UNIVERSITY OF DHAKA

Department of Botany
Curriculum for the BS Honours Courses
Session: 2022-2023 onward

Department of Botany
University of Dhaka
Dhaka-1000, Bangladesh

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DEPARTMENT OF BOTANY

University of Dhaka, Dhaka-1000

Bachelor of Science with Honours (BS Hons) Program in Botany

1. Introduction

The Department of Botany was established as Biology Department under the University of Dhaka in 1939 by the active leadership of Professor Panchanan Maheshwari. At that time, the department consisted of Botany and Zoology and the students were enrolled under BSc pass degree program. The students of the then Bengal Agriculture Institute (At present, Sher-e-Bangla Agriculture University, Sher-e-Bangla Nagar) were also taught for the BSc pass degree in the same Biology Department. At the beginning, the department was housed in the Chemistry Department, situated in the Curzon Hall Campus of the University of Dhaka. The department was later on shifted to the present building. In 1954, the first MSc program in Botany was started and the first batch of the students were awarded MSc in 1950.

Professor Panchanan Maheshwari, the founder head returned to India in 1949 and then Dr. Majeed Ahmd, Reader of Biology, took the charge. Dr. Ahmad left the department in December. 1951. Professor Girija Prashanna Majumdar, Professor of Botany of Presidency College, Calcutta, India was appointed as the Head of the Department.

Professor Majumder started BSc (Hons) course in Botany in 1952. Under this new program, tudents of Botany were first awarded BSc (Hons) degree in 1954. On the Executive Council of Dhaka University at its meeting on 24 April, 1954 decided to establish separate Departments of Botany and Zoology by splitting the Department of Biology.

Therefore, the Department of Botany started functioning independently from July 1954 and Professor Girija Prashanna Majumdar became the founder Head of the Department. In September 1954, Professor Majumdar left for India and Professor Majeed Ahmad took the charge. Under the able and dynamic leadership of Professor Majeed Ahmad, the expansion of the department was successfully ventured. In 1969, Professor Majeed Ahmad left Dhaka for joining a fellowship to UK and then Professor AKM Nurul Islam was appointed as the Head of the Department. In 1970 Professor Majeed Ahmad returned and took the charge again. In 1971, after the emergence of independent Bangladesh from Pakistan, Professor Majeed Ahmad left Bangladesh and Professor Ahmad Shamsul Islam was appointed as the Head of the Department. Presently, the Department of Botany has been functioning under the Faculty of Biological Sciences.

The department was established with an aim to produce quality graduates through offering BS (Hons), MS, MPhil, and PhD degrees. Initially, a three-year BSc (Hons) course was introduced in 1954 since the establishment of the Department of Botany. Over the years, the Department of Botany has grown in every sphere of the botanical disciplines and now has taken a shape one of the largest departments in the University of Dhaka. Considering the needs of global equivalence of its BSc (Hons) degree program, in 1998, the department converted its three year BSc (Hons) degree program to a four year BSc (Hons) degree which continued until 2008. From 2008, onward the name of the degree was changed to BS (Hons) degree.

At present, there are 28 members of teaching staff and 33 supporting technical and office staffs catering the needs of around 450 students including a number of MPhil and PhD research scholars. The department also offers non major courses for other departments of the University of Dhaka such as Department of Soil, Water and Environment; Department of Zoology and Department Geography and Environment. The number of non-major students is currently around 490.

The Department has a long tradition of research in various fields of plant sciences under the MS, MPhil and PhD programs. The faculty members along with their research students pursue research in diverse fields which has resulted in a large number of research publications in various national and international journals. The department is also collaborating academic and research programs with India, Japan, UK, Germany and USA.

Besides well equipped laboratories for the students, there is a rich seminar library. In each year, new books and journals are purchased and added to enrich and update the library. A total of over 16,000 reference books, journals, reports and proceedings are now present in the seminar library. In the recent year, a computer laboratory with internet facility has been established for the use by the students and researchers.

There are nine research laboratories which are devoted to the following disciplines:

1. Environmental Microbiology and Biotechnology
2. Mycology and Plant Pathology
3. Phycology, Limnology and Hydrobiology
4. Higher Cryptogams
5. Angiosperm Taxonomy
6. Plant Ecology and Environments
7. Plant Physiology, Biochemistry and Nutrition and Plant Anatomy
8. Cytogenetics
9. Plant Breeding and Biotechnology

At present, the Department of Botany, University of Dhaka has been offering BS (Hons) degree program based on the syllabi covering the diverse fields of botanical sciences. The subject is taught by skilled and experienced academic staffs in a conducive teaching-learning environment. The medium of instruction of this program is English.

2. Introduction to the Program

2.1 **Title of the Program**: The title of the program is Bachelor of Science with Hons. The degree is abbreviated as **BS (Hons)** in Botany.

2.2 **Duration of the Program**: It consisted of four academic years (July to June) divided into four sessions each having one academic year. The maximum duration of each session makes 42/44 weeks which are distributed as follows:

Classes	**30 weeks**
Preparation Time for the Course Final Examinations: 1st, 2nd and 3rd Years	4 weeks
Preparation Time for Course Final Examination: 4th Year	6 weeks
Course Final Examination (Theory + Practical)	8 weeks
Total	**42/44 weeks**

The result of annual examinations is published within 6 weeks from the date of holding the last examination.

2.3 **Eligibility for Admission**: Students having total minimum GPA 8.0 (sum of HSC and SSC GPA) having minimum GPA 3.5 in HSC and SSC examinations are eligible to apply and to seat for a centrally controlled admission test of the unit 'A' carried out in each academic session of the University of Dhaka. The students seeking admission must have a GPA 3.0 in Biology. From the merit list of successful candidates via their selection of subject choices are eligible for the admission in the BS (Hons) program in the Department of Botany.

2.4 **General Objectives of the Program**: Botany deals with the different aspects and knowledge on plants and microbes. The objectives of the program is to gather an up to date and useful knowledge on various disciplines of botany for the benefit of mankind and environment and our socio-econmic conditions through learning and research. The main part of the objectives could be highlighted as follows:

2.4.1 To promote academic and research knowledge in botany under the rules and regulations of the University of Dhaka

2.4.2 To produce qualified graduates to meet the modern national and international demands on plant sciences

2.4.3 To engage the graduates in nation-building programs through their proper training in botany

2.4.4 To increase the capacity of the graduates for dissemination of academic and research knowledge to the next generation plant scientists

2.4.5 To train the graduates in learning good governance, team work, interpersonal relationships and leaderships in order to face the national and global scientific challenges

2.4.6 To increase knowledge skill related to the components of biodiversity, climate changes, food security, invention and promotion of new crop plants, adaptations and conservation of the biodiversity

2.4.7 To adopt, practice and give input to the innovative biotechnological principles for a sustainable and productive agriculture and other plant related activities practiced in the modern society

3. Structure of the curriculum

The BS (Hons) degree program is covered by a set of theoretical and practical **(laboratory/field)** project oriented courses. Every year students should go for field trips to collect samples related to their field work. Major contents have been provided below:

a) **Theoretical courses**: a minimum of **15 class hours** per session constituting one credit hour

b) **Practical courses**: credits for practical (**laboratory based / fieldwork / research project oriented**) courses are determined by the relevant course teacher

c) Assignment of credits to the project work to be carried out by the respective student is being allocated by the course teacher

d) A minimum of 140 credits must have to be earned for the successful completion of the graduate degree program by the students

A year-wise distribution of credits during the **four academic years** has been provided below:

Year-wise distribution of credits in Four Years

Year	Theory (Credits)	Practical (Credits)	Viva-voce (Credits)	Extra-Departmental (Credits)	Total Credits
1st Year	12	6	2	8	28
2nd Year	16	6	2	8	32
3rd Year	24	12	2	0	38
4th Year	28	12	2	0	42
Total	**80**	**36**	**8**	**16**	**140**

4. Assessment System

The total performance of a student in a given course (departmental or extra-departmental) is evaluated on the basis of a series of continuous assessment, in course and course final examinations.

4.1 In-course, class attendance and course final examination

a) **In-course test**: In-course tests of minimum one hour duration shall be conducted and evaluated by the course teacher. There will be at least 2 (two) written tests for 4/3- credit courses and at least 1 (one) written test for 2-credit courses.

b) **Class attendance**

i) 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.

ii) 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.

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

c) **Make up test**: Make up test will be arranged for a student who fails to appear in the in-course test/tests. Absence in any in-course test will be counted as zero for calculating the average in in-course test for that course. However, a student can apply to the Chairman of the department for make-up test. The Chairman will place the application before the academic committee if the particular student has met with an accident or his/her parents has expired or he/she has gone through a surgical procedure or any other such situation which the Academic Committee feels can be considered. The make-up test must be held during the course period.

d) **Course final examination**

i. The course final examination is conducted centrally by the Controller of Examinations, University of Dhaka as per existing system.

ii. Pattern of theory questions is decided by the academic committee. However, there will be no objective part.

iii. The course final examinations will be of 3 hours duration for 4-credit courses, 2½ hours for 3-credit courses and 2 hours for 2- credit courses.

iv. For evaluation of the course final examination there is two examiners: one internal (course teacher) and the other external (will preferably be within the department/university).

v. Under double-examiner system and in case of difference of more than 20% of marks, there will be a 3rd examiner. Marks of nearest two examiners will be average out as final marks.

e) **Assessment of project courses**: Mode of assessment of project will be determined by the respective examination committee.

f) **Viva-voce**: *Viva-voce* examination is conducted by the respective Examination Committee approved by the University. One external examiner preferably from one public university of Bangladesh and nominated by the Academic Committee of the Department of Botany must be present in the examination committee.

g) **Extra-departmental course**: Extra-departmental course includes practical classes based on the course materials. In such cases, the assessment on the practical part is done only by a final examination

h) **Continuous assessment**: The scheme of continuous assessment that a teacher proposes to follow for a course is announced by the teacher on the first day of classes.

i) The distribution of marks for a theoretical and practical course is as follows:

Class attendance	5%
In-course assessment	35%
Course Final Examination	60%

j) The distribution of marks for an **extra-departmental course** is as follows:

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

k) **Basis for awarding marks for class attendance will be as follows**:

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

l) Retakes

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

ii) Students who have been promoted on probation for failing to earn requisite CGPA without any **'F'** will be allowed to sit for retake examination for maximum 8 credits (including practical course and viva-voce). Within 6 weeks after publication of results, conducted by the respective original examination committee for the year.

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

4.2 **Projects and assignments**: The style and mode of awarding of small research projects and/or assignments to the students of final year BS (Hons) classes will be decided by the Academic Committee of the Department.

4.3 **Types of questions**: Questions for in-course tests should preferably be of the objective type subjected to the approval of the Academic Committee. Additional assessments may be made by a course teacher as determined by him/her. In such cases the marks distribution for these additional assessments will be determined by the Academic Committee. The course teacher will show the assessed in-course scripts to the students. For theory

courses the continuous assessment is made through a set of in-course examinations and class attendance

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

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

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

4.4.1 **The explanations of letter grades are described as follows**

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

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

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

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

4.4.2 **Grade codes for retakes, readmissions and improvement**

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

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

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

d) Courses taken by the students in excess of the required minimum and not counted for calculation of GPA will be identified by prefixing the letter grade earned with the letter **'N'**.

4.4.3 **Calculation of GPA and CGPA**

a) **Calculation of Grade Point Average (GPA)**: Grade Point Average (GPA) is the weighted average of the grade points obtained in all the courses passed by a student in an academic year. The Grade Point Average (GPA) is computed in the following manner. For example, if a student passes six courses in Ist Year having credits of C1, C2, C3, C4, C5 and C6 and his/her obtained grade points in these courses are G1, G2, G3, G4, G5 and G6 respectively then,

$$\text{GPA} = \frac{\Sigma(\text{Grade point} \times \text{Credits})}{\Sigma \text{ Credits attempted}}$$

For example, if a student takes 6 courses in one academic year and obtains the following grades:

Course	Credits	Letter-grade	Grade points
101	4	A^+	4.00
102	4	C^+	2.50
103	4	A^-	3.50
104	2	B^-	2.75
105	2	B	3.00
106	2	F or I	0

Then the GPA for the particular year, calculated up to two digits after decimal point, will be:

$$\text{GPA} = \frac{4(4.00) + 4(2.50) + 4(3.50) + 2(2.75) + 2(3.00) + 2(0)}{4 + 4 + 4 + 2 + 2 + 2} = 2.86$$

b) **Cumulative Grade Point Average (CGPA)**: Cumulative Grade Point Average for 2nd year, 3rd year and 4th year results is computed by dividing the total accumulated grade points earned up to date by total credit points attempted and calculated to two digits after decimal point. Total credits in each of the Year will be used as weights for the calculation as shown in the following examples.

Year	GPA	Credit
Ist Year	4.0	20
2nd Year	3.0	30
3rd Year	3.5	25
4th Year	3.0	20

The **CGPA** in this case will be:

$$\frac{(20 \times 4) + (30 \times 3) + (25 \times 3.5) + (20 \times 3)}{20+30+25+20} = 3.34$$

4.4.4 **Practical examination**: Continuous assessment of practical (laboratory/field) courses is made through observation of the student at work, a quiz conversation between the student and the course teacher, assignments and evaluation of practical reports.

4.4.5 **Requirements for Degree and Diploma**: To graduate with a Bachelor's degree, a minimum total of 140 credits or more if approved by the university authorities, with no F grade in any course must be earned by a student within 4-6 academic years after his/her first admission in the graduation programme. He/she must also have earned the minimum required **CGPA 2.5 on a 4.00 scale.**

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

4.4.6 **Promotion**

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

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

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

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

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

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

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

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

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

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

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

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

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

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

4.4.7 **Rules and guidelines**

i) **Drop out**: A student failing to earn the required minimum GPA/CGPA and/or to earn requisite credits after retakes, he/she may take readmission, with the approval of the Academic Committee of the respective department, to appear in the course final examinations with the next batch. If he/she fails again to earn the required minimum GPA/CGPA and/or to earn requisite credits he/she will be dropped out of the programme.

ii) **Improvement of earned credits**

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

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

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

iv) **Time limits for completion of Bachelor of Science with Honors Degree, BS (Hons)**: A student must fulfill all the requirements for a Bachelor's degree within a maximum period of six academic years, starting from the year of registration.

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

vi) **Other General Regulations**

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

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

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

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

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

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

5. Structure of course

Detailed curriculum outline of
First Year BS Honours Course
(2022-2023 Onward)

Departmental Courses	**Credit hours**
BOT 101: General Microbiology	2
BOT 102: Lower Fungi	2
BOT 103: General Phycology	2
BOT 104: Bryophyta	2
BOT 105: Angiosperm Taxonomy	2
BOT 106: Biodiversity	2
BOT 107: **Practical-1**: General Microbiology, Lower Fungi and General Phycology	3
BOT 108: **Practical-2**: Bryophyta, Angiosperm Taxonomy and Biodiversity	3
BOT 109: **Viva-voce**	2

Extra-Departmental Courses (For the students of Botany)

BMB 11: Basic Biochemistry - I	4
ZOOL 1001: Animal Diversity	4
Total = 28	

Extra-Departmental course for the students of Zoology and Soil, Water and Environment

BOT 1001: Introductory Botany	4
BOT 1002: Ecology, Environment and Plants	4

BOT 101: General Microbiology — Credit hour: 2

Introduction

General Microbiology is a compulsory course in four years integrated BS (Hons) in Botany program. It deals with basic concept, structure, classification, and importance of different types of microorganisms. It is structured in a way that the students develop clear understanding of the concept of microbiology, scope of microbiology, abiogenesis versus biogenesis, contribution of scientists in microbiology, types of microorganisms and their importance to human beings. Students also understand the infectious diseases and their causal agents.

Course objectives

(a) To define microbiology and its scope.
(b) To describe the contribution of microbiologists.

(c) To identify different types of microorganisms.
(d) To describe the importance of microorganisms for humans.
(e) To explain the causes of infectious diseases.

Course contents

Units	**Contents**	**No. of Lectures**
1. Introduction	Introduction, Origin of life - abiogenesis versus biogenesis, Contribution in microbiology, Five-kingdom and Three-domain concept	3
2. Bacteria	Introduction, Classification, Flagella, Pili, Capsule, Cell wall, Cell membrane, Cytoplasm, Spore, Superbugs, Bacterial habitats, and importance	8
3. Archaea	Introduction, Archaeal taxonomy, Phylum Crenarchaeota, Phylum Euryarchaeota, Shared features of bacteria and Archaea, Importance of archaea	2
4. Viruses	Introduction, Virus genomes, Virus proteins, Capsid, Attachment and entry of viruses into cells, Transcription, Translation and transport, Virus genome replication, Assembly and exit of virions from cells, HIV, Nipah virus, Ebola virus, Dengue virus, Corona Viruses, Importance of viruses	10
5. Viroids	Introduction, Discovery, Structure, Replication, Diseases	1
6. Prions	Introduction, Discovery, Structure, The protein-only hypothesis, Replication, Transmission, Diseases	2
7. Mycoplasma	Introduction, Discovery, Structure, Properties, growth, motility, Diseases	1
8. Actinomycetes	Introduction, Discovery, Taxonomy, Structure, antibiotic production, Diseases	1
9. Rickettsia	Introduction, Discovery, Structure, Transmission, War fever, Diseases	2

Unit wise learning outcomes

Unit	Learning outcomes
1	• Define microbiology • Describe the scope of microbiology • Distinguish abiogenesis versus biogenesis • Explain chemical theory of origin of life • Discuss major contributors in microbiology • Discuss the five-kingdom concept • Explain the three-domain concept
2	• define bacteria • Describe arrangement of bacterial cells • Describe the structure, chemical composition, and function of bacterial appendages • Discuss superbugs and their importance • Describe the distribution of superbugs • Explain bacterial habitats • Mention common bacterial diseases
3	• Describe archaea • Role of archaea in earth • Archaeal taxonomy • Classify archaea • Discuss the importance of archaea
4	• Discuss reasons for studying viruses • Describe the characteristics of viruses • Describe the components of virions • Illustrate the variety of virus genome • Outline the functions of virus structural and non-structural proteins • Define the terms helical symmetry and icosahedral symmetry • Explain how animal viruses attach to and enter their host cells • Explain genes are transcribed and translated • Discuss roles of virus and host proteins in virus genome replication • Describe the assembly mechanisms for nucleocapsids with helical and icosahedral symmetry • Explain the importance of HIV • Write an illustrated account of the replication of HIV-1 • Describe the disease caused by Corona virus • Write the importance of Nipah virus. • Explain the disease caused by Ebola virus

	• Describe the disease caused by Dengue virus • Describe importance of viruses
5	• Describe discovery of viroids • Write the characteristics of viroids • Mention common diseases of viroids
6	• Describe discovery of prions • Define the terms prion and transmissible spongiform encephalopathy • Evaluate the protein-only hypothesis • Describe the characteristics of prions • Discuss the transmission of prions • Describe prion diseases in animals and man
7	• Describe the discovery of mycoplasma • Write the characteristics of mycoplasma • Mention common diseases of mycoplasma
8	• Describe the discovery of actinomycetes • Write the characteristics of actinomycetes • Describe production of antibiotic from actinomycetes • Mention common diseases of actinomycetes
9	• Describe discovery of rickettsia • Draw a rickettsia • Write the characteristics of rickettsia • Describe the war fever by typhus • Mention common diseases of rickettsia

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Instruction strategies and Learning experiences

- Attend lectures
- Question-answer
- Group discussion
- Guided discussion
- Project discussion
- Demonstration

Assignment: Students will be given assignment on selected units
Assessment: In-Course examination, Assignment, Course final examination, Practical examination, Viva-voce

BOT 102: Lower Fungi

Credit hour: 2

Introduction

This is the basic course in 4-years integrated B. S. (Honors) in Botany program. It is designed in a way that the students develop clear understanding of the concept of lower fungi and its importance to mankind, different growth parameters and reproduction of fungi, origin and classification of lower fungi, general characteristics of lower fungi and their classification, details of Myxomycetes class, comparison between slime molds with protozoa, details of class Chytridiomycetes and order Chytridiales, black wart disease of potato and its casual organism, details of class Oomycetes with Saprolegniales and Peronosporales orders, late blight of potato disease and its causal agent (*Phytophthora infestans*), class Zygomycetes and order Mucorales, bud rot disease of jackfruit. Students will also understand the role of Endogonaceae family fungi as biofertilizer.

Course objectives

(a) Importance of lower fungi to mankind in the earth.
(b) Know about the basic features, structures, reproduction, life cycle and classification of lower fungi.
(c) Learn salient features and classification of lower fungi.
(d) Difference between slime molds and protozoa.
(e) Learn habitat, somatic features, and reproduction of Chytridiomycetes, Oomycetes and Zygomycetes.
(f) Identify the important diseases of plants caused by lower fungi, even in the form of epidemics.
(g) Use the fungi to produce commercial products such as yeast powder, alcohol, citric acid, mushroom production, etc.
(h) Application of fungi as biofertilizer.

Course contents

Units	Contents	No. of Lectures
1. Introduction to lower fungi	Historical development, scope, and importance to mankind.	**3**
2: Myxomycetes:	Slime molds: A brief account of the	**4**

	habitat, structure, reproduction and importance of slime molds, comparison with protozoa.	
3. Structures and reproduction of fungi:	Habitat, vegetative features, range of vegetative structures, growth and development, nutrition, reproduction; origin and classification of fungi.	**6**
4. Classification	General characteristics and classification of lower fungi.	**3**
5. Studies of different classes.	**Chytridiomycetes**: Chytridiales; life cycle of *Synchitrium endobioticum*. **Oomycetes**: Saprolegniales and Peronosporales; life cycle and importance of *Saprolegnia parasitica* and *Phytophthora infestans*. **Zygomeycetes**: Mucorales; life cycle of *Rhizopus stolonifers*.	**4** **4** **3**
6. Endogonaceae	Occurrence, characteristics, and their role as biofertilizer.	**3**

Unit wise learning outcomes

Units	Learning outcomes
1	• Contribution of different scientists in the field of Mycology • Known about importance of lower fungi to mankind
2	• Get idea about habitat, structure and reproduction of slime molds • Importance of slime molds • Comparative study between slime molds and protozoa
3	• Basic features, structure, reproduction, life cycle and classification of fungi.
4	• Salient features of lower fungi • Classification of lower fungi
5	• Habitat, somatic features and reproduction of the important orders and families under Chytridiomycetes, Oomycetes and Zygomycetes classes. • Life cycle and economic significance of different pathogens such as *Synchtrium endobioticum*, *Saprolegnia parasitica* and *Phytophthora infestans*.
6	• Characteristics of Endogonaceae family • Role of the members of Endogonaceae as biofertilizer

References
1. Agrios GN 1997. Plant Pathology. 5th edition. Academic Press. Toronto.
2. Alexopoulos CJ, CW Mims and M Blackwell 1996. Introductory Mycology. (4thediton), John Wiley & Sons, New York.
3. Hawker LE 1967. Fungi. Hutchinson University Library. Cambridge Univ. Press. London.
4. Moore-Landecker E 1982. Fundamentals of Fungi. Prentice Hall, NewJersy.
5. Trigiano RT, T Mark and AS Windham 2004. Plant Pathology. Concepts and laboratory Exercises. CRC Press London.
6. Webster J 1980. Introduction to Fungi. Cambridge University Press. London.

Instruction strategies and Learning experiences
- Group discussion on the given lecture
- Question answer
- Guided discussion
- Demonstration of fresh materials

Assingment: Students will be given assignment on particular units

Assessment: In-Course examination, Assignment, Course final examination, Practical examination and Viva-voce

BOT 103: General Phycology

Credit hour: 2

Introduction

Phycology is usually studied as a specialization within botany or marine science program. Phycology is the study of algae. This course is for anyone interested in learning the fundamentals of algae. The course is taught in the First year classes of four years integrated BS (Honours) program in Botany. It is a basic course of Phycology. Algae are an extremely diverse group of organisms that can be found in almost every ecosystem on the planet, and they play an essential role for life on earth. They are little bio-factories that use the process of photosynthesis to create chemical compounds that we can utilize for food, feed, medicine, and even energy. This course will cover what algae are, why they are important and their ecology.

Course objectives

(a) What is Phycology**,** what algae are, why they are important and their ecology.
(b) Explain the terms sporophyte, gametophyte, and alternation of generations
(c) Illustrate, with a named example for each, the following types of life cycle: isomorphic alternation of generations, heteromorphic alternation of generations, no alternation of generations.
(d) Essential features of the lichen symbiosis.

(e) Methods for sampling algae in the field.
(f) To identify algae.

Course contents

Units	Contents	No. of Lectures
1. Introduction to Phycology:	Characteristics and importance of algae	**3**
2. Classification (Lee 20 08)	Bases of classification, pigments, storage products and flagella; endosymbiotic theory of chloroplast evolution; history of classification of algae, outline of the classification of Lee 2008 and characteristics of the different phylums	**4**
3. Algal habitats:	Aquatic (fresh, brackish and marine water); terrestrial; subaerial and special habitats (symbiotic, parasitic, cryogenic, thermal and desert algae).	**3**
4. Structure and reproduction	Range of vegetative structure and reproductive methods in algae.	**4**
5. General characteristic and life history	General characteristics of the following classes and life history of the genera mentioned below: (a) Cyanophyceae: *Gloeotrichia* (b) Rhodophyceae: *Polysiphonia* (c) Chlorophyceae: *Chlamydomonas*, *Oedogonium* and *Chara* (d) Euglenophyceae: *Euglena* (e) Bacillariophyceae: *Pinnularia* (f) Phaeophyleae: *Sargassum*	**15**
5. Lichen	Habitat, structure, growth forms and economic importance	**1**

Unit wise learning outcomes

Units	Learning outcomes
1	• Able to define Phycology • This section will cover what algae are, how they've evolved, and how they've transformed our planet. They will also go over how humans have used algae throughout the history. • Scopes of Phycology and its development in Bangladesh • How to use algae to assess environmental problems

2	• Algae are extremely diverse, and in this section, you will learn about the following different types: • Early history of phycology • Classification of phycology • Characteristics of the different phylum of algae • Modern thoughts on algal taxonomy
3	• Covers the basics of algal ecology including some of the other organisms they interact with in nature and in industrial settings. • Ecology of major groups of algae
4	• Brief discussion about habit and structure • Distinguish the main morphological forms
5	• Brief discussion about classification of mentioned classes • Brief discussion about life history of mentioned genera
6	• Brief discussion about habit, habitat and structure of lichens • Growth forms and economic importance of lichens

References

1. Bold HC and NJ Wynne 1978, 1985. Introduction of the Algae. Prentice-Hall, New Jersey.
2. Fritsch FE 1935, 1945. The structure and reproduction of the algae. Vols 1 and 2, Cambridge Univ. Press, Cambridge.
3. Lee RE 1980, 1989, 2008. Phycology (1st , 2nd and 3rd Edns). Cambridge Univ. Press, Cambridge.
4. Mason E H Jr 1983. The Biology of Lichens. 3rd Edn., Edward Arnold, London.
5. Round FE 1981. The Ecology of Algae. Cambridge Univ. Press. Cambridge.
6. Smith GM 1950. The freshwater algae of the United States, McGraw-Hill, N.Y.

Instructional strategies and Learning experiences

Lecture followed by
- Group discussion
- Question-answer
- Demonstration

Assignment: Students will be given assignment on particular units

Assessment: In-Course examination, Assignment, Course final examination, Practical examination and Viva-voce

BOT 104: Bryophyta

Credit hour: 2

Introduction

This is a basic course in four years integrated BS (Hons) in Botany program. Bryophytes constitute a significant and important group in the plant kingdom since they are the earliest diverging lineages of the extant land plants and made the colonization of land possible for the plants. Bryophytes provide insights into the migration of plants from aquatic environments to land. Several physical features link bryophytes to both land plants and aquatic plants Therefore, this course is undeniably one of the fundamental courses in the Department of Botany. The course presents the origin and evolution of important aspects of bryophyta with the description of taxonomy, morphology, reproductive processes, life cycle, economic importance, and phylogenetic relationships of the varied groups, proceeding from the simple to the complex. Major groups of common bryophytes will be described for better understanding of the group of plants as well as their evolutionary progression.

Course objectives

(a) Differentiate Bryophyta from other groups of plant and thereby learn the importance of studying bryophytes.
(b) Develop an idea about the origin and evolutionary progression of thalloid to leafy plants, stomata, and reproductive structures among different groups of bryophytes.
(c) Know the diversity of sporophytic and gametophytic structure of major groups of bryophytes along with their reproduction, life cycle and economic importance.
(d) Gain a general knowledge of transition in plant phylogeny from lower to higher gradation.

Course contents

Units	Contents	No. of Lectures
1. Introduction	Definition, characteristic, distribution, habitats, and economic and biological significance of bryophytes.	**2**
2: Classification of bryophytes	Classification proposed by different bryologist and discussion on general characters of three main divisions of bryophyta with diagnostic features.	**2**
3: Origin and evolution	Theories and debates regarding the origin of bryophytes; Evolution among different groups of bryophytes.	**3**

4: Genera of bryophytes	Distribution, habitat, habit, external and internal features, asexual/vegetative and sexual reproduction, life cycles and spore dispersal mechanism of the following genera: **(a)** *Sphaerocarpos*, **(b)** *Riccia*, **(c)** *Marchantia*, **(d)** *Porella*, **(e)** *Anthoceros*, **(f)** *Sphagnum* and **(g)** *Funaria*.	**18**
5: Alternation of generations	Diversity of gametophyte and sporophyte structures and alternation of generations in bryophytes.	**5**

Unit wise learning outcomes

Units	Learning outcomes
1	• Define bryophyta and identify plants of this groups • Idea about general characters of bryophytes • Investigate the distribution and habitats of bryophytes • Recognize economic and biological importance of bryophytes
2	• Analyze detailed classification of bryophytes proposed by different bryologists • Characterize three different classes of bryophyta • Known plants from three different classes of bryophyta • Differentiate among three classes of bryophyta
3	• know about two schools of thoughts about the origin of bryophytes • Debate among the two schools of thoughts about the origin of bryophytes • Inspect the origin of sporophytic generation from the gametophytic thallus of bryophytes • Interpret evolution among the three different classes of bryophytes
4	• Acquire in depth knowledge on external features, anatomy, developmental biology, reproduction, and spore dispersal mechanism of important representatives of bryophytes in addition to their specific importance.
5	• Analyze diversity in gametophytic and sporophytic structures of different bryophytes • Discuss alternation of generations in bryophytes with respect to their evolution

References

1. Bapna KR and Kachroo P 2000. Hepaticology in India-I & II. Himangshu Publications, Udaipur, Delhi.

2. Parihar NS 1956. An Introduction to Embryophyta. Vol. I, Central Book Depot, Allahabad.
3. Scagel RF, Bandoni RJ, Rouse GE, Schofield WB, Stein JR and Taylor TMC 1965. An Evolutionary Survey of Plant Kingdom. Wadsworth Publishing Company Inc. Belmont, California.
4. Schofield WB 1985. Introduction to Bryology. Macmillan Publishing Com., New York.
5. Smith GM 1955. Cryptogamic Botany. Vol. II. McGraw-Hill, New York.
6. Vashista BR, Sinha AK and Kumar A 2007. Botany for degree students part III Bryophyta. S Chand & Co. Ltd., New Delhi.

Instruction strategies and Learning experiences

- Lecture followed by group discussion
- Question-answer
- Guided discussion
- Project discussion
- Demonstration

Assignment: Students will be given assignment on particular units

Assessment: In-Course examination, Assignment, Course final examination, Practical examination and Viva-voce

BOT 105: Angiosperm Taxonomy Credit hours: 2

Introduction

Angiosperm taxonomy is the study description, identification, nomenclature, and classification of angiosperm plants. The topics covered include i) basic ideas of angiosperm taxonomy, historical development and importance of angiosperm taxonomy, ii) detailed basis of angiosperm taxonomy including description, identification techniques, nomenclatural rules and classification systems, iii) angiosperm flora diversity of Bangladesh, how to study angiosperm flora, herbarium techniques, information of world largest herbaria and their roles, iv) molecular systematic techniques viz. molecular markers, DNA bar coding and cladistics. Special attention will be paid in the individual research project development.

Course objectives:

(a) Describe angiosperm plant species.
(b) Identify plants using different techniques.
(c) Provide scientific name using icbn rules.
(d) Survey angiosperm flora and to make herbarium sheet.
(e) Arrange angiosperm species using classification systems.

(f) Use molecular techniques to demonstrate phylogenetic systems of classification.
(g) Conduct individual project related to flora survey in natural habitats.

