RFLP, ASO, and microarray for disease detection.
- Describe the types and applications of gene medicine and DNA/RNA vaccines for treating diseases like cancer, dengue, and COVID-19.
- Compare traditional and industrial methods of beer, wine, and ethanol production.
- Explain the importance of enzymes in the food and pharmaceutical industries.
- Evaluate the impact of GMOs, Bt gene technology, and antimicrobial agents in agriculture.
- Explain the production and clinical applications of insulin, growth hormones, and antibodies.
- Discuss the role of genetically modified organisms in plastic degradation and wastewater treatment.
- Assess the benefits and risks of genetic engineering in environmental conservation.

Course contents and number of classes by course sub-title

Title/sub-titles of course contents	No. of classes
Pharmaceutical Biotechnology Diagnosis of diseases: Karyotyping, fluorescence in situ hybridization (FISH), restriction	**8**

Title/sub-titles of course contents	No. of classes
fragment length polymorphism (RFLP) analysis, allele specific oligonucleotide (ASO), microarray; Gene medicine: Types and application of gene medicine; DNA/RNA vaccines: Application of vaccine against cancer, dengue, covid-19 and other animal diseases; Gene editing technologies: CRISPR-Cas9 in industry; HBV antigen: Types of HBV antigen to detect HBV infection.	
Food and Beverage Biotechnology Food-beverages: Traditional and industrial methods of beer, wine and ethanol production;	**4**
Bioprocess Engineering Insulin and growth hormone: Production of insulin and growth hormone; Antibody: Types, production, clinical importance. Enzymes: Features of enzymes, importance of enzyme production in food and pharmaceuticals industry.	**4**
Agricultural Biotechnology Improving agronomic traits by genetic modification: *Bt* gene, resistant strains; Genetically modified foods (GMOs): Benefits and risks. Antimicrobials: Mechanism of action, different types, industrial application of genetically modified antimicrobials; Antibiotics: Common antibiotics, mode of action, side effects, general principles of antibiotic use.	**6**
Environmental Biotechnology Plastic Degradation: Role of genetically modified *Ideonella sakaiensis* for degradation of plastics;. Wastewater Treatment: Use of genetically engineered *Escherichia coli*, black soldier fly for sewage cleanup.	**4**

Course Learning Outcomes

By the end of this course, students will be able to:

- Explain advanced diagnostic techniques such as karyotyping, FISH, RFLP, ASO, and microarray.
- Evaluate the role of gene medicine, DNA/RNA vaccines, and CRISPR-Cas9 in healthcare and industry.
- Describe the production of insulin, growth hormones, and antibodies and their clinical applications.
- Explain the role of enzymes in the food and pharmaceutical industries.
- Assess the benefits and risks of GMOs, antimicrobial agents, and Bt gene technology in agriculture.
- Explain traditional and industrial methods of beer, wine, and ethanol production.
- Discuss the role of genetically modified organisms in plastic degradation and wastewater treatment.
- Analyse the impact of biotechnological innovations on sustainability and environmental conservation.

Instructional Strategies

The course will be delivered through lecture and discussion, aided by power point presentations, video clips, etc. Classes will be made participatory and interactive through questions and answers, and group work exercises in the classroom. At the beginning of each class student feedback on previous

class lecture will be taken. Student feedback on the overall course delivery and content will be taken in the last class through a questionnaire survey.

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

Class/lecture types	Number of classes	Class/lecture types	Number of classes
Lecture and discussion	26	Review and Questionnaire survey	1
Students' group presentation	2	In-course exam	1

Assessment

There will have at least one In-course tests. A total of 15 marks will be allocated for In-course exams and 2.5 marks for class attendance. Another 2.5 marks will be allocated for surprise test/oral presentation/assignment. A course final examination, consisting of 30 marks will be conducted centrally by the university. The students will be frequently asked questions in the classrooms to assess individual's performance.

Course No.	Course Title	No. of Credits	Credit Hours
ZG 589	**Molecular Ecology**	**2**	**30**

Introduction to the course

Molecular ecology explores the use of molecular data to understand ecological processes. The course applies molecular techniques to study biodiversity, species interactions, population dynamics, and ecosystem functioning. Students will gain theoretical knowledge and practical skills to analyze ecological data at the molecular level.

