Department of Botany, University of Dhaka
CURRICULUM For M.S. Courses
(Session 2024-2025 Onward)

In the Department of Botany, students are taught a total of 140 credit (80 theoretical, 36 practical, 8 Viva-Voce and 16 Extra Departmental) on various aspects of basic Botany in their 4 year BS Honors (Integrated Grading System) terminal degree. After completing BS (Hons.) degree in Botany, one may get himself or herself admitted into the M.S. degree program of one year duration. For the MS degree program, 23 courses based on advanced and applied knowledge in Botany are offered. Students make their choices for 5 theoretical courses out of the 23 courses offered. After completion of the courses, an in depth knowledge of the selected courses will be acquired by the individual student to meet challenges for higher studies and in research, teaching and developmental activities in the field of botanical science as well as in practical life. An excerpt of the M.S. Grading System syllabus is given below:

		CREDITS				
Distribution of courses	**Groups**	**Theory**	**Thesis/ Practical**	**Viva voce**	**Seminar Presentation**	**Total**
Five theoretical courses selected by each student out of 23 offered courses for the session concerned, each course carrying 4 credit hours and Thesis/practical, Viva-voce and Seminar presentation as compulsory courses.	Non thesis	20	6	2	2	**30**
	Thesis	20	6	2	2	**30**

Students will choose 5 (five) courses of 100 marks each, along with compulsory courses, covering a total of 30 credits of 750 marks. There will be a compulsory course of 2 credits (50 marks) on the presentation of a seminar on a selected topic and 2 credits (50 marks) viva-voce. Students may take practical (intending to problem solving on important aspects) partly on the subjects or may take a research project and submit a thesis for the partial fulfillment of the degree of Master of Science (MS) in Botany.

Theoretical Courses	**Credits**
BOT 501: Angiosperm Systematics	4
BOT 502: Medicinal Plants and Herbal Medicines	4
BOT 503: Conservation Biology	4
BOT 504: Applied Phycology	4
BOT 505: Applied Limnology	4
BOT 506: Hydrobiology	4
BOT 507: Physiological Ecology	4
BOT 508: Natural Resource Management	4
BOT 509: Molecular Plant Ecology	4
BOT 510: Advanced Plant Physiology	4
BOT 511: Applied Mycology	4
BOT 512: Plant Pathology and Plant Protection	4
BOT 513: Seed Pathology	4
BOT 514: Environmental Microbiology and Biotechnology	4
BOT 515: Microbial Biotechnology	4
BOT 516: Molecular Cytogenetics	4
BOT 517: Plant Molecular Genetics	4

BOT 518: Plant Genetic Engineering 4
BOT 519: Plant Breeding and Biometry 4
BOT 520: Advanced Plant Nutrition 4
BOT 521: Applied Cytogenetics 4
BOT 522: Molecular and Applied Phycology 4
BOT 523: Advanced Plant Anatomy 4

Compulsory courses:

BOT 524: General seminar presentation (all students): Nature of topics of the seminar will be decided by the Examination Committee 2
BOT 525: Practical (Non-thesis group) 6
BOT 526: Thesis (60% Thesis Examination+ 40% Presentation) (Thesis group) 6
BOT 527: Viva-Voce (all students) 2

DETAIL SYLLABUS FOR M.S. COURSES

Theory

BOT 501: Angiosperm Systematics Credit hour: 4

Introduction

Systematics is fundamental to our understanding of the world around us because it provides the basis for understanding the patterns of diversity on Earth, the basis for communication about all living things and understanding patterns of diversity provides us with a basis for testing hypotheses of evolutionary processes. Plant systematics will explore the origin and diversification of land plants while emphasizing flowering plants. The course will cover the basic systems, principles and methods utilized in modern plant systematics. This course will examine recent develops within the field of systematics in the areas of phylogenetic systematics and classification. The course will equip students with the advanced knowledge and skills in any area of angiosperm taxonomy, molecular systematics, ecology and evolution.

Course objectives

(a) Explore botanical expedition in Bangladesh and its adjoining areas, and identify floristic regions of Bangladesh with their characteristics and flora
(b) Learn how to publish taxonomic works in the form of checklist, flora, revision and monograph
(c) Understand ecological and anatomical evidences and their role in plant systematics as well as learn reproductive biology and its relations to systematics
(d) Learn the means of practical naming of plants, naming of cultivated plants and rules for cultivar and hybrid.
(e) Know different ways of data presentation and documentation
(f) Understand molecular systematics, DNA markers and their application, and DNA barcoding and its application

Course content

Units	Contents	No. of Lectures
1: Botanical exploration	History of the botanical exploration in the Indian Subcontinent and taxonomic research done in Bangladesh.	4
2: Floristic regions of Bangladesh	The Gangetic Plain, the Sundarbans, Chittagong Hill Tracts, Chittagong forests, Dhaka-Tangail-Mymensingh Sal forests, Vegetation of Sylhet, Flora of Northern and Western districts, the Lalmai Elevation.	2
3: Taxonomic works	Presentation of taxonomic works for publications: Checklist, flora, revision, monograph.	3

4: Ecological evidence	Habitats, environmental relationships, adaptive features.	3
5: Anatomical evidence	Leaf anatomy, stem anatomy, stelar anatomy and their significance in plant systematics.	3
6: Reproductive Biology and Systematics	Population size and density, breeding systems in relation to systematic, reproductive biology study methods, isolating mechanism and endemism.	3
7: Practical naming of plants	Naming by comparison, naming by means of bracket keys and indented keys, naming by an expert, faults and limitations of keys.	3
8: Naming of cultivated plants	Cultivars, ICNCP, general rules governing hybrids.	2
9: Data presentation and documentation	Drawings presentation of chromatographic data, histograms, hybrid index, scatter diagram.	3
10: Molecular systematics	Introduction, nuclear and chloroplast DNA in systematics and phylogenetics, application of DNA markers in molecular systematics and phylogenetics, DNA barcoding.	4

Unit wise learning outcome

Units	Learning outcomes
1	• Learning and understanding the botanical expedition made in Bangladesh and its surrounding regions by the British, Dutch explorers, William Roxburgh, J.D. Hooker, C.B. Clarke, NathelianWallich, David Prain, J. Sinclair, L. Heining and others. • Understand localities in Bangladesh along with the number of plant specimens.
2	• Recognize the floristic areas and forest types of Bangladesh including The Gangetic Plain, the Sundarbans, Chittagong Hill Tracts, Chittagong forests, Dhaka-Tangail-Mymensingh Sal forests, Vegetation of Sylhet, Flora of Northern and Western districts, the Lalmai Elevation, and their floristic composition.
3	• Understand the means for publication of taxonomic works. • Learn how to publish taxonomic works in the form of checklist, flora, revision and monograph and what elements to be included in revisionary and monographic treatment.
4	• Recognize how ecological parameters are connected with systematics. • Demonstrate ability to critically and systematically integrate knowledge and perspectives and to analyse and assess habitats, adaptive feature and environmental relationships.
5	• Be able to evaluate how stomata and trichomes can play imporatant role in angiosperm systematics. • Moreover, students will learn the nature of stem and stellar anatomy and their roles in solving the taxonomic problems.
6	• Recognize inbreeding, outbreeding, heterosis in plants. • Will understand the interrelationships between breeding systems and systematics. • Learn different mechanisms for isolation, endemism and endemic plants of Bangladesh.
7	• Be able to understand different means for naming plants, • Know how to distinguish different plant groups by means of dichotomous keys and their limitations.
8	• Understand how to name the cultivated plants • Be acquainted with the international code of nomenclature for cultivated plants, • Learn the rules for governing hybrids.
9	• Evaluate and present data through drawings, histogram, hybrid index, two-dimensional data by scatter diagram, and three dimensional data by principle coordinate analysis etc. • Examine the way for proper documentation of taxonomic data.
10	• Be able to understand underlying principles of molecular systematics • Be familiar with different types of molecular markers and their application

	• Learn DNA barcoding as a new tool for taxonomy, as well as to reconstruct phylogenetic trees.

References

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2. Cronquist A 1969. The Evolution and Classification of Flowering Plants. Honghton. Mifflin Co. Mass. USA.
3. Hooker JD 1872-1897. Flora of British India. Vols. 1-7.
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7. Radford AE, WC Dickson, JR Massey and CR Bell 1974. Vascular Plant Systematics. Harper & Raw Publishers. NY.
8. Soltis PS, DE Soltis and JJ Doyle 1998. Plant Molecular Systematics II. Chapman Hall, New York.
9. Stace CA 1989. Plant Taxonomy & Biosystematics. 2nd ed. Edward Arnold. London.
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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 few units.

BOT 502: Medicinal Plants and Herbal Medicines Credit hour: 4

Introduction

This course introduces the students to the medicinal plant wealth of the world, specially to those of Bangladesh. Medicinal plants supply the entire drug materials of herbal medicine which was the only healthcare system in the prehistoric time and remained at the top position until the introduction of modern medicine. Due to side effect of the modern medicine herbal medicine becoming popular again throughout the world, specially in the USA, UK and other developed countries. With the emergence of Superbug in the recent years herbal medicine becoming more popular in the healthcare system. The quality of herbal medicines depend largely on the correct identification of medicinal plants, good agricultural and collection practices (GACP), good manufacturing practice (GMP), making them free from any contaminants and so on. The availability of medicinal plants is gradually declining and hence their conservation is very much necessary. All these important topics are addressed in this course.

Course objectives

(a) Introduce the students to medicinal plants. Give them knowledge on the discovery, identification methods and uses of medicinal plants.
(b) Acquaint the learners with the pharmaceutical importance of plant metabolites, antibacterial and antifungal activities of medicinal plants and the plants as the source of modern synthetic medicines.
(c) Acquaint the learners with different systems of medicines including traditional Chinese medicine.

(d) Make the learners know about GMP, GACP, quality control methods of herbal medicine and the methods of conservation of medicinal plants.