Course contents

Units	Contents	No. of Lectures
1. Introduction	Introduction **t**o angiosperm taxonomy and systematic, history plant taxonomy development, importance and application of angiosperm taxonomy	**4**
2. Description of Angiosperm flora	Roots, stems, leaves, inflorescences, flowers and fruits	**2**
3. Techniques of identification of plants	Introduction to the keys, type of keys and construction of keys, Major plant families and their identifying characters, importance: Dicot plant families *viz.* Acanthaceae, Apocynaceae, Fabaceae, Moraceae, Rubiaceae, Euphorbiaceqae, Lamiaceae, Myrtaceae, Solanaceae and Astertaceae. Monocot plant families *viz.* Poaceae, Cyperaceae, Liliaceae and Orchidaceae.	**6**
4. Approaches to nomenclature	ICBN/ICN, Rules of Nomenclature, steps followed new species to science	**4**
5. Classification	Types of Major classification system, emphasis on phylogenetic systems	**4**
6. Study of angiosperm flora	Introduction to angiosperm flora of Bangladesh, Qualitative and quantitative survey methods of flora, Herbarium techniques, world largest herbaria and modern role of herbaria	**6**
7. Molecular systematic	Type of PCR-based of molecular markers for phylogenetic analyses. Application of DNA-bar coding in taxonomy, cladistics method.	**4**

Unit wise learning outcome

Units	learning outcomes
1	• Will be able to define taxonomy of angiosperm and systematics, able to know historical background of angiosperm taxonomy, importance of taxonomy in the contemporary world.
2	• Will be able to describe angiosperm plant species using taxonomic characters of plants

3	• Will be able to prepare taxonomic keys to identify plant families, identification charachters of some selected families
4	• Will be capable to know the basic principles of botanical nomenclature and how to report new species to scientific world
5	• Will be able to know the modern classification systems of angiosperms.
6	• Will able to learn the techniques of flora survey of particular ecosystem both qualitative and quantitative ways, how to prepare herbarium sheets, importance of herbaria of the world, also to know.
7	• Will be able to learn the basic principles molecular systematics and cladistics.

References

1. Albert E. Radford 1974. Vascular plant systematic, Harper and Row Publishers, New York.
2. Dirk R Walters, David J Keil, and Zack E Murrell 2006. Vascular Plant Taxonomy, 5th edition, Kendal/Hunt Publishing Company.
3. Harris JM and MW Harris. Plant Identification Terminology. Spring Lake Publishing, Spring Lake, UT. (a very useful book with illustrations!).
4. Soltis PS, Soltis DE and Doyle JJ 1998. Molecular Systematics of Plants II: DNA Sequencing. Kluwer Academic Publishers Boston, Dordrecht, London. ISBN 0-41211-131-4.
5. Smith J 1977. Vascular Plant Families. Mad River Press. Nice all-purpose plant taxonomy text. Good bibliography of local floras. Many CA families, each with floral formulae.
6. Stace C 1980. Plant Taxonomy and Biosystematics. Arnold. Readable, brief treatment of basic plant taxonomy, along with other aspects of plant evolution.
7. Cronquist A 1988. The Evolution and Classification of Flowering Plants. New York B G. An excellent, albeit one-sided, view of evolutionary relationships and evolution of characters, with family descriptions.

Instruction strategies and Learning experiences

Lecture followed by
- Group discussion
- Question-answer
- Guided discussion
- Project discussion
- Demonstration in the field

Assignment: Individual project on particular angiosperm plant species/habitat
Assessment: In-Course examination, Assignment, Course final examination, Practical examination and Viva-voce

BOT 106: Biodiversity

Credit hour: 2

Introduction

This is a basic course in 4-years integrated B. S. (honors) in Botany program. Since Biodiversity is very important for the existence and well-being for our planet, it is structured in a way that the students develop clear understanding of the concept of biodiversity, types of biodiversity, creation of biodiversity, importance of time in biodiversity creation, history of earth's origin and its changes in terms of physical, chemical, and biological properties with time period in different geological era. Students also understand the reasons of losses and ways of protection of biodiversity through various ways including national and international organizations and importance of biodiversity from the evolutionary point of view.

Course Objectives

By the end of the course students will able to-

(a) Understand the concept of biodiversity & explain it with reference of geological era.
(b) Know the importance of biodiversity.
(c) Measuring of biodiversity components of the world since the earth is born.
(d) Identify the different factors and their effects responsible for creation of biodiversity.
(e) Different types of biodiversity components and their local as well as worldwide distribution.
(f) Causes of biodiversity losses and extinction, conservation strategies for biodiversity conservation.
(g) Role of some important organizations working for biodiversity conservation worldwide.

Course contents

Units	Contents	No. of Lectures
1. Concept of Biodiverstiy	Definition, unity and diversity, requirements, early and modern concepts, potential, importance of time, the age of bacteria; natures experiment with animals, founding dynasties and terminal disasters, species of the past and the current crisis. **Geological era:** Prehistoric periods of the earth and the representative plant groups belonging to those periods supported by	**5**

	fossil evidences.	
2. Creation of biodiversity	Factors, earth's origin, surface features, continental drifts, geographical positioning system, seasonal cycles, climate and biodiversity, glaciation, effects of natural calamities on biodiversity; re-colonization/colonization of biota in volcanic islands and in a newly emerged island; biodiversity and future changes in climate.	**4**
3. Types of biodiversity	Genetic and sub-cellular, taxonomic, ecological, wetlands, domestic. Measuring biodiversity, the number of species known to us, endemism, mega-diversity countries of the world/biodiversity Hot spots and biodiversity pattern in Bangladesh.	**2**
4. Loss and conservation of biodiversity	Causes of biodiversity, loss and extinction, conservation, and its measures (*in situ* and *ex situ*). Role of some important organizations for biodiversity conservation such as IUCN, UNEP, MAB, Green Peace, CITES, WCMC, WWF and Ramsar Convention Bureau for biodiversity consrvation, threatened ecosystems of Bangladesh.	**3**
5.	Importance and threats to biodiversity	**1**

Unit-wise Learning Outcomes

Unit No.	Learning Outcomes
01	▪ Concept of Biodiversity, Requirements of biodiversity, early and modern concepts ▪ Importance of time in relation to biodiversity abundance and loss ▪ Know about the dynasties and terminal disasters, massive extinction and current crisis ▪ Prehistoric periods of the earth by fossil evidences.
02	▪ Scientific evidences of earth's origin and its biodiversity ▪ Factors responsible for creation of biodiversity ▪ Effects of natural calamities and climate change on biodiversity ▪ How to protect precious biodiversity components from the adversity of nature
03	▪ To know about the types of biodiversity

	▪ How to measure biodiversity ▪ To know about the total species number of the world and about different countries those are rich in biodiversity components and playing significant role to conserve biodiversity ▪ Biodiversity pattern in different localities of the world as well as Bangladesh
04	▪ Acquire knowledge about the causes of biodiversity loss and extinction ▪ Conservation methods of biodiversity ▪ To know about different organizations, function and role in conserving biodiversity worldwide
05	▪ To acquire knowledge about the threats to biodiversity ▪ Why biodiversity is so important for our survival in this universe

References

1. Ashthana D K and M Ashthana 1998. Environment: Problems and Solutions. S. Chand, New Delhi.
2, Bell P R and CLF Woodcock 1983. The diversity of green plants. Edward Arnold, London.
3. Bhuiyan, M. A. H. 2022. Variation, diversity, and phylogenetic relationships among strains of *Pyramimonas* Schmarda from Ryukyu Islands, Japan. Biosystematics and Bioresources. Chapter 3. Pages. 53-66 Editors: Debabrata Maity and Krishnendu Acharya. A Publication by Messrs Bishen Singh Mahendra Pal Singh, Dehradun, India.
4. Jeffries M J 1997. Biodiversity and Conservation. Routledge, New York.
5. Laetsch W M 1979. Plants. Basic concepts in Botany. Little Brown & Co., Boston.
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7. Starr C and R Taggart 1984. Biology – The unity and diversity of life. Wordsworth Publ. Co. Belmont, California.
8. Thornton IWB 1984. Krakatau – The Development and Repair of a Tropical Ecosystem. AMBIO **13**(4): 217-225.

Instructional strategies/ Learning experiences

- Lecture followed by group discussion
- Question-answer
- Guided discussion
- Project discussion
- Demonstration

Assignment

Assignment on particular unit will given to the students.

Assessment

In-Course examination, Assignment, Course final examination, Practical examination, and Viva-voce

BOT 107: Practical – 1

Credit hour: 3

A. General Microbiology, B. Lower Fungi and C. General Phycology

A. General Microbiology

Unit No.	Title	Learning outcomes
1	Microscopic observation of living bacteria by hanging drop method	• Observe live bacterial cells under compound microscope
2	Microscopic observation of curd bacteria by simple staining	• Observe curd bacteria under compound microscope
3	Study of nodule bacteria by simple staining	• Observe nodule forming bacteria under compound microscope
4	Isolation of air borne bacteria by exposure plate technique	• Isolate bacteria from air
5	Isolation of bacteria from garden soil by culture plate technique	• Isolate bacteria from soil
6	Preparation of subculture onto agar slants	• Prepare subculture into a slant from bacterial colony

B. Lower Fungi

Units	Title	Learning outcomes
1	To acquaint with the techniques for preparing temporary slides of fungal specimens for microscopic examinations	• To know how to handle the microscope.
2	Morphological studies of the non-mycelial and mycelial vegetative bodies of the fungi, fungal tissues, special somatic structures, asexual	• Observe the non-mycelial and mycelial vegetative bodies of the fungi, fungal tissues, special somatic

	and sexual spores	structures, asexual and sexual spores under compound microscope.
3	Laboratory studies of the locally available members of the Myxomycetes and fungi covered in the theory	• Observe the members of Myxomycetes and fungi under microscope.
4	Leaf and stem of Bhat (*Clerodendrum viscosum*) infected with *Synchytrium*, Leaf of *Amaranthus*/*Boerrhaavia*/ *Ipomea* (kolmi) infected with *Albugo* spp., Leaf of colocasia/potato infected with *Phytophthora*, Bud of jackfruit infected with *Rhizopus*	• To know about the different diseases caused by fungal pathogens.
5	Field trip to collect fungi and diseased plant materials	• To know how to collect the diseased sample from local area.

C. General Phycology

Units	Title	Learning outcomes
1	Visiting Curzon Hall Campus to show some algal habitats and study of some of the representatives	• To know about the algal habitats and how to collect the algal samples from different habitats
2	Study of the genera covered in the theory with emphasis on both vegetative and reproductive structures	• To observe algal material under compound microscope and herbarium specimen. • To know the different algal habits and identify algae
3	Study of morphological forms of chloroplasts in algae	
4	Study of planktonic, benthic, terrestrial, subaerial, epiphytic, epizoic, endophytic, symbiotic, marine, brackish water and edible algae	
5	Study of lichens	• To Identify different growth forms of lichens
6	Local Excursion to show algal habitats and collection of algal	• To expedition of collection of algal materials from natural

	samples	habitats and exploration of algal ecology

Note: During study students must describe each genus with diagrams, mention identifying characters and classification

BOT 108: Practical -2 **Credit hour**: 3

A. Bryophyta, B. Angiosperm Taxonomy and C. Biodiversity

A. Bryophyta

Units	**Title**	**Learning outcomes**
1	Observation of morphology and anatomy of the following bryophytes: *Riccia, Marchantia, Dumortiera, Plagiochasma* and *Bryum*.	• Acquire in depth practical knowledge on external and internal features and characterize and compare with others to distinguish and identify up to genus.
2	Identify the following bryophytes: *Riccia, Ricciocarpus, Anthoceros, Notothyllus, Barbula* and *Fissidens*	• Acquire quick identification ability of the common bryophyta found in nature.

B. Angiosperm Taxonomy

Units	Title	Learning outcomes
1	Survey techniques of flora, plant collection and preservation of plant specimens**;** Tour to herbarium	• Students will be learning flora survey techniques both qualitative and quantitative ways and will also learn modern herbarium techniques
2	Dissecting flowers and describing floral forms and structures using scientific terms, floral formula and diagram	• Students will learn how to make plant species profile using taxonomic terms
3	Plant Identification: Using and constructing botanical keys	• Student will learn how to construct identification keys
4	Constructing phylogentic tree	• Students will learn how to

	with hypothetical data by hand and computer program	classify plants species using modern computer tools

C. Biodiversity

Units	Title	Learning outcomes
1	Display of specimens from the major plant groups (one example in each from algae to angiosperms), their characteristic features. Study of some fossil specimens.	Study of diversified plant groups including prokaryotic organisms to eukaryotic; including bacteria, prokaryotic to eukaryotic algae and their reproductive structures, endosymbionts, bryophytes, pteridophytes, lichens, coral reefs, gymnosperms, angiosperms, giant and endemic algae, their characterization, classification, uses and geographical distribution. Exploration of fossil evidence of the prehistoric periods of earth's origin. To be acquainted with the plants of Departmental Botanical Garden, Curzon Hall campus, D. U.
2	Plants showing some unique diversities (one representative from each category): Cyanellae, endosymbionts, lichens, littoral macrophytes, marine benthic plants and brackish water plants.	
3	Field visits. To acquaint with the major plant of Departmental Botanical Garden, Curzon Hall Capmus	

BOT 109: Viva-voce **Credit: 2**

Extra Departmental Courses

BOT 1001: Introductory Botany **Credit hour: 04**

(For the Students of Department of Soil, Water and Environment and Zoology)

Introduction

This is an extra-departmental course designed for the 1st year B.S. Honors students of the Department of Zoology and Department of Soil, Water and Environment under the University of Dhaka. Since the 1st year Honors students of those departments will be requiring some basic knowledge on plants during their studies in their respective departments, the present course has been offered from the Department of Botany. Considering the style and content of the offered course on Botany, the students will be able to acquire knowledge on the

classification system of the plants together with the exposure of lower and higher organisms starting from prion to bacteria and algae to angiosperms. Apart form this, the overall knowledge regarding the concept and utility of biodiversity and its conservation will also be taught to them. The students will be able to learn the concept of the subject of ecology where forests of Bangladesh and plant's adaptive features towards various environmental factors and the flow of energy via food chains and food webs are dealt. Lessons on plant diseases their causes, symptoms and controls will be given. The students will be able to identify and learn the scientific names of plants with plant parts yielding medicines, oil, fiber and timbers. Cultivation and processing of tea will also be a part of their curriculum.

Course objectives

(a) Learn the five kingdom system of classification and distinguish eu- and prokaryotes.
(b) Study economic importance of lower organisms: prion, viroid, virus, bacteria, cyanobacteria, etc.
(c) Know algae and phytoplankton
(d) Classify and characterize fungi and lichen, know their economic importance.
(e) Characterize bryophytes, pteridophytes and gymnosperms and learn their habitats and economic importance.
(f) Study angiosperms with the salient features of three selected families.
(g) Know salient features of five selected genera starting from algae to gymnosperms.
(h) Learn different aspects of biodiversity, its conservation and role of IUCN, UNEP, MAB, WWF, etc.
(i) Define ecology, ecosystem, food chain, food web and energy flow; gather knowledge on adaptive features of plants and forests of Bangladesh.
(j) Know – how crop plants get diseased, what are the causal organisms and how could you control disease.
(k) Know scientific- and local names of 10 each of medicinal, oil, fiber and timber yielding plants of Bangladesh; how tea is cultivated and processed.

Course contents

Units	Contents	No. of Lectures
1. Classification	Five kingdoms and their characteristics.	**2**
2. Procaryotes and others	Characteristics and economic importance of the following groups: Prion, Viroid, Rickettsia, Virus, Mycoplasma, Cyanobacteria and Bacteria.	**10**

3. Algae	Characteristics, habitat, classification - up to class according to Lee (2008) and economic importance.	**3**
4. Phytoplankton	Characteristics, classification and economic importance.	**3**
5. Fungi	Characteristics, classification - up to class according to Alexopoulos and Mims and economic importance.	**3**
6. Lichen	Characteristics, classification and economic importance.	**3**
7. Bryophyta, Pteridophyta and Gymnosperm:	Characteristics, habitat and economic importance.	**5**
8. Angiosperm	Characteristics, types of classification of plant kingdom, differences between monocot and dicot; salient features of Asteraceae, Fabaceae and Poaceae.	**2**
9. Salient features	*Gloeotrichia*, *Agaricus*, *Marchantia*, *Selaginella* and *Cycas*.	**2**
10. Biodiversity	Introduction, causes, types and importance of biodiversity, global status of biodiversity and mega-diversity countries of the world.	**4**
11. Conservation of biodiversity	Causes of loss of biodiversity, *in situ* and *ex situ* conservation. Role of IUCN, UNEP, MAB, Green Peace, CITES, CMC and WWF on biodiversity conservation Bureau.	**3**
12. Plant Ecology	(a) Adaptation and characteristics of hydrophytes, halophytes and xerophytes. (b) Structure and components of an ecosystem; food chain, food web, energy flow in ecosystem; (c) Forests of Bangladesh; dominant plants of mangrove and decidous forests.	**6**
13. Plant Pathology	Concept of disease in plants, causes of plant diseases; how do plant pathogens cause disease in plants, symptomatology and elementory knowledge of plant disease control. Causal organisms, symptoms and control measures of the following plant diseases: (a) Brown spot of rice (b) Late blight of potato	**8**

	(c) Stem rust of wheat (d) Red rot of sugarcane	
14. Economic Botany	(a) Local and scientific names, parts used and importance of at least ten important medicinal, oil, fibre and timber yielding plants of Bangladesh. (b) Cultivation and processing of tea.	**6**

Unit wise learning outcome

Units	Learning outcomes
1	• Gather knowledge on how five kingdoms namely, archaea, protista, plantae, fungi and animalia are placed and characterized
2	• Understand characteristic features and economic importance of lower organisms
3	• Learn characteristics, classification and economic importance of algae
4	• Learn characteristics, classification and economic importance of phytoplankton
5	• Learn characteristics, classification and economic importance of fungi
6	• Get to know characteristics, classification and economic importance of lichens
7	• Learn characteristic features, classification, habitat and economic importance of liverworts, mosses, ferns and naked seeded plants
8	• Gather knowledge on characters of angiosperms, monocot and dicots and salient features of families namely, Asteraceae, Fabaceae and Poaceae
9	• Learn salient features of *Gloeotrichia*, *Agaricus*, *Marchantia*, *Selaginella* and *Cycas*
10	• Update knowledge on biodiversity, causes, types importance, mega diversities
11	• Learn conservation of biodiversity and know the role of several international organizations promoting biodiversity
12	• Get concepts of ecology and adaptation of plants in water, saline habitat and in deserts; structure and function of ecosystem, food chains and webs, energy flow; forests and mangroves of Bangladesh
13	• Learn about Plant Pathology and plant diseases, pathogens causing diseases in plants, symptoms, disease control for rice, potato, wheat and sugarcane

14	• Learn scientific names, local names of medicine, oils, fiber and timber yielding plants of Bangladesh; growing processing of tea.

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1. Agrios GN 2002. Plant Pathology, Academic Press, London.
2. Bannister P 1976. Introduction to Physiological Plant Ecology. Blackwell Scientific Publications.
3. Bashar MA and MR Islam MR 2005. Degree Botany, Hassan Book House, Dhaka.
4. Bell PR and CLF Woodcock 1983. The diversity of green plant. Edward Arnold, London.
5. Etherington JR 1971. Environmental and Plant Ecology. John Willey and Sons.
6. Jeffries MJ 1997. Biodiversity and conservation. Routledge, New York.
7. Khondker, M; Bhuiyan, M. A. H. and Bashar, M. A. 2023. Towards an appraisal of Biodiversity in Bangladesh. *J. biodivers. conserv. bioresour. manag.* **9**(1), 79-100. DOI: https://doi.org/10.3329/jbcbm.v9i1.66634. Dhaka, Bangladesh.
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9. Pandey BP 1980. Economic Botany. S. Chand & Company Ltd.
10. Smith GM 1955. Cryptogamic Botany. Vol. I and II. McGraw-Hill Co., Ltd., New York.

Instruction strategies and Learning experiences

- Lecture followed by group discussion
- Question answer
- Guided discussion
- Project discussion
- Demonstration

Assingment: Students will be given assignment on particular units

Assessment: In-Course examination, Assignment, Course final examination, Practical examination, and Viva-voce

Practical (Marks 20)

Units	Title	Learning outcomes
1	Study of diversity of habit and habitat of plants in nature.	Able to know the habitat of different plants
2	Demonstration of common algae, fungi, lichen, bryophytes, pteridophytes, gymnosperms and angiosperms.	Will be able to identify different types of plant groups
3	Study of angiosperm families: Poaceae, Asteraceae, Fabaceae and Nymphaeaceae.	Learn to identify different important families of angiosperms

4	Identification of economic plants and plant products.	Know the economically important plants of Bangladesh
5	Study of common hydrophytes, halophytes and xerophytes.	Learn the extreme habitat of plants with examples
6	Study of brown spot of rice, stem rust of wheat, red rot of sugarcane and tikka disease of groundnut	Will be able to know the important plant diseases of Bangladesh

BOT 1002: Ecology, Environment and Plants Credit hour: 4 (For the Students of Department of Geography and Environmental Science)

Introduction

This course has been designed for the extra-departmental students of the University where focuses are given to the different aspects of Ecology and Environmental Sciences. Ecology is a multidisciplinary synthetic branch of Biology that deals with studies the interactions between living organisms and the non-living components of the environment. Synecology also known as community ecology studies interactions between and among species as well as communities and focuses on the aspects of adaptation, phytogeography, succession of plant communities, nutrient cycling, ecosystem structure and functions, distribution and diversity of forests and methods for studying vegetation. Autecology focuses on the adaptation, distribution and abundance of individuals and populations of organisms. The environment of plants consists of hydrosphere, lithosphere and atmosphere. But human activities are destroying these components of environment and biological diversity which have developed over a millions of years. Under current global change scenario this course focuses to familiarize the students from other departments about Plant Ecology to make them fit to combat the new challenges of the earth.

Specific objectives

The specific objectives of the course are to teach students the basic concepts of environments of plants, adaptation, ecological processes, phytogeography, biogeochemical cycling of nutrients, current status of forests in Bangladesh and how to conduct vegetation survey and apply statistics on analyzing diversity and other phytosociological variables.

Course content

A: Synecology (Vegetation Ecology)		
Units	**Course content**	**No. of lectures**
1. Introduction	Definition, History, Scope and sub-divisions of Ecology, environment and plants Hydrophytes, Xerophytes and Halophytes; their ecological features.	5
2. Plant succession	Definition, types and causes of succession	3
3. Methods of studying vegetation	Methods of studying vegetation. Study of communities; Life form classes	6
4. Ecosystem	Classification, structure and components of ecosystems; food chain and food web; Energy and mineral movement in Ecosystem	4
5. Forest Ecology	Plants and Environment of deciduous and Sundarban mangrove forests of Bangladesh	3
6. Phytogeographical regions	Brief account of Phytogeographical regions of the world	2
7. Sampling	Sampling; Tests of comparison and application of quadrat measures and random sampling	2
B: Autecology (Physiological Ecology)		
1. Environment of plants	The hydrosphere and the biosphere	2
2. The role of green plants	The role of green plants in nature with reference to: (i) The Sun-a thermonuclear energy source; (ii) Radiant energy; (iii) Human population and food supply; and (iv) CO_2 and world climate.	5
3. Soil environment	Physical and chemical aspects and distribution of plants	4
4. Energy environment	Energy budget of different climatic zones	2
5. Salinity	Sources of salinity, Classification of saline habitats	3
6. Biogeochemical cycles	Definition, types of biogeochemical cycle; water and carbon cycles	5
7. Biodiversity	Introduction, causes of the loss and	4

	degradation of biodiversity, species diversity analysis	
C: Environment		
1. Water resources	The global picture and the environment	4
2. Greenhouse effects	Greenhouse gases, ozone depletion and CFCs, CFCs use in Bangladesh	3
3. Climate change	Causes and consequences	3

Unit wise learning outcome

Units	**Learning outcomes**
A: Synecology (Vegetation Ecology)	
1	• Students will have the basic idea about different branches of Ecology and adaptive mechanisms of plants growing in different habitats
2	• Gain knowledge about the ecological succession in various environmental conditions
3	• Students will be acquainted with sampling, vegetation survey methods as well as gain knowledge about the plant community structure.
4	• Learn about the structure and function of the ecosystem
5	• Learn about the ecological conditions and species composition of different forest types of Bangladesh
6	• Gain idea about the distribution of the vegetation throughout the world and the factors that regulate their pattern of distribution
7	• Will have the knowledge about how to do statistical analyses of vegetation and as well as in analysis and interpretation of results.
B: Autecology (Physiological Ecology)	
1	• Learn about the characteristics of ecospheres
2	• Learn about the role of green plants and sun on the energy conversion, production and the supply of foods
3	• Know properties of soil and its roles in climatic condition
4	• gain knowledge on the availability and exchange of energy
5	• Know extent and sources of salinity and the features of different saline habtats
6	• Enhanced knowledge about the nature and functions of the nutrient cycles on Earth and their ecological implications
7	• Will be able to know about different levels of biodiversity, causes of biodiversity degradation and how to analysis species diversity in different communities

C: Environment	
1	• Will have an idea about the current situation of water resources of the world and crisis faced by different countries of the world
2	• Will be able to know about the causes and consequences of greenhouse effects, depletion of ozone layers and its implications
3	• Will have the knowledge about climate change

Instructional strategies: White board and black board, multimedia and overhead projector will be used in the classroom.

Assignment: Students will be given assignment on particular unit.
Assessment: In-Course examination, Assignment, Course final examination, Practical examination, and Viva-voce

References

1. Bannister P. 1976. Introduction to Physiological Plant Ecology. Blackwell Scientific Publications.
2. Chiras DD. 1985. Environmental Science. The Benjamin Publishing Co. Inc.
3. Daubenmire R 1978. Plant Geography. Academic Press. London.
4. Etherington JR 1971. Environment and Plant Ecology. John Wiley & Sons.
5. Gates DM 1993. Climate Change. Sinauer Associates Inc.
6. Larcher WL 1975. Physiological Plant Ecology. Springer – Verlag
7. Kershaw KA 1958. Quantitative and Dynamic Plant Ecology. Edward Arnold Ltd.
8. Krebs CJ 1978. Ecology: The Experimental Analysis of Distribution and Abundance. Harper International.
9. Muller Dombois D and H Ellenberg 1974. Aims and Methods of Vegetation Ecology. John Wiley & Sons.
10. Odum EP 1971. Fundamentals of Ecology. Toppan Co. Ltd. Japan.
11. Shimwell DN 1971. Description and Classification of Vegetation. Sidgwick & Jackson. London.
12. Waisel J 1972. Biology of Halophytes. Academic Press.

Practical (20 Marks)

1. Students will maintain a Field Note Book to study the vegetation types and the habitats of the University Campus and from local excursions.
2. Morphology and anatomy of plants of hydrophytes and xerophytes.
3. Determination of pH in water and soil samples.
4. Determination of salinity (Chloride) in water samples.
5. Determination of conductivity in water and soil samples.
6. Vegetation analysis.
7. Identification of forest plants from herbarium sheets.

Detailed curriculum outline of Second Year BS Honours Course (Session: 2023-2024 Onward)

Departmental Courses	**Credit hours**
BOT 201: Higher Fungi	2
BOT 202: Gymnosperm, Paleobotany and Economic Botany	2
BOT 203: Anatomy	2
BOT 204: Fundamental Ecology	2
BOT 205: Cytology	2
BOT 206: Fundamental Plant Physiology	2
BOT 207: Fundamental Genetics	2
BOT 208: Elementary Plant Breeding	2
BOT 209: **Practical-1:** Higher Fungi, Gymnosperm, Paleobotany & Economic Botany, Anatomy, Synecology	3
BOT 210: **Practical-2:** Cytology, Fundamental Plant Physiology, Fundamental Genetics, Elementary Plant Breeding	3
BOT 211: **Viva-voce**	2

Extra-Departmental Courses (For the Students of Botany)

BOT 212: Biostatistics	4
SOIL 002: Soil Chemistry and Soil Fertility	4
	Total = 32

Extra-Departmental Courses (For the students of Microbiology, Zoology, Geography & Environment, respectively)

BOT 2001: Genetics and Cytogenetics	4

BOT 201: Higher Fungi

Credit hour: 2

Introduction

Higher Fungi is one of the basic course in 4-years integrated BS (Hons) in Botany program. The course aims to provide the concept of higher fungi and their importance to under graduate students. General characteristics of higher fungi, their classification, details of three classes of higher fungi *viz.* Asocomycetes, Basidiomycetes and Deuteromycete and life cycle pattern of selected members of aforesaid classes has been included in this course.

Course objectives

(a) Know the differences between lower and higher fungi.
(b) Occurrence and importance of higher fungi.
(c) Habitat, nutrition, vegetative structure and special vegetative structure of higher fungi.
(d) Reproduction of higher fungi.
(e) Life cycle pattern of higher fungi.

Course contents

Units	Contents	No. of Lectures
1. Introduction	Contribution of different scientists in the field of Mycology, Classification of higher fungi and Importance of Higher fungi to mankind.	**4**
2. Ascomycetes	General characteristics, classification, and studies of the following groups: a) Endomycetales- with emphasis on the cell structure and life cycle patterns of the members of Saccharomycetaceae. b) Eurotiales- with emphasis on the imperfect and perfect stages of aspergilli and penicilli and their economic importance. c) Erysiphales - a discussion on the genera causing powdery mildew diseases of crop plants and their separation on the basis of cleistothecial appendages. d) Meliolales - common dark mildew fungi and their effect on host plants. e) Clavicipitales - production of ergot by *Claviceps purpurea* on rye plant and its importance.	8
3. Basidiomycetes	General characteristics, classification, and studies on the following groups: a) Ustilaginales - life cycle pattern, discussion on the important smut and bunt fungi and their mode of infecting host plants. b) Uredinales - life cycle patterns, heteroceism and biological	**12**

	specializations found amongst the members of this group. c) Aphyllophorales - moprhological and anatomical details of the basidiocarps of pore fungi and their role as wood-rotting fungi. d) Agaricales - morphological and anatomical details of the basidiocarps of agarics and boleti and their role as ecotrophic mycorrhizae; edible and poisonus mushrooms.	
4. Deuteromycetes	General characteristics, classification, and importance as plant pathogens.	6

Unit wise learning outcome

Units	Learning outcomes
1	• Contribution of different scientists in the field of mycology • IMPORTANCE of higher fungi to mankind
2	• Comparative study between lower and higher fungi. • Classification of higher fungi. • Habitat, structure and reproduction of ascomycetes, • Importance of ascomycetes
3	• Basic features, structures, reproduction, classification, and importance of basidiomycetes.
4	• Gateher knowledge salient features of deuteromycetes • Classification of deuteromycetes • Habitat, structure, and reproduction of deuteromycetes. • Importance of deuteromycetes.

References

1. Alexopoulos CJ, CW Mims and M Blackwell 1996. Introductory Mycology. (4th Edn.), John Willy and Sons Inc., NY.
2. Moore-Landecker. 1982. Fundamentals of the fungi. Prentice Hall, Inc., New Jersey, USA.
3. Mundker BB 1967. Fungi and Plant Diseases, MacMillian & Co. Ltd., Calcutta (revised by S.B. Chattapadhay).
4. Webster J 1980. Introduction to Fungi, Cambridge University Press, London, U.K.

Instructional strategies/ Learning experiences

Lecture followed by
- Group discussion
- Question-answer
- Guided discussion
- Demonstration

Assignment: Students will be given assignment on particular units

Assessment: In-Course examination, Assignment, Course final examination, Practical examination, and Viva-voce

BOT 202: Gymnosperms, Paleobotany and Economic Botany
Credit hour: 2

Introduction

This course aimed at highlighting Gymnosperms, Paleobotany and Economic Botany, designed in such a way that after completion the students will be able to understand the gymnosperms, its classification, characteristics and importance. They will be familiar with importance and necessity of studying of fossil, how plant or plant parts become fossils, and the factors responsible for fossilization. In addition, the methods of determining the age of fossil will be deliberated. Plants as source of economic products with special reference to Bangladesh will be discussed focusing on medicinal plants, pulses, species, essential and fatty oil, timber and fibre. Students will be able to be acquainted with medicinal plants which are commonly used in primary health care. Cultivation and processing of tea and rubber will be discussed in detail as well as processing of sugar.

Course objectives

(a) Define and explain the characteristics of gymnosperms and distinguish them from angiosperm. Identify the gymnosperms found in Bangladesh with their precise locality.
(b) Know about fossils and their significance in plant systematics and evolution.
(c) Learn how plant or plant parts become a fossil and the factors responsible for fossilization.
(d) Know various techniques for determination of fossil age and would be able how to analyze the fossil.

(e) Learn the medicinal plants, present scenario of medicinal plants in the country, their classification, and uses for treating different ailments.
(f) Know the spices and condiments used in our food-stuffs, pulses with their nutritional value, high class timbers, essential and volatile oil with their uses, and different types of fibres including the most important cotton.
(g) Learn how to cultivate and process rubber and tea as well as processing of sugar.