Specific objectives of the course

- To understand the application of molecular tools in ecological research.
- To learn the use of genetic markers for analyzing populations, communities, and ecosystems.
- To apply analytical techniques for interpreting molecular ecological data.

Course Contents and Number of Classes by Sub-title

Title/Sub-title of Course Contents	No. of Classes
Introduction to Molecular Ecology Definition and scope of molecular ecology; Importance of molecular tools in ecological research; Applications in biodiversity studies, species interactions, and ecosystem dynamics.	**2**
Genetic Markers in Ecology Types of genetic markers: mitochondrial DNA, nuclear DNA (microsatellites, SNPs); RAPD, RFLP, Species-specific primers, Allele-specific primer, etc.; Sequencing and genotyping; Application of next-generation sequencing (NGS) in ecology.	**7**
Population Genetics in Ecology Hardy-Weinberg Law; Gene flow, genetic drift, mutation, and selection in natural populations; Measuring genetic diversity: allelic richness, heterozygosity, nucleotide diversity, Haplotype diversity; Population structure and connectivity indices - Fst, AMOVA, etc.	**7**

Title/Sub-title of Course Contents	No. of Classes
Phylogeography and Species Distribution Phylogeographic methods for understanding population structure and history; Phylogenetic tree construction and haplotype networks.	**3**
Community and Ecosystem-Level Molecular Ecology Metabarcoding and environmental DNA (eDNA) for community assessment; Applications in species interactions, food webs, and community ecology; Molecular methods for biodiversity monitoring and habitat assessment.	**2**
Population Epigenetics Epigenetics in Environmental Response; Phenotypic plasticity and adaptation.	**2**
Data Analysis and Bioinformatics Software for genetic and genomic data analysis (e.g., MEGA, Arlequin, Genepop, DnaSP, GenAlEx, R, etc.); Case studies on interpreting molecular ecological data.	**2**

Course Learning Outcomes

Upon completing the course, students will be able to:

- Apply molecular approaches to investigate ecological processes and species interactions.
- Use genetic markers to assess population structure, diversity, and phylogeography.
- Analyze molecular ecological data using computational tools.

Instructional Strategies

The course will incorporate lectures, discussions, PowerPoint presentations, group work, and case studies. Interactive sessions will facilitate active learning.

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

Class/lecture types	Number of classes	Class/lecture types	Number of classes
Lecture and discussion	21	In-course exams	1
Students' group presentation and case studies	5	Feedback on In-course exam	1
Review class	1	Student feedback on course contents and delivery	1

Assessment

There will have at least one In-course tests. A total of 15 marks will be allocated for In-course exams and 2.5 marks for class attendance. Another 2.5 marks will be allocated for surprise test/oral presentation/assignment. A course final examination, consisting of 30 marks will be conducted centrally by the university. The students will be frequently asked questions in the classrooms to assess individual's performance.

References

Allendorf, F.W. & Luikart, G. (2007). Conservation and the Genetics of Populations. Blackwell Publishing.

Frankham, R. et al. (2002). Introduction to Conservation Genetics. Cambridge University Press.

Hedrick, P.W. (2011). Genetics of Populations. Jones and Bartlett Publishers.

Rowe, G. et al. (2016). An Introduction to Molecular Ecology.

Course No.	Course Title	No. of Credits	Credit Hours
ZG 590	Conservation Genetics	2	30

Introduction to the course

This course introduces the fundamental principles of conservation genetics, emphasizing the importance of genetic diversity for species survival and ecosystem resilience. It explores molecular and genomic approaches to conservation, genetic risks in small and fragmented populations, and the application of genetic data in species management. The course also addresses the ethical, legal, and social dimensions of genetic conservation efforts.

Specific objectives of the course

- To understand the foundational concepts and goals of conservation genetics.
- To assess the role of genetic diversity in species conservation and ecological stability.
- To apply molecular markers and genomic data for species monitoring, management, and conservation.
- To evaluate genetic risks associated with small and isolated populations.
- To explore genetic management strategies for conserving threatened species.
- To analyze ethical, policy, and social considerations in genetic conservation.