Course content

Units	Contents	Learning outcome	No. of Lectures
1.	Medicinal plants: Introduction, discovery of medicinal plants in prehistoric times, some ancient scriptures (or books) on medicinal plants, present day discovery of medicinal plants, screening of medicinal plants, taxonomic identification of medicinal plants.	After finishing this unit the learners will be able to define what is a medicinal plant, how they were discovered, how a medicinal plant could be identified taxonomically.	**4**
2.	Medicinal plants of Bangladesh: General discussion, hundred important medicinal plants of Bangladesh, classification of medicinal plants - on the basis of habit, parts used, diseases treated.	After studying this unit the learners will be able to name at least hundred important medicinal plants of Bangladesh, they will be able to classify medicinal plants on the basis of their habit, parts used and to select a plant for a particular disease.	**4**
3.	Some important medicinal plants in world trade.	After completing this unit the learners will be able to identify some most important medicinal plants of the world trade, their commercial product, possibility of cultivation in Bangladesh.	**2**
4.	Plant metabolites and their pharmaceutical importance; primary metabolites; Carbohydrate, lipids, aminoacids and their derivatives, secondary metabolites - Alkaloids, phenols and phenolic glycosides, Terpenoids and steroids, essential oils. Biological action of plant materials, Bio-assaying.,	After completing this unit the learners will be able to discuss about plant metabolites like alkaloids, phenols, terpenoids, steroids and their pharmaceutical uses.	**4**
5.	Plants having antibacterial activities.	The learners will understand how plant materials can act against pathogenic bacteria, what is antibiotic, what are the criteria of ideal antibiotic and the importance of the plants having antibacterial ability.	2
6.	Plant derived antimycoties: antifungal drugs currently in use, antifungal agents isolated from plants, some plants having antifungal activities.	After study this unit the learners will have the knowledge to define antimycoties, plants which have antifungal chemicals in them, how these chemical work to stop fungal growth.	2
7.	Medicinal plants and modern drugs.	The learners will be able to understand modern drugs, plant source of modern drug, role of medicinal plants in the production of synthetic modern drugs.	2
8.	Different systems of medicines: Herbal medicine. Traditional medicine, Ethnobotanical medicine; Modern medicine, Ayurvedic medicine, Unani medicine, Homoepathic medicine.	The learner will be acquainted with the herbal medicine, Ayurvedic and uninani medicine, their main principles, also they will understand what is traditional medicine, Homoeomedicine etc.	6

9.	Traditional Chinese medicine (TCM).	The learners will be able to evaluate importance of Traditional Chinese medicine (TCM), principles of TCM, meridians, TCM prescription and the differences from other contemporary medical system.	4
10.	Criteria for standardization and quality control of herbal medicine in Bangladesh.	The learners will have detail knowledge about control of herbal medicine in Bangladesh.	2
11.	WHO guidelines on good manufacturing practices (GMP) for herbal medicine.	Learners know about quality assurance in the manufacture of herbal medicines, maintaining personal hygiene of the personnel, premises, Documentation, good practices in production as well as good practices in quality control.	4
12.	WHO guidelines for assessing quality of herbal medicine with reference to contaminants and residues.	Learners will be able to understand clearly what are the contamination in herbal medicine including toxic metals, organic pollutants, Mycotoxin, biological contamination and possible sources of contamination.	**4**
13.	Some important antidiabetic plants of Bangladesh.	Learners will understand what is diabetes, complication of diabetic patients, causes of diabetes, plants that can be used to control diabetes.	**2**
14.	Preparation of herbal monograph (e.g. *Andrographispaniculata*).	Learners will know what is herbal monograph and how to prepare a herbal monograph.	**2**
15.	IUCN guidelines for conservation of medicinal plants.	After studying this unit the learners will understand conservation methods, experts required for good conservation, basic studies, utilization, conservation and communication.	**4**
16.	Glossary of common technical terms.	Learners will understand what is called infusion, decoction, phont, triphala, trikatn and other technical terms like diuretic, tonic, stomachic, carminative, expectorant, laxative, purgative, digestive and so on.	**2**

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20. WHO 2001. Traditional Medicine. WHO Kobe Centre.
21. WHO 2007. WHO Guidelines on good manufacturing practices (GMP) for herbal medicines. WHO Press, Geneva, Switzerland.

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 few units.

BOT 503: Conservation Biology Credit hour: 4

Introduction

Conservation biology is the management of nature and of Earth's biodiversity with the aim of protecting species, their habitats, and ecosystems from excessive rates of extinction and the erosion of biotic interactions. To topics covered include the basic ideas of conservation biology, historical development of the subject and conservation model. Types of biodiversity, measurement of biodiversity, importance species, gene and ecosystem are included in the course. The course includes threats to biodiversity viz. mass extinction episodes, global climate change, habitats degradation and loss, overexploitation, fragmentation and exotic species. Community management and population management strategies, restoration steps, *ex situ*, *in situ* conservation, zoos and garden and priority setting also included in the course. Finally, the course also includes social, economic and political factors and the role of different international, local, corporate organizations in conservation programs. A number of case studies also provided in each unit of the course.

Course objectives

(a) The importance of biodiversity including species, gene and ecosystem in social, economic and environmental aspects.
(b) How to determine rare species in nature using ecological principles and IUCN criteria.
(c) Threats to biodiversity in both anthropogenic and natural factors in the face of climate changing environment.
(d) Coarse filter and fine filter approaches for biodiversity conservation in natural habitats.
(e) Artificial techniques to increase the biodiversity in control environment.
(f) How social, economic and political factors influence the conservation policies.
(g) Role of individuals in biodiversity conservation.
(h) How to conduct individual project related to biodiversity conservation

Course contents

Units	Contents	No. of Lectures
1: Conservation and Conservation Biology	A brief history of conservation, overview of conservation ethics, a model of conservation biology.	**2**
2: Biodiversity and its Importance	**Biodiversity-** Species, genes and ecosystems, structure and function, measuring biodiversity, measure of biodiversity, biodiversity and spatial scales, biodiversity verbs, clear lake: a case study **Species Diversity-** Intrinsic value of species and their conservation status, instrumental value of species, uniqueness value of species, Neem tree: a case study **Ecosystem Diversity-** values of ecosystems, ecosystem diversity and species diversity, ecosystems and landscapes, mangrove swamps of Bangladesh: a case study **Genetic Diversity-** importance of genetic diversity, processes that diminish genetic diversity, cultural diversity, Cheetah: a case study.	**2** **1** **1** **1**
3: Threats to Biodiversity	**Mass Extinction and Global Change-** extinction episodes of the past, cretaceous to tertiary extinction: a case study, Permian extinctions: a case study, estimating current rate of extinction; **Global climate change**- causes of global change, the green house effect and global warming, stratospheric ozone depletion, tropospheric pollution and acid deposition, ecological impact of global climate change on biodiversity and ecosystem functioning; **Extinction Process-** Why are some species more vulnerable to extinction than others? population structure, population viability analysis, the eastern barred bandicoot: a case study; **Habitat Degradation and Loss**- contamination, roads, dams and other structure, earth, fire and water, deforestation, desertification, draining, dredging, damming etc., fragmentation in Madagascar: a case study; **Overexploitation-** history of overexploitation, types of exploitation, consequences of overexploitation, some final perspective on exploitation, the gulf of marine: a case study; **Exotic Species-** How do species move? Impact of exotic species, success rates, irony, exotics in Bangladesh: a case study.	**1** **2** **1** **2** **1** **1**
4: Maintaining Biodiversity	**Managing protected ecosystems-** reserve selection, classifying ecosystem, filling the gaps, center of biodiversity, reserve design, reserve size, landscape context, connectivity, reserve management, human visitors, natural disturbances, water regimes, exotic species and abundant native species **Modified ecosystems-** Forestry, age structure, spatial patterns, species composition, livestock grazing, native grazers, natural grazing patterns, natural disturbance regimes, predators and competitors, range management techniques, fisheries, Extractive reserves, ecological management **Cultivated ecosystem-** Biodiversity in cultivated ecosystems, minimizing negative effects of cultivated ecosystems **Built ecosystems-** keeping people at home, biodiversity in built ecosystems, import and exports, how to do it **Restoring ecosystems-** degraded ecosystem, replacement, rehabilitation, restoration, original ecosystem, enhancement, steps in restoration, forest of Pacific Northwest: a case study **Managing Population-** providing resources, controlling threats, direct manipulations, Black Robin: a case study **Zoos and Gardens-** changing roles, building arks, *ex situ* and *in situ* interface, conservation of domesticated species. Arabian Oryx: a case study **Setting Priorities-** levels of biodiversity, geographic scales,	**3** **2** **1** **1** **1** **1** **1**

	choosing areas, choosing among the multiple criteria, choosing species, choosing nations, choosing task, highest priority of all.	
5: The Human Factors	**Social Factors-** values differ, describing values, values change, Bahama Parrot: a case study **Economics-** benefits, cost, distribution of benefits and cost, problems and solutions, butterfly ranching: a case study **Politics and Action-** international agencies, governments, non-governmental organizations (NGOs), corporations, community, individuals, right and responsibilities.	**5**

Unit wise learning outcome

Units	Learning outcomes
1	• Students will be learned historical development of conservation biology and its area of research.
2	• Students will be learned types of biodiversity and their roles in nature and society. • They also learned some conservation ideas from the case studies.
3	• Students will be learned the ways biodiversity and habitats are abolished in nature
4	• Students will be learned different strategies of biodiversity management in nature. • They also learned some artificial techniques in increase the number of individuals of species.
5	• Students will be learned how societies, economics, polities and individuals are involved in conservation

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Instructional strategies:

- ❖ 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: Mid-term, Class attendance, final examination, assignment, practical and viva-voce

BOT 504: Applied Phycology Credit hour: 4

1. Occurrence, distribution, biochemistry and extraction of phycocoloids in algae.
2. Biotechnological potential of algae: Phycocolloids (Alginic acid, Agar-agar and Carrageneen), food and fodder, biofuel and biofertilizer
3. Cultivation of algae for food and industrial use: Cultivation and processing of *Spirulina*, *Chlorella* and *Azolla-Anabaena* complex; cultivation and processing of seaweeds (*Porphyra*, *Laminaria*, etc.); problems in the biomass production.
4. Nitrogen fixation by cyanobacteria: Comprehensive studies on the structure and types of nitrogenases, *nif*gene and regulation of nitrogenase synthesis and function, induction of nodulation in cereal crops-current developments and future.
5. Biomass and productivity of phytoplankton and seaweeds.
6. Ecology of algae: Distribution and adaptation of algae with time and space, chemical defense mechanisms of algae, ultraviolet screens produced by algae.
7. Algae and the environment: Pollution control (sewage and industrial effluents), land reclamation, seaweeds and phytoplankton: cleaners of the world, contribution of algae in abating global warming (cooling of earth).
8. Human health issue: Algal toxins and antibiotics, marine environment and threats to marine ecosystem, marine conservation

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BOT: 505: Applied Limnology Credit hour: 4

Introduction

The present course has been designed as a part of the requirements for the one-year MS degree from the Department of Botany, University of Dhaka. Its objectives are to know the fields of application of limnological knowledge gathered by the students during their course works at the 3rd Year and 4th Year BS classes. Emphasis has been given to the treatment of wastewater and the structure and function of various ecosystem based models. The present course has also insights relevant to mobility of organic carbon fractions, aquatic bacterial secondary production, and behavioral biology of phytoplankton to production under isolated and non-isolated conditions guided by mathematical models. Bases and contribution of aquatic macrophytes for global primary production, macrophytic and mircophytic associations their zonations in various lakes have also been highlighted. Contribution of all these information for an effective lake management is one of the goals of this course.