Course contents

Units	Contents	No. of Lectures
1. Gymnosperms	Introduction, general characteristics, differences between Gymnosperms and Angiosperms, Classification of Gymnosperms, diagnostic characters of Cycadofilicales, Bennettitales, Cycadales, Cordaitales, Ginkgoales, Coniferales and Gnetales with examples.	**3**
2. Gymnosperms of Bangladesh	Gymnosperms commonly found in Bangladesh: Distribution and characteristic features of *Cycas* and *Gnetum*, Primitive characters of *Cycas*; Advanced characters of *Gnetum*	**2**
3. Paleobotany	Introduction and scope of Paleobotany; Definition of fossil and living fossil, Different types of fossils, Factors responsible for fossilization.	**3**
4. Processing and analysis of Fossil	Process of fossilization, Analysis of fossils, Examples of fossils from Gymnosperms, Bryophytes and Pteridophytes, Various techniques for determining the age of fossils.	**3**
5. Paleogeological era	Period and epoch mentioning its characteristic flora and events, Implication and importance of fossils.	**2**
6. Economic Botany	General knowledge of plants as source of economic products with special reference to Bangladesh. *Medicinal Plants*: Definition following WHO, Studies on medicinal plants in Bangladesh; Classification of medicinal plants;	**4**

	Scientific names, families, parts used and uses of important medicinal plants of Bangladesh.	
7. Spices, Oil and Pulse	Definition of spices and condiments; classification; scientific names, family names, parts used, uses of common spices of Bangladesh, *Oil*: defination; difference between oil and fat; classification; different types of essential oil and fatty oils with examples and uses., *Pulse*: Common pulses of Bangladesh, Scientific names, family names, characteristics, parts used, chemical composition and uses.	**4**
8. Fibre and Timber	Definition, classification, textile fibre, broom fibre, rough weaving fibre, filling fibre, natural fabrics, paper making fibre, *Timber*: scientific names, family names, parts used, uses of important timber yielding plants of Bangladesh	**4**
9. Tea, Rubber and Sugar	*Tea*: Origin, Cultivation, Processing, *Rubber*: Introduction, para-rubber, characteristics, cultivation, processing, *Sugar*: Cultivation and Processing	**5**

Unit wise learning outcomes

Units	Learning outcomes
1	• Will be able to identify gymnosperms in nature and capable to differentiate between gymnosperms and angiosperms. They will understand the classification and characteristic features of different orders of the naked seeded plants.
2	• The commonly found gymnosperms will come in light and the precise locality of them to be known; the details characteristic features of *Cycas* and advanced characters of *Gnetum* will shed more light on these groups.
3	• The scope of this important branch will be underlined; in-depth information on fossil, its types and factors affecting fossilization will be learnt by the students.
4	• Will learn how plant or plant parts become a fossil and what the techniques by which fossils can be analyzed; they will know the examples of fossils from different groups like gymnosperms, bryophytes and pretidophytes. In addition, how the age of fossils is

	determined will be perceptible to them.
5	• This unit will disclose different period, epoch and era when different groups of plants appeared and became extinct, how long they lasted for, and what was the climatic condition at that time.
6	• Through this Unit the students will be able to define medicinal plants scientifically following WHO, and the scenario of medicinal plants of Bangladesh and their classification. Students will be familiar with important medicinal plants of the country used for treatment of different ailments including diabetes, cancer, cardiac diseases, jaundice, dysentery & diarrhoea, gastritis, cough & cold and other common diseases, and which parts are used for these diseases.
7	• The spices and condiments used in our daily life will be highlighted with their scientific names, parts and other uses. The nutritional composition, i.e. percentage of carbohydrate, protein, water, fat, fibre, etc. along with uses of common pulses of Bangladesh will come in light. Moreover, students will learn differences between oil and fat, different types of essential oil and fatty oils with examples and uses, all of which will be useful in practical life.
8	• Fibre, being a very important and indispensable plant product in our daily life, students will know their classification, from where they are obtained and uses in detail. They will also learn the best timber yielding plants of the country and the characteristics of wood of those plants.
9	• The outcome of this Unit includes acquaintance of origin, cultivation and processing of tea; how rubber is cultivated and processed from latex and how it can have positive impact in our life; and what is the cultivation procedure of sugarcane and sugar is processed. Going through this Unit hands-on knowledge will be gained on these very important products which could be applied in practical life.

References

1. Chester R Amold 1977. An Introduction of Paleobotany. Tata McGraw-Hill Pub. House Co., New Delhi.
2. Farooq A Lone, Maqsooda Khan and GM Buth 1993. Palaeoethnobtany, Oxford and IBH Pub. House Co., New Delhi.
3. Hill AF 1951. Economic Botany (Indian reprint 1979), Tata McGraw-Hill Publ. Co., Ltd., New Delhi.
4. Panday SN, SP Misra and PS Trivedi 1997. A Text Book of Botany, Vol. (ii), Vikas Publ. House, New Delhi.
5. Pandey BP 1980. Economic Botany, S. Chand & Company Ltd.

6. Vashishta PC 1990. Gynmnosperms, S. Chand & Co. Ltd., New York.
7. Yusuf M, JU Chowdhury, MN Haque and J Begum 2009. Medicinal Plants of Bangladesh. Bangladesh Council of Scientific and Industrial Research, Chittagong, Bangladesh
8. nvmvb GgG 1996. Dw™¢`weÁvb (wØZxq LÛ), nvmvb eyK nvDm, XvKv|

Instructional strategies/ Learning experiences

- Lecture followed by
- Group discussion
- Question-answer
- Guided discussion
- Demonstration

Assignment: Students will be given assignment on particular units

Assessment: In-Course examination
- Course final examination
- Assignment
- Practical examination
- Viva-voce

BOT 203: Plant Anatomy

Credit hour: 2

Introduction

A course in BS (Hons) in Botany curriculum which is targeted to give up to date knowledge on plant anatomy and cell biology to the 2nd year students of the 4 year honors course. The course covers detailed discussion on cell types and structures, tissue systems, and anatomical structures of stem, root and wood. The study of aforementioned topics will help students to understand the structures and function of plants from cell level to organism level. Moreover, this course offers basic knowledge on plant anatomy which is necessary of better understanding in 300/400 level courses i.e., physiology, breeding taxonomy, ecology, etc.

Course objectives:

(a) Familiarize students with various types of cells.
(b) Introduce different types of tissues and tissue systems.
(c) Explain structures and growth in different stem, root and leaf.
(d) Study internal structures of studied plants.
(e) Provide necessary theoretical knowledge to develop skills (section and stain of fresh plant material in practical study).
(f) Grow interests among students for acquiring advanced knowledge in plant anatomy.

Course contents

Units	Contents	No. of Lectures
1. Introduction	Different cell types and tissue systems.	**5**
2. Cell wall	Chemical and physical nature and its origin, structure, and function.	**3**
3. Meristem	Origin, classification, structure, and function. The role of meristem in organization of plant body.	**2**
4. Vascular tissue	Vascular tissue systems and their functions.	**2**
5. Primary structure	Primary structure of monocot and dicot root and stem; dorsiventral and isobilateral leaf.	**3**
6. Secondary growth	Normal and anomalous secondary growth in dicto root and stem.	**3**
7. Root stem transition	Root stem transition	**1**
8. Secretory tissue	Important secretary structures and their characteristics and function	**2**
9. Protective tissue	Origin, function and structures and development of periderm and related tissue	**2**
10. Mechanical tissue	Types and characteristics	**2**
11. Wood anatomy	Physical and chemical nature of wood. Identifying procedures of transverse, tangential and radial sections.	**3**
12. Internal structures of wood	*Tectona grandis, Artocarpus heteropjylla, Bombax ceiba, Magnolia grandiflora.*	**2**

Unit wise learning outcomes

Units	Learning outcomes
1	• Learn basic structures and functions of different types of cells
2	• Understand structural components of plant cell walls and membranes
3	• Describe the mechanism of growth and development in plant organs
4	• Explain mineral and water transportation in different t part of plants

5	• Discuss the difference between monocot and dicot plants in organ level
6	• Outline and describe the process of secondary growth in root and stem
7	• Learn root stem transition process and location
8	• List and categorize the anatomy of internal and external secretory structures
9	• Summarize the formation of protective layers
10	• Explain mechanical balance in plants
11	• Identify and analyze wood structure
12	• Characterization of wood quality
13	• Design, carry out, and present a laboratory study in plant anatomy

References

1. Eames AJ and Macdaniels LH 1947. An introduction to plant anatomy (2nd Edn.), McGraw Hill Book Co., Inc., New York.
2. Esau K 1991. Plant anatomy (Reprint). Wiley Eastern, New York.
3. Fahn A 1968. Plant anatomy. Pergamon Press, Oxford.
4. Pandey BP 1989. Plant anatomy. S Chand and Co. Ltd., New Delhi.
5. Foster AS 1949. Practical anatomy (2nd Edn.) Van Nostrand Co., New York.

Instruction strategies and Learning experiences

- Class lecture using black board/white board
- Question answer
- Practical demostration
- Group discussion

Assignment: Students will be given assignment on particular units

Assessment: In-Course examination, Assignment, Course final examination, Practical examination, and Viva-voce

BOT 204: Fundamental Ecology

Credit hour: 2

Introduction

Ecology is a multidisciplinary synthetic branch of biology that embraces disciplines mainly of taxonomy, physiology, genetics and evolution. It deals with the study of adaptation, distribution and abundance of organisms. It studies interactions between and among species as well as communities. Understanding the nature, structure and functions of the complex ecological communities and

processes is important for sustainable use, conservation and management of the biological resources. The course 'Fundamental Ecology' focuses on the aspects of definition and origin of the discipline, adaptation, biotic interaction, population and community organizations, phytogeography, succession of plant communities, nutrient cycling, ecosystem structure and functions, distribution and diversity of forests and methods for studying vegetation.

Course objectives

The specific objectives of the course are to teach students basic knowledge of ecological processes, adaptation, phytogeography, biogeochemical cycling of nutrients, structure and functions of ecosystems, community organization and succession of communities. The course also aims to teach students types and current status of forests in Bangladesh and how to conduct vegetation survey and how to apply statistics on analyzing vegetation data.

Course contents

Sl.	Units	Contents	N0. of Lectures
1.	Introduction	• History and definition of ecology • Sub-divisions of ecology • Scope of ecology	2
2.	Adaptation of plants	• Definition and types of adaptation • Adaptive features of hydrophytes, xerophytes and halophytes • Resource allocation • Classification of life history patterns • r- and *K*-selection	4
3.	Ecosystem	• Definition of ecosystem • Structure and components of ecosystems • Classification of ecosystem • Dynamics of ecosystem with reference to nutrient and energy flow • Food chain and food web • Ecological pyramid • Soil food web (top down and bottom up regulation) • Causes of biodiversity • Links between biodiversity and ecosystem function	3
4.	Population ecology	• Introduction	2

		• Performance structure • Spatial structure • Age structure • Genetic structure • Population dynamics	
5.	Community ecology	• Introduction • Definition of community • The niche concept • Evenness and relative abundance • Physical structure • Dynamics of plant communities	2
6.	Plant succession	• Definition and types of succession • Causes of succession • Climax concept of succession • Sere, hydrosere and xerosere • Models of succession	2
7.	Vegetation ecology and methods of studying vegetation	• Definition of vegetation • Classification of vegetation • Life form classes and biological spectrum • Characters of vegetation (Qualitative and quantitative) • Methods for analysis of vegetation	4
8.	Forest Ecology	• Definition of forests, classification of major forests • Introduction to the forests of Bangladesh • Description of evergreen/semi-evergreen, deciduous, mangrove and fresh water swamp forests of Bangladesh: ecological adaptation, soil/water condition, and dominant plant species.	3
9.	Biogeochemical cycles	• Definition, types and significance of biogeochemical cycle • Water cycle • Gaseous (carbon cycle) • Sedimentary (phosphorus) cycle • Dynamics of nutrient cycling and interactions of biogeochemical cycles	2
10.	Phytogeography	• Definition of phytogeography • Causes of geographical distribution of plants	2

		• Brief account of phytogeographical regions of the world, and Indian Sub-continent • Interactions among Floristic plant geography, Taxonomy and Geology • Ecological plant geography	
11.	Land use types	• Classification of land by climate, vegetation and land use • Ecological impacts of land use change	2
12.	Sampling	• Definition and types of sampling • Tests of comparison • Application of quadrat measures.	2

Unit wise learning outcomes

Unite	**Unit-wise learning outcomes**
1	This unit will give students basic idea about the discipline of Ecology
2	This unit will give students broad knowledge about the adaptation mechanisms of plants
3	Students will learn about the structure and function of the ecosystems and gain knowledge about the underlying factors of global biodiversity
4	Students will learn about the plant demography and their spatial structure an dynamics as well
5	Students will gain knowledge about community organization and also know how to classify plant communities
6	Students will gain knowledge about the ecological succession of plants
7	Students will learn about the techniques of vegetation survey as well as gain knowledge about the plant community structure
8	Students will learn about the diversity and ecology of the forest plants of Bangladesh
9	Students will learn about the nature and functions of the nutrient cycles on Earth
10	This unit will give students idea about the distribution of the vegetation and the factors that regulate them
11	Students will learn about the distribution of land and plant resources across the world
12	Students will learn the sampling techniques for vegetation analysis

References

1. Barbour MC 1999. Terrestrial Plant Ecology. 3rd Edition. Addison Wesley Longman
2. Daubenmire R 1978. Plant geography. Academic Press. London
3. Greig-Smith P 1983. Quantitative Plant Ecology. 3rd Edition. University of California Press
4. Hossain MZ 2021. Methods for Ecological Studies. Ariban Publishing Tech. Australia
5. Schulze E.-D, Beck E and Muller-Hohenstein K 2005. Plant Ecology. Springer
6. Smith RL and Smith TM 2001. Ecology and Field Biology. 6th Edition. Pearson
7. van der Maarel E and Franklin J 2013. Vegetation Ecology. Wiley-Blackwell, UK
8. Wardle DA 2002. Communities and Ecosystem: Linking the Above and Below Ground Components. Princeton University Press, Princeton and Oxford
9. Weaver JE and Clements FE 1978. Plant Ecology. McGraw-Hill Book. N.Y.

Instructional strategies and Learning experiences:

- Class lecture using black board/white board/multimedia projector
- Question/answer
- Guided discussion
- Practical demonstration
- Field visits/Study tour

Assignment: Students will be given assignment on selected topics.

Assessment: In-Course examination, Assignment, Course final examination, Practical examination, and Viva-voce

BOT 205: Cytology — Credit hour: 2

Introduction

This is a basic course in 4 -years integrated BS (Hons) in Botany program. It will be very helpful to the students for developing clear knowledge about the origin, structure, chemical composition and functions of different types of cells and cellular organelles. In addition, the students will get detailed information regarding cell cycle and cell division.

Course objectives

(a) Define and explain cell, cell concept, cell cycle, apoptosis, amitosis, mitosis, meiosis, and their biological significance.
(b) Get clear idea about the origin, structure, chemical composition and functions of different types of cell and cellular organelles.
(c) Learn about the principles of cellular signaling and cell communication processes.
(d) Explain the nature of different special types of chromosomes.

Course contents

Units	Contents	No. of Lectures
1. Introduction to Cytology and its history	Introduction, cell, cell concept and primitive cell; a brief history of Cytology.	**2**
2. Prokaryotic and eukaryotic cell	Ultrastructure of a generalized prokaryotic and eukaryotic cell, ultrastructure of generalized plant and animal cell. Differences between: (i) prokaryotic and eukaryotic cells, (ii) plant and animal cells.	**1**
3. Cell wall and Cell membrane	Kinds, ultrastructure, chemical composition, and function.	**3**
4. Membrane bounded organelles	Discovery, distribution, morphology, ultrastructure, chemical composition, and function of membrane bounded organelles *viz.* Mitochondria, Chloroplasts, Endoplasmic, Reticulum, Golgi Complex and Lysosome.	**7**
5. Ribosome	Discovery, distribution, ultrastructure, kinds based on S-value, chemical composition, biogenesis, and function.	**1**
6. Cytoskeleton	Discovery, distribution, structure and function of microtubules, actin, and intermediate filaments; centrioles, and spindle fiber.	**2**
7. Nucleus	Discovery, morphology, nucleo-cytoplasmic index, ultrastructure, chemical composition and functions of the nucleus and sub-compartments of nucleus such as nuclear membrane, nuclear pore, Cajal bodies, chromosome territory, inter-chromosomal domain, chromosomes, and nucleolus.	**2**
8. Membranes and transport mechanisms	Transport of ions and small molecules across membranes, protein trafficking between membranes, vesicle-mediated protein transport concept, exocytic and endocytic pathway.	**2**
9. Cell communication	Introduction of cell signaling mechanisms, Ca^{2+} signaling, G protein-coupled receptor.	**2**
10. Cell division	Cell cycle, cell cycle regulation, apoptosis	**5**

Credit hour: 2

	(programmed cell death), amitosis, mitosis, meiosis and their biological significance.	
11. Special type of chromosomes	Discovery, occurrence, origin, ultrastructure, and function of polytene chromosomes, B-chromosomes, lampbrush chromosomes.	**3**

Unit wise learning outcomes

Units	Learning outcomes
1	• Will get clear idea about cell, cell concept and primitive cell and will gather knowledge about brief history of Cytology.
2	• Will learn about chemical and physical structure of prokaryotic cell and eukaryotic cell, ultrastructure of a generalized plant and animal cell.
3	• Will get idea about ultrastructure, chemical composition, and function of cell wall and cell membrane.
4	• Will obtain brief idea about ultrastructure, morphology, chemical composition, and function of membrane bounded organelles *viz.* Mitochondria, chloroplasts, endoplasmic, reticulum, golgi complex and lysosome.
5	• Will get clear knowledge about structure and function of ribosome and able to classify ribosomes based on S-value.
6	• Learn about the ultrastructure and function of microtubules, actin, and intermediate filaments and know how they are distributed throughout the cell.
7	• Gather brief knowledge about the discovery, morphology, ultrastructure, and function of nucleus and also get clear idea about all the parts of the nucleus.
8	• Gather brief knowledge about ions and small molecules transport across membranes, protein trafficking between membranes, vesicle-mediated protein transport concept, exocytic and endocytic pathways.
9	• Learn about cell signaling mechanisms, Ca^{2+} signaling, and G protein signaling modules.
10	• Will gather a brief and clear knowledge about cell cycle and its regulation, activities of CDK-cyclin complexes, apoptosis, checkpoints and all kinds of cell divisions.
11	• Will learn about different special types of chromosomes. They also get clear knowledge about the distribution, origin, feature, morphology, and biological significance of these special types of chromosomes.

References

1. Aktaruzzaman M 1997. Koshbidya (Cytology). Hassan Book House, Dhaka.
2. Plopper G, D Sharp and E Sikorski 2013. Lewin's CELLS. Jones & Bartlett learning. Massachusetts, USA.
3. Alberts B, D Bray, K Hopkin, AD Johnson, J Lewis, M Raff, K Roberts and P Walter 2013. Essential Cell Biology. Garland Science. Taylor & Francis Group, NY, USA.
4. Pollard TD, WC Earnshaw, G Johnson and J Lippincott-Schwartz 2016. Cell Biology. Elsevier, Philadelphia, USA.
5. Sumner AT 2003. Chromosomes - organization and function. Blackwell Publication, UK.
6. Swanson CP 1965. Cytology, MacMillan Co. Ltd., London.
7. Taylor DJ, NPO Green and GW Stout 2004. Biological Science (3rd edition), Cambridge University Press, Cambridge, UK.

Instruction strategies and Learning experiences

- Lecture followed by group discussion
- Question answer
- Guided discussion
- Project discussion
- Demonstration

Assignment: Students will be given assignments on particular units.

Assessment: In-Course examination, Assignment, Course final examination, Practical examination, and Viva-voce.

BOT 206: Fundamental Plant Physiology

Credit hour: 2

Introduction

This is a basic course in 4 –years integrated BS (Hons) in Botany program. It is structured in a way that the students develop clear understanding of plant physiology with special reference to the concept of water relations, water absorption and translocation in plants, transpiration, photosynthesis, and respiration. Students also understand about photoperiodism, vernalizaiton, physiology of seed, the reasons for seed dormancy and ways to overcome it through various artificial methods.

Course objectives

(a) Explain principles governing water movement into and inside of plants and finally how excess water evaporates from plants.

(b) Describe how green plants trap sun light and convert it into chemical energy to manufacture their own food.

(c) Distinguish how lower and higher groups of plants obtains energy in the form of ATP through respiration.

(d) Correlate the connection between external factors viz. relative day and night length, low temperature etc. and the flowering of plants.

(e) Tell different changes accompanying seed germination.

(f) Find out the reasons for seed dormancy and also be able to solve the problem.

Course contents

Units	Contents	No. of Lectures
1. Water relations in plants	Water properties, principles of water movement in plants, water potential (Ψw), soil-plant-atmosphere continuum, movement of the xylem sap and Ψp, plasmolysis, imbibition, colloids.	**4**
2. Absorption and translocation of water	Mechanism of active and passive absorption, external factors affecting absorption of water, relative importance of active and passive absorption, translocation of water, path and mechanism of translocation of water, different theories with special emphasis on the role of transpiration pull and cohesion of water.	**4**
3. Transpiration	Types of transpiration, mechanism of opening and closing of stomata, significance of transpiration.	**2**
4. Photosynthesis	Light reaction, action of light, photophosphorylation, dark reaction or chemical reaction, assimilation of CO_2, Calvin cycle, factors affecting photosynthesis.	**4**
5. Respiration	Introduction, aerobic respiration, glycolysis, pyruvate to acetyl CoA formation, TCA cycle, electron transport system, respiratory quotient, anaerobic respiration-fermentation with special reference to alcohol and lactic acid fermentation.	**4**
6. Photoperiodism	Brief history, classification, photoperiodic induction, importance of dark period, perception of photoperiodic stimulus, transmission of stimulus, presence of floral hormone, components of floral stimulus, role	**3**

	of phytochrome in flowering.	
7. Vernalization	Brief history, vernalization and flowering, site of perception of vernalization, devarnalization, mechanism of vernalization-phasic development theory and hormonal theories, gibberelline and the flowering response.	**3**
8. Physiology of seed	Seed structure and development, viability of seeds, germination process and types of germination, conditions necessary for germination, physiological, biochemical, and other changes accompanying seed germination.	**3**
9. Dormancy of seed	Causes of seed dormancy, methods of breaking seed dormancy, advantage of dormancy of seed, secondary dormancy of seeds.	**3**

Unit wise learning outcomes

Units	Learning outcomes
1	• Explain the mechanisms of xylem and phloem sap movements in plants and some life related phenomena.
2	• Describe how water is absorbed from soil by root and then is translocated to the top of the plant.
3	• Tell how plant releases its excess water.
4	• Interpret how green plants trap sunlight and manufacture their own food.
5	• Describe how plants obtain their energy.
6	• Elucidate the day's and night's influence on flowering of plants.
7	• Explain the role of low temperature in plant's flowering.
8	• Tell different changes accompanying seed germination.
9	• Gain knowledge to identify different reasons for seed dormancy and adopt measures to break the dormancy.

References

1. Salisbury FB and C Ross 1995. Plant Physiology, (4th Edn.) CBS, New Delhi.
2. Devlin RM and FH Witham 1986. Plant Physiology (4th Edn.), CBS Publishers and Distributors, New Delhi.
3. Hess D 1975. Plant Physiology, Springer International Student Edition.
4. Jain VK 2007. Fundamentals of Plant Physiology, S. Chand and Company Ltd., New Delhi.

5. Jain JL 1983. Fundamentals of Biochemistry, S. Chand and Company Ltd., New Delhi.

Instruction strategies and Learning experiences

- Lecture followed by group discussion
- Question answer
- Guided discussion
- Project discussion
- Demonstration

Assignment: Students will be given assignment on particular units

Assessment: In-Course examination, Assignment, Course final examination, Practical examination, and Viva-voce

BOT 207: Fundamental Genetics

Credit hour: 2

Introduction

Genetics is an area of science that is advancing perhaps more rapidly than any other, with each advancement offering us a fresh insight into biological sceince. It is a relatively young science but one that has had an immeasurable effect upon biological study. The potential of genetic research in many areas of life, from plant to animal, is overwhelming. Covering all the fundamental facets of genetics, including the biological construction of genes and how they work, how dominant and recessive genes influence the inheritance of particular inherited traits, and the importance of chromosomes, this course will provide you with an introduction to the scientific subject that has taught us the most about the origins of life.This course provides an ideal stepping stone to understand the principles of genetics with application to the study of biological function at the level of molecules, cells, and multicellular organisms, including plants and humans. The topics include: basic terms, principles, and research methods used in the study of genetics, Mendelian inheritance to exceptions, biological variation resulting from recombination, mutation, and selection, population genetics, and use of genetic methods for sex determination. Students will discover the principles of heredity from its basic principles to the most recent advances in the field and learn how they can map genes, analyse the linkage, and understand their function.

Course objectives

(a) Understand the principles and concepts of Genetics.
(b) Apply the principles of inheritance as formulated by Mendel.

(c) Apply the principles of extensions to Mendelian inheritance, including multiple allelism, lethal alleles, gene interactions, and sex-linked transmission.
(d) Understand how Mendelian genetics can be improvised in plant breeding research.
(e) Analyze genetic data using statistical procedures.
(f) Deduce the relationship between genetic, physical, and cytogenetic maps.
(g) Understand the nuclear and cytoplasmic inheritance pattern.
(h) Apply the Hardy-Weinberg Law in analyzing population genetics for gene frequency, sex linkage, equilibrium, and heterozygote frequency.

Course contents

Units	Contents	No. of Lectures
1.Mendelian inheritence	(a) Historical background of Genetics (b) Life of Gregor Johann Mendel, his experiments, and achievements; reasons of Mendels success (c) Monohybrid, dihybrid and trihybrid inheritence, (d) back cross and test cross, (e) Probability in Mendelian inheritance, Chi-square test.	3
2. Exceptions of Mendelism	a) 1st law-(i) Incomplete dominance, (ii) Co-dominance, (iii) Lethal gene, (b) 2nd Law-(i) Single recessive epistasis (9:3:4), (ii) Duplicate recessive epistasis (9:7), (iii) Single dominant epistasis-cumulative effect of duplicate genes (9:6:1), (iv) Duplicate gene-one incomplete dominance (12:3:1), (v) Pleiotropism.	**4**
3. Multiple allele and pseudoallele	(i) Definition, characteristics, and examples: ABO blood type alleles and Rh factor alleles in humans, self –incompatibility alleles in plants, eye-colour in *Drosophila* and coat colour in rabbit, (ii) Significance of multiple alleles.	3
4. Linkage and recombination	(a) Discovery of Linkage: autosomal and sex, (b) Linkage maps and Linkage detection, genetic interference, and coincidence.	**4**
5. Gene and environment	(a) Effect of environmental factors on the genotype and phenotype of organisms, (b) Phenocopy.	**2**
6. Sex	(a) Different methods with examples- (i) XX-	**4**

determination	XO type,(ii) XX-XY type, (iii) ZZ-ZW type, (iv) X-Y type, (b) Balance concept of sex determination in *Drosophila* (c) Y chromosome and sex determination in mammals, (d) Sex-limited, sex-linked and sex-influenced traits.	
7. Quantitative inheritance	Qualitative versus quantative traits; multiple factor hypothesis; kernel colour in wheat, skin colour in human, corolla length in *Nicotiana longiflora*; polygenic inheritence and continuous variation.	**3**
8. Cytoplasmic inheritence	Nuclear versus cytoplasmic inheritence; (a) Extranuclear inheritence in eukaryotes, maternal effects (b) Extranuclear inheritence by cytoplasmic organelles; chloroplast and mitochondria, plastid inheritence- variegation in plants, inheritence in *Mirabilis jalapa*, iojop inheritence in corn.	**2**
9. Genetic constitution of a population	Gene pool and gene frequencies, equilibrium of gene frequencies and Hardy-Weinberg law; Changes in gene frequencies under mutation, migration, selection, and genetic drift.	**3**
Review	Review of course contents and discussion on problem set assignment.	**2**

Unit wise learning outcome

Units	Learning outcomes
1	• Explain Mendel's Principles of Segregation and Independent Assortment • Describe the chromosomal basis of inheritance • Evaluate the validity of research results by Probability analysis
2	• Describe non-Mendelian inheritance • Explain the influence of dominant and recessive genes in the inheritance of particular inherited traits
3	• Understand the term multiple alleles and pseudo alleles. • Explain the role of multiple and pseudo alleles behind human blood typing, self-incompatibilty in plants etc.
4	• Explain the effect of crossing-over on the inheritance of genes in linkage groups • Construction of the genetic map of genes on chromosomes. • Detect linkage and determine the genetic distance and

	interferences
5	• Explain how the environmental factors regulate genotype and phenotype of the organism • Understand genomic imprinting and genotype-environment interaction. • Explain the broad-sense heritability equation.
6	• Distinguish between sex chromosomes and autosomes. • Explain the role of sex chromosomes in sex determination. • Describe how an x or y-linked gene affects the inheritance of traits.
7	• Understand the inheritance of polygenic traits and how it is influenced by multiple genetic factors and environmental factors • Know what a quantitative vs. A categorical trait is • Explain multiple factor hypothesis • Explain of genetic factors affect quantitative traits (additive gene action, dominant gene action and epistatic gene action).
8	• Understand the cytoplasmic inheritance and how it differs from nuclear inheritance • Know the structure and endosymbiotic origin of mitochondria and chloroplasts • Understand the various patterns of inheritance associated with extra nuclear genomes • Understand the process of epigenetic inheritance • Understand how maternal effect influences the phenotype of the offspring and the molecular basis of this pattern of inheritance.
9	• Define the terms population, species, allelic and genotypic frequencies, gene pool, and fixed allele, genetic drift, bottle-neck effect, founder effect • What is the hardy-weinberg equilibrium and what are its conditions • Use the hardy-weinberg principle to explain when microevolution occurs • Explain how mutations, gene flow, nonrandom mating, genetic drift, and natural selection contribute to the process of microevolution • Calculate genotypic and allelic frequencies from a given population • Name different kinds of natural selection, and with example discuss the effect of each on a population.

References

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2. Avers CJ 1980. Genetics. Willard Grant Press, Boston, USA.
3. Ayala FJ and Kiger JA 1980. Modern Genetics, The Benjamin/Cummings Publishing company Inc. London
4. Hartl LH and Ruvolo M 2012. Genetics, Analysis of genes and genomes, Jones and Bartlett Learning, USA.
5. Gardner EJ, Simmons MJ and Snustad DP 1991. Principles of Genetics, John Wiley and Sons Inc.
6. Islam AS 1985. Bangshagati Bidyar Mulkatha, bangla Academy, Dhaka.
7. Lewin B 2004. Genes VIII. Prentice Hall
8. Miglani GS 2000. Basic Genetics. Narosa Publishing house.
9. Stricberger MW 2008. Genetics (3rd edition). PHI, India.
10. Watson JM Molecular biology of Genes (3rd edition). Benjamin. Inc.

Instruction strategies and Learning experiences

- Lectures with harmonized power point presentation on the Unit followed by interactive question-answer
- Group discussion
- Problem set assignments on each Unit

Assignment: Students will be given assignment on particular units

Assessment: In-Course examination, Assignment, Course final examination, Practical examination, and Viva-voce

BOT 208: Elementary Plant Breeding

Credit hour: 2

Introduction

This is a basic course in 4 years BS (Hons) in Botany, structured in a way that after completion the students will be able to understand the concept and activities of plant breeding, its nature and relation with other branches of sciences, the necessity of studying the reproductive biology of crop plants. The methods of crop improvement will be discussed with detailed field techniques, their merits and limitations following the procedure of releasing improved variety from laboratory to the farmer. Finally, the concepts of origin of cultivated crops will also be discussed.

Course objectives

(a) Define and explain the concept, activities, and nature of plant breeding.
(b) Know the relation of plant breeding with other branches of sciences.
(c) Learn the field techniques various methods of crop improvement.
(d) Learn the necessity of following plant quarantine rules.

(e) Know the process of release of improve variety from lab to Farmer.
(f) Know the origin of cultivated crops.

Course contents

Units	Contents	No. of Lectures
1	Definition, activities, nature, aims and objectives of plant breeding Relation with other branches of biology, e.g., genetics, cytogenetics, plant physiology, plant pathology, entomology, microbiology, taxonomy, biometry, etc.	**6**
2	a) Reproductive biology in crop plants: methods and mode of reproduction, fertility, and incompatibility relationship. Different methods of crop improvement. Selection, Hybridization, Plant Introduction and Acclimatization, Mutation breeding, Plant Biotechnology, In-course examination.	**7**
3	Breeding methods in self- and cross-pollinated crops. Hybridization: Hybridization with related and distantly related crops, back-cross breeding. Plant Introduction and Acclimatization- detail procedure, Plant quarantine; Mutation breeding: History, mutagens, effects of mutation on survival, mechanism of action mutagens, and procedure of mutation breeding, application, and limitations of mutation breeding.	**14**
4	Release of an improved variety from laboratory to the farmers. Concepts of centre of origin of cultivated crops.	**3**

Unit wise learning outcomes

Units	Learning outcomes
1	• Know the definition, activities, and nature of plant breeding. • Learn the aims & objectives of plant breeding. • Know the relationship of other branches of sciences with plant breeding
2	• Learn the crops plants breeding system in relation to plant breeding activities. • Briefly know the different methods of crop improvement with their merits and demerits.
3	• Learn about the detailed methodologies of field techniques of the following crops improvement methods- Selection, Hybridization, Plant introduction & Acclimatization and Mutation breeding.

4	• Know the procedure of release of an improved variety developed in the laboratory. • Know the different centers of origin of cultivated crops.

References

1. Allard RW 1964. Principles of Plant Breeding. John Willey & Sons, N.Y.
2. Briggs FN and PF Knowles 1978. Introduction to Plant Breeding. Reinhold Publishing Corporation, N.Y., London.
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7. Simmonds NW 1979. Principles of Crop Improvement, Longman, London.
8. Singh BD 2005. Plant Breeding Principles and Methods. Kalyani Publishers, New Delhi.