Course Contents and Number of Classes by Sub-title

Title/Sub-title of Course Contents	No. of Classes
Introduction to Conservation Genetics Definition and goals of conservation genetics; Importance of genetic diversity for species survival and resilience; Role of conservation genetics in preventing biodiversity loss.	2
Genetic Diversity and Small Population Management Measures of genetic diversity and population health; Inbreeding depression, Effective population size, and genetic drift in small populations; Genetic risks associated with small and isolated populations.	5
Conservation Applications of Molecular Markers Population monitoring and management using markers; Identification of populations and kinship; Assessment of genetic health; DNA barcoding and eDNA for identifying and monitoring rare and endangered species.	3
Population Fragmentation and Gene Flow Population fragmentation, gene flow and connectivity in conservation planning; Identification of conservation units- Defining genetic management units; Case studies on fragmented populations and habitat corridors.	4
Conservation Genomics and Adaptive Potential Using genomic data to assess adaptive potential and resilience; Genome-wide association studies (GWAS) in conservation; Applications of genomics in understanding local adaptation and environmental stress responses.	3
Conservation Strategies Based on Genetic Data Genetic management strategies for the wild and farm populations: captive breeding, translocation, and genetic rescue; Assisted gene flow and genetic restoration programs; Case studies on the genetic management of endangered species.	3
Ethics, Policy, and Social Dimensions of Conservation Genetics Ethical implications of genetic interventions in conservation; Legal frameworks for biodiversity and genetic resources (e.g., CITES, Nagoya Protocol); Indigenous knowledge, community engagement, and the social context of conservation efforts.	2

Course Learning Outcomes

- After completion of the course, the students will be able to-
- Explain the fundamental principles and goals of conservation genetics.
- Assess the significance of genetic diversity for species survival and ecosystem stability.
- Apply molecular markers and genomic tools to monitor and manage populations.
- Analyze genetic risks in small, fragmented, and isolated populations.
- Design genetic management strategies for conserving endangered species.
- Evaluate the ethical, policy, and social dimensions of conservation genetics.

Instructional Strategies

The course will incorporate lectures, discussions, PowerPoint presentations, group work, and case studies. Interactive sessions will facilitate active learning.

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

Class/lecture types	Number of classes	Class/lecture types	Number of classes
Lecture and discussion	22	In-course exams	1
Students' group presentation and case studies	4	Feedback on In-course exam	1
Review class	1	Student feedback on course contents and delivery	1

Assessment

There will have at least one In-course tests. A total of 15 marks will be allocated for In-course exams and 2.5 marks for class attendance. Another 2.5 marks will be allocated for surprise test/oral presentation/assignment. A course final examination, consisting of 30 marks will be conducted centrally by the university. The students will be frequently asked questions in the classrooms to assess individual's performance.

References

Allendorf, F.W. and Luikart, G. 2007. *Conservation and. the Genetics of Populations.* Blackwell Publishing, UK.

Frankham, R., Ballou, J.D. and Briscoe, D.A. 2002. *Introduction to Conservation Genetics.* Cambridge University Press, UK.

Frankham, R., Ballou, J.D., Briscoe, D.A. and McInnes, K.H. 2004. *A Primer of Conservation Genetics.* Cambridge University Press, UK.

Hedrick, P.W. 2011. *Genetics of Populations.* 4th edition. Jones and Bartlett Publishers, USA.

Pierce, B.A. 2005. *Genetics: A Conceptual Approach.* 2nd edition. W.H. Freeman and Company, New York, USA.

Graham Rowe et al., 2016. An Introduction to Molecular Ecology.

Course No.	Course Title	No. of Credits	Credit Hours
ZG 591	**Practical in Genetics and Molecular Biotechnology (Gr-A)**	**6**	**90**

Introduction to the course

This course is designed to enhance student's ability and practical skills in extraction and analytical procedures and techniques related to DNA study, karyotyping, phylogenetic analysis, interpreting genetic data, etc. It will provide hands-on experience in many modern techniques used in genetics and molecular biotechnology. The experiments have been chosen to give students a solid foundation on

the areas concerned. A strong emphasis is also placed in the acquisition of basic skills (such as writing, communication, computing, problem-solving and experimental design) in the laboratory.