Course objectives

(a) Know Limnological system analysis, holistic approaches, its classification, enclosures
(b) Learn biomanipulation, procedure, effects, eutrophication control
(c) Exercise predictive powers of limnology, models, predict future about eutrophication
(d) Learn waste water treatment technology, its various steps, protocol, methods
(e) Know contaminated waters, self-purification, indicator organisms, rehabilitation
(f) Learn pelagic carbon dynamics, fate of various fractions of organic carbon, EOCn
(g) Study aquatic bacteria, older and newest concepts, biomass, production measurement
(h) Know photosynthetic behavior, isolated, non-isolated communities of phytoplankton
(i) Learn passage of dissolved nutrients in aquatic plants, expression models, kinetics
(j) Know chemical composition of aquatic plants
(k) Learn macrophyte production, biomass measurements, comparison at a global scale
(l) Study benthic microalgal habitats, niche, classification, diversity, biomass assessment
(m) Learn distribution of macrophytes, phytosociological association, vertical, horizontal
(m) Know lake management and optimum resource harvesting and benefits obtained

Course content

Sl. No.	Course content	No. of Lectures
Unit 1	**Limnological system analysis**: Introduction, holistic approach in limnology, limnological system analysis, 1st holistic, reductionist and 2nd holistic approaches, limnological methods, its classification, artificial enclosures, utilization of it for experiments, case study.	**5**
Unit 2	**Biomannipulation**: Background, principle, its use to eradicate eutrophication problem, various case studies.	4
Unit 3	**Predictive powers of Limnology**: Concept, practical implication, historical insights, Vollenweiders Input-Output Model, its application and functional strategy, regression models, its application for predictions, Models proposed by Seipp and Ibrekk (1988), their structure and function.	**5**
Unit 4	**Wastes and wastewater treatment**: Delimitation of waste and wastewater, definition, composition, origin, classification and subdivisions of waste products, average pollutant values, periodicity, population equivalent (PE), treatments: flow chart, view of a modern treatment plant, stages, mechanical, fat traps, hydrocyclone, settling floatation, biological treatment, activated sludge plant, trickling filter plant, third stage treatment, activated sludge treatment, lagoon system overview.	**6**
Unit 5	**Contaminated waters**: Self-purification effects, concept, trophic and saprobic relationships, indicator organisms and saprobic systems, levels of pollution and indicator organisms. Biotic conditions of rivers before and after pollution, rehabilitation of contaminated waters.	**6**
Unit 6	**Carbon dynamics**: Concept, DOC, location, pathway, POM structure, DOC composition, DOM classification, concentration in some European lakes, pelagic C-cycle's schema, EOCn, release rate determination via differential filtration technique, heterotrophic augmentation.	**5**
Unit 7	**Aquatic bacteria**: Relevancy older and newer concepts, quantitative aspects,	**5**

	biomass determination, bacterial secondary production, magnitude, measurement procedures, ^{3}H-thyamidine uptake rate, determination, calculation to absolute values.	
Unit 8	**Photosynthetic behavior of phytoplankton**: Response to productivity of a population of phytoplankton under isolated and non-isolated conditions, calculation models proposed by different scientists, effect of temperature and inorganic carbon, application of respiration model.	**5**
Unit 9	**Passage of dissolved materials into water plants:** Passive and active transport, Michaelis Menten Kinetics, Droop's Model, uptake of ion by Characeae and some angiosperms, uptake of K, P by aquatic plants, uptake by rooted submerged plants. Chemical composition of aquatic plants, N, P, water and ash, Na, Ca, Mg, Si, As, Cu, Zn and Cd.	**5**
Unit 10	**Production by aquatic macrophytes:** Concept, sample collection, biomass interaction, global primary production, fraction of aquatic primary production to it, energy budget of Lake Mendota	**5**
Unit 11	**Benthic microalgae:** Habitats, niche, classification, diversity, deep water algae from some lakes of central Europe, haptobenthos biomass determination, range as chl-a concentration, production data	**5**
Unit 12	**Macrophyte distribution:** Objectives for its determination, vertical extent, restriction, zonation, comparison of dominant macrophytes, lake management	**5**

Unit wise learning outcome

Unit No.	Learning outcomes
1	• Knowledge on holistic approach and system analysis of limnology • Information on 1st , reductionist and 2nd holistic states, outcomes • Limnological methods, types, artificial enclosures, research results
2	• Principles and application of biomannipulation for lake recovery • Examples of some case studies
3	• Predictive powers, historical background, strength • Vollenweiders input output model for forecasting eutrophication • Regression model parameters, their use to predict different states • Models as proposed by Seipp and Ibrekk to predict lake scenarios
4	• Magnitude of the problem related to waste and wastewater • Characterization of wastewater, their origin, composition • Average pollutant contents, periodicity, population equivalent • Flow chart about treatments of wastewater, modern treatment plant • Detail knowledge about different stages of treatment procedure • Functioning of less modern lagoon system for treating wastewater
5	• Contaminated waters definition and self purification capacity • Learned about indicator organisms and characteristic saprobity • Levels of pollution and indicator organisms • Biotic conditions of rivers before and after pollutant discharge in it • Rehabilitation procedure of contaminated waters
6	• Dynamics various components of carbon in pelagic • Structure, location, pathway, composition of DOC, DOM, POM • Concentration of pelagic carbon in some European lakes • Schematic representation of pelagic carbon cycle • EOCn release rate determination and heterotrophic augmentation
7	• Old and newer concept in relevant to aquatic bacteria • Biomass and quantitative aspect of aquatic bacteria • Bacterial secondary production, use of ^{3}H-thymidine uptake • Calculation of values
8	• Photosynthetic behavior of isolated and non-isolated communities of phytoplankton • Learned mathematical models to calculate the results and comparison • Effect of temperature and inorganic carbon on the production rate • Model to calculate respiration value
9	• Active and passive transport of dissolved material into water plants

	• Michaelis Menten Kinetics and elaboration of Droops Model • Ion uptakes strategy by Characeae and some angiosperms • Chemical composition in the tissues of aquatic plants
10	• Primary productivity by aquatic macrophytes, determination • Sample collection for biomass measurement • Global primary production in all the ecosytems • Fraction contributed by aquatic sectors of the world, comparison
11	• Habitat, niche and composition of benthic microalgae, diversity • Deepwater algae in some lakes of Europe • Haptobenthos biomass determination, range of chl-a concentration
12	• Distributional pattern of macrophytes in lakes • Phytosociological expressions depending on their distribution • Lake management tools, approaches and benefits

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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: Incourse examination will be taken after completing the lectures on units 1-4.

BOT. 506: Hydrobiology Credit hour: 4

Introduction

The Master's Course Hydrobiology is a fundamental and applied knowledge of aquatic ecosystems (streams/rivers, lakes and wetlands). Students shall get insight into the essential functions and processes of chemical/physical and biotic system components, as well as their interactions. They shall further get to know the principles of nutrient dynamics, water quality and habitat characteristics. Students learn to describe aquatic organisms (fish, planktic and benthic invertebrates, aquatic plants and algae) and their ecological demands, as well as their relations to the abiotic system components in order to detect systemic links. They learn to identify and critically examine human impacts as well as to evaluate their consequences for ecosystems. Based on this, students shall develop measures for the protection and the restoration of aquatic ecosystems in terms of ecologically orientated water management concepts. And finally this course will help to understand what types of hydrobilogical researches were done in Bangladesh and its present status in relation to advanced researches in the other countries of the world.

Course objectives

a) Modern thoughts on hydrobiology
b) Characteristics, ecology, their interactions with environment
c) the physical, chemical and biological nature of water and their variations in time and space;
d) the key concepts concerning various water types and water quality problems in relation to water
e) use and sustainability;

f) practical methods and techniques for water quality, monitoring and management;
g) the key concepts concerning health issues associated with water.
h) hydrobiological researches in Bangladesh and its status in relation to other countries

Course content

Units	Ccontent	No. of Lecture
1. Introduction	Introduction and scope	**6**
2. Aquatic Botany	Classification of aquatic macrophytes and their diversity, biochemical components of macrophytes, meso-scale culture and their uses	**6**
3. Wetland ecosystem	concept and classification of wetlands, wetlands in Bangladesh, characteristics of wetland soils, socio-economic characteristics of wetlands, wetland management and international perspective, functions and benefits of wetland	**6**
4. Primary productivity	Factor affecting productivity; inter relationships of macrophytes, algae and bacteria in the aquatic enviromnent and their use in bio-fuel and organic manure production; nutrient recycling.	**6**
5. Conservation	Conservation of aquatic plants in freshwater and marine habitats, conservation of wetlands.	**4**
6. Running water ecosystem	Life in running waters and marine communities and relation to terrestrial ecosystems.	**4**
7. Contaminants	Contaminants in freshwater bodies in Bangladesh with special emphasis on: arsenic, fluoride, pesticides, manganese and cyanotoxins and their bioremediation.	**10**
8. Eutrophication and pollution	causes and consequences; sewage wastewater treatments, human impact on water ecosystems.	**4**
9. Oceanography	Principles; elements of physical, chemical, biological and geological oceanography; essentials of marine ecology; fisheries and aquaculture; marine conservation; marine pollution; global climate change; effects of climate and sea-level changes on the natural resources of Bangladesh, socio-economic implications of climate change for Bangladesh.	**10**
10. Use	Sustainable use of aquatic resources as food, feed and other purposes	**4**

Unit wise learning outcome

Units	Learning outcomes
1	• Describe hydrobiology • How hydrobiology, morphology and aquatic organisms relate to biochemical processes and ecological functions of inland aquatic ecosystems; • Scopes of hydrobiology • Hydrobiological researches in Bangladesh and its status in relation to other countries
2	• Classification of aquatic macrophytes • How aquatic plants relate to biochemical processes • Methods of macrophyte culture • Scope of macrophytes and its culture • evaluate how catchment land use, climate variability, invasive species and fisheries • exploitation might impact on the ecology of lakes, rivers and wetlands;
3	• What is wetland • Concepts of wetlands • Socioeconomic characteristics of wetlands • Wetlands using concepts of an environmental management system, including management objectives for realistic action plans; benefits of wetland