Instruction strategies and Learning experiences

- Lecture followed by group discussion
- Question answer
- Demonstration

Assignment: Students will be given assignment on particular units

Assessment: In-Course examination, Assignment, Course final examination, Practical examination, and Viva-voce

BOT 209: Practical -1

Credit hour: 3

A. Higher Fungi, B. Gymnosperm, Paleobotany and Economic Botany, C. Anatomy, and D. Fundamental Ecology

A. Higher Fungi

Units	Title	Learning outcomes
1	Laboratory studies of the locally available members of fungi covered in theory: *Aspergillus niger, Penicilium* sp., *Oidium* sp., *Cercospora* sp., *Alternaria* sp.	• Know the structure of different fungi covered in theory. Study the selected fungi in nature.

	Curvularia sp., *Colletotrichum* sp., *Macrophomina phaseolina*, *Botryodiplodia theobromae*, *Sclerotium rolfsii*, *Agaricus* sp., *Pleuretus* sp., *Ganoderma* sp., *Polyporus* sp., *Ustilago tritici*, *Ustilago hordei*. Rust fungi.	
2	Techniques of growing fungi on culture media	• Isolation of fungal organisms from diseased plant parts following blotter and tissue planting methods.

B. Gymnosperm, Paleobotany and Economic Botany

Units	Title	Learning outcomes
1	Morphology and anatomy of *Cycas* and *Pinus* leaflet	• Learn the external and internal morphology of gymnosperms, particularly *Cycas* and *Pinus* leaf and understand the anatomical xerophytic characters of these plants.
2	Identification of fossils	• Students will be able to identify different types of fossils.
3	Identification of medicinal plants in the field	• Students will be able to identify the important medicinal plants in the field in and around Dhaka University compound.
4	Studies on economically important plants and plant products including their commercial names, scientific names, family names, parts used and uses	• Understand the economically important plants and plant products, their commercial names, parts used and different uses of those plants.

C. Anatomy

Units	Title	Learning outcomes
1	Maceration technique and study of different cell types.	Variable characteristics features of main different types of plant cells e.g., parenchyma, collenchyma, sclerenchyma, simple and complex types of cells will be

		studied using differential staining and light microscopy.
2	Primary growth: Transverse section of dicot and monocot stem.	Organization of different types of cells and tissue within stem of both dicot and monocot plants through transverse section will make students familiar with the primary structure during development.
3	Anatomy of leaf: Transverse section of dorsiventral and isobilateral leaf.	Students will be acquainted with different tissue types and their arrangement in the most important organ of plant i.e. leaf from both dicot and monocot species.
4	Secondary growth: Jute, *Boerhaavia* and *Dracaena* stem.	With different types of plant specimen students will acquire knowledge on how structurally plants are designed for their secondary growth to gain thickness.
5	Wood anatomy: Transverse, radial and tangential sections of *Tectona*, Artocarpus, *Bombax* and *Magnolia*.	Cellular structure and composition of different kinds of wood will give insight about their developmental characteristics as well as economic value.

D. Fundamental Ecology

Sl. No.	Topic	Learning outcomes
1	Maintain field note book to study the seasonal variation of plant species and their habitats in and around Dhaka city	• Understand natural vegetation as well as the components and functions of the ecosystems • Understand how to analyze/ survey vegetation • Learn how to study adaptation of plants • Know how to analyze environmental factors (e.g., water quality etc.) • Learn application of computer software for multivariate analysis of biotic community
2	Morphological and anatomical studies of hydrophytes and xerophytes	
3	Study of common hydrophytes and xerophytes of Bangladesh	
4	Determination of Dissolved Oxygen (DO) in aquatic habitat	
5	Vegetation survey: Determine the frequency, density, abundance, and Importance Value Index (IVI) of the different species of the plant community	
6	Application of computer software in community analysis	
7	Local excursions to study wetland and dry land habitat species; sun and shade habitat species	

BOT 210: Practical -2 **Credit hour**: 3

E. Cytology, F. Fundamental Plant Physiology, G. Fundamental Genetics, and H. Elementary Plant Breeding

E. Cytology

Units	Title	Learning outcomes
1	Study and handling of simple and compound microscopes.	• This unit will help the students to develop expertise in using simple and compound microscopes to study microscope slides containing course-relevant materials.
2	Preparation of cytological stains such as acetocarmine and aceto-orcein.	• After attentive response of this unit, students will be able to prepare some stains that frequently used in cytological studies.
3	Study of cell types such as leaf epidermal cells, root cells, pollen mother cells, pollen grain, stamenal hair, bast- fibre (phloem fibre) cells.	• This unit will enable the students to understand and identify several types of cells.
4	Preparation of temporary slide to study mitosis in onion root tip cells by aceto-orecin squash method.	• This unit will help the students to learn basic techniques of temporary slide preparation with different stages of mitotic cell division.
5	Study of permanent slides and photomicrographs of mitotic cell division.	• Upon successful completion of this unit, students will be able to identify different stages of mitotic cell division with the help of photographs and permanent slides.

F. Fundamental Plant Physiology

Units	Title	Learning outcomes
1	Chlorophyll is essential for photosynthesis	• Develop skill to demonstrate chlorophyll's essentialiality for photosynthesis
2	Evolution of oxygen during photosynthesis	• Demonstrate evolution of oxygen during photosynthesis
3	Demonstration of Osmosis with potatosmoscope	• Demonstrate osmosis in living plants
4	Demonstration of the stomatal transpiration by four leaves method	• Demonstrate stomatal transpiration in leaves
5	Evolution of heat during respiration	• Use Dewar flask to show heat evolution during respiration
6	Separation of leaf pigments by paper chromatography	• Show skill to use the qualitative and quantitative analytical methods to separate and determine leaf pigments

G. Fundamental Genetics

Units	Title	Learning outcomes
1	Solving the problems related to Mendelian inheritance	• Explain the inheritance pattern of traits where two or more than two alleles for the trait exist.
2	Verification of various monohybrid and dihybrid ratios by Chi-square and goodness of fit tests.	• Understand the segregation pattern of monohybrid and dihybrid ratios by Chi-square and verify it by goodness of fit tests.
3	Problems related to various types of alleles, gene interactions, linkage and crossing over.	• Explain the effect of crossing-over on the inheritance of genes in linkage groups.
4	Studies on the quantitative variations in available plant materials and segregating populations	• Perform statistical analysis of population genetic data, summarise and interpret the outcomes in written and oral form
5	Estimation of alleic and gene frequencies using data obtained from various populations.	• Calculate the genetic variability parameters including alleic and gene frequencies from various population.

H. Elementary Plant Breeding

Units	Title	Learning outcomes
1	Test of pollen grain fertility	• Students will learn how to test pollen grain fertility using nuclear stains
2	Study of floral biology in different plant species	• Know the reproductive biology of the selected crops plants, namely, flower structure including position and number of anthers, their morphology, anthesis time, etc.
3	Hybridization techniques in available economically important plants	• Students will learn how to select parents for hybridization including selfing of parents, hand emasculation tagging, bagging, pollination and proper record keeping.
4	Test of seed germination in clay pots and in the field conditions	• Students will know how to prepare pots and fields for sowing seeds and record the rate of seed germination.
5	Collection and preservation of germplasm of different crops	• Students will know the techniques of collection and preservation of different economically important germplasm of agricultural importance
6	Multiple alignments of selected sequences	• Able to identify conserve regions of DNA or protein sequences. They can also design degenerate primers from multiple alignment of peptide sequences and finding phylogenetic relationship.

BOT. 211: Viva-voce **Credit: 2**

Extra Departmental Courses

BOT 212: Biostatistics **Credit hour: 4**

(For the Students of Department of Botany)

Introduction

Biostatistics is the branch of statistics concerned with mathematical facts and data related to biological events. Moreover, biostatistics is the application of statistics to a wide range of topics covering almost all branches of biology.

Biostatistical modeling forms an important part of numerous modern biological theories. Since it's beginning the science of genetics used statistical concepts to understand observed experimental results. Using the tools of statistics, biostatisticians help answer pressing research questions in various branches of biology. This course is designed to provide the students the knowledge, skill and understanding on the collection, summarization, analysis and interpretation of results and findings from scientific investigations

Course objectives

(a) To understand the basic principles and concepts of biostatistics.
(b) To enhance students' learning capacity on data collection, data summarization and analysis to obtain desired output.
(c) To make students familiar with various statistical tools and techniques for performing various statistical investigations in solving various problems.
(d) To make students familiar in developing statistical hypothesis for various specific investigations.
(e) To introduce the students to process and techniques in identifying areas of experimentation and investigations.

Course contents

Units	**Contentd**	**No. of Lectures**
1. Definition and scope of biostatistics	Variables, random variables, discrete and continuous variables, population, samples, random samples, statistic, and parameter.	**4**
2. Organization and presentation of data	Qualitative and quantitative data, frequency distribution. Tabulation and graphical presentation, histogram, frequency polygon, bar diagram, pie chart, scatter diagram.	**6**
3. Types of distributions	Symmetrical and asymmetrical distributions, skewness, and kurtosis	**4**
4. Measures of central value and dispersion	Mean, mode, median; measures of dispersion, range, mean deviation, variance, standard deviation, standard error, coefficient of variation, confidence limit.	**8**
5. Probability	Concept of probability, some elementary probability, probability rules. Probability distributions: normal, binomial and poisson distributions and their applications.	**4**
6. Test of significance	Hypothesis testing, null hypothesis, alternative hypothesis, level of significance.	**2**

7: Comparison of two means	Student's t-test, unpaired and paired t-test, t-test for large and small samples.	**6**
8. Chi-square test	Goodness of fit test, test of independence, test of homogeneity, association of attributes, 2 x 2 contingency table.	**6**
9. Interrelation-ships of quantitative variables	Correlation, correlation coefficient; linear regression: regression coefficient, regression equation	**6**
10. Analysis of variance:	One way and two-way classifications of variance, comparison of three or more samples, F-test, significance test for F.	**6**
11. Experimental design	Concepts of experimental design, experiment, experimental unit, treatment, principles of experimental design, analysis of variance for completely randomized design (CRD), randomized block design (RBD) and Latin square design.	**6**
12. Multiple comparisons	Least significant difference (LSD) test, Duncan's multiple range test (DMRT).	**2**

Unit wise learning outcomes

Units	**Learning outcomes**
1	• Know the importance of biostatistics in various branches of biological sciences. • Know the different types of variables including random variables, nature of discrete and continuous variables. • Know the genetic nature of qualitative and quantitative variables. • Know the concept of population, sample, and random samples.
2	• Know the various ways of presentation of qualitative and quantitative data, • Know the techniques of summarization and tabulation of data, various graphical presentation of qualitative and quantitative data,
3	• Know the nature of distribution, symmetrical and asymmetrical distributions. • Know the significance of symmetrical and asymmetrical distributions. • Know the nature of skewness and kurtosis.

4	• Know the various measures of central value including mean, mode and median. • Know the various measures of dispersion including range, mean deviation, variance, standard deviation, standard error, and coefficient of variation. • Know the significance of estimating variance for biological materials. • Know the significance of estimating confidence limit.
5	• Know the concept of probability, probability rules applicable for biological materials • Know Probability distributions: normal, binomial and poisson distributions and their applications
6	• Know the concept of hypothesis and hypothesis testing. • Know the application of null and alternative hypothesis for statistical tests. • Know the method of finding out probability levels in various statistical significance tests.
7	• Know the methods of comparison of means from two populations and samples. • Know the methods of t-test for unpaired and paired samples. • Know the method for t-test large and small samples. • Know the significance of t-test in biological materials
8	• Know concept and importance of Chi-square test. • Know goodness of fit test, test of independence, test of homogeneity. • Know the idea of association of attributes and application of contingency table.
9	• regression coefficient, regression equation • Know the concept interrelationships of quantitative variables. • Know the method of estimating correlation and correlation coefficient, preparation of scatter diagrams and test of significance of correlation coefficient. • Know the technique of estimation linear regression, development of regression equation, preparation of regression line and significance test for regression.
10	• Know the methods for comparison of three or more samples, F-test, significance of F-test in biological investigations.
11	• Know the concepts and principles of experimental design. • Know the types of experimental design used in various biological investigations including completely randomized

	design (CRD), randomized block design (RBD) and Latin square design. • Know the methods of analysis of variance following different experimental designs, variance ratio test and interpretation of obtained results.
12	• Know the concepts for multiple comparisons of treatments following F-test. • Know the methods used for multiple comparison using Least significance difference test (LSD), Duncans's multiple range test (DMRT),

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Instructional strategies/ Learning experiences

- Lecture followed by Question-answer
- Group discussion
- Project discussion
- Practical demonstration

Assignment: Students will be given assignment on particular unit.
Assessment: In-Course examination, Assignment, Course final examination, Practical examination, and Viva-voce

Practical (Marks: 20)

Units	Title	Learning outcomes
1	Acquisition of random samples from a population, recording of data about continuous variables. Presentation of qualitative and quantitative data	• Students will learn the techniques of collecting random samples from small and large populations. • Students will learn the process of summarizing and presenting qualitative and quantitative data using frequency distribution, frequency curve, bar graph, histogram, frequency polygon etc.
2	Analysis of data with the help of scientific pocket- and desk top electronic calculators.	• Students will learn the technique of analyzing various collected data using scientific calculators.
3	Estimation of central value and dispersion using various samples and populations.	• Students will carry out experiments to estimate central value from various large and small samples. • Students will also perform experiments to estimate the various measures of dispersion including variance, standard deviation, standard error, coefficient of variation.
4	Comparison of two samples and populations through t-test	• Learn the technique of for the comparison of means from two small and large samples using t-test
5	Chi-square test for goodness of fit, test of independence and test of homogeneity.	• Perform chi-square test to estimate goodness of fit, to test the fix ratio hypothesis, as well as to test the heterogeneity and homogeneity of various materials.
6	Estimation of correlation coefficient, preparation of scatter diagram, test of significance for correlation coefficient.	• Learn to estimate correlation coefficient and to test its significance. • Learn to prepare scatter diagram to represent correlation between variables,

7	Estimation of regression coefficient from various experiments and their interpretations.	• Students will estimate regression coefficient from experimental materials, develop regression equation, preparation of regression line and significance test for regression.
8	Comparison of three or more samples through F-test.	• Students will learn to carry out experiments for the comparison of three or more samples through F-test. • They will learn the technique in interpreting the results obtained from the variance analysis.
9	Designing and performing experiments with CRD, RBD, Latin square designs.	• Students will learn to prepare lay out for different experimental designs. • Students will also perform analysis of variance following various experimental designs. • They will learn the technique in interpreting the results obtained from the variance analysis. • Learn to estimate the best treatment following F-test using LSD test.

BOT 2001: Genetics and Cytogenetics Credit hour: 04
(For the Students of Department of Zoology)

Introduction

This is an extra Departmental course in 4 –years integrated B. S. (honors) in Botany program. It will be very helpful to the students for developing clear knowledge about Mendelism, exceptions of Mendelism, Multiple alleles, Pseudo allele, cytoplasmic inheritance and chromosome mapping. In addition, the students will get detail information regarding cell cycle and cell division. The students will able to define and explain the natures of different special type of chromosomes, physical and chemical nature of chromosome, karyotype and ideogram. Students will get clear idea about the identification, kinds, detection, genetic effect and meiotic behavior of different types of structural chromosomal aberration such as deletion, duplication, translocation and inversion and explain different types of numerical aberration of chromosomes. In addition, students

will get clear idea about the cytological behaviour and application of trisomy and autopolyploid.

Course objective

Genetics

(a) Explain the scope and brief history of Genetics.

(b) Get clear idea about Mendelism, exceptions of Mendelism, Multiple allele, Pseudo allele, cytoplasmic inheritance and chromosome mapping.

Cytogenetics

(a) Define and explain Cell, Cell-cycle, amitosis, mitosis, meiosis and their biological significance.

(b) Explain the nature of different special type of chromosome,

(c) Define and explain physical and chemical nature of chromosome, karyotype and ideogram,

(d) Get clear idea about the identification, kinds, detection, genetic effect and meiotic behavior of different types of structural chromosomal aberration such as deletion, duplication, translocation and inversion,

(e) Explain the scope and brief history of Cytogenetics,

(f) Define, classify and explain different types of numerical aberration of chromosomes.

(g) Get clear idea about the cytological behavior and application of trisomy and autopolyploidy.

Course content

A. Genetics:

Units	Course content	
1:	Definition, brief history and scope of Genetics and Cytogenetics.	1
2:	Different branches of Genetics and their importance.	1
3:	Mendelism: Brief life sketch of Gregor Johann Mendel, rediscovery of Mendelism, 7 pairs of contrasting characters of garden pea, law of segregation, law of independent assortment, reasons for Mendel's success, determination of phenotypic and genotypic ratios by alzebra, statistics and forking method and summary of Mendelism.	7

4:	Exception to Mendelian laws: (i) Apparent (a) 1st law - Incomplete dominance (1:2:1), lethality (1:2), co-dominance; (b) 2nd law - single recessive epistasis (9:3:4), double recessive epistasis (9:7), single dominant epistasis (9:6:1), double dominant epistasis (15:1), (b) duplicate gene - one shows incomplete dominance (12:3:1), (ii) Real - linkage, sex linkage, non-disjunction, preferential distribution.	7
5:	Multiple allele and pseudoallele: definition, features and examples.	2
6:	Multiple genes and quantitative inheritance: Multiple genes (polygenes) and quantitative inheritence: features of multiple genes, differences between principal and secondary gene, polygene and pureline selection, examples, transgressive segregation.	5
7:	Chromosome mapping: definition, arrangement of linked genes, mapping of 2- and 3 genes linkage, co-efficient of co-incidence (CI), solving problems.	5
8:	Cytoplasmic and extranuclear inheritance: different types with example.	5
B. Cytogenetics		
9:	Chromosomes: physical and chemical structure, karyotype and idiograms.	5
10:	Special type of chromosomes: Physical structure, chemical structure and function of (a) Polytene, (b) Lampbrush and (c) B-chromosome.	6
11:	Cell division: (a) Cell cycle, (b) Mitosis and (c) Meiosis with their significance.	6
12:	Chromosomal aberration: i. General classification. ii. Structural aberration-type, origin, detection and meiotic behaviour of- (i) deletion, (ii) duplication, (iii) inversion and (iv) translocation. Numerical aberration-type, origin, detection, meiotic behaviour and segregation of (i) Autopolyploid and (ii) Trisomic.	13

Unit wise learning outcome

Units	Learning outcomes
1	• Students will get a brief idea about the history, base of this branch, importance and scope of cytogenetics and genetics in

	modern research of Biology.
2	• Students will gather knowledge about different branches of genetics.
3	• Students will learn about brief sketch of Mendelism
4	• Students will obtain clear knowledge about different laws proposed by Mendel with their apparent and real exceptions
5	• Students will get idea about Multiple allele and pseudoallele
6	• Students will able to describe multiple genes and quantitative inheritance
7	• Students will obtain brief idea about chromosome mapping
8	• Students will able to describe cytoplasmic and extranuclear inheritance
9	• Students will get a clear and brief knowledge about chromosomes, structural and chemical composition, nature, nucleosome model and function of chromosomes. • Students will able to prepare karyotype and ideogram, describe symmetric, asymmetric, monomodal and bimodal karyotype, also learn about the significance of karyotype study.
10	• Students will learn about different special types of chromosomes. They also get clear knowledge about the distribution, origin, feature, morphology and biological significance of these special types of chromosomes.
11	• Students will gather a brief and clear knowledge about all kinds of cell divisions.
12	• Students will get general idea about chromosome aberration. • Students will get brief and clear knowledge about all types of structural aberrations of chromosomes such as deletion, inversion, duplication, translocation, etc. and consequences that occurs due to those aberrations. • Students will get overview idea about numerical aberrations of chromosomes. Students will learn about origin, distribution, occurrences, sources, cytological behavior, kinds, phenotypic expressions and consequences of trisomy and autopolyploid.

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Instructional strategies

Lecture followed by group discussion
Question-answer
Guided discussion
Project discussion
Demonstration

Assignment: Students will be given assignment on particular unit.
Assessment: In-Course examination, Assignment, Course final examination, Practical examination, and Viva-voce

Practical (Marks: 20)

1. Observation of morphological and biochemical mutants of *Drosophila/Neurospora*.
2. Preparation of stains for cytological work.
3. Study of mitosis in onion root tip cells.
4. Study of permanent slides and photomicrographs of different stages of mitosis and meiosis.

Units	Title	Learning outcomes
1	Observation of morphological and biochemical mutants of *Drosophila/Neurospora.*	• This unit will enable the students to understand and identify several types of morphological and biochemical mutants of *Drosophila/Neurospora.*

2	Study and handling of simple and compound microscopes. Preparation of cytological stains such as acetocarmine and aceto-orcein.	• This unit will help the students to develop expertise in using simple and compound microscopes to study microscope slides containing course-relevant materials. • After attentive response of this unit, students will be able to prepare some stains that frequently used in cytological studies.
3	Preparation of temporary slide to study mitosis in onion root tip cells by aceto-orecin squash method.	• This unit will help the students to learn basic techniques of temporary slide preparation with different stages of mitotic cell division.
4	Study of permanent slides and photomicrographs of mitotic and meiotic cell division.	• Upon successful completion of this unit, students will be able to identify different stages of mitotic and meiotic cell division with the help of photographs.

Detailed curriculum outline of Third Year BS Honours Course (Session: 2024-2025 Onward)

Departmental Courses **Credit hours**

BOT 301:	Environmental Microbiology	2
BOT 302:	Plant Pathology	2
BOT 303:	Advanced Phycology	2
BOT 304:	Physiological Ecology and Conservation Biology	2
BOT 305:	Contemporary Systematics	2
BOT 306:	Plant Cell Chemistry and Defense	2
BOT 307:	Molecular Genetics	2
BOT 308:	Principles of Crop Improvement	2
BOT 309:	Pteridophyta	2
BOT 310:	Introductory Limnology	2
BOT 311:	Structural Cytogenetics	2
BOT 312:	Embryology of Angiosperms	2
BOT 313:	**Practical-1:** Environmental Microbiology, Plant Pathology, and Advanced Phycology	3
BOT 314:	**Practical-2:** Physiological Ecology & Conservation Biology, Contemporary Systematics, and Plant Cell Chemistry and Defense	3
BOT 315:	**Practical-3:** Molecular Genetics, Principles of Crop Improvement, and Pteridophyta	3
BOT 316:	**Practical-4:** Introductory Limnology, Structural Cytogenetics, and Embryology of Angiosperms	**3**
BOT 317:	**Viva-voce**	**2**
		Total = 38

BOT 301: Environmental Microbiology **Credit hour**: 2

Introduction

This is a basic course in four years BS (Hons.) in Botany program. This course introduces the importance of microorganisms to ecosystems, and biogeochemical cycles. The field of Environmental Microbiology offers great potential for the development of new and innovative strategies and products for the management and protection of the environment. The course provides an understanding of the relationships of living organisms- microorganisms, plants and animals with each other and their abiotic environment.

A series of lectures and practical sessions cover key themes in contemporary environmental microbiology including microbial diversity and function, sensing and adaptive responses of bacteria, biogeochemical cycling and microbial communities and interactions. Laboratory sessions allow students to gain experience in the experimental design and practical skills of research in the context of mini-research projects involving environmental issues. This course emphasizes how the principles and techniques of Environmental Microbiology can be applied to a range of environmental problems.

Course objectives

- To define environmental microbiology
- To describe the distribution of microorganisms in environments
- To describe the role of bacteria in nutrient cycling
- To understand microbial diversity and interactions

Course content

Units	Course content	No. of Lectures
1. Introduction	Environmental microbiology as a discipline; microbial influences on our daily lives.	2
Terrestrial environments	Physicochemical characteristics of the earth environment; soil as a microbial environment; microorganisms in surface soils; distribution of microorganisms in soil; microorganisms in subsurface environments.	4
Aquatic environments	Microbial habitats in aquatic environments; microbial lifestyles in aquatic environments; marine environments; freshwater environments; notable aquatic environments.	4
4. Aeromicrobiology	Introduction; aerosols; nature of bioaerosols; aeromicrobiological pathway, microbial survival in the air; extramural aeromicrobiology; intramural aeromicrobiology; bioaerosol control; biosafety in the laboratory.	4
Extreme environments	Low temperature environments, high temperature environments; desiccation and UV stress; Aphotic environments.	2

Microorganisms and biogeochemical cycling	Introduction; carbon cycle; nitrogen cycle; sulfur cycle; iron cycle.	5
Microbial diversity and interactions	Microbial communities; microbial diversity in natural systems; microbial interactions; microbial diversity and natural products.	3
Microbial communication	Introduction; signaling via quorum sensing in Gram-negative bacteria; signaling in Gram-positive bacteria; other types of signaling.	3
Domestic and indoor microbiology	Household sources of pathogens; Fomites-role in disease spread; transfer of pathogens.	2
Global emerging microbial issues	Microbial contributions to climate change; global change and microbial infectious disease.	1

Unit wise learning outcome

Units	Learning outcomes
1	• define environmental microbiology • explain scope and importance of environmental microbiology • discuss microbial influences on our daily lives o overall health of the planet o infectious entities o healing substances o drinks o food o breathing substances
2	• discuss earth's living skin • describe physicochemical characteristics of the earth environment o earth environments o the solid phase o the liquid phase o soil atmosphere • discuss soil as a microbial environment o biotic stresses o abiotic stresses • describe microorganisms in surface soils o bacteria o actinomycetes o archaea

	o fungi o algae o protozoa • describe distribution of microorganisms in soil • describe microorganisms in subsurface environments o microorganisms in shallow subsurface environments o microorganisms in deep subsurface environments
3	• mention microbial habitats in aquatic environments • describe microbial habitats in the aquatic environment o physical and chemical characteristics o overview of planktonic microbes o overview of benthic microbes o at the Interface: biofilms and microbial mats • describe microbial lifestyles in aquatic environments o primary production o secondary production • describe marine environments o marine planktonic communities o marine benthic communities • discuss freshwater environments o springs, streams and rivers o lakes • discuss notable aquatic environments o brackish waters o hypersaline waters o subterranean waters o wetlands
4	• recall atmosphere, its characteristics and stratification • define aeromicrobiology and bioaerosol • mention nature of bioaerosols • discuss aeromicrobiological pathway • explain microbial survival in the air • describe extramural aeromicrobiology • describe intramural aeromicrobiology • explain bioaerosol controlling mechanisms • describe biosafety in the laboratory
5	• identify extreme habitats • describe low temperature environments o McMurdo dry valleys, antarctica • describe high temperature environments

	o geothermal hot springs o desiccation and UV stress • the Atacama desert, Chile • describe aphotic environments based on chemolithoautotrophy o deep-sea hydrothermal vents o an acid mine drainage system o a desert carbonate cave
6	• define biogeochemical cycles • explain Gaia hypothesis • describe carbon cycle o carbon reservoirs o carbon fixation and energy flow o carbon respiration • describe nitrogen cycle o nitrogen reservoirs o nitrogen fixation o ammonia assimilation (Immobilization) and ammonification (Mineralization) o ammonium oxidation o nitrate reduction • describe sulfur cycle o sulfur reservoirs o assimilatory sulfate reduction and sulfur mineralization o sulfur oxidation o sulfur reduction • describe iron cycle o iron reservoirs o iron in soils and sediments o iron in marine environments o iron oxidation o iron reduction
7	• define microbial communities • describe microbial diversity in natural systems o microbial community o microbial diversity o species o microbial diversity in soil and ocean environments o environmental factors that impact microbial diversity o functional diversity and the resilience of microbial communities • describe microbial interactions

	○ microbe microbe interactions ○ microbial megacommunities ○ microbial interactions impacting animal and human pathogens • discuss microbial diversity and natural products
8	• describe signaling via quorum sensing in Gram-negative bacteria • Explain interspecies cross signaling • discuss quorum sensing in *Agrobacterium tumefaciens* • describe signaling in Gram-positive bacteria (e.g., Gamma-butyrolactones) • define peptide signaling • describe types of signaling - ○ discuss universal signals (e.g., autoinducer-2 and autoinducer-3) ○ bacterial muropeptides ○ eavesdropping on the party line ○ quorum quenching and quorum sensing inhibition ○ interkingdom signaling: sociobiology and the concept of holobionts
9	• describe household sources of pathogens (e.g., air, food, and water) • discuss fomites: role in disease spread ○ occurrence of pathogens on fomites ○ persistence of pathogens on fomites ○ explain transfer of pathogens
10	• describe microbial contributions to climate change ○ nitrous oxide emissions from Soil ○ methane emissions from landfills • discuss global change and microbial infectious disease ○ global warming and microbial infectious disease ○ urbanization and deforestation

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Instruction strategies and Learning experiences

- Lecture followed by group discussion
- Question answer
- Guided discussion
- Project discussion
- Demonstration

Assignment: Students will be given assignment on particular units
Assessment: In-course examination will be taken after completing the lectures on units 1-5.

BOT 302: Plant Pathology **Credit hour**: 2

Introduction

Plant pathology is one of the basic courses in 4-years integrated BS (Honors) in Botany program. The course aims to provide the concept of *plant diseases*, causes, nature, kinds, types, biotic causes, impact of pathogens, disease cycle and economically important pathogens. It also encompasses control measures of plant diseases.

Course objectives

After completion of this course students will be to –

(a) Know the concept of disease in plants.
(b) Describe types of plant diseases.
(c) Discuss the history of plant pathology.
(d) Explain the role of fungi as causes of plant diseases.
(e) Calculate the losses caused by plant diseases.
(f) Describe the parasitism and disease development.
(g) Illustrate the effect of pathogens on plant physiological functions.
(h) Describe genetics of plant disease.
(i) Describe diseases in crop plants.

Course contents

Units	Contents	Lecture
1. Introduction	Historical background and scope	1
2. Concept of disease in plants	Types of plants diseases, history of plant pathology and significant plants disease, losses caused by plant diseases, and diagnosis of plant diseases	5
3. Parasitism and disease development	Parasitism and pathogenicity, host range of pathogens, development of disease in plants, stages in the development of disease (inoculation, penetration, infection, dissemination, overwintering and/or over summering), relationships between disease cycles and epidemics	4
4. Effects of pathogens on plant physiological functions	Effects of pathogens on photosynthesis, translocation of water and nutrients, respiration, permeability of cell membranes, transcription and translation, growth, and reproduction of plant	3
5. Genetics of plant disease	Genes and disease, plant resistance to pathogens, genetics of virulence in pathogens and of resistance in host plants, resistance (R) genes of plants	3
6.Environmental factors that cause plant diseases	Effects of temperature, moisture, oxygen, wind, light, air pollution, host-plant nutrition, soil pH and minerals, and herbicide	3
7. Control of plant diseases	Exclude the pathogen, eradicate, or reduce pathogen inoculum, protection by biological, physical, and chemical methods, cross protection, use of transgenic plants	5
8. Diseases of crop plants	Symptoms, causal agent, disease cycle and control measures of the following crop plants - a) Rice: blast, brown spot, sheath blight, sheath rot, stem rot, and foot rot b) Wheat: stem rust, leaf rust and loose smut c) Pulses and beans: rust of beans and lentil, leaf spot of bean and cowpea, anthracnose of bean d) Jute: stem rot, black band, anthracnose, and	6

	soft rot e) Sugarcane: red rot and whip smut f) Groundnut: tikka and rust	

Unit wise learning outcome

Units	Learning outcomes
1.	• Outline of plants and disease
2.	• Types of plant diseases • Contribution of different scientists • Significant plant diseases • Losses caused by plant diseases • Diagnosis of plant diseases
3.	• Parasitism and pathogenicity • Host range of pathogens • Development of disease in plants • Stages in the development of disease o inoculation o penetration o infection o dissemination o Overwintering and/or over summering • Relationships between disease cycles and epidemics
4.	• effects of pathogens on - o photosynthesis o translocation of water and nutrients o respiration o permeability of cell membranes o transcription and translation o growth and reproduction of plant
5.	• genes and disease • plant resistance to pathogens • genetics of virulence in pathogens and of resistance in host plants • resistance (R) genes of plants
6.	• Environmental factors that cause plant disease – o temperature; moisture; inadequate oxygen; wind; light; air pollution; nutritional deficiencies; soil pH and minerals and herbicides
7.	• Control of plant diseases – o exclude the pathogen

	o eradicate, or reduce pathogen inoculum o biological, physical, and chemical methods o cross protection o use of transgenic plants
8.	• Symptoms, causal agent, disease cycle, and control measure of the crop plants – o Rice: blast, brown spot, sheath blight, sheath rot, stem rot, and foot rot o Wheat: stem rust, leaf rust and loose smut o Pulses and beans: rust of beans and lentil, leaf spot of bean and cowpea, anthracnose of bean o Jute: stem rot, black band, anthracnose, and soft rot o Sugarcane: red rot and whip smut o Groundnut: tikka and rust

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Instruction strategies and Learning experiences

- Lecture followed by group discussion
- Question answer
- Guided discussion
- Project discussion
- Demonstration

Assignment: Students will be given assignment on particular units

Assessment: In-course examination will be taken after completing the lectures on units 1-4.

BOT 303: Advanced Phycology

Credit hour: 2

Introduction

This course will cover the Advanced Phycology and why algae are important for technological application, and why we are interested in them for both their environmental benefit, as well as some of their products, benefits, and challenges that impact our ability to make commercially viable products from

algae. You will also explore the vast diversity of algae including the classifications, culture, growth and their evolution. Later you will learn about algal ecology and their interactions with environment. And finally, you will study what types of algal researches were done in Bangladesh and its status in relation to world history.