Specific objectives of the course

- To introduce the students to the methods and techniques related to DNA study, karyotyping and population study, and gather skills in the extraction and analysis of DNA and related analytical procedures.
- To enable student data mining, pairwise and multiple sequence alignment using bioinformatics tools such as NCBI blast, SeaView, Serial Cloner, MEGA.
- To enable students to perform experimental trail and culture, maintain experimental species in the laboratory conditions.

Course contents and number of classes by course sub-title

Title/sub-titles of course contents	No. of classes
Basic Genetics Animal models of genetics – Culturing fruit fly, aphid, mosquito, zebra fish, ornamental fish, mouse, etc. as instructed by the course teachers.	**6**
Cytogenetics Karyotyping of selected animal species	**3**
Molecular Genetics Estimation of total protein/nucleic acids; Isozyme study using PAGE; Genomic DNA isolation and PCR analysis.	**6**
Bioinformatics Gene annotation (BLAST, Annotation programmes); Primer design; Regulatory elements analysis; Multiple sequence alignment; Molecular phylogenetic tree construction; Protein modelling, docking.	**5**
Population Genetics Data analysis; Measuring genetic diversity; Use of software's (e.g. POPULUS).	**2**
Exposure visit and demonstration **Assignment Project** Any genetics and molecular biotechnology related short-term project to be assigned by course teachers	**1** **1**

Course Learning Outcomes

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

- Perform karyotyping and make appropriate diagnosis from background information of the karyotype performed;
- Use DNA extraction techniques and to isolate genomic DNA from a variety of organisms;
- Screen for any part of the extracted DNA using the Polymerase Chain Reaction (PCR);
- Perform spectrophotometry to identify compounds and measure their concentrations in a wide variety of experimental situations;
- Perform data mining, pairwise and multiple sequence alignment using bioinformatics tools such as NCBI blast, SeaView, Serial Cloner, MEGA ;
- Carry out phylogenetic analysis and predict protein structure;
- Culture, maintain genetic model organism different environmental conditions;

- Appreciate the basics of the karyotyping and identify selected chromosomal abnormalities and their clinical outcomes;
- Design quality PCR primers and understand directionality and specificity; and
- Align pairwise and multiple sequence, construct phylogenetic tree and predict protein structures.

Instructional Strategies

This practical course will be based on practical demonstration classes, hands-on training, lectures and performing a few laboratory based experimentations. Two-three teachers will demonstrate and guide every individual student in the laboratory. Classes will be made participatory and interactive through questions and answers. Students' analytical ability and problem-solving capacity will be tested by creating different imaginary problems related to respective topics. All necessary equipment and chemicals will be provided to the students during demonstration class or laboratory experimental trails. Students are also supposed to prepare practical assignment on a particular topic and to report/present the findings as per class room instructions. A number of field/laboratory visits will be organized by course teachers.

Distribution of class lectures: Total number of classes/lecture: 30 (3 hours per class)

Class/lecture types	Number of practical classes	Class/lecture types	Number of practical classes
Lecture, discussion, laboratory experiments and hands-on training	24	Research project design and assessment	2
Feedback on in-course exam and group presentation	2	In-course exam	2

Assessment

Assessment will be done on class attendance (5%), In-course examination (35%) and final examination (60%). Two in-course examinations will be taken for this course. In-course assessment will consist of class examinations, assignments, notebooks and field reports and consisting 27.5 marks. Project report 25 marks and class attendance 7.5 marks. A portion of in-course marks will be allocated for continuous assessment through observations of student at work and assignments. Assignment project will be allocated for each student individually and the project report will be evaluated by all course teachers of the branch. Other assessment components viz. report of field/laboratory/research organizations visits and Lab/Notebook will be evaluated with final examination.

References

Dubey R.C. 2014. *A Text Book of Biotechnology*. 5th Ed. SC & Co. Pvt. Ltd. India.

Glick, B.R. and Pasterniak J.J. 2003. *Molecular Biotechnology- Principles and Applications of Recombinant DNA*. 3rd edt. ASM Press, Washington, DC, USA.