	• Produce a wetland management plan;
4	• Define the concept of primary productivity • Measurements of primary productivity • Estimation of their seasonal and annual rates • Production of Bio-diesel and organic manure • Interaction between aquatic plants and microorganisms and their relationship • Nutrient cycles in aquatic habitat
5	• Conservation process of wetlands • Conservation of aquatic plants in different habitats
6	• Characteristics of running water ecosystem • Hydrobiological cycle in running water ecosystem • Classification according to their life form categories • Relationship between running water and terrestrial ecosystem
7	• Discuss about Contaminants in freshwater bodies in Bangladesh with special emphasis on: arsenic, fluoride, pesticides, manganese and cyanotoxins and their bioremediation.
8	• Discuss about Eutrophication and pollution • Causes and consequences of Eutrophication and pollution • Bioremediation • Sewage wastewater treatments • evaluate the usefulness of wetlands as treatment systems of waste water • evaluate human impacts on sea/ocean, rivers, lakes and ponds
9	• Define and understand Oceanography • Discuss about different physical, chemical and biological properties of Oceans and seas • essentials of marine ecology, fisheries and aquaculture • marine conservation; marine pollution • global climate change; • effects of climate and sea-level changes on the natural resources of Bangladesh • socio-economic implications of climate change for Bangladesh.
10	• Sustainable use of aquatic resources as food, feed and other purposes

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4. Nishat A, Z Hussain, MK Roy and A Karim (eds.) 1993. Fresh water wetlands in Bangladesh: Issues and approaches for Management. IUCN, Gland, Switzerland. xii + 283 pp.
5. Odum EP 1971. Fundamentals of Ecology. W.B. Saunders Co. Philadelphia. pp. 574.
6. Tyagi R 2010. Textbook of Hydrobiology. Discovery publishing house, ISBN 13: 9788183565578, 181 pp.

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 will be taken after completing every three unit lectures.

BOT 507: Physiological Ecology Credit hour: 4

A. Plants in relation to aerial environment (Plants and Microclimate):

1. Radiation and plants, radiation laws, spectral distribution and radiation units; radiation in natural environments; radiation distribution within plant communities; modification of light climate by vegetation; distribution of dust and gases near the ground; temperature profiles within vegetation.
2. Energy balance and gaseous exchanges in plants; energy calculation in forest canopies.
3. $C_3$and C_4 adaptation; distribution of C_4 species in North America, Central Europe, Kenya; Ecological aspects of CAM.
4. Greenhouse gases and aerosols, key greenhouse gases influenced by human activities; long term atmospheric carbon dioxide variations; atmospheric distribution, sinks and sources of methane.
5. Effects of increased atmosphere carbon dioxide and climate change on terrestrial ecosystems.
6. Climate change: Evidence for global warming: The earth's energy balance; Flow of energy and water between land, sea and atmosphere.

B. Plants in relation to soil environment:

1. Adaptation to wetland environments, metabolic aspects of flood tolerant and flood intolerant plants and their ecological significance and criticisms; Mn and Fe toxicity to plants and their effect on chloroplast ultrastructure.
2. Stress terminology, Adaptation to stress, kinds of environmental stress, molecular basis of freezing injury and tolerance, and measurement of drought avoidance and tolerance.
3. Community characteristics and measurements of species grouping; Association analysis by 2 x 2 contingency table.
4. Ecological biochemistry (allelopathy). The biochemical bases of adaptation to climate and soil. Environmental effects on the production of secondary metabolites.

C. **Plants in relation to Aquatic Environment:**

1. Acidification of freshwater: Natural acidity, anthropogenic acidification, acid rain; prevention and cure of acid rain.
2. Eutrophication: Eutrophic ecosystems, sources of excess nutrients.
3. Natural Resource Conservation: History of conservation, classification of natural resources, terrestrial mineral resources and their conservation.

References

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3. EtheringtonJR 1978. Physiological Plant Ecology, Edward Arnold.
4. Etherington JR 1976. Environment and Plant Ecology, John Wiley & Sons.
5. Gates DM 1993. Climate change and its Biological consequences. Sinauer Associate, Inc.
6. Harborne JB 1982. Introduction to Ecolgoical Biochemistry. Academic Press.
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18. Townsend CR and C Peter 1981. Physiological Plant Ecology. Blackwell Sci. Pub.
19. UNEP 1992. Climate change and Energy Efficiency in Industries.

BOT: 508: Natural Resource Management Credit hour: 4

Introduction

High loss of biodiversity and other natural resources through species and habitat loss and destruction have been a major global problem. The accelerated rates of loss are a consequence of human activities. The problem has continued despite increased establishment of new protected areas, high international spending on conservation and availability of international agreements on conservation of biodiversity. Consequently, it has been argued that the conventional approach to conservation through isolating protected areas, sometimes referred to as 'fortress' or 'fences and fines' has not been effective. Protected areas in many developing countries have been described as "Paper park" which are ineffectively managed and providing little or no protection for biodiversity. As a result, an alternative approach to conservation, commonly referred to as community-based conservation or natural resources management (CBNRM), has become widely adopted particularly in developing countries.

Course objectives

(a) To make students familiarize with the recent approaches to community oriented conservation and management of different natural resources.
(b) To acquire knowledge on the different approaches to restoration of different ecosystems.

Course content

A: Natural resource management

Units	Course content	No. of Lectures
1	Introduction, Collaborative management, Community-Based Natural Resource Management (CBNRM), Stake holders, Areas of action, Values of Parks, Conceptual models in community conservation	4
2	Review of The Tropics – Heterogeneity in time and space, agent, substrate and response, Competition between tree and grass layer- Walter's two layered model.	3
3	Tropical biodiversity and forest, Biodiversity Conventions (CBD), Bioprospecting, Ecosystem Functioning and Non Timber Forest Products (NTFP), Tropical Forest Management.	4
4	Management of dry land resource systems: Evolution of dry land, Dryland climatic variation, equilibrium and non- equilibrium conditions, Functional and dys-functional landscape, Stocking rate, Concept and calculation of carrying capacity.	4
5	Coastal Zone Management: Different management practices, Marine protected areas (MPAs), Integrated coastal management (ICM), Lessons Learned from Community-Based Marine Reserves and Its Effectiveness, Coastal zone management of Bangladesh	3

B*:* Restoration Ecology

6	Introduction to Restoration Ecology: Definition, Goal, Objective, Reference point, Linkage between restoration and Ecology, System structure and function.	3
7	Principles of restoration Ecology: Some familiar concepts, Processes and context	3
8	Ecological foundations and interactions. Patch theories, Isolated areas and biogeography, Key aspects of restoration projects, Integration of Traditional ecological knowledge in Restoration	3
9	Rivers and streams: Allocation of resources to wetland restoration, Design and project principles	3

Unit wise learning outcome

Units	Learning outcomes
1	Based on an advanced knowledge, students will be able to discuss pros. and cons. of different approaches to community participation in natural resource management. Students will also be

	able to critically evaluate and synthesize their knowledge about CBNRM.
2	Students will have in depth knowledge about how heterogeneity is formed over time across the landscape and about the competition between trees and grass layers over resources.
3	Will be able to play key role in tropical biodiversity management, can play a major role in negotiation in different discussion groups of biodiversity conservation and bioprospecting.
4	Will be able to synthesis their knowledge of dry land resource management in other ecosystems such as the concept of stoking rate and carrying capacity can be scaled up in the coastal islands management.
5	Will play critical role in coastal zone management especially of the Sundarbans and marine protected areas.
6	Will have clear concept on ecosystem functions, structures, services and their implication to restore different degraded ecosystems.
7	Will be able to put context into restoration of ecosystems.
8	Will be acquainted with the key aspects of restoration and traditional knowledge and integrating these knowledge in restoration.
9	Will be able to help in designing restoration project of aquatic ecosystems.

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11. Primack RB 1995. A Premier of Conservation Biology. Sinauer, USA.
12. Whitford WG 2002. Ecology of desert systems. Academic Press, NY.

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 topics

Assessment: First in-course examination will be taken after completing the lectures on units 1-3 and second in-course will be held on after completion of units 6-9.

BOT. 509: Plant Molecular Ecology Credit hour: 4

Introduction

Recent advancement in molecular biology has revolutionized ecological research. The modern molecular methods for genetically characterizing individuals, populations and species have provided a wealth of novel data and fascinating new insights into the ecology and evolution of plants, animals and microbes. Molecular markers are useful to quantify genetic diversity, track the movements of individuals, measure inbreeding, identify the remains of individuals, characterize new species and retrace historical patterns of dispersal. These applications are of great interests among the ecologists and are used frequently to address practical ecological questions such as which endangered populations are most at risk from inbreeding, and how much hybridization has occurred between genetically modified crops and their wild relatives. Now a days, it is possible to accomplish researches such as identifying the geographic source of invasive species from only a few samples, or monitoring populations of elusive species from a tiny amount of samples by using molecular genetic data which was previously unthinkable tasks.

Specific objectives:

- introduce students with molecular methods and markers useful to address research questions in ecology such as identification and phylogeny of individuals and species and retrace historical patterns of dispersal and distribution of organisms
- teach students how to apply molecular knowledge in biodiversity conservation, wildlife forensics, mitigation of global climate change and environmental pollution
- Enhance knowledge of the students about the molecular mechanisms of adaptation by plants

Course contents, unit-wise learning outcomes, number of lectures per unit

Sl.	Unit	Subtitle	Unit-wise learning outcomes	Lecture
1	Introduction to molecular ecology	• Definition • Emergence of molecular ecology • Ecological genetics • Genotype, phenotype and phenotypic plasticity with reference to ecology	• Gain conceptual knowledge about molecular ecology • Learn the historical development of molecular ecology	2
2	General molecular biology	• Ecological relevance of DNA, Cloning, Gel electrophoresis, Detecting DNA, Blotting, PCR, DNA sequencing, Cloning, Proteomics, Genomics • Sample sources for DNA • DNA extraction and preservation • Enzymes used in molecular biology • Methods for sample storage	• Learn the fundamentals of molecular biology in relation to ecology	3
3	Molecular markers in Ecology	• Modes of inheritance • Definition and types of markers used in ecology • Sources of genetic variation • Theory of Natural selection and Neutral theory of molecular evolution	• Gain knowledge about the inheritance patterns in organisms • Learn the use of molecular markers in ecological questions	4
4	Identification of species, individuals, and sex	• Introduction • Importance of molecular data in identifying species, individuals and sex • Defining species • Use of molecular markers in identifying species, individuals and sex	• Learn the importance of molecular data in taxonomic questions	2