Course objectives:

By the end of the Course students will be able to-

(a) Modern thoughts on algal taxonomy.
(b) Characteristics, ecology, and their interactions with environment.
(c) How to culture algae.
(d) Techniques of isolation and culture.
(e) How to use algae to the modern technology.
(f) How to use algae to assess environmental problems.
(g) Algal researches in Bangladesh and its status in relation to world history.

Course contents

Units	**Contents**	**No. of Lectures**
1. Classification of algae	Comparative study of classification of Fritsch 1935, Bold and Wynne 1985 and Lee 2008: Characterize the classes mentioned by Bold and Wynne (1985).	5
2. Growth	Growth pattern and evolutionary trends in algae.	4
3. Chloroplast	Ultra structure of chloroplasts in algae.	3
4. Metabolites	Extracellular metabolites in algae.	3
5. Algal culture and morphogenesis	Scope of algal culture; methods of algal culture (unialgal and axenic cultures); growth curve in batch culture and morphogenesis in blue green algae	6
6. Applications of algae	Technological applications of algae: Bio-diesel, oil and coal deposition, indicators of polluted water and algal toxicity, fossil diatoms and genetic engineering	**5**
7. Phycological researches	Phycological researches in Bangladesh and its status in relation to world history	**4**

Unit wise learning outcomes

Units	Learning outcomes
1	• Classification of algae • Comparative study between different classes • Modern thoughts on algal taxonomy • Characteristics and ecology of major groups
2	• algae are extremely diverse, and in this section you will learn about the main different types. • How the algae protect themselves against environmental changes and evolution
3	• Briefly discussion about the ultra structure of chloroplasts in Algae
4	• brief Discussion about extracellular metabolites in Algae
5	• Methods for sampling of algae in the field • Distinguish the main morphological forms • Scope of algal culture • Methods of algal culture (unialgal and axenic cultures) • Growth curve in batch culture and morphogenesis in blue green algae.
6	• discuss the technological applications of Algae • discuss the benefits of algae and how to use them in everyday life • Production and research about Bio-diesel, oil and coal deposition, indicators of polluted water and algal toxicity, fossil diatoms and genetic engineering. • how to use algae to assess environmental problems
7	• algal researches in Bangladesh • the status of algal research • its status in relation to world history

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7. Round FE 1981. The ecology of algae. Cambridge Univ. Press, Cambridge.
8. Smith GM 1951. Manual of Phycology. Ronald, N.Y.
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Instructional strategies/ Learning experiences

- LECTURE FOLLOWED BY GROUP DISCUSSION
- QUESTION-ANSWER
- DEMONSTRATION

Assignment: Students will be given assignment on particular units

Assessment: In-Course examination, Assignment, Course final examination, Practical examination, and Viva-voce

BOT 304: Physiological Ecology and Conservation Biology

Credit hour: 2

Introduction

Almost in every corner of the world plants have colonized even in the inhospitable places including deserts and field of ice. The environment of plants consists of hydrosphere, lithosphere, and atmosphere. But human activities are destroying these three components of the environment and biological diversity which have developed over a millions of years. The climate of the world has been disrupted resulting in the decrease in species diversity including genetic diversity within species. Physiological Ecology helps in understanding the adaption of individual species and population whereas Conservation Biology is an interdisciplinary approach which would help to fight the changes in situations. To make students to cope with the problems faced in the future career this course has been designed to understand the key elements of the plants adaptation to different situations; and different aspects of conservation of nature.

Course objectives

The objective of the course is to acquaint the students with the -

(a) Physical world, adaptive mechanisms to plants in different situations, ecotoxicology and different methods of conservation of genetic diversity and the nature.

Course contents

Units	Contents	No. of Lectures
A. Physiological Ecology		
1. The	(i) Vertical structure of the physical world. (ii)	**3**

Physical World	Surface area of the globe, (iii) Water storage in the hydrosphere, (iv) Composition of sea water (v) Variation of atmospheric temperature and pressure with altitude.	
2. The ecosystem	Interplay of biological and environmental factors. Growth of human population for the past half million years.	**2**
3.	Physico-chemical aspects of waterlogged soils; Oxygen Diffusion Rate (ODR) and Oxidation-Reduction Potentials; Classification of saline habitats.	**3**
4.	Effects of salt concentration on germination of halophytes. Ecotypic differentiation.	**2**
5	Greenhouse effect; Ozone layer depletion, Carbon dioxide and the world climate.	**3**
6	Methods of measurement of primary production; Factors limiting primary productivity in aquatic and terrestrial communities.	**3**
7	Pesticides and Related compounds, DDT and its effects; Lead and Mercury concentrations in the habitat.	**2**
8	World Forests. Total territory of forest land; Species diversity. Hot Spots and Megadiversity.	**3**
B. Conservation Biology		
9	A Brief History of Conservation Biology. Conservation Biology and the Management of Natural Resources. Some characteristics of Conservation Biology. Threats to Biological diversity; Rates of extinction; Human caused extinctions.	**3**
10	Conservation values and Ethics. The value of Biodiversity; Instrumental value and intrinsic value.	**1**
11	Management of Genetic variation in Natural population. Contribution of Molecular Biology to Conservation.	**3**
12	Types of species and Communities most likely to be affected by global climate change. Common Problems in Conservation Biology.	**2**

Unit wise learning outcome

Units	Learning outcomes

A. Physiological Ecology	
1	• Will have the knowledge about the physical world
2	• Students will be able to measure the ecosystem interactions and human impacts on ecosystems
3	• Will have the knowledge about the physic-chemical properties of the waterlogged soil and adaptive mechanisms of plants growing there
4	• Will be able to critically evaluate the effect of salinity on the growth of different species and morphological changes of plants
5	• Will be able to know sources and effects of different green house gases, causes of ozone layer depletion of the earth
6	• Will have the skills to measure the primary productivity and critically evaluate factors involving in controlling the productivity
7	• Will have the knowledge about the toxic effects of different pollutants
8	• Will have the skills to measure species diversity of the different forest ecosystems and will be acquainted with different hot spots and mega diversity countries of the world
B. Conservation Biology	
9	• Will have the knowledge about different approaches to conserve the natural resources and how to apply these approaches
10	• Will be able to critically evaluate the values of biodiversity hence the importance of biodiversity conservation
11	• Will have clear concept on the role of molecular biology in conserving the nature including genetic diversity
12	• Will be able to critically evaluate the effects of global climate change on different species and communities

References

1. Bannister P 1976. Introduction to Physiological Plant Ecology. Blackwell Scientific Publications.
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4. Etherington JR 1976. Physiological Plant Ecology. John Wiley & Sons.
5. Lambers H and FS Chapin 1997. Plant Physiological Ecology. Springer.
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Instruction strategies and Learning experiences

- Lecture followed by group discussion
- Question answer
- Guided discussion
- Project discussion
- Demonstration

Assignment: Students will be given assignment on particular units
Assessment: In-Course examination, Assignment, Course final examination, Practical examination, and Viva-voce

BOT 305: Contemporary Systematics

Credit hour: 2

Introduction

Systematics is the scientific discipline that encompasses the description, identification, nomenclature and classification of organisms and the reconstruction of their macro-evolutionary history. Knowing the identity and evolutionary relationships of organisms is crucial to any biological study and Systematics is therefore a very important cornerstone of Biology. This course is designed to meet the need for knowledge and understanding of methodology and principles of Plant Systematics. This course enables students to understand and evaluate rules of plant nomenclature, phylogenetic systems of classification, application of cytology, palynology and phytochemistry in systematics, recognize and identify the major plant groups, and biodiversity conservation.

Course objectives

(a) Define and explain principles, rules, regulations, provision and recommendations of International Code of Nomenclature for Algae, Fungi and Plants (ICN).
(b) Know the concept of species, ecotype and different categories of biosystematics.
(c) Learn different phylogenetic systems of plant classification and comparisons among them.
(d) Know how chromosomal, pollen and phytochemical characters play important roles in solving taxonomic and phylogenetic problems along with breeding systems.
(e) Learn Biodiversity Conservation in global context as well as Bangladesh context, and the present status of biodiversity in Bangladesh along with aquatic angiosperms of the country.
(f) Know how to identify the plant families, their distribution and economic importance, as well as means for plant identification.

Course contents

Units	Contents	No. of Lectures
1	Nomenclature and ICN's rules: Details of binomial system of nomenclature; historical background of ICN; principles, ICN; rules, regulations and recommendations of ICN; major provisions of ICN and their codes; exception of rules of ICN.	**4**
2	Species concept.	**2**
3	Ecotype concept and biosystematic categories.	**2**
4	Systems of classification and their comparison: Bessey, Hutchinson, Cronquist and Takhtajan systems of classification.	**5**
5	Sources and taxonomic evidences: Cytology, Palynology and Phytochemistry.	**4**
6	Breeding system: inbreeding, outbreeding, self incompatibilities, apomixis and pollination.	**2**
7	Biodiversity and conservation: Concept, importance, methods of conservation; principles for conserving biodiversity; taxonomic aspects of plant conservation; national parks and protected areas of Bangladesh; endangered and threatened plants of Bangladesh; NBSAP.	**4**
8	Aquatic angiosperms of Bangladesh and their importance.	**2**
9	Different types of keys for plant identification; Diagnostic characters, distribution, phylogeny and economic importance of the following families: Fabaceae, Euphorbiaceae, Apocynaceae, Lamiaceae, Cucurbitaceae, Acanthaceae, Polygonaceae, Solanaceae, Asteraceae, Nymphaeaceae, Asclepiadaceae, Convolvulaceae, Poaceae, Cyperaceae and Orchidaceae.	**5**

Unit wise learning outcome

Units	Learning outcomes
1	• Understanding of nomenclature and be able to synthesize the principles, rules, regulations and provisions of ICN
2	• Demonstrate deeper insights into different concepts of species, the fundamental unit of taxonomic hierarchy
3	• Demonstrate ability to critically and systematically integrate

	knowledge and perspectives and to analyse, assess and deal with ecotype concept and biosystematics categories
4	• Understand key methods and principles of phylogenetic classification ssystems along with their outlines, pros and cons
5	• Be able to evaluate how chromosomal data, pollen characters and bio-chemical characters play vital role in plant systematics and phylogenetics
6	• Recognize major patterns and processes of breeding systems in plants
7	• Be able to retrieve and critically evaluate the status of Biodiversity in global and Bangladesh context, mode of biodiversity conservation as well as the scenario of the extinct, endangered and threatened plants of the country, and demonstrate an ability to reflect on their personal impact on biodiversity
8	• Learn aquatic angiosperms of Bangladesh, their classification and how they can play an important role for ecosystems and human benefit.
9	• Be able to recognize and identify important plant families with the use of identification keys, better understanding of plant morphology terminology and how to describe plant species profile scientifically, and economic importance of plants used in practical life.

References

1. Davis PH and VH Heywood 1963. Principles of Angiosperm Taxonomy. Oliver Boyd, Edinburgh & London.
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5. Khan MS (ed.) 1973-2002. Flora of Bangladesh. Fascicles 1-53. Bangladesh National Herbarium, Dhaka.
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Instruction strategies and Learning experiences

- Lecture followed by group discussion
- Question answer

- Guided discussion
- Project discussion
- Demonstration

Assignment: Students will be given assignment on particular units

Assessment: In-Course examination, Assignment, Course final examination, Practical examination, and Viva-voce

BOT 306: Plant Cell Chemistry and Defense **Credit hour**: 2

Introduction

This is a basic course in 4-years integrated BS (Hons) in Botany program and the scientific discipline within Plant Physiology. 'Plant Cell Chemistry and Defense' is a science concerned with the chemical nature and behavior of the living matter and also the chemical changes produced under environmental stresses. It brings biology and chemistry together. The coverage of the subject is divided into a few sections which include - secondary metabolites (terpenoids, alkaloids and phenolic compounds) and various mechanisms in the cells activated during anti-stress responses of plants (plant stress and signaling hormones, reactive oxygen species, antioxidant enzymes, non-enzymatic antioxidants, plant cell wall biomechanics, signaling and stress response). The course has been meticulously designed to enlighten the students about key concepts regarding various adverse effects of abiotic stresses on metabolism and on other physiological processes that control growth and productivity of plants.

Course objectives

(a) The main focus of 'Plant Cell Chemistry and Defense' is in understanding how biological molecules give rise to the processes that occur normally within living cells as well as how plants responds and adapts to adverse conditions, which in turn relates greatly to understand the function of whole plant.

(b) Students will have a good fundamental knowledge of several aspects of plant function and defense mechanism. It focuses on the basic and specialized mechanisms activated during anti-stress responses of plants.

(c) Successful completion of this course will end with an introduction to the interactions of plants with their environment and stress-adaptation.

(d) Moreover, students will have the ability to analyze the mechanisms of stress resistance which plants have developed to cope with stress conditions in order to prevent injury and maintain life functions.

Course contents

Units	Contents	No. of Lectures
1. Terpenoids	(a) Secondary metabolites; (b) Chemistry, characteristics and distribution of terpenoids; (c) Classification; (d) Pathway of terpenoid biosynthesis in plants; (e) Biological function; (f) Essential oils - features, classification and importance.	**4**
2. Alkaloids	(a) Discovery; (b) Chemistry, characteristics and distribution; (c) Classification; (d) Plant families with alkaloids; (e) Physiological role.	**3**
3. Phenolic compounds	(a) Discovery; (b) Chemistry and characteristics; (c) Classification; (d) Pathway for the biosynthesis of phenol (Shikimic acid pathway); (e) Importance.	**3**
4. Plant stress and signaling hormones:	(a) Types and causes of plant stresses; (b) Types of stress hormones (abscisic acid, salisyclic acid, jasmonic acid and brassinosteroid) and chemistry; (c) Role as main mediators in stress improvement; (d) Biosynthetic pathway of abscisic acid and salisyclic acid under stress.	**4**
5. Reactive oxygen species:	(a) Types of ROS (singlet oxygen, hydrogen peroxide, superoxide radical and hydroxyl radical); (b) Chemistry and features of different types of ROS; (c) Generation of ROS by energy transfer; (d) Sites of ROS production in plant cells; (e) Targets of ROS.	**4**
6. Antioxidant enzymes:	(a) Definition and types of antioxidant enzymes; (b) Chemistry and features of catalase (CAT), ascorbate peroxidase (APX), guaiacol peroxidase (GPX) and superoxide dismutase (SOD); (c) Enzymatic Defense system during stresses.	**4**
7. Non-enzymatic antioxidants:	(a) Chemistry and features of ascorbic acid, flavonoids, carotenoids, tocopherols, glutathione and proline; (b) Role in improving stress tolerance in plants.	**4**
8. Plant cell wall biomechanics, signaling and stress response	(a) Cell wall composition and structure; (b) Bioactive oligosaccharides; (c) Xyloglucan; (d) Pectin methylesterase; and (e) Calmodulin.	**4**

Unit wise learning outcome

Units	Learning outcomes
1	• clarify the concept of primary and secondary metabolites and their importance; explain chemistry, distribution, classification, biosynthesis and biological function of terpenoids; comprehensible knowledge on essential oils.
2	• impart knowledge about discovery, chemistry, distribution, classification and physiological role of alkaloids.
3	• explore discovery, chemistry, characteristics, classification and importance of phenols; explicit concept of biosynthesis of shikimic acid.
4	• cognizance of plant stresses and stress hormones; list different types of stress hormones with molecular formulae and structures; state roles of these hormones in stress improvement.
5	• extensive knowledge on ROS; recognize different types of ROS; describe their chemistry, site, role and adverse effects on plants.
6	• define antioxidant enzymes; discern different antioxidant enzymes; understand their chemistry, features and defense mechanism under hostile environment.
7	• comprehend various non-enzymatic antioxidants; perceive their mechanisms in improving stress tolerance in plants.
8	• elucidate conception of plant cell wall biomechanics; deeper understanding of cell wall signaling during biotic and abiotic stresses and involvement in plant defense.

References

1. Nelson DL and MM Cox 2008. Lehninger Principles of Biochemistry (5th Ed.), Freeman and Company, N.Y.
2. Hopkins WG and NPA Hüner 2009. Introduction to Plant Physiology (4th Ed.), John Wiley and Son, Inc.
3. Buchanan BB, Gruissem W and RL Jones 2015. Biochemistry and Molecular Biology of Plants (2nd Ed.), Wiley Blackwell, U.S.A.

4. Gupta SD 2011. Reactive Oxygen Species and Antioxidant in Higher Plants, Science Publishers, Enfield, USA.
5. Hasanuzzaman M, M Fujita, H Oku and MT Islam 2019. Plant Tolerance to Environmental Stress, CRC press, Taylor and Francis group, UK.
6. Pessarakli M 2011. Hand Book of Plant and Crop Stress, (3rd Ed.) CRC press, Taylor and Francis group, UK.
7. Pareek A, SK Sopory, HJ Bohnert and Govindjee 2010. Abiotic Stress Adaptation in Plants, Springer, Netherlands.

Instruction strategies and Learning experiences

- Lecture followed by group discussion
- Question answer
- Guided discussion
- Project discussion
- Demonstration

Assignment: Students will be given assignment on particular units.

Assessment: In course examination will be taken after completing the lectures on units 1-4.

BOT. 307: Molecular Genetics

Credit hour: 2

Introduction

Genetics particularly molecular genetics play a central role in all aspects of life of all living organisms. Molecular genetics is considered as the frontier sciences of the 21st century. It is understood that the genes play in shaping our lives and the lives of all living creatures on the planet Earth.

This course is designed to learn the necessary details, concepts, selected techniques, and basic skills related to molecular genetics. Specifically, the course will discuss about the structure and functions of DNA and RNA, transcription, regulation of gene expression as well as the process of genetic engineering, gene cloning and recombinant DNA technology.

Undertaking these course students will have the opportunity to get an insight on the various principles and methods of molecular biology as well as molecular genetics. Through this knowledge students will be able to handle DNA molecules for its characterization and required manipulation.

Both theoretical presentations and practical laboratory demonstrations will allow students to gain experience in different basic and applied concepts and methods of molecular biology to be utilized for several biological investigations.

Course objectives

(a) To understand the basic principles and concepts of Molecular genetics
(b) To understand the core concept of gene, gene expression in the light of molecular genetics.
(c) To highlight the basic techniques of gene isolation, genetic characterization, genetic manipulation applicable for crop development, maintaining environment and biodiversity.
(d) Contributions of various national international institutes concerning molecular biology/molecular genetics.

Course contents

Units	Contents	No. of Lectures
1. Nucleic acids	(a) Nucleic acid as genetic material of living organisms: evidences to prove the genetic nature of DNA; RNA as the genetic material in viruses; (b) DNA: chemical composition and structure, Watson-Crick model, general features of DNA; (c) RNA: chemical composition, structure, types of RNA and their characteristics.	**6**
2. Replication of DNA	Mechanism of DNA replication; Meselson-Stahl experiment, Cairns' autoradiography experiment; replication of circular DNA molecules.	**2**
3. DNA repair mechanism	Photoreactivation, excision repair, post replication recombination repair and SOS repair.	**2**
4. Mutation	Nature and types of mutations, molecular basis of mutation, point mutation, physico-chemical mutagens, detection of mutation in *Drosophila* by *ClB* and attached-X methods: isolation of mutants in *Neurospora*.	**2**
5. Transposable genetic elements	Genetic instability and discovery of transposable elements; transposable elements in bacteria and eukaryotes; significance of transposable elements.	**2**

6. Recombination in Bacteria	Transfer of genetic materials; transformation, transduction and conjugation; genetic mapping in *E. coli* by conjugation.	**2**
7: Gene expression	Protein synthesis apparatus - structure of tRNA and ribosome; mechanism of transcription; post- transcriptional modifications of mRNA, tRNA and rRNA; genetic code: characteristics of genetic code, deciphering the code, degeneracy and wobble, initiation and termination codons, universality of the code, the code dictionary; mechanism of translation.	**6**
8: Regulation of gene expression in prokaryotes	General features of gene regulation; induction and repression: operon concept; *lac*, *ara* and *trp* operons.	**2**
9: Gene manipulation	Gene manipulation techniques- Transgenesis and site-specific recombination: Cre-Lox, Phi31 integrase, etc., Genome editing: ZFNs, TALENs, CRISPR/Cas9 - Multi-gene assemblies and high-throughput DNA assembly techniques and Ethical considerations.	**2**
10: Gene cloning	Recombinant DNA and gene cloning, plasmid and phage vectors, restriction enzymes, restriction maps and their properties, recombinant selection and screening.	**2**
11. Polymerase Chain Reaction (PCR) technology	Methodology and various applications of PCR technology.	**2**

Unit wise learning outcomes

Units	Learning outcomes
1	• know the structure and biochemical properties of DNA and RNA molecules as well as the genetic properties of DNA and RNA molecules.
2	• know the mechanism of replication of linear and circular DNA molecules.
3	• know the various mechanisms of damaged DNA molecules.
4	• know the concept of nature and types of mutations, molecular basis of mutation, various detection methods and applications of mutation.
5	• know the discovery of transposable elements, significance of transposable elements.
6	• know the various methods for the exchange of genetic materials in bacteria.
7	• know the mechanism of gene expression, protein synthesis, transcription and translation mechanisms, role of genetic code in protein synthesis.
8	• know the mechanism of regulation of gene expression in prokaryotic organisms.
9	• know the genome editing mechanism, types and role of genetic manipulation in molecular science.
10	• know the mechanism of gene cloning and development of recombinant DNA molecules and their role.
11	• know the Polymerase Chain Reaction (PCR) technology, its methodology and various applications of this technology.

References

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9. Molecular Biology of the Gene, 7th edition. J.D. Watson et al. Pearson
10. An Introduction to Genetic Engineering, 3rd edition. D.T. Nicholl. Cambridge University Press.
11. Gene Cloning and DNA Analysis: An Introduction, 7th edition. T.A. Brown. Wiley.
12. Principles of Gene Manipulation and Genomics, 7th edition. S.B. Primrose, R. Twyman. Wiley

Instructional strategies/ Learning experiences

- Lecture followed by Question-answer
- Group discussion

- Project discussion
- Practical demonstration

Assignment: Students will be given assignment on particular unit.
Assessment: In-Course examination, Assignment, Course final examination, Practical examination, and Viva-voce

BOT 308: Principles of Crop Improvement

Credit hour: 2

Introduction

Plant breeding is the art and science of changing the genetics of plants for the benefit of humankind. Plant breeding uses principles from a variety of sciences to improve the genetic potential of plants. The process involves combining parental plants to obtain the next generation with the best characteristics. From times immemorial, the plant breeding has been helping the mankind. With knowledge of classical genetics, number of varieties has been evolved in different crop plants. Since the population is increasing at an alarming rate, there is a need to strengthen the food production which is serious challenge to those scientists concerned with agriculture.

Undertaking these course students will have the opportunity to get an insight on the various principles and methods through which they may be able to develop better crop varieties tolerant to biotic and abiotic stresses as well as having improved nutritional qualities. Both theoretical presentations and practical laboratory demonstrations will allow students to gain experience in different basic and applied concepts and methods of plant breeding to be utilized for crop improvement. They will also have an opportunity to know about various national and international agricultural research institutes engaged in crop improvement.

Course objectives

(a) Basic principles and concepts of plant breeding.
(b) Various methods of crop improvement.
(c) Applications of polyploidy and embryo rescue techniques in plant breeding.
(d) Methods for the development of biotic and abiotic stress tolerant crops.
(e) Contributions of various national international agricultural research institutes, etc.

Course contents

Units	Contents	No. of Lectures

1. Self- and cross incompatibility	Self- and cross incompatibility in cultivated plants: Mechanism of self- and cross incompatibility, methods of overcoming incompatibility barriers.	**4**
2. Male sterility systems:	Cytoplasmic, genetic and genetic cytoplasmic, use of male sterility in crop improvement.	**2**
3. Heterosis breeding	Basis of heterosis and inbreeding depression, use of heterosis in plant breeding.	**2**
4. Polyploidy:	Definition, classification, characteristic features of polyploidy, use of polyploidy in crop improvement.	**4**
5. Haploid breeding	Development of haploids through conventional breeding and tissue culture methods, significance of haploid breeding.	**2**
6. Development of crop varieties	Development of disease resistant, salt and drought tolerant crop varieties through hybridization.	**3**
7. Embryo rescue	Embryo rescue technique in overcoming barriers of distantly related crosses.	**3**
8. Germplasm conservation	*In situ* and *Ex situ* germplasm conservation and cryo-preservation, importance of germplasm conservation in crop breeding.	**4**
9. Agricultural research institutes	Introduction to different national and international agricultural research institutes engaged in the development of improved varieties of different crop plants.	**6**

Unit wise learning outcomes

Units	Learning outcomes
1	• Know the mechanisms of self- and cross incompatibility systems and their use in plant breeding
2	• Know different male sterility systems and their applications in plant breeding
3	• Know basis of heterosis and inbreeding depression and their use in plant breeding
4	• Know the concept of polyploidy and its use in crop improvement
5	• Know the methods of production and significance of haploids in

	crop improvement
6	• Know the methods of development of biotic and abiotic stress tolerant crop plants
7	• Know how to recover hybrids resulted from distantly related crosses using embryo culture techniques
8	• Know how to conserve germplasm using different methods and their utilization in crop breeding
9	• Know the contribution of different national and international agricultural research centres towards development of improved crop varieties

References

1. Allard RW 1964. Principles of Plant Breeding. John Willey & Sons, N.Y.
2. Briggs FN and PF Knowles 1978. Introduction to Plant Breeding. Reinhold Publishing Corporation, N.Y., London.
3. Chaudhari HK 1976. Elementary principle of plant breeding. Oxford & IBH Publishing Co., New Delhi.
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9. Simmonds NW 1984. Evolution of crop plants. Longman, London.
10. Van der Have DJ 1979. Plant Breeding perspectives. Centre for Agricultural Publishing, Documentation, Wageningen.

Instruction strategies and Learning experiences

- Lecture followed by Question-answer
- Group discussion
- Project discussion
- Practical demonstration

Assignment: Students will be given assignment on particular units

Assessment: In-Course examination, Assignment, Course final examination, Practical examination, and Viva-voce

BOT 309: Pteridophyta **Credit hour**: 2

Introduction

This course is designed in such a way that after completion the students are going to be able to perceive the pteridophytes and gymnosperms, their classification, characteristics and importance. Pteridophytes constitute a significant and important group in the plant kingdom since they have made the colonization of land. Pteriodophyta is considered possible for the plants and evolutionary link between spore bearing and seed plants. The course presents the origin and evolution of important aspects of pteridophyta with the description of taxonomy, morphology, reproductive processes, life cycle, economic importance and phylogenetic relationships of the varied groups, both living and extinct, proceeding from the simple to the complex. This course also highlights detailing of gymnosperms including their internal structure, primitive and advance features alongside with natural distribution in Bangladesh.

Course objectives

(a) Differentiate pteridophyta from other groups of plant and thereby learn the importance of studying pteridophytes.
(b) Develop a sense of origin and evolutionary progression of leaf, stele and overall sporophytic body among different groups of pteridophytes.
(c) Attain the knowledge of seed habit in relation to heterospory nature of pteridophytes.
(d) Know the diversity of sporophytic and gametophytic structure of existing groups of pteridophytes along with their reproduction, life cycle and economic importance.
(e) Define and explain the characteristics of gymnosperms and distinguish them from angiosperm and identification of gymnosperms found in Bangladesh.
(f) Gain a general knowledge of transition in plant phylogeny from lower to higher gradation.

Course content

Units	**Contents**	**No. of Lectures**
1. Introduction and importance	Definition, general characters, similarities and dissimilarities between bryophytes and pteridophytes. Importance of studying pteridophytes.	**2**
2. Classification	Classification proposed by different pteridologist and discussion on general characters of four main divisions of pteridophyta.	**2**

3. Origin and evolution	Theories and debates regarding the origin of pteridophytes from algae and bryophytes, evolution among different groups of pteridophytes.	**3**
4. Types of steles and their evolution	Stelar theory, different types of stele found in pteridophytes and their evolution to more diversification and complex structure.	**3**
5. Detailed study of important genera	Distribution, habitats, external and internal features, reproduction, life cycle and economic of different important genera: The following genera will be discussed: (a) *Psilotum*, (b) *Selaginella*, (c) *Equisetum*, (d) *Ophioglossum*, (e) *Marsilea.*	**12**
6. Heterospory and seed habit	Definition, importance and origin of heterospory, origin of seed habit, seed habit in *Selaginella.*	**2**

Unit wise learning outcomes

Units	Learning outcomes
1	• know about the scope of pteridophytes as a subject and relevance to other groups of plants.
2	• basis of classification and knowledge of different groups of pteridophytes.
3	• knowledge on how plant evolved from lower to higher present forms.
4	• development of vascular system from primitive to advanced form in pteridophytes
5	• structural and developmental in depth knowledge of important representatives of pteridophytes in addition to species specific importance.
6	• evolutionary knowledge on heterospory and seed formation
7	• identify gymnosperms in nature and capable to differentiate between gymnosperms and angiosperms.
8	• understand the classification and characteristic features of

	different orders of the naked seeded plants.
9	• the commonly found gymnosperms will come in light and the precise locality of them to be known; the details characteristic features of *Cycas* and advanced characters of *Gnetum* will shed more light on these groups.

References

1. Emes AJ 1964. Morphology of vascular plants. Tata McGraw-Hill Publishing Co., Ltd., Bombay.
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3. Parihar NS 1956. An Introduction to Embryophyta vol. I & II. Central Book Depot, Allahabad.
4. Smith GM 1955. Cryptogamic Botany, vol. II. McGraw-Hill Book Company Inc. N.Y., London.
5. Vashista PC 1993. Botany for Degree Students: Pteridophyta, S. Chand and Company Ltd., Ramnagar, New Delhi.
6. Vashishta PC 1990. Gynmnosperms, S. Chand & Co. Ltd., New York.

Instruction strategies and Learning experiences

- Class lectures using blackboard/whiteboard followed by questions and answers.
- Synchronized slide presentation through multimedia projector.
- Group discussion.
- Demonstration.

Assignment: Students will be given assignment on particular units.
Assessment: In-Course examination, Assignment, Course final examination, Practical examination, and Viva-voce

BOT 310: Introductory Limnology

Credit hour: 2

Introduction

The course is taught in the 3rd year classes of four years integrated BS (Honors) program in Botany under the University of Dhaka. It is a basic course on Limnology. The domain of Limnology is based upon the knowledge related to the structure, function and biological production of inland aquatic ecosystems. The principal botanical components of the system are photosynthetic bacteria, phytoplankton, attached microalgae and littoral macrophytes which do contribute energy for higher biological secondary

production upon which the human and other top consumers are dependent. Highlighting the importance of global freshwater resources, its budget, conservation and management and the functional aspects from the standpoint of ecosystem principles are discussed in the course. How functional aspects of any aquatic ecosystem relate to the environment is also established.

Course objectives

(a) To relate our earth's freshwater resources with the concept of Limnology and Hydrobiology and justify the link of Limnology with other disciplines of Biology and Environmental Sciences. Learn the past, future and the scopes.
(b) To learn origin and cyclic rotation of water, relationship between water and world population growth on a global perspective, inland water classification, lakes, distribution and origin of basins, types with special reference to Bangladesh.
(c) To know the molecular and physical properties of water, its comparison with other identical liquids of nature, different physical factors and their effects on aquatic organisms.
(d) To learn energy related driving forces in water, solar radiation, quality, characters, transformation, and their effects in creating different limnological factors, their effects on organisms.
(e) Learn organisms of water, their habitats, niches, types, distribution and indicator organisms to characterize lake patterns.
(f) Know material budget, biogenic gases and nutrients, their types, cycling, mode of distribution and uptake and assimilation pattern and their role on organisms.
(g) Learn biological production, its extent, types, calculation, measuring procedure, further mobilization and responses.
(h) Know aquatic bacteria, their, types and role to set free nutrients further, carbon consumers.
(i) Know about material and energy transport, application of models, energy dissipation at various trophic levels.