Maniatis T. 1991. *Molecular Cloning (A Laboratory Manual)*, 1st ed., Cold Spring Harbor Laboratory Press, New York, USA.

Sambrook, J. and Russell, D.W. 2001. *Molecular Cloning - A Laboratory Manual*, Vol. 1, 2 & 3, 3rd edition. Cold Spring Harbor Laboratory Press, New York, USA.

Course No.	Course Title	No. of Credits	Credit Hours
ZG 592	**Thesis in Genetics and Molecular Biotechnology (Gr-B)**	**6**	**90**

Introduction to the course

The Thesis course is an integral component of the Genetics and Molecular Biotechnology curriculum, designed to provide students with hands-on research experience and enhance their scientific inquiry skills. This course enables students to apply theoretical knowledge to practical problems by conducting independent research under the supervision of a faculty mentor. Through experimental design, data analysis, and critical interpretation, students gain deeper insights into advanced topics in genetics, molecular biology, and biotechnology. The course also fosters scientific writing and presentation skills, preparing students for future academic or professional research pursuits. Ultimately, this experience nurtures innovation, analytical thinking, and a strong foundation for higher studies or careers in research and development.

Specific objectives of the course

- To develop research skills by engaging students in independent scientific investigation related to Animal Genetics, Molecular Biotechnology, Omics technology, Conservation Genetics etc.
- To enhance analytical and critical thinking abilities through experimental design, data collection, interpretation, and problem-solving.
- To strengthen scientific communication by training students in writing research reports, presenting findings, and defending their work effectively.

Course contents

Students have to choose a specific topic related to genetics and molecular biotechnology for conducting an individual research project for this thesis course. In this case, students may consult with his/her supervisor to select their research project concerning any basic or applied aspects of Animal Genetics, Molecular Biotechnology, Omics Technology, Conservation Genetics, etc. In addition to these, students have complete freedom to fix any topic related to genetics and molecular biotechnology branch. This course is divided into two parts firstly writing a thesis based on individual research project and secondly presentation of the thesis. Students must write their thesis following a standard MS thesis structure including a title, abstract, introduction, methodology, results, discussion, conclusion, and references with optional appendices. The front matters the thesis will includes title page, abstract, table of contents**,** dedication, declaration, and acknowledgements. In the main body, the introduction section will include background, review of existing research**,** research gaps, problem statement, rationale of the study, research hypothesis and questions, aims and objective of the research project. Likewise other sections will contain relevant components of a typical MS thesis**.** The maximum word limit for theses is 30,000 words that will include all text, figures, tables, and photographs, excluding references and appendices. No formal classes will be allocated for the thesis course, however pertinent knowledge and information shall be provided by the supervisors through lectures, meeting and group discussion etc.

Course Learning Outcomes

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

- Ability to design and conduct independent research in the fields of genetics and molecular biotechnology.
- Proficiency in laboratory techniques, data analysis, and interpretation relevant to molecular and genetic research.
- Enhanced critical thinking and problem-solving skills to address scientific questions and challenges.

- Capacity to review scientific literature and apply relevant knowledge to research projects.
- Improved scientific writing and presentation skills for preparing a thesis and communicating research outcomes effectively.
- Experience in working ethically and responsibly in a research environment, adhering to scientific and biosafety standards.

Instructional Strategies

The thesis course adopts independent research, supervised lab work, and regular faculty guidance. Students engage in experimental design, data analysis, and report writing. Progress seminars and discussions enhance critical thinking, scientific inquiry, and research skills, fostering self-directed learning and problem-solving abilities essential for professional development in genetics and molecular biotechnology. Respective supervisor will supervise all of those steps involved in thesis works sharing knowledge, information and experiences through lectures, weekly/monthly meeting, training programmes or workshops. Each thesis student will attend the monthly scientific seminar organized by the department.

Assessment

The total marks for this 6-credit course are 150, with 100 marks allocated to thesis work and report writing, while the remaining 50 marks are reserved for thesis presentation and defense. Thesis will be evaluated by the external examiners while presentation will be evaluated by the examination committee.