5	Population ecology	• Definition of population • Types of population • Quantifying genetic diversity • Factors influencing genetic diversity • Quantifying population subdivision • Quantifying gene flow • Factors influencing gene flow • Population differentiation (genetic drift and natural selection)	• Learn the fundamentals of population genetics in relation to biodiversity conservation and how to quantify genetic diversity	3
6	Phylogenetics and phylogeography	• Definition of phylogenetics • Types of phylogenetic tree • Methods for constructing phylogenetic tree • Molecular markers in phylogeography • Comparative phylogeography • Techniques to study phylogeography	• Learn how to construct phylogenetic trees, how to examine phylogenetic relationships among organisms • Know how to study phylogeography of plants	3
7	Application of molecular ecology	• Wildlife forensics, Agriculture, Climate change context • Future context of molecular ecology	• Know the application of molecular ecology in ildlife forensics, agriculture and global climate change • Learn the future challenge in agriculture and biodiversity and application of molecular ecology	2
8	Conservation biology	• Introduction • Defining biodiversity • Importance of conserving biodiversity • Threats to biodiversity • Importance of molecular data in biodiversity conservation • Importance of population size • Conservation of genetic diversity • Restoration genetics	• Know the importance of conserving biodiversity • Gain knowledge about the threats to biodiversity, ecosystem services • Learn methods for conserving genetic diversity	3
9	Ecological aspects of Genetically Modified Organisms (GMO)	• Debate and concerns about health, environment, biodiversity and ecosystems level effects • Biosafety guidelines about GMO	• Learn environmental concerns of GMO products	2
10	Plant stress biology	• Introduction • Biotic and abiotic stresses in plant • Gene expression • Genome-sequencing and microarrays • Defense mechanisms • Molecular mechanisms of plants´ defense against stresses • Molecular approaches in understanding adaptation of plants	• Students will learn molecular knowledge about the defense mechanisms of plants	2
11	Molecular approaches in community analysis	• Introduction • Importance of microbes in ecosystem • Limitation of studying decomposer communities (microbes) • Methods for studying decomposer	• Gain knowledge about the various methods for studying soil microbial communities • Learn the use of	2

		communities (microbes) • Structural and functional linkages between plant and soil microbial communities.	molecular data in identifying communities in ecosystems	
12	Ecological genomics	• Definition and Introduction • Forest genomics • Environmental genomics	• Students will learn ecological aspects of genomics and application of genomics in solving ecological questions	2

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8. Wardle DA 2002. Communities and Ecosystems. Princeton University Press
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Instruction 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 particular topic.
Assessment: At least two In-course examinations will be taken and a term-Final exam will be held at the end of

BOT 510: Advanced Plant Physiology Credit hour: 4

Introduction

This is one year M. S. degree program in Botany. Plant Physiology is a sub- division of biology pertaining to plant life, along with their processes and functions. It is an experimental, laboratory-based field of science that requires knowledge of physics and chemistry. 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. After completing two Plant Physiology courses (Fundamental Plant Physiology and Plant physiology) in undergraduate program, students will develop understanding of some advanced concepts of plant physiological phenomena with special reference to metabolism, secondary metabolites, bioenergetics, metabolic interrelationships, respiration, phloem transport, absorption and translocation of ions, hormone action, deficiency and toxicity of mineral nutrients, biological clock, senescence and interaction between plants and environment.

Course objectives

a) Understand the breadth and depth of knowledge associated with Plant Physiology;
b) Grasp the basic biochemical, physiological and nutritional concepts which underlie plant adaptations to their environment;

c) Appreciate the fundamental importance of water, light, temperature, nutrients etc. in plant and community function;
d) Able to identify, define and apply the core knowledge related to their research topic;
e) Conduct scientific research on globally relevant problems in plant sciences and contribute this knowledge to their discipline.

Course content

	Course contents	**No. of classes**
1	**Metabolism:** Metabolic pathways - anabolic and catabolic pathways, energy relation between anabolic and catabolic pathways; central pathways; secondary pathways; regulation of metabolic pathways.	3
2	**Secondary metabolites:** Principal function of secondary plant products; major pathways of secondary product biosynthesis and their interrelationship with primary metabolism; distribution of defensive secondary products within plants; importance of secondary metabolites.	3
3	**Bioenergetics:** Concept of free energy, coupling of reactions; energy rich compounds; role of ATP-ADP systems in transferring free energy, ATP as universal currency of free energy in biological systems.	3
4	**Integration, interconversion and metabolic interrelationships:** Integration, interconversion and metabolic interrelationships among carbohydrate, protein and lipid.	2
5	**Respiration:** Energy production through oxidation of carbohydrates and lipids; biological efficiency in oxidation of carbohydrates and lipids; balance of photosynthesis and respiration and their measurement.	2
6	**Phloem transport:** Patterns of translocation, mechanism of phloem translocation, assimilate partitioning, phloem loading and unloading, factors controlling translocation and assimilate partitioning in higher plants.	3
7	**Absorption and Translocation of ions in plants:** Dual mechanism of ion transport, chemiosmotic hypothesis; endodermis as a barrier of translocation, radial migration of ions; Craft and Broyer hypothesis.	3
8	**Mechanism of hormone action:** Auxin, Gibberellin and Cytokinin.	3
9	**Biological clock:** Historical background, circadiam rhythm, rhythm characteristics - light, temperature and applied chemicals; biological clock in nature.	2
10	**Senescence:** Senescence processes in the life cycle of plants; chemical and physiological changes; factors affecting senescence; causes and significance of senescence.	2
11	**Diagnosis of deficiency and toxicity of mineral nutrients:** Nutrient supply and growth response, diagnosis of nutritional disorders by visible symptoms, relation between growth rate and mineral nutrient content.	2
12	**Environmental stress:** Interaction of environmental stresses and ion transport in plants.	2

Unit wise learning outcome

Units	**Learning outcomes**
1	• procure knowledge on different metabolic pathways - anabolic and catabolic pathways, central pathways, secondary pathways;
2	• illuminate the concept of primary and secondary metabolites and their importance; the pathways of secondary product biosynthesis; interrelationship between primary and secondary products;
3	• interpret the mechanism of obtaining, storing and utilizing energy in a biological system;
4	• interconnection among carbohydrate, protein and lipid;
5	• comprehend the knowledge of energy production and biological efficiency in oxidation of carbohydrates and lipids; integrate the balance of photosynthesis and respiration and their measurement;
6	• elucidate phloem transport, source-sink relationship and assimilate partitioning in higher plants;

7	• integrate the mechanisms of absorption and translocation of mineral ions by plants;
8	• outline the mechanism of different hormones in plants;
9	• narrate the reasons of having an internal time measuring system in living organisms;
10	• acknowledge the degenerating process in plants;
11	• acquire knowledge of deficiency and toxicity of mineral nutrients; discern the correlation between growth rate and mineral nutrient content;
12	• perceive the conception of the effect of environmental stress within biological systems and causality of relationships between plants and their environment.

References

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6. 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: 2 Incourse examinations will be taken after students have mastered several topics of the study subject.

BOT 511: Applied Mycology Credit hour: 4

Introduction

This is one of the MS Course in Botany program. It is designed in a way that the students develop clear understanding of the concept of Applied mycology and its importance to mankind. The fungal kingdom consists of a wide variety of organisms with a diverse range of forms and functions. Fungi have been utilized for thousands of years and their importance in agriculture, medicine, food production and the environmental sciences is well known. Applied Mycology brings together a range of contributions, highlighting the diverse nature of current research. Chapters include discussions of fungal associations in the environment, agriculture and forestry, long established and novel applications of fungi in fermentation, the use of fungi in the pharmaceutical industry, the growing recognition of fungal infections, current interests in the use fungal enzymes in biotechnology and the new and emerging field of myconanotechnology. The present syllabus will be demonstrating the broad coverage and importance of mycological research to the students.

Course objectives

(a) By the end of the course students will be able to-
(a) Discuss about the importance of fungi to mankind in the earth.
(b) Know about the role of fungi in food and feed.
(c) Know the role of fungi in Agriculture and forestry.
(d) Know about the use of fungi for the production of commercial products.
(e) Know about the habitat of fungi in detail.
(f) Explain how the fungi involve in wood decay.
(g) Know the about the role of fungi as human pathogens.
(h) Discuss about as source and synthesis of nano particles.

Course content

Units	Course content	No. of Lectures
1: Introduction to Applied Mycology:	Historical development, scope and importance to mankind.	**2**
2: Food mycology	Mushrooms- types, nutritive value and cultivation, poisonous and hallucinogenic, mushrooms, fungi in food processing, fungi as food-mycophagy, role of fungi in nutrition of, stream invertibrates, fungi in the diet of leaf cutting and Atta, saprophytic fungi in food chain, food spoilage by fungi and its preservation, mycotoxin in food and feed.	**4**
3: Agricultural mycology	: Fungi as a biocontrol agent and their biofertilizer potential in agriculture, most commonly encountered soil fungi, fungal insecticides and herbicides. Role of fungi in forestry;Mycorrhizae mutualistic plant-fungus relationships, types of Mycorrhizae and role of mycorrhizea in agriculture.	**4**
4:Industrial mycology:	Primary and secondary products of metabolisms, basis and development of industrial fermentation, isolation of organisms, screening and strain development, antibiotics, vitamins, organic acids, enzymes, alcoholic beverage and alkaloids.	**4**
5: Fungal ecology	Succession of coprophillous fungi, pineneedlemicosera, amphibious fungi in streams, aero-aquatic fungi in ponds, aeromycoflora, other habitats and macrofungal ecology. Wood decay: Fungi associated with wood decay, types of decay, mechanism of wood decay, preventive and control measures.	**4**
6: Wood decay:	Fungi associated with wood decay, types of decay, mechanism of wood decay, preventive and control measures.	**4**
7 Medical mycology	Human pathogenic fungi- superficial mycoses, subcuticular mycoses and systemic mycoses	**4**
8:: **Myconanotechnology**	A new and emerging science- concept of nanotechnology, biosynthesis of silver nanoparticles by fungus *Trichodermareesei*, nanotechnology offers new insights into plant pathology, anti-microbial interior coating based on nanotechnology.	**4**

Unit wise learning outcome

Units.	Learning outcomes
1	Know the contribution of different scientists in the field of Applied mycology. Importance of fungi to mankind.
2	Know about the role of fungi as food, infood spoilage and food processing. .
3	Know the role of fungi in as biofertilizer and biocontrol agents in Agriculture..
4	Know about the use of fungi for the production of commercial products.
5	Know about the habitat of fungi in detail.
6	Explain how the fungi involve in wood decay and their preservation.
7	Know about the role of fungi as human pathogens.
8	Discuss about myconano particles their source and synthesis.