Course contents

Units	Contents	No. of Lectures
1	**Introduction to Limnology**: Earth, water, limnological concept and principles; early history of limnology, supporting invention and techniques, emerging limnology as a science, its development and current trends, temperate and tropical limnology, scopes, modern literatures, and journals.	**3**

2	**The aquatic medium**: water, its origin on earth, hydrological cycle, global usage and budget, water resource and Demophoric growth principles, inland aquatic ecosystems, their pattern, distribution and origin of lake basins, seven special lake types, natural lakes and freshwater resources of Bangladesh.	**5**
3	**Molecular and Physical properties of water:** liquids of nature, the dihydrides of oxygen, comparison, unique features of water, molecular state and transformation, bonding principles, physical factors, density, adhesion, cohesion, viscosity and surface tension, and their effects on aquatic organisms.	**4**
4	**Energy and driving forces**: solar radiation, characters, quality, transformation, underwater light climate, water color, heat budget, stratification and overturn, lake classification on the basis of overturn pattern, limnological zonations, water movement, waves, currents, Seiches, their types and biological impacts.	**4**
5	**Community pattern:** Reed belt, plants, zooplankton and mud and fine sludge inhabiting organisms, their types, distribution, lake characteristics to indicator organisms, *Tanytarsus*, *Chironomus* types, lotic, lentic, periphyton of streams, fishes.	**3**
6	**Material budget of natural waters**: Nutrient types, primary, secondary, trace elements, their availability, cyclic movement, dissolved gases, DO, conductivity, pH, carbon exchange, available compounds, assimilation pattern, classification of aquatic plants depending on carbon uptake, phosphorus, sulfur, iron, manganese, silica, trace elements and their role on organism.	**4**
7	**Biological production:** types, calculation, procedure, secondary productivity, consumption, and destruction, organism's response to P, N, Ca, Mg, Si, alkalinity.	**2**
8	**Role of bacteria:** biomass destruction, autolysis, decomposition, important aquatic bacterial groups, aerobic- and anaerobic carbon consumers	**3**
9	**Material and energy transport**: Mann's Model, Odum's calculation of energy flux at different trophic levels of river.	**2**

Unit wise learning outcomes

Unit	Learning outcomes
1	• Limnology a science in relation to earth's water reserve and distribution • Historical background of the subject • Current trend, tropical and temperate limnology • Scopes of learning limnology • Latest limnological information, literatures, journals
2	• Learned about the origin of water in the pre-historic period • Hydrological cycles, global stock, use, budget, demophoric growth • Classification of inland waters, lakes, types, origin of basins • Seven special lake types of the world • Natural lakes of Bangladesh
3	• Naturally occurring liquids on earth, comparison with water • Molecular states, transformation, bonding principles • Physical factors functional in aquatic ecosystems • Adhesion, cohesion and viscosity factors of water, biological relations • Surface tension of water and development of Neuston community • Overall effects physical factors operating in water on organisms
4	• Concept of energy and its functional behavior in aquatic ecosystems • Light and light related transformation of energy in various forms, creating limnological zones • Heat budget, albedo and water color factors • Thermal stratification and circulation, causes and consequences • Global lake classification depending on mixing and stratification • Waves and currents, their types and biological and physicochemical role
5	• Community patterns, reed belt, other plants, zooplankton • Fine sludge and mud inhabiting organisms, types and distribution • Indicator organisms, their role in selecting lake types • Lotic and lentic habitats, periphyton of stream communities, fishes
6	• Material budget, nutrient types, classification, availability in aqueous medium • Biogenic gases, mode of solubility and vertical distribution, other relevant features in aquatic habitats

	• Major nutrient cycles, role of sulfur, iron, manganese, silica and trace elements on organisms • Inorganic carbon exchange from atmosphere to water, various forms • Carbon uptake mode by aquatic plants, classification of plants depending on this principle
7	• Biological production, its types, calculation • Secondary production, consumption and destruction • Organisms responses to P, N, Ca, Mg, Si, alkalinity
8	• Aquatic bacteria, biomass destruction • Self breaking process of cells, autolysis • Important bacterial groups • Aerobic, anaerobic carbon consumers
9	• Transport of energy and material • Ecological modeling • Calculation of energy transport and flux at different trophic levels

References

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10. Schwoerbel J 1987. Handbook of Limnology. Ellis Horwood Ltd. Chichester. pp. 228.

Instruction strategies and Learning experiences

- Lecture followed by group discussion

- Question answer
- Guided discussion
- Project discussion
- Demonstration

Assingment: Students will be given assignment on particular units
Assessment: In-Course examination, Assignment, Course final examination, Practical examination, and Viva-voce

BOT 311: Structural Cytogenetics

Credit hour: 2

Introduction

This is a basic course in 4-years integrated BS (Honors) in Botany program. To developing clear knowledge about the scope and brief history of Cytogenetics. In addition the students will get detail information about the physical and chemical nature of chromosome, karyotype, idiogram, genome analysis and abnormalities of cell division. Students could develop their knowledge about identification, kinds, detection, genetic effect and meiotic behavior of different types of structural chromosomal aberration such as deletion, duplication, translocation and inversion.

Course objectives

(a) Define and explain physical and chemical nature of chromosome, karyotype, ideogram, genome analysis and abnormalities of cell division.
(b) Get clear idea about the identification, kinds, detection, genetic effect and meiotic behavior of different types of structural chromosomal aberration such as deletion, duplication, translocation and inversion
(c) Explain the scope and brief history of Cytogenetics.

Course contents

Units	**Contents**	**No. of Lectures**
1. Eu chromosome	**A. Physical structure**: (i) Primary constriction or centromere - ultrastructure and chemical properties, classification of chromosomes on the basis of centromeric position and number, procedure for chromosome classification, (ii) Secondary	**3**

	constriction - NOR, SAT and their chemistry, (iii) Arms, (iv) Telomere - function and chemistry, (v) Chromomere (in meiotic chromosome). **B. Chemical structure:** (i) Chromatin - physical and chemical nature, (ii) Eu-chromatin and heterochromatin, role of heterochromatin in chromosome pairing, (iii) Nucleosome model.	
2. Karyotype and idiogram	Karyotype and idiogram in brief, symmetric, asymmetric, monomodal and bimodal karyotype and significance.	**3**
3. Genome analysis	(i) Genome in respect of Cytogenetics, (ii) karyotype analysis, (iii) chromosome association in meiosis, (iv) chromosome banding - CMA, DAPI and C banding, (v) Fluorescent *In situ* Hybridization (FISH) and Genomic *In situ*Hybridization (GISH).	
4. Abnormalities in cell division	(i) Non-disjunction - genetic control of disjunction, ii) endopolyploidy or endoreduplication, (iii) polyteny, (iv) cytomixis, (v) formation of cross-spindle, (vi) elimination of single or set of chromosomes in insects (Sciaridae).	**6**
5. Chromosomal aberrations	General account and classification.	**2**
6. Structural aberration	(i) Deletion - Definition, identification, kinds, detection, genetic effect, meiotic behavior, breakage - fusion - bridge cycle, (ii) Duplication - Definition, identification, kinds, detection, genetic effect, meiotic behavior, breakage - fusion - bridge cycle, (iii) Inversion - definition, kinds, synapsis, results of double crossing over in intra- and extra-loop, consequence of chromatid bridge, (iv) Translocation - definition, kinds, Robertsonian translocation - helps in altering karyotype, meiosis in translocation heterozygote, consequences of crossing over	**16**

	at the interstitial and differential regions of interchange complex, breeding behavior and identification of chromosomes involved in translocation.	

Unit wise learning outcome

Units	Learning outcomes
1	• Will get a brief idea about the history, base of this branch, importance and scope of cytogenetics in modern research of Biology.
2	• Will get a clear and brief knowledge about chromosomes, structural and chemical composition, nature, nucleosome model and function of chromosomes.
3	• Will able to prepare karyotype and ideogram, describe symmetric, asymmetric, monomodal and bimodal karyotype, also learn about the significance of karyotype study.
4	• Will gather knowledge about genome analysis in respect of cytogenetics, karyotype analysis, different types of chromosome banding, FISH, GISH and will learn about different abnormalities in cell division.
6	• Will get general idea about the classifications chromosome aberration.
7	• Will get brief and clear knowledge about all types of structural aberrations of chromosomes such as deletion, inversion, duplication, translocation, etc. and consequences that occurs due to those aberrations.

References

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Instruction strategies and Learning experiences

- Lecture followed by group discussion
- Question answer
- Guided discussion

- Project discussion
- Demonstration

Assignment: Students will be given assignment on particular units
Assessment: : In-Course examination, Assignment, Course final examination, Practical examination, and Viva-voce

BOT 312: Embryology of Angiosperms **Credit hour**: 2

Introduction

A rudimentary course in four-years integrated BS (Hons) for the Department of Botany. Embryology of angiosperms centered on the study of the structures and processes leading to seed formation. This is a fascinating subject because it encompasses many unique developmental events of generative and embryological structures of flowering plants (e.g. sporogenesis, gametogenesis, zygogenesis, endospermogenesis, embryogenesis, apomixes). The study of angiosperm embryology will lead to a better understanding of reproduction, growth and development of plant. Therefore, this subject offers inevitable and fundamental knowledge for plant breeding, seed biology, plant systematic and biotechnological applications in plant development.

Course objectives

(a) Identify and describe development of male reproductive organ of angiosperms.
(b) Recognize different types of ovules along with development of female reproductive organ and their structural organization.
(c) Explain fertilization process leading to zygote formation.
(d) Describe two most striking parts of angiosperm reproduction i.e. Endosperm and embryo development and their classification.
(e) Define apomixis (asexual reproduction) and their applications.
(f) Understand polyembryony development.
(g) Know and apply the knowledge of embryology for experimental and practical purposes.

Course contents

Units	Contents	No. of Lectures
1. Historical background	Discovery of pollen tube, Schleiden's theory of origin of embryo, discovery of true	**2**

	relationship between pollen tube and embryo, discovery of nature and development of male and female gametophyte, discovery of syngamy, chalazogamy, double fertilization, and parthenogenesis.	
2.Microsporangium	Wall layers of microsporangium, sporogenous tissue, cytokinensis and microspore tetrad.	**4**
3. Male gametophyte	Microspore, formation of vegetative and generative cells, division of generative cell, vegetative nucleus and embryo sac like pollen grain.	**2**
4. Megasporangium	Integuments, micropyle, nucellus, integumentary tapetum, archesporium, megasporogenesis and functioning megaspore.	**2**
5. Female gametophyte	Monosporic, biosporic and tetrasporic embryo sacs, organization of mature embryo sac, embryo sacs with disturbed polarity and embryo sac haustoria.	**4**
6. Fertilization	Germination of pollen, course of pollen tube, entry of pollen tube into embryo sac, growth rate of pollen tube and gametic fusion.	**2**
7. Endosperm	Type of endosperm formation - free nuclear endosperm, cellular endosperm, helobial endosperm, relationships between different types of endosperms.	**2**
8. Embryo	Dicotyledons - Crucifer type, asteroid type, solanoid type, chenopodiad type, caryophylad type, development of monocot embryo and modifications of suspensor.	**4**
9. Apomixis	Non recurrent apomixis, recurrent apomixis, gametic and somatic apospory and adventive embryony.	**2**
10. Polyembryony	Cleavage polyembryony, origin of embryos from cells of embryo sac other than egg, embryos arising from cells outside embryo sac, embryos originating from other embryo sacs in ovule.	**2**
11. Experimental Embryology	Control of fertilization, embryo culture, induced parthenogenesis, production of adventives embryos and induced parthenocarpy.	**4**

Unit wise learning outcomes

Units	Learning outcomes
1	• knowledge about historical background of the development of embryology of angiosperm as a branch of natural science.
2	• male reproductive organ (anther) development from sporogenous tissue will be understood.
3	• understand the phenomenon of haploid pollen grains formation and their organization with several peculiarities.
4	• gather knowledge regarding the structural differentiation of ovary, their types and formation of ovule.
5	• substantial perception about development of different types of embryo sac and supporting organs.
6	• apprehension of the fertilization process leading to zygote formation
7	• acquire knowledge about how differently could endosperm be formed and supply nutrition to growing embryo.
8	• get information on cumulative changes in progressive direction for different types of embryo formation
9	• knowledge concerning asexual reproduction in flowering plants and their applications
10	• natural formation of polyembryony and their implications.
11	• apply the knowledge of embryological basics to control and modify various factors of plant body for human benefit.

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Instruction strategies and Learning experiences

Assignment: Students will be given assignment on particular units.

Assessment: In-Course examination, Assignment, Course final examination, Practical examination, and Viva-voce

BOT 313: Practical - 1 **Credit**: 3

A. Environmental Microbiology, B. Plant Pathology, and C. Advanced Phycology

A. Environmental Microbiology

Units	Title	Learning outcomes
1	Isolation of air borne bacteria by air exposure plate technique	• Acquire practical knowledge to isolate microscopic bacteria in the form of colony.
2	Isolation of bacteria from soil	• Development of simplified isolation technique of bacteria from soil.
3	Morphological studies of microbial culture colonies	• Acquire knowledge about different type of microbial colonies *viz.* bacteria, actinomycetes etc.
4	Observation of legume nodule and nodule bacteria	• Acquire knowledge about bacteria associated with legume nodules and their morphological characteristics.
5	Microscopic study of bacteria by Gram staining method	• Development of knowledge about key procedures of identification of bacteria through microscopic observation

B. Plant Pathology

Units	Title	Learning outcomes
1	Laboratory studies of common diseases and pathogenic fungi in crop plants – • Rice: brown spot, sheath blight, stem rot • Wheat: stem rust, leaf rust and loose smut • Pulses and beans: rust of beans, leaf spot of bean and cowpea, anthracnose of bean • Jute: stem rot, black band, anthracnose, and soft rot • Sugarcane: red rot • Groundnut: tikka and rust	• practical knowledge about the selected diseases in crop plants
2	Preparation and sterilization of culture media for fungal growth	• types of plant diseases • diagnosis of plant diseases
3	Isolation of fungi from diseased plants following blotter and tissue planting methods	• isolation and identification of fungi from diseased plants
4	Demonstration of pathogenicity test with soil borne and leaf pathogens	• isolation and identification of fungi from soil and diseased plants
5	Processing and preservation of pathogenic fungal specimens	• studies of fungal diseases in crop plants
6	Local and long field excursions to observe and collect fungal specimens	• study of fungal diseases in crop fields

C. Advanced Phycology

Units	Title	Learning outcomes
1	Work out algae collected during local and long excursions and also algae collected b y students from a wide range of habitats	• To explore the algal habitats and collection of algal samples. • To expedition of collection of algal materials from natural habitats and exploration of algal ecology
2	Study of marine and freshwater algae (plankton, macroalgae including symbiotic and parasitic algae).	• To observe algal material under compound microscope and herbarium specimen.
3	Preparation of dichotomous keys of common algae	• To prepare a dichotomous key of different algal genera with the help of standard literature.
4	Standardization of a microscope and drawing by camera lucida	• To know the technique of standardizing of a microscope and drawing of alga cells by camera lucida

5	Determination of chlorophyll *a* and *b* in a green alga	• To know the technique of determination of chlorophyll *a* and *b* in a green alga

BOT 314: Practical - 2 **Credit**: 3

D. Physiological Ecology and Conservation Biology
E. Contemporary Systematics, and F. Plant Cell Chemistry and Defense

D. Physiological Ecology and Conservation Biology

Units	Title	Learning outcomes
1	Students will maintain a Field Note Book to study the vegetation types of the selected habitats and from local excursions	• Students will be able to recognize different plant species growing in different forests of Bangladesh as plant species growing there have been collected and planted in DU campus for *ex-situ* conservation.
2	Determination of soil moisture content	• Students will be able to know about moisture regime of soil and correlate with climate variations.
3	Determination of pH in soil and water samples and Salinity (Chloride) in water samples	• Students will be able to know the abiotic conditions of freshwater ecosystems and consequences of CO_2 increase in the atmosphere due to human activities.
4	Measurements of Production in Terrestrial habitats	• Productivity of land surface will be determined and students will be able to know yield of the ecosystems
5	Freshwater flora and methods for Conservation	• Students will be able to recognize different plant species growing in different freshwater ecosystems and different methods of conservation.
6	Halophytic plants with characteristic features	• Students will be able to recognize different plant species growing in the coastal zones of Bangladesh with their adaptive mechanisms to

		different stresses.
7	Calculation of soil Conservation value under grass cover and herbaceous cover	• Students will be able to know different methods of conservation of terrestrial habitats.
8	Determination of effective population size and loss of variation	• Students will be able to know different methods of protection of plant populations and loss of genetic variability.
9	Diversity indices, Shannon Wiener Function and determination of individual heterozygosity	• Students will be able to assess species diversity of different forests of Bangladesh and evaluate the changes due to anthropogenic as well as natural disturbance.
10	Germination Eco-Physiology	• Students will be able to asses of growth pattern of different plant species.

E. Contemporary Systematics

Units	Title	Learning outcomes
1	Flora of Dhaka University campus	• Be able to identify the flora of Dhaka University campus.
2	Detailed studies on common angiosperm families available locally	• Students will be able to identify and recognize different angiosperm families of Magnoliopsida and Liliopsida.
3	Systematic relationship of different plant groups	• Better understanding of the terminology on plant morphology and increased in-depth knowledge of writing technical/ scientific description of a species profile.
4	Preparation of Taxonomic keys	• Learn how to differentiate species, genera and families using taxonomic key.

F. Plant Cell Chemistry and Defense

Units	Title	Learning outcomes
1	Tests for reducing and	• provides a qualitative understanding

	non-reducing sugars (Benedict's test and Fehling's test)	of the presence of reducing and non-reducing sugars;
2	Different types of starch grains from different sources (rice, maize, potato and wheat)	• focus on structural uniqueness of different starch grains and also differentiate them;
3	Identification of amino acids	• identify the presence of different amino acids through conducting different simple experiments;
4	Estimation of protein by Lowry's Folin Phenol Cicalteau method	• analyze the amount of protein using spectrophotometer;
5	Determination of vitamin C concentration by titrimetric method	• enable to determine the concentration of vitamin C through standard titrimetric method;
6	Determination of total phenolic compounds in plant tissue	• able to measure total phenolic compounds in plant tissue.

BOT 315: Practical - 3 **Credit hour**: 3

G. Molecular Genetics H. Principles of Crop Improvement, and I. Pteridophyta

G. Molecular Genetics

Units	Title	Learning outcomes
1	Isolation and estimations of proteins from various plant tissues.	• Will be able to isolate protein from plant tissue and be able to estimate the amount of protein using specific quantity of plant tissue.
2	Analysis of plant proteins, sodium dodecyl sulphate polyacrylamide gel electrophoresis (SDS-PAGE) of proteins.	• SDS-PAGE is a useful molecular technique for the analysis of plant proteins. Will be able to learn the procedure for the preparation of proteins samples for SDS-PAGE.
3	Estimation of molecular weight of polypeptides using SDS-PAGE.	• Characterization of proteins from various plants samples particularly through the estimation of molecular weights of polypeptides.
4	Native gel electrophoresis,	• Through this experiment various

	detection of isoenzymes using enzyme location gels.	plant materials including genotypes, germplasm, various species can be characterized.
5	Isolation of DNA from plant tissues.	• Will be able to learn the technique for the isolation of DNA from plant tissue.
6	Agarose gel electro-phoresis of DNA and characterization of various DNA samples.	• Will be able to learn the technique of gel electrophoresis for the molecular characterization of various DNA samples.

H. Principles of Crop Improvement

Units	Title	Learning outcomes
1	Study of pollen morphology and test of pollen fertility in different crop plants	• Students will compare the morphological differences of pollen grains collected from different crops under dry and wet conditions as well as test their rate of viability using nuclear stains.
2	Study of floral biology and hybridization techniques in different economically important crop plants	• Know the reproductive biology of the selected crops plants and may plan how to emasculate and pollinate for one way as well as during reciprocal crosses of respective crops.
3	Study of pollen-pistil interactions using fluorescent and light microscopes	• Students will learn how to study the nature of pollen germination under *in vivo* condition for both self- and cross pollination and follow the pollen tube development under light and fluorescent microscope.
4	Techniques for developing colchiploid plants	• Students will know how to develop polyploidy plants using colchicines and observe their morphological differences.
5	Techniques of embryo culture	• Students will know how to isolate embryo resulted from self- or cross-pollinated seeds and culture them on the nutrient medium.
6	Visits to different agricultural research institutes, namely,	• Through these visits students will be acquainted with the research activities of the respective institutes as well as their

	BARI, BRRI, BINA, BSRI	achievements in various fields.

I. Pteridophyta

Units	Title	Learning outcomes
1	Identification of different genera belonging to four principal classes of Pteridophyta from living and herbarium specimen	Students will have an opportunity to visible and observe the unique morphological features of such of different species representing four main groups of pteridophytes an intermediary group of plants that connect non-vascular primitive to advanced vascular group of plants on earth.
2	Any five of the following genera to be demonstrated in the practical classes including morphological and spore bearing structures depending on availability: (i) *Lycopodium*, (ii) *Selaginella*, (iii*) Pteris*, (iv) *Nephrodium*, (v) *Marsilea*, (vi) *Azolla*, (vii) *Isoetes*	Students will be able to perceive the developmental progression among different groups of pteridophytes through the internal structure study of important vegetative as well as spore bearing reproductive organs (i.e. sporangium, strobilus, sporocarp etc.)
3	Morphology and anatomy of *Cycas* and *Pinus* leaflet	Learn the external and internal morphology of gymnosperms, particularly *Cycas* and *Pinus* leaf and understand the anatomical xerophytic characters of these plants.

BOT 316: Practical - 4 **Credit hour**: 3

J. Introductory Limnology, K. Structural Cytogenetics, and L. Embryology of Angiosperms

J. Introductory Limnology

Units	Title	Learning outcomes
1	Determination of water temperature and air temperature, water transparency, pH, Conductivity, Total dissolved solids and free CO_2 and Dissolved oxygen of pond water.	• Know, how to carry out *in situ* measurements of water temperature, prevailing air temperature and depth of transparency (Secchi depth) in a selected water body and see how do they vary and what do they signify. • Further, know the methods of water sample collection and their subsequent chemical analyses in the laboratory for determining pH, electrical conductivity, total dissolved solids and dissolved oxygen concentration and its percentage saturation of a selected water body
2	Study of some littoral, pelagial and benthal organisms.	• Learn the morphology and diagnostic characters of littoral and benthic macrophytes • Further, learn the composition and taxonomic features of pelagic phytoplankton and its collection procedure

K. Structural Cytogenetics

Units	Title	Learning outcomes
1	Study of meiosis from permanent slides and photographs	• Upon successful completion of this unit, students will be able to identify different stages of meiotic cell division with the help of photographs and permanent slides.
2	Preparation of permanent slides from (i) Meiotic cell division in *Setcreasea purpurea*, ii) Interchange complex in *Rhoeo discolor.*	• This unit will help the students to learn basic techniques of permanent slide preparation with different stages of meiotic cell division in *Setcreasea purpurea* and interchange complex in *Rhoeo discolor*.

L. Embryology of Angiosperms

Units	Title	Learning outcomes
1	Microsporangium: Study of internal structure of any typical anther	• Practical activities during the course will provide students with an understanding of how the male reproductive organ of angiospermic plant namely anther has been developed during their biphasic life cycle.
2	Microgametophyte: Study of external features of different types of pollen grains and determination of germination rate	• Highly variable shape and external features of different types of pollen grains under light microscope will be observed. At the same time a crucial aspect for successful fertilization i.e. rate of pollen grains germination will also be demonstrated.
3	Megasporangium: Study of internal structure of any typical ovule	• Organization of different parts of mature ovule of angiosperm plant through internal structure study will be conducted.
4	Permanent slide: Preparation of permanent slide	• Students will acquire knowledge on how to prepare permanent slides (a basic technique in bioscience) through hands-on practice.

BOT 317: Viva-voce **Credit**: 2

Detailed curriculum outline of Fourth Year B.S. Honours Course (Session: 2025-2026 Onward)

Theory		**Credit hours**
BOT 401:	Microbiological Techniques	2
BOT 402:	Marine Botany	2
BOT 403:	Ethnobotany	2
BOT 404:	Climate Change Biology	2
BOT 405:	Autecology and Environment	2
BOT 406:	Plant Physiology and Plant Nutrition	2
BOT 407:	Genomics, Proteomics and Bioinformatics	2
BOT 408:	Plant Tissue Culture and Biotechnology	2
BOT 409:	Horticulture and Agronomy	2
BOT 410:	Biological Limnology	2
BOT 411:	Numerical Cytogenetics	2
BOT 412:	Environmental Pollution and Bioremediation	2
BOT 413:	Seed Pathology	2
BOT 414:	Evolution	2
BOT 415:	**Practical-1:** Microbiological Techniques, Marine Botany, Biological Limnology, and Ethnobotany	3
BOT 416:	**Practical-2:** Climate Change Biology, Environmental Pollution and Bioremediation, and Seed Pathology.	3
BOT 417:	**Practical-3:** Horticulture & Agronomy, Autecology & Environment, Plant Physiology & Plant Nutrition	3
BOT 418:	**Practical-4:** Plant Tissue Culture & Biotechnology, Genomics, Proteomics & Bioinformatics, and Numerical Cytogenetics	3
BOT 419:	**Viva-voce**	2
		Total = 42

BOT 401. Microbiological Techniques **Credit hour:** 2

Introduction

This is a basic theoretical course and prerequisite to complete the 4-year integrated B. S. (Honors) in Botany Degree. After completing two Microbiology courses in previous years (General Microbiology and Environmental Microbiology), students will learn basic laboratory techniques employed in the

field of microbiology in this course and it mainly focuses on various culture media, cultivation, isolation and culture preservation methods, microbial growth measurement, microbiology of food, milk and water and finally various methods of controlling microbes.

Course Objectives:

(a) Describe how to cultivate various microorganisms in different media and growth conditions.
(b) Discuss and apply various methods of isolation techniques for bacteria.
(c) Explain different methods of culture preservation.
(d) Express bacterial growth and multiplication, relate to bacterial growth curve and effect of pH and temperature on bacterial growth.
(e) Exploit techniques related to measurement of microbial growth.
(f) Describe topics related to microbial assessment of food, food spoilage, food borne pathogenic microbes and their control.
(g) Summarize microorganisms associated with milk and pasteurization.
(h) Recognize microbial water pollution, indicator organism and coliform bacteria.
(i) Identify different practices for controlling of microbes.

Course contents

Units	Contents	No. of Lectures
1: Cultivation of microorganisms	Definition and types of culture media (chemically defined media, complex media, selective media, differential media and enriched media); Sterilization of media; Aerobic and anaerobic culture methods; Pure culture, mixed culture and contaminated culture.	**4**
2: General methods of isolation	Serial dilution; Pour plate and spread plate technique; Membrane filtration technique; Mud-pie technique; Streak dilution technique	**4**
3 Maintenance and preservation of cultures	Introduction to maintenance and preservation of cultures; Methods of culture preservation; Culture collections.	**2**
4: Growth of bacteria	Growth and multiplication of bacteria; Growth curve; Generation time and growth rate; Effect of temperature and pH on bacterial growth	**4**
5: Measurement of microbial growth	Direct microscopic count; Viable cell count (plate count and membrane filtration count); Determination of dry weight.	**2**
6: Microbiology of food	Microbiological examination of foods; Microbial food spoilage; Food borne infection and intoxications; Methods of food preservation (temperature, drying and chemical preservatives)	**4**
7: Microbiology of milk	Microorganisms associated with milk; Milk quality determination by phosphatase test and methylene blue reduction test; Pasteurization	**2**
8: Microbial water pollution	Introduction to microbial water pollution; Indicator organisms and; coliform bacteria; Total and fecal coliforms; Determination of coliform bacteria by MPN technique and membrane filtration technique	**2**
9: Control of microorganisms	Physical control with heat, filtration and radiation; Chemical control with phenol, halogen and alcohol; Control with chemotherapeutic agents and antibiotics	**4**
10: Course review	Review of course content, Discussion on whole Syllabus for preparation of final exam, problem solving, In-course exam script and number showing and discussion on it.	**2**

Unit-wise Learning Outcomes

Units	Learning outcomes
1	• Define and categorize diverse types of bacteriological culture media • Identify uses of different bacteriological culture media and compare between them • Explain function of media sterilization and autoclaving • Analyze mechanism of an autoclave machine • Execute nutrient agar preparation and sterilization by autoclaving in practical class • Report aerobic and anaerobic bacterial culture techniques • Discuss pure culture, mixed culture and contaminated culture
2	• Explain and demonstrate Serial dilution technique • Analyze and distinguish Pour plate and Spread plate technique • Describe Membrane filtration technique

	• Report and perform Mud-pie technique for isolation of *Azotobacter* sp. from soil • Perform aseptic techniques for isolation of microbes • Record and conduct streak dilution technique
3	• Review importance of culture preservation • Discuss different methods of bacterial culture preservation • Compare between different methods of culture preservation • Locate important bacterial type culture collections of the world
4	• Explain growth and multiplication of bacteria • Estimate bacterial growth in logarithmic scale • Sketch and interpret a bacterial growth curve and its different phases • Analyze and calculate generation time and growth rate of a bacterial population • Summarize effect of ph and temperature on bacterial growth • Categorize bacteria based on their optimum growth pH and temperature
5	• Describe method of direct microscopic count • Calculate bacterial population using direct microscopic count • Discuss viable cell count for plate technique and membrane Filtration technique • Memorize process of dry weight measurement for microbial Populations
6	• Diagnose different food items for presence of microbes using various methods • Explain microbial food spoilage basing on food biochemical types • Express symptoms and reasons of food-borne infections and intoxications • Discuss and imply methods of food preservation using heat, drying and chemicals
7	• Categorize microorganisms associated with milk • Determine milk quality using phosphatase enzyme test • Practice methylene blue reduction test to investigate milk quality of various sources • Explain principle of pasteurization • List and describe techniques used for milk pasteurization
8	• Catalogue microbes responsible for water-borne diseases • Identify indicator organism and its importance

	• Differentiate and characterize total coliform and fecal coliform bacteria • Estimate coliform bacteria from a water sample using mpn technique • Recall membrane-filtration technique for testing the presence of coliform bacteria
9	• Explain various physical methods for controlling a microbial population using heat, filtration and radiation • Discuss different chemical methods for controlling a microbial population using phenol, halogen and alcohol • Summarize control of microbes using chemotherapeutic agents and antibiotics • Analyze modes of action of antibiotics on a bacterial cell • Report on culture and sensitivity (c/s) test and e (epsilometer) test

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3. Pommerville JC. 2018. Fundamentals of Microbiology (11th Edition). Jones & Bartlett Learning. USA.
4. Talaro KP and B Chess. 2018. Foundations in Microbiology (10th Edition). McGraw-Hill Education. USA
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Instructional Strategies:

- Lectures followed by discussion
- Participatory question-answer
- Open discussion
- Guided discussion
- Video demonstration on related topics
- In hand demonstration of different laboratory techniques

Assignment: Students will be given assignment on particular units
Assessment: In-Course examination, Assignment, Course final examination, Practical examination, and Viva-voce

BOT 402: Marine Botany **Credit hour**: 2

Introduction

This is a basic course in four years integrated B. S. (Hons.) in Botany Program. We know that the Earth is unique within our solar system for a number of reasons. Its marine ecosystem covers a large portion of biosphere, over 71% (360 million km^2) of Earth's surface with an average depth of 4 km. So, Marine potential is massive. Marine Environment is highly diverse. Marine ecosystems are hot spots for the diversity of flora and fauna. But, total biodiversity including plankton, algae, seaweeds, sea grasses, flowering plants, salt marsh plants, mangroves etc. are still unknown. This course is structured in a way that students will be able to acquire knowledge about marine ecology, its structure, different factors affecting marine environment, plankton and its composition, role and distribution of seaweeds, phytogeography of sea weeds, importance and huge commercial benefits from it, estuarine ecology, Sundarbans and its threat and reclamation. Since marine environments are being damaged due to coral bleaching and several anthropogenic activities like fishing, pollution, habitat alteration, introduction of exotic species and climate change, the environment of these areas are drastically undergoing degradation, so inhabiting organisms could possibly become extinct in near future. So, this course will give the students a clear understanding how marine environment and marine resources act as balancing factors of the earth and how and why we are to take care of it.

Course objectives

(a) To know about marine ecology including life habitat, populations and interactions among organisms and surrounding environment including physical, chemical factors that affect the ability of organisms to survive and reproduce.
(b) To gather knowledge on the diversity of marine phytoplanklton, their classification, productivity, seasonal variation, adaptation and importance.
(c) To explore seaweeds and uses of seaweeds as foods and feeds, know their enormous importance; apply different methods for the cultivation and production of different industrial and pharmaceutical useful products.
(d) To gather knowledge on estuarine ecology, Sundarbans and its reclamation
(e) Production of biofuel from algae, extraction of phycocolloids from marine resources.
(f) Sea grass, salt marshes, reefs, marls and stromatoliths, toxic algae and human health.
(g) Impact of humans on marine environment.
(h) Marine environment a balancing factor of the earth
(i) The course is suitable to equip students with knowledge and solution to our marine ecosystem problems.