Course No.	Course Title	No. of Credits	Credit Hours
ZG 593	**Review article writing and Seminar presentation**	**2**	**30**

Introduction to the course

This course is designed to enhance students' abilities in scientific literature review, critical analysis, and effective communication. It aims to develop skills in writing comprehensive review articles on current topics in genetics and molecular biotechnology. Students will learn to search, evaluate, and synthesize scientific information from various sources. In addition, the course focuses on improving presentation skills through structured seminars, encouraging students to confidently communicate scientific ideas and research findings. This course prepares students for academic writing, public speaking, and professional communication, which are essential for future careers in research, teaching, and biotechnology industries.

Specific objectives of the course

- To develop the ability to critically review and synthesize scientific literature.
- To enhance skills in writing structured and comprehensive scientific review articles.
- To build confidence and competence in delivering effective seminar presentations.

Course contents

Students have to select a specific topic of review project related to genetics and molecular biotechnology for writing a review paper of any types such as narrative review, systematic review,

and meta-analyses. In this case, students may consult with his/her supervisor to select their review project. In addition to these, students have complete freedom to fix any topic related to genetics and molecular biotechnology branch. This course is divided into two parts firstly writing a review paper and secondly presentation of the reviewed article. Students must write their review paper following a standard structure including a title, abstract with keywords, introduction, methodology (if any), results, discussion, conclusion, and references. The maximum word limit for review article is 4,000 words that will include all text, figures, tables, and photographs, excluding references. No formal classes will be allocated for this course, however pertinent knowledge and information shall be provided by the branch teachers through special lectures, monthly group/lab meeting and group discussion etc.

Course Learning Outcomes

- Ability to critically analyze and interpret scientific literature in genetics related fields.
- Proficiency in writing well-structured and coherent scientific review articles.
- Improved oral communication and presentation skills for academic and professional settings.
- Enhanced confidence in presenting scientific concepts and engaging in scholarly discussions.

Instructional Strategies

The course will involve guided literature review, interactive discussions, and regular mentoring sessions. Students will receive training in scientific writing techniques and presentation skills. They will prepare review articles and deliver seminars on selected topics, followed by peer and faculty feedback to improve their critical thinking and communication abilities. The maximum word limit is 4,000 words that will include all text, figures, tables, and photographs, excluding references and appendices.

Assessment

Out of the total 50 marks, 25 will be allocated for review writing and the remaining 25 for seminar presentation. Both the review work and seminar presentation will be assessed by the examination committee.

Course No.	Course Title	No of Credits	Credit Hours
ZG 594	**Viva voce**	**2 credits**	**30**

Introduction to the course

Viva voce or oral examination is an integral component of the MS programme in Zoology. This is a mandatory course for the students of both thesis and non-thesis group of all branches by which students demonstrate their secured knowledge, expertise, and understanding of theoretical, practical and thesis courses. It's also an opportunity for the examiners to evaluate the academic abilities of students, and ultimately for determining whether they have met the requirements of MS degree.

Specific objectives of the course

- To prepare students for presenting their in-depth knowledge of the broader field of study programme.
- To improve the ability of students to communicate to scientific world with secured skills and expertise
- To assess student’s understanding of the programme.

Contents of the course
Course contents of the viva voce include all topics of theory, practical and thesis courses of the respective MS programme. Examination Committee has complete freedom to ask any question related to respective syllabus of the programme. No formal classes will be allocated for this course, however pertinent knowledge and information shall be provided by the course teachers through their routine lectures of theory courses, monthly group/lab meeting and group discussion etc.

Course Learning Outcomes
Upon completion of this course the students will be able to

- Demonstrate how their acquired knowledge, expertise and skills from the courses contribute to their field of study.
- Recognise and explain the current state of knowledge on a particular issue or topic of the programme.
- Demonstrate and assess their academic feats with critical analysis and interpretation of various aspects of the courses.

Instructional Strategies

The course will follow interactive lectures of all theoretical and practical courses and thesis works of the MS programme. Besides, regular lab/group meetings, discussions, and individual or group mentoring sessions will also provide instructions for viva voce. All faculty members of the branch will instruct the students in this regard.

Assessment
This is a two-credit course that carries 50 marks. The respective Examination Committee including external members will assess overall student's knowledge asking questions from the contents of respective syllabus of the MS programme and student will answer questions accordingly.