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Instruction strategies and Learning experiences
- Group discussion on the given lecture
- Question answer

BOT. 512: Plant Pathology and Plant Protection Credit hour: 4

Introduction
The MS in Plant Pathology and Plant Protection provides students with the opportunity to develop specialist knowledge which is applicable to many research institutes and plant quarantine office. Lectures and practical sessions provides pathological knowledge including chemical weapons of plant pathogens, host defense, effects of pathogens on plant physiological functions, genetics of plant diseases, plant disease epidemiology, forecasting of plant disease epidemic, plant disease control and application of biotechnology in plant pathology.Laboratory sessions allow students to gain experience in the experimental design and practical skills of research in the context of mini-research projects.
The course is suitable to equip students with the knowledge in modern day plant pathology in different fields.The Plant Pathology aims to equip graduates with the necessary theoretical understanding, practical research, professional and transferable skills to enable them to undertake further postgraduate training and/or employment within academic research and in research, commercial, government and environmental-settings.

Course objectives
(a) Gather preliminary knowledge about Plant Pathology.
(b) Know the contribution of different scientists in the development of Plant Pathology.
(c) Gather knowldge about the importance of microorganism with special reference to plant diseases.
(d) Know how to control plant diseases
(e) Learn the mechanism of disease development in plants.
(f) Develop knowedge about defense mechanism of host plants.
(g) Learn the relation of genetics in the development of plant disease and defense mechanism against the plant pathogens.
(h) To find out the relation of environment in the development of plant disease.
(i) Learn about plant disease epidemiology. Know the factors of epidemic.
(j) Learn about plant disease forecasting
(k) Know the contribution of biotechnology in plant pathology.

Course content

Units	Course content	No. of Lectures
1. Pathogens attack of host plants	Mechanical forces exerted by the pathogens; Chemical weapons of plant pathogens • Enzymes, • Toxins and • Growth regulators	**4**
2. Host defense against pathogens	• Structural and • Biochemical defenses.	**4**
3. Effects of pathogens on plant physiological functions	Effects of pathogens on • Photosynthesis, • Respiration and • Translocation of water and nutrients.	**2**
4. Genetics of plant diseases	• Genes and disease; • Variability in organisms; • Mechanism of variability in pathogens; • Stages of variation in pathogens; • Types of plant resistance to pathogens;	**4**

	• Genetics of virulence in pathogens and • Resistance in host plants.	
5. Environmental factors on the development of infectious plant diseases	• Effects of temperature, • Moisture and • Soil pH.	**2**
6. Plant disease epidemiology	• Introduction, • Pathogen factors that affect the development of epidemics; • Host factors that affect the development of epidemics; • Environmental factors that affect the development of epidemics; • Effect of human cultural practices and control measures; • Pattern of epidemics; • Measurement of epidemics.	**4**
7. Forecasting of plant disease epidemic	Introduction; Basis of plant disease forecasting • Inter-crop weather and the amount of primary inoculum • Weather conditions during the crop season and the production of secondary inoculums • Amount of disease in the young crop. • Amount of inoculum in soil, planting materials and air • Examples of plant disease forecast systems.	**4**
8. Plant disease control	Introduction; Physical control: Heat treatment, soil sterilization by heat, soilsolarization and control by radiation. Biological control: Use of resistant varieties, suppressive soils, hyperparasites, trap crop and antagonistic plants; integrated approach to control plant diseases.	**4**
9. Biotechnology in plant pathology	Application of biotechnology in plant pathology.	**2**

Unit wise learning outcome

Units	Learning Outcomes
1	▪ Identify plant pathology as an interdisciplinary pursuit ▪ Will be able to know the mechanisms of penetration of pathogen into the host. ▪ Will be able to know the importance of enzymes and toxins in ▪ disease development
2	▪ Gather knowledge about the defencemachenism of host plant against the plant pathogens. ▪ Able to learn the plant tissues related to plant defense. ▪ Will learn the biochemicals present in the plant which take part in defense mechanism.
3	▪ Able to know the effects of pathogens on the physiological process particularly photosynthesis, respiration, transport of minerals and water.
4	▪ Able to know the relation of genes in disease development. ▪ Know the variability of plant pathogens. ▪ Learn about the mechanism of variability in plant pathogens ▪ Learn about the genetics of virulence in pathogens and resistance in host plants
5	▪ Learn about the effects of temperature, moisture and soil pHon the development of infectious plant diseases
6	• Learn pathogen factors that affect the development of epidemics; • Learn host factors that affect the development of epidemics; • Know environmental factors that affect the development of epidemics; • Gather knowedge about the effect of human cultural practices and control measures;

	• Develop idea on pattern of epidemics; ▪ Able to measure epidemics.
7	▪ Able to know about the forecasting of plant disease epidemics. ▪ Know the mechanism to forecast about plant disease epidemic. ▪ Gather knowledge about the examples of plant disease forecast systems.used in different counties.
8	▪ Able to learn plant disease control methods. ▪ Gather knowledge about the physical and biological methods of plant disease control.
9	▪ Students will be able to know the techniques of plant biotechnology. ▪ Gather knowledge about the success of plant biotechnology in the development of resistant disease free variety.

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3. Mehrotra RS 1987. Plant Pathology .Tata McGrew Hill Co.., New Delhi.
4. Singh RS 1980. Introduction to Principles of Plant Pathology. Oxford & IBH Publishing Co. New Delhi.
5. Zadoks JC and RD Schein 1979. Epidemiology and Plant Disease Management. Oxford University Press, New York.

Instruction strategies and Learning experiences

- Lecture followed by group discussion
- Question answer
- Guided discussion
- Project discussion
- Demonstration
- Visit to Pathological laboratories of different Research Institutes

Assignment: Students will be given assignment on particular units

Assessment: Incourse examination will be taken after completing the lectures on units 1-3 and 4-6.

BOT. 513**: Seed Pathology** **Credit hour: 4**

1. Historical development; development of seed health testing; economic significance of seed-borne fungi; loss in germination and vigour, development of plant disease, discoloration and sheivering, biochemical change, alteration in physical properties of seed.
2. Diseases and injuries of seeds: Physiogenic or non pathogenic diseases- mineral deficiency and humidity; seed diseases caused by fungi, bacteria, virus; mechanical injuries and insect injuries in seeds.
3. Penetration and establishment of fungi in seeds: Systemic infection through flowers, fruits or seedstalk; penetration through stigma, ovary wall and seed coat; penetration through natural openings;. seed infection by bacteria, virus and nematode.
4. Location of microorganisms in seeds: Histopathology of some seed-borne pathogens; seed infection: embryo; endosperm; seed coat and pericarp; glume.
5. Factors affecting seed infection: Host genotype; environment; crop management; type of inocula; seed quality; plant growth stage; mother plant infection; insect infestation; pathogen interaction.
6. Environment and plant-seed transmission: Time of infection and growth stage, time of infection and weather conditions, time of infection and flowering period of host, time of infection and localization in seed, time of infection and seed-borne fungus flora, infection or contamination during harvest.
7. Epidemiology and inoculum threshold of seed borne pathogen: Epidemiology (monocyclic and polycyclic disease); inoculum threshold (fungi, bacteria, virus); development of inoculum thresholds.
8. Spoilage of seeds by storage fungi: Field and storage fungi; invasion by storage fungi; loses; conditions favouring storage fungi development; deterioration of seeds by storage fungi, detection of damage and control.
9. Seed certification: Objectives of seed certification, types of seed classes, phases of certification, methods of seed certification, field standard and seed standard for paddy, wheat and jute in Bangladesh.

10. Control of seed borne pathogens: Principles of seed disease control; selection of seed production area, crop management, seed treatment and procedure; systematic and protective fungicides used in seed treatment; certification, plant quarantine, disease resistance.

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Singh D and SB Mathur 2004. Histopathology of Seed-borne infections. CRC Press Publ.

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BOT 514: Environmental Microbiology and Biotechnology Credit hour: 4

Introduction

Environmental Microbiology and Biotechnology is a theoretical course out of the courses offered for the M.S. degree in Botany program. This course is structured in a way that the students develop clear understanding of the concept of Environmental microbiology, microbial habitats, detection of microbial populations in environmental samples, interaction of microorganisms in the environment, role of microorganisms in environments, their biotechnological application for treatment of domestic wastes, industrial wastes, waste water treatment and the improvement of the contaminated environmental sites. Students also understand the reason of damages and ways of protection of the environment through proper application of potential microorganisms. Furthermore, stress was also given some of the applied aspects like on the discovery and application of new microbes and their products to benefit human health and welfare.

Course objectives

To define environmental microbiology and its scope

To identify different types of microorganisms in the environment

To describe nucleic acid-based method of analysis

To identify indicator bacteria in the environment

To describe the role of bacteria in nutrient recycling

To describe the role of bacteria for decomposition of domestic and industrial wastes

To apply potential microorganisms for improvement of the contaminated environmental sites

To describe the application of microbes for human health and welfare

Course content

Units	Content	No. of Lectures
1: Microorganisms in the environment	Terrestrial: Surface and subsurface conditions. Aquatic: Biofilms, microbial mats and benthic; fresh, brackish, and marine water habitats.	4
2: Environmental sample collection and processing	Soils and sediments – sampling strategies and methods for surface and subsurface soils, sample processing and storage; Water - sampling strategies and method for water, processing of water sample for microbial analysis, detection of microbial populations.	2
3: Nucleic acid-based methods of analysis	Structure and complementarity of nucleic acids; obtaining nucleic acids from the environment, extracting community bacterial DNA from soil and water samples; nucleic acid-based methods – gene probes and probing, PCR, RT-PCR, recombinant DNA techniques, restriction fragment length polymorphism analysis, temperature gradient gel electrophoresis, plasmid analysis, reporter genes.	4
4: Indicator	Total coliforms, fecal coliforms, fecal Streptococci, *Clostridium*	3

microorganisms	*perfringens*, HPC, standards and criteria for indicators.	
5: Microorganisms in recycling	Transformations of nitrogen and nitrogen compounds: nitrogen fixation, proteolysis, ammonification, nitrification, nitrate reduction, denitrification; phosphorus in freshwater and marine environments, removal of phosphorus from wastewater.	4
6: Domestic wastes and waste treatment	Domestic wastewater, modern wastewater treatment, oxidation ponds, septic tanks, land application of wastewater.	2
7: Microorganisms and organic pollutants	Biodegradation process, relationship between contaminant structure, toxicity and biodegradability, factors affecting biodegradation; environmental factors affecting biodegradation – oxygen, organic matter content, nitrogen, temperature, pH, salinity, and water activity.	3
8: Bioremediation	Scope and characteristics of contaminants – organic compounds, mixture of organic compounds; contaminant availability for biodegradation – sorption to surfaces, formation of a nonaqueous phase; engineering strategies for bioremediation – site characterization, engineered *in-situ* bioremediation, intrinsic *in situ* bioremediation and natural attenuation, *in-situ* bio barriers, *ex-situ* bioremediation; bioremediation by addition of oxygen, nutrient and microorganisms; and evaluating bioremediation.	3
9: Antibiotics and other chemotherapeutic agents	Chemotherapy, isolation of antibiotic-producing microorganisms, action of antibiotics, antibiotic-resistant bacteria, superbugs, synthetic chemotherapeutic agents, microbial susceptibility to chemotherapeutic agents.	3
10: Biofuel and Biogas	Introduction, biogas, types of biogas plant, trends in production of biogas from organic wastes, improvement of the quality of biogas; Biodiesel production – potential microorganisms, strategies to engineered microbes, types of biodiesel, application and problem associated with the production of biodiesel.	2