Course contents

Units	Contents	No. of Lectures
1	Marine Botany: General aspects, The Oceanic Environment: the Oceans and Seas, Marine plants and their habitats, Marine ecology: (a) physical (light, temperature, waves and current, circulation, density etc.) and (b) Chemical (nutrient elements, pH, salinity, oxygen, Carbon cycle, etc.) properties of seawater. (c) Horizontal and vertical zonations of seas and oceans.	**4**
2	Marine phytoplankton: Classification and diversity and adaptation of phytoplankton, Food chain and energy transfer, productivity of phytoplankton and biomass and seasonal variation/distribution of plankton.	**4**
3	Seaweeds: Introduction to the seaweeds, general morphology, seaweeds and their occurrences, diversity and importance of seaweeds, edible seaweeds, factors (Oceanic currents, temperature, surf, waves etc.) affecting seaweed distribution, biomass and phytogeography of seaweeds.	**4**
4	Sea grasses: characteristics, evolution and distribution, adaptations. Salt marshes: introduction, geographic distribution, adaptations	**2**
5	Estuarine ecology: introduction, evolution and biogeographic distribution, biodiversity of mangroves, Sundarbans: geo-ecological status, its flora nd fauna, salinity effects on it, formation and causes of degradation of Sundarbans and its reclamation, services of Sundarbans, management of estuarine ecology	**4**
6	Marine environment a balancing factor of the earth: Role of phytoplankton and seaweeds (Carbon sink, Cleanser of the atmosphere, cooling of the Earth, etc.).	**2**
7	Formation, morphology and fossil records of reef, marls and stromatoliths, marine plants of coral reefs	**2**
8	Blooms and their impact on aquatic biota and human being	**2**

9	Marine biotechnology: Algal industry, status of seaweed cultivation, production and utilization in different countries of the world (e. g., China, Japan, Korea etc.) and in Bangladesh. Seaweed culture in the coastal area of Bangladesh. (a) Seaweed farming model, cultivation of nori, kelp etc. (b) Biofuel production from algae (c) Extraction of phycocolloids and uses as food and industrial and pharmaceutical products.	**4**
10	The Impact of Humans on the Marine Environment: Modification and destruction of habitats, pollution, threatened and endangered species, conserving and enhancing the environment.	**2**

Unit wise learning outcomes

Units	Learning outcomes
1	• Define and understand Marine Botany • Different factors including different chemical and physical properties of Oceans and seas • Horizontal and vertical zonations of Oceans and seas
2	• Know about the diversity of phytoplankton • Importance of phytoplankton, classification and adaptation • How different factors affects biomass of phytoplankton • Seasonal variation of plankton
3	Concept on Seaweeds • Morphology, diversity and importance of seaweeds • Factors affecting seaweed distribution • Biomass of seaweeds • Phytogeography of seaweeds
4	• Sea grasses: characteristics, evolution and distribution, adaptations. • Salt marshes: introduction, geographic distribution, adaptations
5	• Estuarine ecology: introduction, evolution and biogeographic distribution, biodiversity of mangroves • Estuarine Ecology and its importance • Sundarbans: geo-ecological status, its flora and fauna, salinity

	effects on it, formation and causes of degradation of Sundarbans and its reclamation, services of Sundarbans, management of estuarine ecology
6	• How a marine environment acts as a balancing factor of the earth • Role of phytoplankton and seaweeds • Carbon sink, cleanser of the atmosphere, cooling of the earth.
7	• Formation, morphology and fossil records of Reef, marls and stromatolites, • Marine plants of coral reefs
8	• Blooms and their impact on aquatic biota and human being
9	• Seaweeds identification, cultivation and processing • Identify phycocolloids, their production and uses • Methods of Marine biotechnology • Potentiality of extraction of biofuels from algae • Seaweeds use as food, industrial and pharmaceuticals products
10	• Destruction of marine habitats, pollution, • Threatened and endangered species, • Conserving and enhancing the environment.

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Instruction strategies

- Lecture followed by group discussion
- Question answer
- Guided discussion
- Project discussion
- Demonstration
-Field visit to important marine and estuarine environments.

Assignment: Students will be given assignment on particular units
Assessment: In-Course examination, Assignment, Course final examination, Practical examination, and Viva-voce

BOT 403: Ethnobotany **Credit hour**: 2

Introduction

Ethnobotany is the study of relationships between plants and people. The topics covered include: basic ideas of ethnobotany, historical development of the subject, scopes and main areas of ethnobatanical research, traditional botanical knowledge, plants in material culture, research methods in ethnobotany, ethnopharmacology, sampling techniques, screening techniques, ethical issues in plants collection for the research, understanding of plant world, how perceptions change, cognitive ethnobotany and plant human interaction, applied aspects of ethnobotany, local and global interest in ethnobotanical data, biocultural reserves, laws protocols. Special effort will be paid on individual research project development.

Course objectives

(a) Traditional knowledge of plants including medicinal plants, food and vegetable, arts and technologies etc.
(b) Indigenous knowledge of agriculture, environment, germpalsm management, biodiversity conservation techniques.
(c) Health care knowledge of medicinal plants and potential plants for drug discovery program.
(d) Way to apply ethnobotanical data for resource conservation, community development, sustainable economic growth.
(e) How to conduct individual project related to applied ethnobotany.

Course contents

Units	Contents	No. of Lectures
1. Introduction	Definition and history, current scope and potential applications.	**4**
2. Traditional Botanical Knowledge (TBK)	Basic approaches to the study of traditional botanical knowledge (TBK) and subsistence, Wild plant resources, Domesticated plants and Traditional agriculture.	**4**
3. Methods in ethnobotanical study	Research protocol, types of interviews and questions, techniques of inquiries for data collection, sampling and sample consideration, data reliability using models.	**5**
4. Ethnopharma-cology	Definition, novel compounds, sampling methods, types of screening, plant collection for phytochemical analysis, preserving the plants, field note and ethical issues.	**4**
5. Plants in material culture	Plants used as timber, in construction, in art and technology, ritual and symbolism, as fibers, plant extracts and exudates, managing resources for material culture.	**5**
6. Understanding traditional plant use and management	Understanding the decision making environment, factors affecting environmental perception, Ethnotaxonomy and perceived environment.	**2**
7. History of plant- human interaction	Palaeoethnobotanical evidence	**2**

8. Applied and applying ethnobotany	Practical applications of ethnobotanical data and Sustainability and viability of ethnobotany based projects, Legal mechanism, and ethical codes.	**4**

Unit wise learning outcomes

Units	Learning outcomes
1	• will be able to define the subject ethnobotany and historical background of development and also to know the applications of the subject in the modern world.
2	• will be able to learn the traditional knowledge of wild and domesticated plants and to know traditional agriculture systems and also to know the basic approaches of the studies of traditional botanical knowledge of plants
3	• will be able to learn the techniques of ethnobotanical studies and also to know the data analysis and presentation strategies, to know the techniques to conduct individual project on ethobotany.
4	• will be able to know the ethnopharmacology techniques for the validation folk medical knowledge and ethical issues
5	• will be able to know the list of plant species used in different aspects of material culture.
6	• will be able to learn how to perceive plant environment by the local people and also to learn folk taxonomy of plant world.
7	• will be able to know the evidences of plants and human interactions.
8	• will be able to gain knowledge from the practical application of ethnobotanical data and to know the legal status in the use of traditional knowledge.

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Instruction strategies

- Lecture followed by group discussion
- Question answer
- Guided discussion
- Project discussion
- Demonstration

Assignment: Students will be given assignment on particular units
Assessment: In-Course examination, Assignment, Course final examination, Practical examination, and Viva-voce

BOT 404: Climate Change Biology **Credit hour**: 2

Introduction

Global climate change is not a new idea. Initially the focus was on the physical and biological sciences. There is a general lack of consensus in the scientific communities concerning both a comprehensive definition and the conceptual scope of global climate change. As evidence, the three problems that have been given greatest attention - climate change, ozone depletion and loss of biodiversity - are all of anthropogenic in origin. The processes of global changes tend to be highly non-linear and are characterized by human responses that can have positive or negative feedbacks. Therefore, the human dimensions and the essential role of plant scientists must be recognized in resolving global environmental problems. To familiarize the students with the global climate systems and changes being happening, this course focuses on the atmospheric and oceanic circulation, effects of climate changes on functions of organisms and ecosystems etc.

Course objectives

(a) Global climate systems.
(b) Ocean structure and circulation.
(c) Consequences of natural and anthropogenic processes on organisms, and complexity and functions of ecosystems.
(d) Adaptation to climate changes.

Course contents

Units	Contentd	No. of Lectures
1. Understanding global climate	Earth's climate system, atmospheric structure and circulation, Hadley cell, Ferrell cell, Polar cell, mean residence time (MRT), intertropical convergence zone (ITCZ), ocean structure and circulation, El-Nino and La-Nina.	**8**
2. Causes of global climate change	Factors affecting the changes of earth's average temperature, human drivers of change, terrestrial and marine sink of CO_2, CO_2 effects on climate. (5 classes)	**5**
3. Climate change phenomena	Evidence and consequences of global climate change, projecting future changes in the earth's climate.	**4**
4. Landform effects and vegetation	Influence on climate, temporal variability in climate, long term change, anthropogenic climate change, relationship of climate to ecosystem distribution and structure.	**4**
5. Impacts of globalclimate change	Responses of different organisms and ecosystems to climate change, extinction risks, challenges to agriculture in the context of Bangladesh.	**3**
6. Mitigation and adaption	Mitigation and adaptation mechanisms for the global climate change, Solar radiation management (SRM), C-sequestration, C-trading and global climate model (GCM), global initiatives. Solar Radiation Management (SRM)	**5**

Unit wise learning outcomes

Units	Learning outcomes
1	• Will be able to acquire information on the complexity and function of the climate systems
2	• Will be able to critically evaluate and synthesize their knowledge about the factors involved in global changes.
3	• Will have knowledge about the future programs to mitigate climate change

4	• Will have good understanding on the effects of different land uses and vegetation cover on climate
5	• Will be able to evaluate the influence of climate changes on different organisms and ecosystems
6	• Will have sufficient knowledge about the current trends of the world regarding climate change

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Instruction strategies

- Lecture followed by group discussion
- Question answer
- Guided discussion
- Project discussion
- Demonstration

Assignment: Students will be given assignment on particular units
Assessment: In-Course examination, Assignment, Course final examination, Practical examination, and Viva-voce

BOT 405: Autecology and Environment Credit hour: 2

Introduction

Ecology is a branch of science that systematically studies the interactions between living organisms as well as between living and non-living components of the environment. It deals with the interactions that determine adaptation, distribution and abundance of organisms. Therefore, studying the surrounding environment of the organisms is also important since the periphery of the environment starts from the time of conception till the death of any living being. Environmental Science is such a field where numerous current significant subjects are being coincided in a single point. With a handsome amalgamation, Environmental Science deals with some very important aspects like pollution, waste management, hydrology, atmospheric-oceanic environment, climate change, natural resource management, meteorology, biodiversity conservation, environmental impact assessment and so on.

Course objectives

This course focuses on training students with a broad understanding on areas covered by plant ecology, environmental science and relevant research approaches. The course will include basic concepts of environment of plants, interactions among organisms, ecosystem stability and environmental pollution.

Course contents

Unit	Contents	No. of Lectures
Section A: Autecology		
1. Introduction	• Definition, historical development and contribution of the prominent Ecologists of the world • Plant growth, Influence of the environment, Population response, Adaptability and adaptedness	2
2. The environment of plants	• The hydrosphere • The atmosphere • The lithosphere • The biosphere • The ecosphere	2
3. Radiation environment	• The Sun-a thermonuclear energy source • Radiation • Irradiance • Leaf canopies	2

	• Effects of radiation and irradiance on plants	
4. Energy environment	• Energy exchange in the natural environment • Radiation balance • Spatial and temporal variation in radiation balance • Energy budget of the different climatic zones	2
5. Salinity	• Definition of salinity • Sources of salinity • Salt cycles in nature • Classification of saline habitats • Adaptive features of halophytes	3
6. Plant response to environmental stress	• Introduction • Response to temperature • Response to ionic toxicity • Response to gaseous toxicity	2
7. Interactions between organisms	• Definition and significance • Types of interactions: competition (competitive superiority; occurrence, extent and ecological effects), predation and parasitism (nature of attack, plant defense, plant responses), allelopathy (Mechanism, allelopatthy in perspective)	2
Section B Environment		
8. Basic concept of Environment and Environmental Science	• Definition of Environment and Environmental science and its importance • Sustainable development • Global environmental issues • Six key themes of Environmental Science • Human-environment interaction • Ecological footprint • Environmental ethics and environmentalism	4
9. Marine environment	• Classification of marine habitat • Productivity in relation to the Bay of	2

	Bengal • Mathematical models • Marine pollution	
10. Soil environment	• Physical properties • Chemical properties	2
11. Ecosystem balance and imbalance	• Ecosystem stability and homeostasis • Factors influencing ecosystem balance • Human impacts on ecosystems	2
12. Water resources	• Basic water requirements • Global picture of water use • Global water availability • Sources of natural water • Causes and impacts of water shortage(drought and floods) • Remedies of water shortage	3
13. Environmental toxicology	• Toxicity • Mechanism of toxicity • Toxic substances (e.g. heavy metals, plastics etc) and their effects • Extent of arsenic toxicity in water, soil and plants in Bangladesh	2

Unit wise learning outcomes

Unit	**Learning outcomes**
Section A: Autecology	
1	Students will learn the history of the development of the discipline
2	Students will learn about the characteristics of ecospheres
3	Students will learn about the role of solar radiation on the growth of plants and the supply of foods
4	Focuses on the availability and exchange of energy
5	Extent and sources of salinity and the features of halophytic plants
6	Students will learn about the detrimental effects of environmental effects on plant
7	Students will learn about the community organization and interactions
Section B Environment	
8	Students will gain foundation knowledge about environment
9	Focuses on the structure and productivity of marine environment
10	Properties of soil in relation to the distribution of plants
11	Students will learn the factors that regulate ecosystem stability

12	Students will know about the importance, availability and shortage of water resource. They will also learn about the solutions to the shortage of this resource.
13	Students will learn about the nature, types and mechanisms of toxicity as well as the extent of arsenic toxicity in Bangladesh

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Instructional strategies and Learning experiences:

- Class lecture using black board/white board/multimedia projector
- Question/answer
- Guided discussion
- Practical demonstration
- Field visits/Study tour

Assignment: Students will be given assignment on selected topics.
Assessment: In-Course examination, Assignment, Course final examination, Practical examination, and Viva-voce

BOT 406: Plant Physiology and Plant Nutrition Credit hour: 2

Introduction

This is a basic course in 4-years integrated BS (Hons) in Botany program. Plant Physiology is a sub-discipline of botany concerned with the physical, chemical and biological functioning of plants. Plant Physiology is usually divided into three major parts: the physiology of nutrition and metabolism; the physiology of growth, development and reproduction; and environmental physiology. In this course, topics covered - photosynthesis in C_4 and CAM plants, photorespiration, mineral nutrition, ion absorption of plants, plant hormones, nitrogen fixation and enzymes.

Course objectives

(a) Develop cogent and critical arguments based on the course material;
(b) Integrate related topics from separate parts of the course;
(c) Build up the knowledge in pertinent plant physiological processes such as photosynthesis, respiration, mineral nutrition, transport, growth substances etc;
(d) On satisfying the requirements of this course, students will have the increased knowledge of metabolic and physiological processes unique to plants, together with a better understanding of significance of mineral nutrition, mechanism of ion absorption, regulation of growth and development, influence of enzymes and environment.

Course contents

Units	Contentd	No. of Lectures
1. Photosynthesis	Details of C_4 and CAM pathways, (b) Comparison of C_3, C_4 and CAM pathways.	**4**
2. Respiration:	Pentose phosphate pathway and Photorespiration.	**4**
3. Growth and development	Discovery, classification, distribution, transport and chemical nature of plant growth substances, Physiological effects of auxin, gibberellin, cytokinin, ethylene and abscisic acid.	**3**
4. Enzymes:	Nomenclature and modern classification of enzymes with examples, Michaelis-Menten equation, Factors affecting enzyme activity.	**3**
5. Mineral nutrients	Essential elements, sources and functions of essential elements, role and deficiency symptoms of essential elements.	
6. Ion absorption of plants:	Mechanism of ion absorption: Passive absorption: Donnan equilibrium and Cation exchange theory. Active absorption: Evidence of active absorption; Carrier concept; and Anion respiration or Lundegardth theory.	**4**
7. Pathways of translocation of ions	Apoplastic and symplastic pathway.	**2**

Unit wise learning outcomes

Units	Learning outcomes
1	• enhance knowledge on different pathways of photosynthesis in plants; state the differences among C_3, C_4 and CAM pathways;
2	• itemize and describe Pentose phosphate pathway and Photorespiration and reveal the environmental influences upon carbon metabolism in plants (e.g. with respect to alternative fixation pathway and photorespiration);
3	• describe the major effects and physiological mechanisms of growth regulators (hormones) in plants;
4	• procure knowledge and understand the basic functions of enzyme activity;
5	• have clear conception of essential mineral elements and the role of these minerals play in organic molecule synthesis and use; also perceive the deficiency symptoms of essential elements;
6	• comprehend and integrate the mechanisms of absorption of mineral ions by plants;
7	• discern apoplastic and symplastic pathway.

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3. Hewitt EJ and TA Smith 1974. Plant Mineral Nutrition. The English University Press, London.
4. Hopkins WG 1991. Introduction to Plant Physiology, 2nd Edn. John Wiley and Son, Inc.
5. Jain VK 2004. Fundamentals of Plant Physiology. 7th Edn. S.Chand and Company Ltd., New Delhi.

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Instruction strategies and Learning experiences
- Lecture followed by group discussion
- Question answer
- Guided discussion
- Project discussion
- Demonstration

Assignment: Students will be given assignment on particular units
Assessment: In-Course examination, Assignment, Course final examination, Practical examination, and Viva-voce

BOT 407: Genomics, Proteomics and Bioinformatics

Credit hour: 2

Introduction

This is a basic course in 4 –years integrated BS (Hons) in Botany program. It is structured in a way that the students develop clear understanding of the concept of Genomics, Proteomics and Bioinformatics. Students will also get the chances to learn about isolation and characterization of DNA, RNA and Proteins, subdividing the genome by restriction digestion and separating them by gel electrophoresis. The student will be able know about various bioinformatics tools for the analysis DNA, RNA and Protein sequences to identify the function and finding similar genes available in databases.

Course objectives
(a) Define and explain Genomic, Proteomics and Bioinformatics
(b) To know the techniques of genome and proteome analysis.
(c) Learn the principles of different sequencing techniques
(d) To know the various bioinformatic data bases
(e) Learn the sequence analysis using bioinformatic tools
(f) Understand necessity of drug design using bioinformatic tools

Course contents

Units	Contents	No. of Lectures
1: Genomics	**Gen** Organization and structure of genomes- Genome size, Sequence complexity, Genome structure in viruses and prokaryotes, the organization of nuclear DNA in eukaryotes.	**10**

	Subdividing the genome- Fragmentation of DNA with restriction enzymes, Separating large fragments of DNA, Isolation of chromosomes, Chromosome micro-dissection, Vectors for cloning DNA, Choice of vector. Genome sequence acquisition and analysis- Physical mapping of genomes, sequencing whole genomes- sequencing methods and strategies, Benefits of genome sequencing.	
2: Proteomics	Introduction to Proteomics, Protein Structures and folding, Protein-protein interaction study: Yeast-2-hybrid systems. Protein separation for sequencing: 2-D gel electrophoresis, Tandem-mass spectrometry. Analysis of protein Sequences: Identification of Protein families and evolutionary relationships, Basic principles of protein sequence comparison, finding distant relationships, revealing protein motifs, 3D structural comparisons.	**10**
3: Bioinformatics	Introduction of Bioinformatics, Bioinformatics Databases and search tools, Similarity Searches on Sequence Databases, Pair-wise alignments, multiple sequence alignment, Phylogenetic analysis, Application of bioinformatics. Networks in Bioinformatics/proteomics**:** Biological networks (Protein interaction networks, gene regulation networks), Functional genomics: Identification and characterization genes from newly sequenced genome, Molecular Docking for Drug Design.	**10**

Unit wise learning outcome

Units	Learning outcomes
1	• Understand the Organization and structure of genomes of prokaryotes, eukaryotes and archea. • Learn process of isolation is single chromosome and segment of a particular chromosome. • Learn the techniques of subdividing the genome and know

	about the vectors for cloning DNA • Learn the high throughput Genome sequencing techniques and analysis of the sequences.
2	• Know the types of Protein Structures and folding and the importance of protein folding related to specific function. • Learn the techniques of protein separation, studying protein-protein interaction and sequencing of peptide. • Learn the study of phyllogenetic relationship among members of different protein families. • Learn the use of softwares to predict protein 3D structure and finding the domains and motifs.
3	• Know the different bioinformatic databases. • Learn the principles and application procedure of different tools for analysis of dna, rna and proteins. • Know the different alignment techniques for nucleotide or peptide sequences with their principles. • Identify the unknown nucleotide or peptide sequences through blast search analysis as well as the principles of similarity search tools. • Learn the study of phylogenetic analysis and functional genomic analysis of unknown gene sequences. • Know the principles of drug design based on bioinformatic tools.

References

1. Brown T.A. 2007. Genomes 3 (3rd edition), published by Garland Science Publishing
2. Campbell AM and LJ Heyer 2003. Discovering Genomics, Proteomics and Bioinformatics (2nd Edition). Pearsons Education. ISBN: 0-8053-4722-4.
3. Claverie JM and C Notredame 2007. Bioinformatics for DUMMIES (2nd Edition) Wiley Publishing, Inc.111 River Street, Hoboken, NJ 07030-5774.
4. Pevsner J 2009. Bioinformatics and functional genomics (2nd Edition) John-Wiley and Sons, Inc.
5. Primrose SB and RM Twyman 2006. Principles of Genome Analysis and Genomics (7th Edition) Blackwell Publishing, USA.
6. Reinders J and A Sickmann 2009. Proteomics: Methods and Protocols. Humana Press.
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9. Twyman R 2004. Principles of Proteomics (Advanced Texts). Garland Science/BIOS Scientific Publisher | ISBN-10: 1859962734.

10. Mount D.W. 2004. Bioinformatics -sequence and genome analysis, second edition. CBS Publishers and Distributors, India

Instruction strategies

- Lecture followed by group discussion
- Question answer
- Guided discussion
- Project discussion
- Demonstration

Assignment: Students will be given assignment on particular units
Assessment: In-Course examination, Assignment, Course final examination, Practical examination, and Viva-voce

BOT 408: Plant Tissue Culture **Credit hour**: 2

Introduction

In spite of a doubling of the world population in the last three decades, agricultural production rose at an adequate rate to meet world food needs. However, an additional 3 billion people will be added to the world population in the next three decades, requiring an expansion in world food supplies to meet the projected needs. As the world population increases, there would be a need for an agricultural production system that is a pace with population growth. Unfortunately, arable land is in short supply, stemming from new lands that have been brought into cultivation in the past, or surrendered to urban development. Consequently, more food will have to be produced on less land. This calls for improved and high-yielding varieties to be developed by plant breeders.

The Green Revolution contributed significantly towards increasing the yields of major crops have dramatically changed over the years. However, the productivity of most of the major crops are almost in the peak and there is a little scope to increase the productivity further using conventional breeding techniques. Another major concern is that most of the population growth will occur in developing countries where food needs are currently most serious, and where resources for feeding people are already most severely strained, because of natural or human-made disasters, or ineffective political systems. It is under this background the application of plant tissue culture and modern biotechnology may play a vital role towards development of high yielding, abiotic and biotic stress tolerant crops which could be grown in stress prone areas like salinity and drought.

Studying this course students will have the opportunity to gather an in depth knowledge on various aspects and methods of plant tissue culture and biotechnology as well as their application in crop improvement. This course will also highlight the methods of developing genetically modified crops as well as the methods of producing industrially important secondary metabolites. Both theoretical presentations and practical laboratory demonstrations will allow students to gain experience in different basic and applied concepts and methods of plant tissue culture and modern biotechnology to be utilized for crop improvement.

Course objectives

(a) Provide basic principles and historical background of plant tissue culture and biotechnology.
(b) Provide information on basic requirements for setting up a plant tissue culture laboratory, procedures and terminology of aseptic culture.
(c) Describe the applications of tissue culture for large scale propagation of economically important Plants for commercial utilization.
(d) Provide lession on specialized cell culture techniques and their uses in plant science research and industry.
(e) Methods and applications of meristem culture, anther culture and somatic hybridization.
(f) Describe methods for the production of secondary metabolites familiarize students with the technology of plant genetic engineering.

Course contents

Units	Contents	No. of Lectures
1	Historical background of plant tissue culture and biotechnology.	**2**
2	Laboratory organization, plant tissue culture media and other nutritional and hormonal supplements, sterilization of tissue culture media, equipments and plant materials.	**5**
3	Cellular totipotency, establishment and maintenance of callus, cell suspension culture.	**4**
4	*In vitro* organogenesis and somatic embryogenesis.	**4**
5	Micro-propagation and its commercial application.	**2**
6	Production of disease free plants through meristem culture, virus indexing using ELISA test.	**2**
7	Somaclonal and gametoclonal variations: causes, stability and applications.	**2**

8	Anther and pollen culture for haploid, factors affecting haploid production and application of haploid in crop improvement.	**3**
9	Isolation and culture of protoplasts, somatic hybridization and cybridization.	**2**
10	Production of secondary metabolites through *in vitro* culture techniques.	**2**
11	Plant genetic engineering, concepts, methods and applications.	**2**

Unit wise learning outcomes

Units	Learning outcomes
1	• Students will know the importance and developmental history of plant tissue culture and biotechnology
2	• Will be able to design and setting up of a plant tissue culture laboratory based on the need of the users
3	• Will familiarize the requirements and various ingredients of plant tissue culture media including plant growth regulators essential for plant tissue culture
4	• Will know how to maintain aseptic environment during culturing of cell and tissues as well as sterilization of various equipments and appliances
5	• Will familiarize different specialized cell culture techniques including callus culture, *in vitro* organogenesis and somatic embryogenesis, micropropagation, etc.
6	• Will know how to regenerate virus free plants through meristem culture techniques and their indexing using immunological methods
7	• Will know the mechanisms of somaclonal and gametoclonal variation produced through *in vitro* culture techniques
8	• Will know the various factors that affects haploid production using *in vitro* culture techniques and the significance of anther culture in crop improvement
9	• Will be able to know the procedure of isolation of protoplasts and fusion process of somatic cells and their importance in overcoming breeding barriers
10	• Will know the process of production of industrially important secondary metabolites using *in vitro* culture techniques including their advantages ad limitations
11	• Students will be able to know the concepts and applications of

	plant genetic engineering towards developing crops tolerant to biotic and abiotic stresses as well as with enhanced nutritional qualities

References

1. Bhojwani SS. 1990. Plant Tissue Culture: Applications and Limitations. Elsevier. Amsterdam, Oxford, New York, Tokyo.
2. Bhojwani SS and Razdan MK.1996. Plant Tissue Culture: Theory and Practice. Elsevier. Amsterdam, Oxford, New York, Tokyo.
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Instruction strategies and Learning experiences

- Lecture followed by Question-answer
- Guided discussion
- Project discussion
- Demonstration

Assignment: Students will be given assignment on particular units
Assessment: In-Course examination, Assignment, Course final examination, Practical examination, and Viva-voce

BOT 409: Horticulture and Agronomy **Credit hour**: 2

Introduction

This is a basic course in 4-years integrated BS (Hons) in Botany program. It is structured in a way that the students develop clear understanding of the concept of horticulture and agronomy, scopes of horticulture in Bangladesh, classification of horticultural plants and vegetables, seed bed preparation,

propagation of horticultural plants, fertilizer and irrigation. Students also learn about horticultural aspects and intensive cultivation of different crops viz. vegetables (Olericulture), fruits (Pomology) and flowers (Floriculture).

Course objectives

(a) Distinguish between horticulture and agronomy.
(b) Classify horticultural plants and vegetables with special reference to Bangladesh.
(c) Prepare an ideal seed bed and raise seedlings in it following scientific method.
(d) List and describe various methods of vegetative propagation.
(e) Apply the knowledge of vegetative propagation in novel situation e.g., repairing injuries, increasing quality of fruit, imparting disease resistance etc.
(f) Justify among different scientific methods to properly irrigate and fertilize fields or gardens.
(g) Establish garden of different vegetables (e.g., tomato, brinjal, lady's finger etc.), fruits (mango, pineapple, lemon etc.) and flowers (e.g., rose, tuberose, chrysanthemum etc.).

Course contents

Units	**Contents**	**No. of Lectures**
1. Introduction	Definition, historical background, branches of horticulture, Distinguishing features of horticulture and agronomy, Objectives and scope of horticulture, urban horticulture.	**2**
2.Classification of horticultural plants	Botanical classification, Agronomic classification, Classification based on uses.	**2**
3. Classification of vegetables	Classification based on different criteria with examples especially from Bangladesh.	**4**
4. Preparation of seedbed:	Seed bed, soil type, location and its classification, Preparation of an ideal seed bed, Seed rate calculation, Seed sowing method, pre- and post-transplanting care of seed and soil before sowing.	**5**
5. Propagation of horticultural plants	Classification with examples, Advantages and disadvantages of vegetative propagation, Details about cutting, layering and grafting.	**5**
6. Fertilizer	Types and classification of fertilizer,	**4**

	Composition, dosage, time and methods of fertilizer application.	
7: Irrigation	Methods and importance of irrigation, Sources, quality and quantity of irrigation water.	**4**
8: Olericulture	Horticultural aspects and cultivation of different vegetables in Bangladesh. e.g. tomato, brinjal, lady's finger.	**2**
9: Pomology	Horticultural aspects, plantation and cultural practices of fruit yielding plants. e.g. mango, pineapple, lemon.	**1**
10: Floriculture	Floricultural aspects and cultivation of the flowering plants. e. g. rose, tuberose, chrysanthemum.	**1**

Unit wise learning outcome

Units	Learning outcomes
1	• gain an understanding of horticultural science and its relationships to other disciplines.
2	• classify horticultural plants.
3	• classify vegetables with special reference to Bangladesh.
4	• prepare an ideal seed bed and raise seedlings in it following scientific method.
5	• demonstrate an in-depth disciplinary knowledge and capacity to apply the knowledge of vegetative propagation at horticultural system issues in multiple cases.
6	• show the demonstrated skill in scientifically fertilizing a field.
7	• develop ability to employ irrigation knowledge to horticultural problems.
8	• gain knowledge on the intensive cultivation of different vegetables.
9	• gain knowledge on the intensive cultivation of different fruit yielding plants.
10	• gain knowledge on the cultivation of different flowering plants.

References

1. Janick J 1972. Horticulture Science. W.H. Freeman and Co. San Francisco.
2. Sadhu MK 1989. Plant Propagation, New Age International (P) Ltd. Publishers, New Delhi, India.
3. Fordham R and AG Biggs 1985. Principles of Vegetable Crop Production. William Collins Sons & Co. Ltd., London.

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6. FRG 2012. Fertilizer Recommendation Guide. Bangladesh Agricultural Research Council (BARC), Farmgate, Dhaka 1215. 274 p.

Instruction strategies and Learning experiences

- Lecture followed by group discussion
- Question-answer
- Guided discussion
- Demonstration
- Quizzes
- Piazza website

Assignment: Students will be given assignment on particular units

Assessment: In-Course examination, Assignment, Course final examination, Practical examination, and Viva-voce

BOT 410: Biological Limnology **Credit hour**: 2

Introduction

This course is taught in the 4th year classes of four years integrated BS (Honors) degree program in Botany under the University of Dhaka. The students learn Fundamentals of Limnology in their 3rd Year Honors Course. So, the present course has been designed to offer the students an up to date knowledge on the organisms of inland aquatic ecosystems, together with their functional behavior. Contribution of organisms in the energy pipeline of biological production systems is also highlighted. The goal could be best achieved via introducing the students with the qualitative and to some extent quantitative aspects of aquatic biodiversity of inland waters. The 'Grasses of water' i.e., the phytoplankton community is explained following their types, pattern, biological role and their adaptive features in the liquid environment. The methods to achieve a quantitative value in terms of organic carbon in the food chain by phytoplankton are also elaborated. Furthermore, the presence and role of aquatic angiosperms and other groups of plants in the aquatic ecosystem has been clarified. Emphasis has been given to the ecophysiological adaptations such as heterophylly for carrying out photosynthesis in aquatic medium by aquatic macrophytes. Some details on the geographical distribution, dispersal, endemism and example of fossil of hydrophytes have been given. The obnoxious and beneficial roles of aquatic weeds have been highlighted. After visiting this course every student will get knowledge on the biological part of limnology.