Unit wise learning outcome

Units	Learning outcomes
1	• define environmental microbiology • describe the surface soil microorganisms • distinguish sub-surface soil microorganisms • explain the survival capacity of microorganisms in extreme environments • discuss the role of microorganism in the formation of biofilm • explain the role of microorganisms in the formation of microbial mat • describe the importance of microorganisms in the benthic site • describe the activities of microorganisms in estuaries • describe the distribution and role of microorganisms in the marine environments
2	• describe the methods of sampling from different environmental sites • describe the process of environmental samples • chemical analyses the environmental samples • microbiological analyses the environmental samples • bacterial cultural counts in the environmental samples • bacterial total counts in the environmental samples
3	• mention the structure and complementarity of nucleic acids • describe the procedure for isolation of nucleic acid from the environmental samples • describe the procedure for extracting community bacterial DNA from soil samples • describe the procedure for extracting community bacterial DNA from water samples • describe gene probes and probing, PCR, RT-PCR, recombinant DNA techniques, restriction fragment length polymorphism analysis • describe temperature gradient gel electrophoresis, plasmid analysis, reporter genes
4	• define total coliforms

	• explain the method used to count the total coliforms in the water sample • describe the procedure for detection and enumeration of total coliforms from aquatic habitats • define fecal coliforms • mention the presence of fecal coliforms in the water sample • describe the procedure for detection and enumeration of fecal coliforms from aquatic habitats • define fecal Streptococci • mention the presence of the group of fecal streptococci in water sample • explain the *Clostridium perfringens* as pathogenic organism • describe the procedure of heterotrophic plate count (HPC) in environmental samples • mention standards and criteria for indicator organisms
5	• describe the mechanism of transformations of nitrogen and nitrogen compounds in nature • define nitrogen fixation • mention nitrogen fixing microorganisms • define proteolysis • discuss the role of microorganisms in proteolysis • define ammonification • describe the role of microorganisms in ammonification • define nitrification • describe the role of microorganisms in nitrification • define nitrate reduction • describe the role of microorganisms in nitrate deduction • define denitrification • describe the role of microorganisms in denitrification • mention the source of phosphorus in freshwater • mention the source of phosphorus in marine environments • describe the role of phosphorus in environments • describe the mechanism of removal of phosphorus from wastewater
6	• define domestic wastewater • describe the procedure of modern wastewater treatment • define oxidation ponds • mention types of oxidation ponds • describe the process of wastewater treatment by oxidation ponds • define septic tanks • describe the role of microorganisms in septic tanks for treatment of the domestic wastewater • discuss the land application of wastewater
7	• define biodegradation process • mention the role of microorganism in biodegradation • describe the relationship between contaminant structure, toxicity and biodegradability • describe the factors affecting biodegradation • describe the environmental factors affecting biodegradation – oxygen, organic matter content, nitrogen, temperature, pH, salinity, and water activity
8	• define organic compounds • mention the scope and characteristics of contaminants • define the mixture of organic compounds • describe the contaminant availability for biodegradation – sorption to surfaces, formation of a nonaqueous phase • define bioremediation • discuss the engineering strategies for bioremediation – site characterization • describe the engineered *in-situ* bioremediation, intrinsic *in situ* bioremediation and natural attenuation, *in-situ* bio barriers • Explain *ex-situ* bioremediation • Describe the process of bioremediation by addition of oxygen, nutrient and microorganisms • Explain the potentiality of bioremediation

9	• define chemotherapeutic agents • describe the procedure for isolation of antibiotic-producing microorganisms from environments • describe the mechanism of action of the antibiotics • describe the antibiotic-resistant bacteria • define superbugs • describe the development of superbugs in environments • Describe the threat of superbugs for human health • describe the procedure for production of synthetic chemotherapeutic agents • discuss the microbial susceptibility to chemotherapeutic agents
10	• define biogas • describe types of biogas plants • mention the name of substrates uses for biogas production • describe role of microorganisms in biogas plants • discuss the application and uses of biogas • describe the process for improvement the quality of biogas • define biodiesel • mention the name of substrates uses for biodiesel production • describe the role of microorganisms in biodiesel production • explain the role of engineered microbes in biodiesel production • discuss the application and problem during production of biodiesel

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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 examinations
- Assignment
- Course final examination

BOT. 515: Microbial Biotechnology Credit hour: 4

Introduction

The MS in Microbial Biotechnology provides students with the opportunity to develop specialist knowledge which draws from the expertise in Biotechnology and Microbiology that is applicable to many industrial and environmental sectors. Microorganisms are the workhorses of many industrial processes and students who study for the MS Microbial Biotechnology can gain a thorough understanding of these at a whole organism.

A series of lectures and practical sessions cover key themes in contemporary **microbial biotechnology**including **fermentation biotechnology, enzyme biotechnology, biodegradation of xenobiotic compounds, microbial polysachharides and polyester, wastewater treatment technology, archaeal biotechnology.**Laboratory sessions allow students to gain experience in the experimental design and practical skills of research in the context of mini-research projects involving **microbial biotechnology**. Curriculum content will be research-engaged and, in particular, students will undertake a period of independent scientific research, in accordance with the University's 'Student as Producer' project.The Microbial Biotechnology aims to equip graduates with the necessary theoretical understanding, practical, research, professional and transferable skills to enable them to undertake further postgraduate training (i.e. PhD level) and/or employment within academic research and in industrial, commercial, government and environmental-settings.

Course objectives

(a) Gather preliminary knowledge about microbial biotechnology.
(b) Gatherknowldge about the importance of microorganism with special reference to microbial biotechnology.
(c) Know about different aspects of biorector design and fermentation biotechnology.
(d) Know about dairy biotechnology and the importance lactic acid bacteria.
(e) Know the sources and application of enzymes.
(f) The course is suitable to equip students with the knowledge in modern day microbial biotechnology in different fields.

Course content

Units	Course content	No. of Lectures
1. Introduction:	Biotechnology- an interdisciplinary pursuit; Scope and importance of biotechnology and microbial biotechnology; Major areas of microbial biotechnology.	**2**
2. Fermentation Technology:	Principles of fermentation; Introduction to fermenter and bioreactor; Design and principles of fermenter and bioreactor; Media and microorganism for fermentation; Types of fermentation (batch fermentation, continuous fermentation, fed batch fermentation, liquid fermentation and solid state fermentation); Biochemistry and processes of citric acid production.	**3**
3. Antibiotic	Nature of antibiotics; Mode of action; Isolation and screening of antibiotic producing organisms from soil; Giant colony technique and culture and sensitivity (C/S) test; Fermentation process of penicillin.	**2**
4. Enzyme biotechnology	Natures of enzymes; Applications of enzymes; Sources of enzymes; Production of microbial enzymes.	**2**
5. Enzyme mobilization	Introduction to enzyme immobilization; Methods of enzyme immobilization; Advantages of enzyme immobilization	**2**
6. Dairy biotechnology	Introduction to major dairy products (casein, yogurt, cheese, whey and ice-cream); Lactic acid bacteria (LAB); Probiotics and prebiotics, Starter culture; Commercial production of yoghurt and cheese.	**4**
7 Single Cell Protein (SCP)	Introduction to Single Cell Protein; Production and application of SCP; Acceptability and toxicology of SCP.	**2**
8. Microbial Polysaccharides and Polyesters	Introduction to microbial polysaccharides and polyesters;Major microbial polysaccharides (xanthan and dextran); Major microbial polyesters (PHA, PHB and Biopol); Biosynthesis and biodegradation of poly-3-hydroxyalkanoates.	**3**
9 Wastewater Treatment Biotechnology	Characteristics of domestic wastewater; Methods of wastewater treatment; Applications of activated sludge (AS) process, anaerobic sludge digestion and upflow anaerobic sludge blanket (UASB).	**3**
10. Solid Waste Treatment	Introduction to solid waste; Solid wastes treatment by landfills and composting.	**2**
11.Microbial Interactions with Xenobiotic Compounds:	Introduction of xenobiotic compounds; Persistence and biomagnifications of xenobiotic compounds; Polychlorinated biphenyls and dioxins; Alkyl benzyl sulfonates.	**3**
12. Archaea	Introduction and biotechnological application of archaea	**1**
13. Overview of the course	Overall discussion about Microbial Biotechnology	**1**