Course objectives

(a) Know aquatic biodiversity, reasons of creation, classification, patterns, energy flow
(b) Learn aspects of plankton, sinking mechanism, resistance offered, seasonality, pattern
(c) Know primary production, measurements, seasonality, consult a case study
(d) Understand nutrient utilization by plankton, specific responses, eutrophication
(e) Study biodiversity of aquatic vascular plants, distribution, evolution, adaptation
(f) Learn concept of heterophylly, role in photosynthesis, effect of turbulance
(g) Know dispersal and geographic distribution of aquatic plants, endemism and fossils
(h) Learn aquatic weeds, composition, effects, eradication, economic values

Course contents

Units	Contents	No. of Lectures
1	**Aquatic biodiversity**: Water as an environment for organisms, energy flow, creation of diverse biotic communities, composition, pattern and classification.	**3**
2	**Plankton**: Introduction, definition, classification, general features, collection procedure, composition, size and shape, common aquatic algae, pigment, biomass, suspension mechanism of plankton in water, relevant to this GALD, V, SA/V, their relationships, form resistance of plankton, distribution, spatial, temporal, diacmic, monoacmic seasonal behavior of phytoplankton.	4
3	**Primary productivity**: Definition, aquatic organisms relevant to the process, methodology of determination, Light and Dark bottle O_2 and ^{14}C technique, manipulation with examples, merits and demerits of the methodologies, seasonality of primary productivity and its components in a man-made lake of Bangladesh.	**4**
4	**Resource utilization by plankton**: Phytoplankton and nutrient relationships, limiting nutrients, biomass responses of phytoplankton to different nutrients, namely, P, N, Si, relationship of *Skeletonema* plankton with various concentrations of silica. Eutrophication, concept, process of occurring, classification, causes,	**4**

	consequences, and remedies.	
5	**Aquatic macrophytes**: Vascular and avascular aquatic plants, their types, classification, horizontal and vertical distribution, evolution of aquatic tracheophytes, supporting evidences, group wise anatomical adaptive features with illustration.	**4**
6	**Heterophylly**: Concepts relevant to heterophylly in aquatic plants, its relationship with photosysnthesis, morphological adaption in promoting underwater photosynthesis, effect of turbulence on photosynthesis of laminar and capillary leaves.	**3**
7	**Dispersal and geographical distribution**: Different modes and means of dispersal, adventives species, quantitative aspects of colonization. Extensive, Eurasian, European, Asiatic, discontinuous distribution on a global scale, endemism and fossil records of hydrophytic plants.	**4**
8	**Aquatic weeds**: Definition, effects, types, typical species of weed characters, their control, manual, mechanical, biological, chemical, biomass utilization for benefits, economic values as food, feed, fodder, fertilizer, commercial, medicinal purposes, ecosystem services, interactions, biotic relationships.	**4**

Unit wise learning outcomes

Units	Learning outcomes
1	• Flow of energy relevant to biotic communities • Organisms associated, niche characters • Creation of diverse biotic communities • Composition, pattern and classification
2	• All about plankton, general features, classification, collection • Size, shape, examples in common, pigment, biomass • Suspension mechanism, relevant factors to it • Distribution spatial, temporal, seasonal behavior, pattern
3	• Primary productivity as central theme, organisms making it • Determination procedures of productivity, merits, demerits • Seasonal sequence of productivity and its components
4	• Nutrients, type, availability, source, depletion in concentration • Concept of limiting nutrients, their responses, governing mechanisms

	• *Skeletonema* and its relationship with different concentration of Si • Concept of surface water eutrophication, causes and consequences • Involved nutrients, control measures against their contamination
5	• Diversity of vascular and avascular macrophytes • Classification, horizontal and vertical distribution, evolution • Group wise anatomical adaptive features with illustration
6	• Concept of heterophylly in aquatic plants • Relationship between photosynthesis and heterophylly • How morphological adaptation promotes underwater photosynthesis • Turbulence effects on photosynthesis of laminar and capillary leaves
7	• Means and modes of dispersal of aquatic plants • Dispersal over continents, types, patterns, species composition • Endemic and fossil records of hydrophytes
8	• Concepts of aquatic weeds, species composition, problems • Control measures, harvested biomass utilization • Economic and environmental values of aquatic plants on global scale • Ecosystem services and biotic relationships

References

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Instruction strategies and Learning experiences

- Lecture followed by group discussion
- Question answer
- Guided discussion
- Project discussion

- Demonstration

Assignment: Students will be given assignment on particular units
Assessment: In-Course examination, Assignment, Course final examination, Practical examination, and Viva-voce

BOT 411: Numerical Cytogenetics **Credit hour**: 2

Introduction

This is a basic course in 4-years integrated BS (Hons) in Botany program. Development of clear knowledge about different types of numerical aberration of chromosome. Students will get detail information regarding the cytological behavior and application of trisomy, monosomy, nullisomy, haploid, triploid, autotetraploid, allopolyploid, auto-allopolyploid and segmental allopolyploid and synthetic classification of polyploidy. Students will get knowledge about different human abnormalities caused by chromosomal aberration.

Course objectives

(a) Define, classify and explain different types of numerical aberration of chromosome.
(b) Get clear idea the cytological behavior and application of trisomy, monosomy, nullisomy, haploid, triploid, autotetraploid, allopolyploid, auto-allopolyploid and segmental allopolyploid and synthetic classification of polyploidy.
(c) Explain the reason and nature of different human abnormalities caused by chromosomal aberration.

Course contents

Units	**Contents**	**No. of Lectures**
1. Numerical aberration	An introduction	**1**
2. Aneuploid: (a) Hyperploid	**Trisomics -** Definition, origin, sources, kinds, identification, cytological behaviour, phenotypic expression, segregation and genetic ratio of different types of trisomic. **(b) Hypoploid: monosomics and nullisomics -** introduction, origin, occurrence, identification, cytological and breeding behaviour.	**8**

3. Euploid	**(a) Haploid -** Definition, origin, classification, phenotypic characters, cytological behavior and economic importance, **(b) Polyploids:** Definition, identification, origin, types, cytological behaviour, phenotypic characters of triploid, autotetraploid, allopolyploid, autoallopolyploid and segmental allopolyploid, synthetic classification of polyploidy, application in agriculture.	**10**
4. Speciation through allopolyploidy and segmental allopolyploidy	(i) *Primulakewensis*, (ii) *Spertinatownsandii*, (iii) *Raphano-brassica*, (iv) *Nicotianatabacum*, (v) *Brassica* spp., (vi)*Gossypium*spp., (vii) *Triticumaestivum*, (viii) *Triticale*, (ix) *Crepisfoetida-rubra*and (x)*Setcreaseapurpurea*.	**7**
5. Human cytogenetics	Brief introduction, Down's syndrome, Patau's syndrome, Edward's syndrome, Klinefelter's syndrome, Triplo X/Trisomy syndrome, XYY syndrome and Turner's syndrome.	**4**

Unit wise learning outcomes

Units	Learning outcomes
1	• Will get idea about numerical aberrations of chromosomes.
2	• Will learn about origin, distribution, occurrences, sources, cytological behavior, kinds, phenotypic expressions and consequences of different types of aneuploids.
3	• Will acquire knowledge about origin, distribution, occurrences, sources, cytological behavior, significance, phenotypic expressions, evolutions, characters and consequences of haploid and polyploidy. They will also gather knowledge about synthetic classification of polyploidy and application of different polyploidy in agriculture.
4	• Will get knowledge about different example of speciation through allopolyploidy and segmental allopolyploidy.
5	• Will gather knowledge about different types of chromosomal aberration in human, features of different syndrome and consequences.

References

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Instruction strategies and Learning experiences

- Lecture followed by group discussion
- Question answer
- Guided discussion
- Project discussion
- Demonstration

Assignment: Students will be given assignment on particular units
Assessment: In-Course examination, Assignment, Course final examination, Practical examination, and Viva-voce

BOT 412: Environmental Pollution and Bioremediation — Credit hour: 2

Introduction

Environmental pollution and bioremediation is one of the courses in 4-years BS (Honors) in Botany program. This course deals with major causes of pollution of the land surface, water habitats, and the food chains. It covers sources and release of pollutants in the environment, mechanisms of dispersion, the hazards associated with different pollutants, accumulation of toxic substances, and reduction of emissions and remediation of contaminated environments.

Course objectives

(a) To understand the nature of pollutants and its impact in the environment.
(b) To determine the role of microbes in pollution and bioremediation in polluted environment.
(c) To overview the recent pollution problems and potential biological remediation measure.

Course contents

Units	Contents	No. of Lectures
1. Pollutants and solid waste	Types of pollutants, plastics, heavy metals, PCBs, pesticide toxicity and solid waste; biosensor to detect environmental pollutants.	3
2. Biodeterioration of materials	Basic concept, factors involved in biodeterioration; biodeterioration of leather, plastics, stones, and rubber; microbial production of bioplastics; control of biodeterioration, physical, chemical, and biological methods.	5
3. Biodegradation of recalcitrant industrial wastes	Microbial activity in water and soil; pesticide and xenobiotic chemicals in the environment; biodegradable persistent and recalcitrant wastes; relationship between structure and recalcitrance; concept on ring cleavage, factors affecting microorganisms to biodegradation of pesticide and xenobiotic compounds, removal of substituent groups and ring opening in model molecules; chloro-organics; organic dyes; phenols; petroleum hydrocarbons.	5
4. Enrichment and isolation of pollutant degrading microbes	Approaches to enrich and isolate microbes having catabolic properties.	3
5. Approaches to bioremediation	Basic concept; remediation methods; intensive and extensive technologies; environmental modification for bioremediation; microbial seeding and bioengineering approaches to the bioremediation of pollutants; monitoring of the bioremediation of xenobiotic pollutants	6
6. Waste treatment technologies	Physical, chemical, and biological treatment; activated sludge; advanced treatments; biological removal of nitrogen and phosphorous	3
7. Biotechnological aspect for effluent treatment	Biodegradation of effluent by addition of microorganisms, oxygen, and nutrients; genetic manipulation, enzyme and specialized bacteria.	3

8. Toxicity in wastewater	Impacts of toxicity on wastewater treatment; heavy metals, organic toxicants; enzymatic assays and microbial bioassays.	2

Unit wise learning outcomes

Units	Learning outcomes
1	Will be able to define pollutants. Able to classify pollutants. Apply biosensor to detect environmental pollutants.
2	Able to define biodeterioration. Will identify factors effects on biodeterioration. Learn about biodeterioration of different materials. Learn to control of biodeterioration through different methods. Know the methods of bioplastic production.
3	Able to know the role of microorganisms in water and soil. Learn about the persistent and recalcitrant wastes in natural habitats. Capable to identify factors affecting biodegradation of pesticide and xenobiotic compounds.
4	Capable to enrich and isolate microbes having catabolic properties.
5	Able to describe bioremediation methods. Learn to application of bioengineering approaches to bioremediation of pollutants. Capable to monitoring the bioremediation of xenobiotic compounds.
6	Learn physical, chemical and biological treatment methods of organic contaminants. Able to describe the biological removal of nitrogen and phosphorus from natural habitats.
7	Learn the biodegradation of organic compounds by addition of microorganisms, oxygen, and nutrients. Able to discuss genetic manipulation, enzyme, and specialized bacteria; biosensor to detect environmental pollutants.
8	describe impacts of toxicity on wastewater treatment; heavy metals, organic toxicants; enzymatic assays and microbial bioassays.

References

1. Microbial Ecology: Fundamentals and Applications, Atlas RM and Bartha R; Addison Wesley Longman, NY.
2. Current Perspective in Microbial Ecology, Klug MJ and Reddy CA; American Society for Microbiology, Washington
3. Ecological Systems and the Environment, Foin TC; Houghton Mifflin, London
4. Biotreatment Systems, Vol. II, Wise Donald L, Boca Raton: CRC Press, Inc.
5. Wastewater Microbiology, Bitton G; Wiley, Florida

Instruction strategies and Learning experiences

- Lecture followed by group discussion
- Question answer
- Guided discussion
- Project discussion
- Demonstration

Assignment: Students will be given assignment on particular units

Assessment: In-Course examination, Assignment, Course final examination, Practical examination, and Viva-voce

BOT 413: Seed Pathology **Credit hour**: 2

Introduction

The course of Seed pathology is the sub-discipline of plant pathology in 4-years integrated BS (Hons) in Botany program. It is structured in a way that the students develop clear understanding of the concept of seed pathology, economic significance of seed-borne diseases, different seed diseases caused by seed-borne pathogens, pattern of infection, seed transmission, location of fungi in seeds of crop plants, methods of seed health testing for the detection of seed-borne pathogens and non-pathogens, seed histopathology, methods of seed-plant-seed transmission, seed certification standards, deterioration of seeds due to storage fungi and control of seed-borne inocula. Students also understand about the diseases and deterioration caused by bacteria, fungi, nematodes, viroids and viruses; and physiological and mechanical disorders.

Course objectives

(a) Discuss about the total losses of seed production due to diseases in the world.
(b) Differentiate between healthy seeds and infected seeds.
(c) Explain how the seeds are infected by fungi.
(d) Identify the causal organisms of respective seed borne diseases.

(e) Know about the field standards and seed standards of different crops *viz.*, rice, wheat, jute, etc.
(f) Apply the quarantine rules or seed health regulations during seed exchange in national level as well as international level.
(g) Discuss how the seed borne fungi reduce the seed quality as well as how they cause harmful effect on human and animal by producing different kind of mycotoxins.
(h) Establish the control measures for the specific seed borne diseases in storage.
(i) Justify the rules and regulation for commercial seed certification.
(j) Discuss about the "Seed ordinance" 1977.

Course contents

Units	Content	No. of Lectures
1. Introduction	Historical background, scope and prospects of Seed Pathology, economic significance of seed-borne diseases.	**4**
2. Seed diseases	Seed abortion, discoloration, stromatization, necrosis, rot, physiogenic disease (marsh spot, hollow heart) etc.	**4**
3. Location of fungal hyphae in seeds	Seed infestation, infection, location of Oomycetes, Ascomycetes, Basidiomycetes and Deuteromycetous fungi in seeds of crop plants, colonization of seed tissues.	**6**
4. Seed health testing	Objectives of seed health testing, Methods of seed health testing and identification of seed-borne diseases of fungal origin.	**2**
5. Histopathology	Microtechniques in seed histopathology: Histological methods.	**4**
6. Seed-plant-seed transmission	Types of development of seed transmission, Methods of seed-plant-seed transmission.	**2**
7. Seed certification	Methods of seed certification, field standards and seed standards for rice, wheat and jute.	**2**
8. Storage diseases	Effects of storage on seed quality, human, cattle etc.; storage facilities in Bangladesh with remedies.	**2**
9. Control of seed borne diseases	Seed treatment with special references to chemicals; integrated control and seed quarantine.	**4**

Unit wise learning outcomes

Units	Learning outcomes
1	• Will able to know about previous history of Seed Pathology, objectives and scope of learning Seed Pathology and economic significance of seed-borne diseases
2	• Will learn about different terms related to seed-borne diseases, different types of seed-borne diseases of various crops and know about causal agents of different seed-borne diseases
3	• Able to identify different sites of seed borne infection, locations of Oomycetes, Ascomycetes and Basidiomycetes in seeds and know about colonization of host tissue by pathogens
4	• Will gain knowledge about main objectives of seed health testing and different kinds of standard methods of seed health test
5	• Will able to learn about different procedures of seed softening and various kinds of histological methods to find out the internal mycelium of pathogens in the host tissues
6	• Will get idea on the mechanism of seed-plant-seed transmission • Know about eight principal types of disease cycle and infection course according to Paul Neergaard
7	• Will able to know how to do certify the seed? • To apply the idea about field and seed standards in different crops *viz.*, rice, wheat, jute, etc.
8	• Will know about the spoilage of seeds at storage condition, harmful effects of storage fungi and storage facilities in Bangladesh
9	• Will able to apply different control measures for the specific seed borne diseases in storage and know about seed quarantine

References

1. Agarwal VK and James B Sinclair 2004. Principles of Seed Pathology (2nd ed.), CRC Press Publ. 560 pp.
2. Agrios GN 2005. Plant Pathology (5th ed.) Academic Press, San Diego, London, Boston, New York, Tokyo, Toronto.635 pp.
3. Anonymous 1976. Seed Certificate Agency. Ministry of Agriculture, Bangladesh.
4. Singh D and SB Mathur 2004. Histopathology of Seed-borne Infections. CRC Press Publ.
5. Jha DK 1995. A Text Book on Seed Pathology, Vikash Publ. House Pvt. Ltd.
6. Suryanarayana D 1978. Seed Pathology. Vikash Publ. House, New Delhi.

Instruction strategies and Learning experiences

- Lecture followed by group discussion
- Question answer

- Guided discussion
- Project discussion
- Demonstration

Assignment: Students will be given assignment on particular units
Assessment: In-Course examination, Assignment, Course final examination, Practical examination, and Viva-voce

BOT 414: Evolution **Credit hour**: 2

Introduction

Evolution is one of the unifying ideas in biology. It was emerged in the middle of the 19th century through the work of Charles Darwin. Through careful observation and study Darwin proposed that all living individuals were descended from a common ancestor and that the differences among them were due to the changes that had accumulated slowly and gradually over a long period of time. To explain these changes, Darwin invoked a mechanism that is generally called natural selection. One of the best ways to understand the present is to understand the past. Evolutionary Biology is the study of the changes in life forms over time - changes that have occurred over millions of years as well as those that have occurred over just a few decades.

This course covers the various mechanisms of evolution, how these mechanisms work, and how change is measured. This course will serve as a foundation for studying fossil records and current classification schemes in biology. The course will provide about the fundamental evidences with a look at the history of life according to the fossil record and a discussion of the broad range of life forms as they are currently classified. This course provides the lesson to understand the evolutionary concepts of selection and speciation. Through this course evolutionary change can be measured through the concept of Hardy-Weinberg Equilibrium. Also, this course will introduce the materials for future study and research in macroevolution and microevolution.

This course provides a comprehensive introduction to evolutionary biology. Students are introduced to both short-term and long-term evolutionary processes and they explore the patterns that result from those processes. Topics covered include the history of evolutionary theory, evidence for evolution, the origin of life, the origin of plants and animals and genetic evolution, natural selection, sexual selection, species and speciation, human evolution, and evolutionary issues in modern society.

Course objectives

(a) Natural selection as key to understanding the natural world; how natural selection produces adaptation; the origins of genetic variation; fitness, the common methods for studying adaptive genetic change.
(b) Population genetic consequences of selection, mutation, migration (gene flow), inbreeding; genetic drift, an important evolutionary force.
(c) Results of natural or artificial selection on quantitative characters: the interplay between heritability and the environment.
(d) Phylogenetic thinking: why we need phylogenies for a deeper understanding of all aspects of evolution.
(e) How new species arise; the major species concepts.
(f) The history of life; the evolution of humans.

Course contents

Units	Contents	No. of Lectures
1. Introduction	Origin versus creation, theory of special creation, concepts regarding origin and back ground of evolution.	**2**
2. Pre-Darwinian concepts	Buffon, Saint Hilaire, Robert Chambers, Herbert Spencer, Franz Unger, Lamarck, Lamarckism, criticism of Lamarckism and Neo-Lamarckism.	**2**
3. Darwin-Wallace theory	Brief life sketch of Charles Darwin and R. A. Wallace, voyage of the HMS Beagle by Darwin, development of the theory, essence of Darwinism, criticism of Darwinism (emotional and scientific) and Neo-Darwinism.	**4**
4. Evidences of evolution	Paleontological, missing link, living fossil, biogeographical and ecological regions of world, adaptive radiation, comparative anatomy, vestigial organs, embryological, cytological, biochemical and molecular evidences.	**4**
5. Synthetic theory of evolution	Stebbins' proposal, evolution process, genetic explanation, Hardy-Weinberg law, static and dynamics of gene in population, genetic death and genetic drift.	**4**
6. Natural selection	Types: stabilizing, directional, disruptional, sexual, frequency dependent, kin and reproductive selection.	**4**

7. Speciation	Species concept, characteristics of species, steps of evolution: micro-, macro-, mega-evolution, patterns of evolution: adaptive divergence, adaptive radiation, parallel, iterative, convergence, anagenesis, cladogenesis, stasigenesis, Isolation: pre-mating, post-mating, sympatric- and allopatric isolation.	**4**
8. Chemical theory of origin of life	(a) Experimental evidences-Operin-Haldane hypothesis, Miller-Urey experiment. (b) Stages of chemical evolution-origin of carbohydrate, fatty acids, purine, pyrimidine, polypeptide, pre-organic condensation, organic compound, formation of polymer (protenoid microsphere). (c) Origin of prokaryotes and eukaryotes.	**4**
9. Human evolution	Man's place in nature, relation with other primates, some special features of human, comparative karyotype and molecular analysis between ape and human, fossil evidences.	**1**
10. Cosmology	A brief structure of the universe and big bang theory.	**1**

Unit wise learning outcome

Units	Learning outcomes
1	• Know about the concept of evolution and back ground information about evolution, understand that by biological evolution indicating that many of the organisms that inhabit the Earth today are different from those that inhabited it in the past
2	• Know about Pre -Darwinian concepts of evolution including Lamarckism and Neo-Lamarckism
3	• Know about life sketch of Charles Darwin, voyage of the HMS Beagle by Darwin, development of the theory of evolution by Darwin, and Neo-Darwinism. Understand that the four propositions underlying Darwin's theory of evolution through natural selection are: (1) more individuals are produced than can survive; (2) there is therefore a struggle for existence; (3) individuals within a species show variation; and (4) offspring tend to inherit their parents' characters. Moreover,

	understanding that the three necessary and sufficient conditions for natural selection to occur are: (1) a struggle for existence; (2) variation; and (3) inheritance
4	• Know about the various evidences of evolution including fossil records, comparative anatomy, vestigial organs, embryological, cytological, biochemical and molecular evidences. Also learn about biogeographical and ecological regions of world
5	• know about the Synthetic theory of evolution including evolution process, genetic explanation, Hardy-Weinberg equilibrium and demonstrate the problem-solving use of the theory in population genetics studies of natural populations; • provide examples of the mechanisms of evolution and describe how they impact the genetic makeup of populations
6	• Know the process of Natural selection: Types of natural selection includeing stabilizing directional disruptional sexual and reproductive selection
7	• Define and apply the biological, morphological, ecological, and phylogenetic species concepts. • Distinguish between sympatric and allopatric speciation. • Define, recognize, and understand the significance of reproductive isolating mechanisms in reducing gene flow between populations. • Distinguish between prezygotic and postzygotic barriers to reproduction.
8	• know the chemical theory of origin of life on Earth, identify important evolutionary events that have occurred throughout Earth's geological history, starting with the hypotheses on the origin of life.
9	• Know about the fossil evidence for human evolution in the context of living great apes and modern humans, also the chronologically from our earliest human ancestors, up until modern humans who inhabit the world today
10	• know about the basic understanding about cosmology as a fact of universal evolution

References

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2. Case CJ 1986. Cosmology. The search for order of the universe. Tata Books @ Inc.
3. Darwin C 1992. The origin of species (ed. G.K. Burrow). Penguin Books.

4. Dobzhansky Th, FJ Ayala, GL Stebbins and JW Valemteni 1990. Evolution. W.H. Freeman, San Francisco, Surjeet Publication
5. Lewin R 1984. Human evolution. Blackwell Science Publication.
6. Rastogir VB 1990. Organic evolution. Keder Nath Ram Nath., New Delhi.
7. Stebbins GL 1971. Process of organic evolution. Prentice-Hall Inc., New Jersey.
8. Strickberg MQ 1990. Evolution. Jones-Bartlet publication, Boston.

Instruction strategies and Learning experiences

- Lecture followed by Question-answer
- Group discussion
- Project discussion
- Practical demonstration

Assignment: Students will be given assignment on particular units
Assessment: In-Course examination, Assignment, Course final examination, Practical examination, and Viva-voce

PRACTICAL

BOT 415: Practical - 1 **Credit hour: 3**

A. Microbiological Techniques, B. Marine Botany, C. Biological Limnology, and D. Ethnobotany

A. Microbiological Techniques

Units	Title	Learning outcomes
1	Preparation and sterilization of culture media	• Acquire knowledge about preparation culture media and sterilization by autoclaving.
2	Isolation of bacteria from soil by serial dilution method	• Development of knowledge to perform serial dilution technique to isolate bacteria from soil sample
3	Isolate pure cultures by streak dilution technique	• Purification of isolated bacteria using streak dilution technique.
4	Methylene blue reduction test	• Acquire knowledge about methylene blue reduction test used in milk quality test.

5	Isolation and observation of *Azotobacter* by mud-pie technique	• Learn about a very simplified culture technique to isolate a free living nitrogen fixing bacteria*Azotobacter*from soil.
6	Preparation of bacteriological stains	• Know about the preparation about different basic bacteriological stains *viz.* Crystal violet, Safranin, Lugol's Iodine solution etc.

B. Marine Botany

Units	Title	Learning Outcomes
1	Field trips to St. Martin's Island/Sundarbans/Patuakhali Mangrove Forests- the collection of Phytoplankton, Seaweeds and salt marsh plants.	Gain preliminary knowledge of marine ecology, its structure, different factors affecting the marine environment. It would be possible to know about the diversity and classification of algae, phytoplankton, seaweeds, seagrasses, flowering plants, salt marsh plants, mangroves etc. and their distribution, cultivation and processing and production of foods, industrial and pharmaceuticals products, and their economic importance. Determination of different pigments in algae.
2	Measuring pH, salinity, specific gravity and NTU of marine water.	
3	Systematic study of some common phytoplankton, seaweeds, and sea-grasses/salt marsh plants.	
4	Commercially important seaweeds	
5	Commercial products of seaweeds.	
6	Determination of chlorophyll *a* and *b* in a green alga and phycobilins in red algae	

C. Biological Limnology

Units	Title	Learning outcomes
1	Study on the morphology and anatomy of some selected aquatic plants covering different taxonomic groups.	Know the morphology and anatomical peculiarities of different macrophytes. Identify the specific adaptive features

2	Calculation of phytoplankton primary productivity by applying Talling's Model.	Practice the calculation of different model parameters of Tallings Integration Model on primary productivity by using the measured field data
3	Study of different life forms of aquatic plants	Learn the life forms of aquatic plants, particularly buds, turions and bulbils and also identify morphological reduction processes under adverse condition of some macrophytes
4	Qualitative and quantitative aspects of pelagic phytoplankton.	Collect, sediment and obtain a plankton concentrate from a pond water sample. Identify them and quantify them per unit volume of pond water sample.

D. Ethnobotany

Units	Title	Learning outcomes
1	Individual research project report on particular area or community or disease.	Students will know how to develop research project, how to collect data, how to analyze data, how to write research report, and how to present research to the audience
2	Practical Ethnobotany: Observation and study of human interaction with plants in different localities, cultures and societies	Students will get practical experiences from the field and how to interact people, society and culture with plants for their daily needs including foods, health care, tools, furnishers, religion and faith, etc.

BOT 416: Practical - 2 **Credit hour: 3**

E. Climate Change Biology, F. Environmental Pollution and Bioremediation, and G. Seed Pathology

E. Climate Change Biology

Units	Title	Learning outcomes
1	Measurement of spatial and temporal atmospheric temperature variation of Dhaka city and adjacent areas	• Students will be able to recognize the changes in the temperature of atmosphere due to different human activities and natural phenomena.
2	Measurement of wetlands temperature variations in and around Dhaka city	• Students will be able to recognize the changes in the temperature of freshwater ecosystems due to different human activities and natural phenomena.
3	Measuring C-sequestration of different plant species	• Students will be able to assess the capacity of different plants species to capture and store C from the atmosphere in different parts of its body.
4	Estimation of C-reserve of soil of different places/forest lands	• Students will be able to assess the stocks of C of different terrestrial habitats and their roles in mitigation to climate changes.
5	Students will present a topic related to climate change issues (Subject matter will be determined with discussion to the course teacher).	• Students will be able to address different climate related issues and role of different world organization in combating climate changes. They will also be able to communicate different climate issues at different levels.

F. Environmental Pollution and Bioremediation

Units	Title	Learning outcomes
1.	Detection of indicators and pathogenic microbes in water	• Able to isolate indicator organisms from aquatic habitats

2.	Isolation and selection of amylolytic and proteolytic bacteria from soil by - o Starch hydrolysis test o Casein hydrolysis test	• Able to isolate amylolytic bacteria • Able to isolate proteolytic bacteria
3.	Isolation of biodegradative microbes from environment	• Able to isolation of biodegradative microbes from environment
4.	Wastewater treatment (e.g., biodegradation, chlorination)	• Learn to modern wastewater treatment method by biodegradation
5.	Remediation of metal ions through microbes.	• Able to isolate metal degrading bacteria

G. Seed Pathology

Units	Title	Learning outcomes
1	Microtechniques in seed histopathology	• Observe the exact expanse of fungal mycelium in seed.
2	To acquaint with machinery and chemicals used in seed treatment	• To know how to use different machinery and chemicals for the proper seed treatment.
3	Seed health testing: Methods and factors	• Know about different kinds of standard methods of seed health test. Isolation of different pathogens associated with seeds.
4	Study of the effect of seed treatment with chemicals/biological agents	• Observe the inhibiting effect of chemicals as well as biological agents on the seed-borne pathogens.
5	Study of the seed-borne diseases	• Identify the causal organisms of respective seed borne diseases.
6	Collection of diseased seed samples from fields	• Observe the disease symptom of different crops associated with seeds in the field condition.

BOT 417: Practical - 3 **Credit hour: 3**

H. Horticulture and Agronomy, I. Autecology and Environment J. Plant Physiology and Plant Nutrition

H. Horticulture and Agronomy

Units	Title	Learning outcomes
1	Preparation of seed bed in the field and in earthen containers	Prepare an ideal seed bed in the field and earthen containers
2	Determination of viability of seeds and percentage germination	Determine viability of seeds and percentage of germination
3	Transplantation of seedlings. Pre- and post-transplantation care	Develop knowledge to transplant the seedlings and also learn about how to take care of seedlings
4	Soil correction before cultivation of crops	Develop skill to correct the soil before crop cultivation
5	Preparation of different concentrations of growth regulator	Develop capacity to prepare different concentrations of growth regulator
6	Rooting of cuttings by growth regulator application	Develop skill to form root in the cuttings by growth regulator application.
7	Identification and photograph collection of different flowers & vegetables	Identify different seasonal flowers & vegetables

I. Autecology and Environment

Sl.	Topic	Learning outcomes
1	Students will maintain a field note book to study vegetation types and habitats of the campus of the University of Dhaka and also from local excursion	• Understand natural vegetation as well as the components and functions of the ecosystems • Understand how to analyze/ survey vegetation • Learn mechanisms of adaptation of plants • Know how to determine environmental pollution (e.g., water quality etc.) • Learn how to study soil properties • Learn application of computer software for multivariate analysis of biotic community
2	Determination of minimal sample area (Quadrat size) by species-area curve method	
3	Study of stomatal types by various methods	
4	Determination of leaf traits e.g., SLA (Specific Leaf Area) and RWC (Relative Water Content)	
5	Plants of wetland habitats	
6	Determination of soil texture	
7	Study of pollution level in water by determining BOD and COD	

J. Plant Physiology and Plant Nutrition

Units	Title	Learning outcomes
1	Determination of osmotic pressure by plasmolytic method	• Understand the concepts of plasmolysis, deplasmolysis and also the cause of plasmolysis in peels of *Rhoeo discolor* in hypotonic and hypertonic solutions using salt solution;
2	Separation of pigments by separating funnel	• Learn about extraction and chemical separation technology, specifically, how to do a liquid phase-extraction in order to separate a mixture of molecules;
3	Determination of presence of enzymes in plant tissue	• Detect the presence of different enzymes (e.g., catalase, oxidase, peroxidase and dehydrogenase) in plant tissue;
4	Extraction and measurement of K^+ and Na^+ in plant tissue	• Visualize simple technique for making the important measurements of sodium and potassium ion in root tissue using a calibration curve by flame photometer;
5	Extraction and measurement of Cl^- in plant tissue	• Extract and determine chloride ion in plant tissue through standard titrametric method;
6	Extraction and measurement of NO_3^- in plant tissue	• Extract and analysis the amount of nitrate in plant tissue using spectrophotometer.

BOT 418: Practical - 4 **Credit hour: 3**

K. Plant Tissue Culture and Biotechnology, L. Genomics, Proteomics and Bioinformatics, and M. Numerical Cytogenetics

K. Plant Tissue Culture and Biotechnology

Units	Title	Learning outcomes
1	Handling of different laboratory equipments	• Through this topic students will have the opportunity to know how the equipments used in the plant tissue culture and biotechnology laboratory are properly handled.
2	Sterilization techniques for plant materials and equipments	• Biotechnology experiments are being carried out under aseptic conditions. Through this topic students will learn how to sterilize tissue culture media as well as equipments needed for the experiments.
3	Plant tissue culture medium preparation	• Students will know how to prepare stock solutions for different media ingredients as well as hormonal supplements and how to finally prepare the medium for specific experiments.
4	Organogenesis from multicellular explants	• Through this topic students will know how to initiate organogenesis using different explants of multicellular origin.
5	Embryo culture technique	• Students will have the opportunity to know how to isolate embryo resulted from self- or cross-pollinated seeds and culture them on the nutrient medium.
6	Agrobacterium-mediated transformation using marker gene	• Students will learn the steps of transferring marker as well as gene of interest using Agrobacterium-mediated genetic transformation.

L. Genomics, Proteomics and Bioinformatics

Units	Title	Learning outcomes
1	Restriction digestion of plant genomic DNA and electrophoretic separation in Agarose gel	• Students shall be able to perform restriction digestion of DNA and analyze the digested DNA through agarose gel electrophoresis.
2	SDS-PAGE analysis of total protein content of a plant isolated from tissues/plants of different condition	• Know the procedure of isolation, quantification, and separation of proteins from different tissues.
3	Analysis of DNA, RNA or Protein sequences in Bioedit software	• Learn how to analyze DNA, RNA and Protein sequences in various purposes such as restriction map analysis, find ORF, translation of RNA to protein sequences, reverse translation, pairwise and multiples sequence alignment using Bioedit software.
4	Designing primer using Primer3+ software	• Students will know how to design primer following both manual process and using software like Primer3+.
5	BLAST search to find similar gene or protein	• Using bioinformatics techniques students will have the opportunity to study the functional analysis of unknown sequences of DNA, RNA or Protein
6	Multiple alignments of selected sequences	• Student will learn designing regenerate primers, construction of phylogenetic tree through multiple sequence alignment using Bioedit software

M. Numerical Cytogenetics

Units	Title	Learning outcomes
1	Determination of centromeric type, centromeric index, relative length and chromosome	• Upon successful completion of this unit, students will be capable in the determination of centromeric type, centromeric

	formula from the supplied plates.	index, relative length and chromosome formula from the supplied plates.
2	Preparation of karyotypes and idiograms from the supplied plates.	• This unit will help the students to learn basic techniques of preparation of karyotypes and idiograms from the supplied plates.
3	Study of meiosis and determination of chiasma frequency in the pollen mother cells (PMCs) of *Setcresea purpurea*, (2n=24).	• After attentive response of this unit, students will be able to determine chiasma frequency from the pollen mother cells (PMCs) observed in meiotic cell division of *Setcresea purpurea* (2n=24).
4	Basic idea about different chromosome banding.	• This unit will help the students to develop basic idea about different types of chromosome banding.
5	Study of meiosis in polyploid, translocation heterozygote and different abnormalities in cell division from the supplied plates.	• After successful completion of this unit, students will gather clear knowledge about the occurrence of different abnormalities during meiosis in polyploid and translocation heterozygote

BOT 419: Viva-voce **Credit: 2**