Unit wise learning outcome

Units	Learning Outcomes
1	▪ Identify biotechnology as an interdisciplinary pursuit ▪ Categorize different types of biotechnology ▪ Relate scope and importance of biotechnology and microbial biotechnology ▪ Discuss importance of microbes in the biotechnology sector ▪ Catalogue major horizons of microbial biotechnology
2	▪ Discuss principles of fermentation ▪ Record and differentiate between fermenter and bioreactor ▪ Assess different designs and principles of bioreactors ▪ Recognize media and microorganisms for fermentation ▪ Categorize different types of fermentation ▪ Identify biochemistry and processes of citric acid production
3	▪ Summarize discovery of antibiotics ▪ Evaluate nature of antibiotics ▪ Classify modes of action of different antibiotics ▪ Explain the process of isolation and screening of antibiotic producing organisms from soil ▪ Analyze giant colony technique and culture and sensitivity (C/S) test ▪ Discuss antibiotic production method ▪ Report on fermentation process of penicillin
4	▪ Discuss natures of enzymes ▪ Summarize applications of enzymes ▪ Identify sources of enzymes ▪ Explain various processes for production of microbial enzymes
5	▪ Catalogue properties of enzymes ▪ Review mode of action of enzymes ▪ Express sources and applications of various enzymes ▪ Explain enzyme immobilization ▪ Catalogue various methods of enzyme immobilization ▪ Recognize advantages of enzyme immobilization ▪ Critique advantages of enzyme immobilization over suspension cultures
6	▪ Enlist major dairy products ▪ Review groups of microflora of milk ▪ Recognize and describe lactic acid bacteria ▪ Identify and compare between probiotics and prebiotics ▪ Characterize probiotics, prebiotics and synbiotics ▪ Define starter culture ▪ Report on commercial production of yoghurt and cheese ▪ Catalogue different types of cheese
7	▪ Explain single cell protein ▪ Diagnose advantages of microbes for production of SCP ▪ List microbes used for production of various SCP ▪ Debate on use of SCP as an alternative food source ▪ Discuss use of various substrates for the production of SCP ▪ Recognize methods for production and application of SCP ▪ Critique the acceptability and toxicology of SCP
8	▪ Describe microbial polysaccharides and polyesters ▪ Catalogue and discuss on production and application of major microbial polysaccharides ▪ Catalogue and discuss on major microbial polyesters ▪ Analyze biosynthesis and biodegradation of poly-3-hydroxyalkanoates
9	▪ Review importance of water ▪ Discuss on water pollution ▪ Analyze characteristics of domestic wastewater and sewage ▪ Summarize various methods of wastewater treatment ▪ Discuss and compare among applications of activated sludge (AS) process, anaerobic sludge digestion and upflow anaerobic sludge blanket (UASB)
10	▪ Identify solid wastes ▪ Explain solid waste treatment techniques by landfills and composting
11	▪ Discuss and identify xenobiotic compounds

	▪ Explain characteristics of xenobiotic compounds attributing to their recalcitrant properties ▪ Impact of xenobiotic compounds onpersistence and biomagnifications. ▪ To know aboutdirty Dozen associated with environmental pollution. ▪ Analyze polychlorinated biphenyls and dioxins ▪ Alkyl benzyl sulfonatesas biodetergent and their fate in environment.
12	▪ Review Whittaker's classification and establish the position of archaea ▪ Discuss on morphological and physiological characteristics of archaea ▪ Review the role of archaea in biogeochemical cycles ▪ Describe biotechnological applications of archaea
13	▪ Acquire a comprehensive knowledge about different aspects of microbial biotechnology

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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: Incourse examination will be taken after completing the lectures on units 1-5 and 6-9.

BOT 516: Molecular Cytogenetics Credit hour: 4

Introduction

This is a basic course in MS (Masters) in Botany program. It will be very helpful to the students for developing clear knowledge about the evolution of karyotype, polyploid complex as an evolutionary unit and origin of higher categories, effects of pre-treatment and fixation on chromosome morphology for karyotype study, the origin and evolution of chromosome banding method, classification and nomenclature of chromosome bands, the nature, mechanism and application of different chromosome banding method.

Course objectives

(a) Students will get a brief idea about the evolution of karyotype, concept of karyotype asymmetry and symmetry, variation within genera with respect to the kryotypes, karyotype asymmetry and seed plant phylogeny, origin of bimodal karyotypes. In addition students will able to describe secondary modification of polyploidy through different causes.

(b) Students will obtain knowledge about polyploid complex as an evolutionary unit and origin of higher categories. In addition, they will able to describe the reversibility of polyploidization, divergent trends in diploids and polyploids, different stages of polyploid complex.

(c) Students will able to develop knowledge about effects of pre-treatment and fixation on chromosome morphology for karyotype study. Moreover they will be able to prepare some pre-treating agents and fixatives that frequently used in cytogenetical studies.
(d) After attentive response of this unit, students will be able to get a brief idea about the origin and evolution of chromosome banding method. In addition, they will also get idea on classification and nomenclature of chromosome bands and develop knowledge about banding and chromosome evolution.
(e) Students will able to describe the nature, mechanism and application of C-banding and G-banding method.
(f) Students will obtain knowledge about Fluorescent banding with CMA, DAPI, DIPI, Ithidium dromide, *etc*.`
(g) Students will get a brief idea about the types, nature, mechanism and application *In situ* hybridization.

Course content

Units	Course content	No. of Lectures
1	Evolution of karyotype: Principal morphological criteria of chromosomes and their significance, dislocation hypothesis, concept of karyotype asymmetry and symmetry, genera of seed plants having constant karyotypes, variation within genera with respect to the kryotypes, increasing and decreasing karyotype asymmetry, karyotype asymmetry and seed plant phylogeny, origin of bimodal karyotypes (earlier and present concept).	**4**
2	Secondary modification of polyploidy: Mutation and genetic recombination, chromosomal segregation, unidirectional introgression, secondary hybridization, secondary doubling, secondary hybrid polyploidy.	**3**
3	Polyploid complex as an evolutionary unit and origin of higher categories: Reversibility of polyploidization, divergent trends in diploids and polyploids, different stages of polyploid complex (initial, young, mature, declining, relictual).	**3**
4	Effects of pre-treatment and fixation on chromosome morphology for karyotype study: (i) pre-treating agents-concentration, duration and temperature of 8-hydroxyquinoline, paradichlorobenzene (PBD), colchicines, α-bromonapthalene and ice-cold water, (ii) acetic acid, Carnoy's fluid, modified Carnoy's fluid, propionic acid alcohol solution as fixatives.	**2**
5	Chromosome banding: Definition, origin and evolution of chromosome banding method, classification and nomenclature of chromosome bands.	**3**
6	Banding and chromosome evolution: (a) Speciation with no apparent changes in banding pattern. (b) Differences in heterochromatin between species. (c) Rules governing the evolution of heterochromatin. (d) Rearrangement of euchromatic parts of chromosomes.	**3**
7	C-banding-methods, nature, mechanism and application.	**3**
8	G-banding methods, nature, mechanism and application.	**3**
9	Fluorescent banding: (a) Ethidium, a fluorochrome that shows no specificity, (b) CMA, shows specificity for GC-rich DNA, (c) DAPI and DIPI, show specificity for AT-rich DNA, (d) Application of CMA- and DAPI-banding.	**3**
10	*In situ* hybridization: (a) Definition, types of probes. (b) Slide preparation, isolation of repeats by *Cot-I* method, PCR-product, digestion with restriction endonuclease, ligation to plasmid, structure of puc 18 plasmid, clonning, labelling of probes, hybridization, post-hybridization wash, mounting and observation. (c) Chromosome mapping using known DNA probes by fluorescent *in situ* hybridization (FISH). (d) Determination of genomic homology and identification of hybrid and putative parents by genomic *in situ* hybridization (GISH).	**3**

Unit wise learning outcome

Units	Learning outcomes
1	Students will get a brief idea about the evolution of karyotype, concept of karyotype asymmetry and symmetry, variation within genera with respect to the kryotypes, karyotype asymmetry and seed plant phylogeny and origin of bimodal karyotypes.
2	Students will able to describe secondary modification of polyploidy through different causes such as mutation and genetic recombination, chromosomal segregation, unidirectional introgression, secondary hybridization, secondary doubling and secondary hybrid polyploidy.
3	Students will obtain knowledge about polyploid complex as an evolutionary unit and origin of higher categories. In addition, they will able to describe the reversibility of polyploidization, divergent trends in diploids and polyploids and different stages of polyploid complex.
4	This unit will help the students to develop knowledge about effects of pre-treatment and fixation on chromosome morphology for karyotype study. Moreover they will be able to prepare some pre-treating agents and fixatives that frequently used in cytogenetical studies.
5	Students will get a brief idea about the origin and evolution of chromosome banding method. In addition, they will also get idea on classification and nomenclature of chromosome bands.
6	This unit will help the students to develop knowledge about banding and chromosome evolution with special emphasis on speciation with no apparent changes in banding pattern, differences in heterochromatin between species, rules governing the evolution of heterochromatin and rearrangement of euchromatic parts of chromosomes.
7	Students will gather knowledge about nature, mechanism and application of C-banding-method.
8	Students will able to describe the nature, mechanism and application of G-banding method.
9	Students will obtain knowledge about Fluorescent banding with CMA, DAPI, DIPI, Ithidium dromide, *etc*.`
10	Students will get a brief idea about the types, nature, mechanism and application *In situ* hybridization.

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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: Incourse examination will be taken after completing the lectures on units 1-5 and 6-10.

BOT 517: Plant Molecular Biology Credit hour: 4

Introduction

This is a basic course in 1 –years integrated M. S. (Masters) in Botany program. It is structured in a way to provide advanced ideas and basic principles about the molecular tools for studying gene and gene function. Students will also get the detailed knowledge about mechanism of homologous DNA recombination, eukaryotic

DNA replication as well as transcription and translation. Moreover, transcriptomics and regulation of eukaryotic gene expression will also be discussed.

Course objectives

a) Acquisition of advanced knowledge about gene and gene functioning.
b) Learn the basic principles and molecular mechanism of DNA replication, transcription and translation in eukaryotic systems.
c) To know the various bioinformatics data bases
d) Learn the sequence analysis using bioinformatics tools
e) Understand necessity of drug design using bioinformatics tools

Course content

Units	Course content	No. of Lectures
1. Molecular tools for studying gene and gene function:	Molecular Separation: Gel electrophoresis, 2-D gel electrophoresis, ion exchange chromatography, gel filtration chromatography, Nucleic acid and protein hybridization techniques, Labeled tracers: Auto radiography, phosphorimaging, liquid scintillation counting and non-radioactive tracers, DNA sequencing, Site directed mutagenesis, Gene knockouts	**12**
2. DNA Replication	Summery of DNA replication in prokaryotes, Enzymology of eukaryotic DNA replication, Eukaryotic DNA replication: detailed mechanism	**4**
3. Homologous Recombination in DNA:	RecBCD pathway for homologous recombination, Experimental pathway for the RecBCD pathway.	4
4 Transcription in Eukaryotes	Eukaryotic RNA polymerases and their promoters, General transcription factors in Eukaryotes, Transcription activators in eukaryotes.	**10**
5. Translation in Eukaryotes:	Initiation of translation, Eukaryotic initiation factors, Eukaryotic translation control.	**4**
6. Regulation of Eukaryotic Gene Expression	Chromatin structure and its effects on transcription, Alternative splicing of mRNA, Trans-spilicing, Post-transcriptional gene regulation by microRNA, Translation and post-translational control, Hormonal control of gene expression.	**10**
7. Transcriptomics	Traditional approaches to RNA expression analysis, Global analysis of RNA expression - i) Expressed sequenced tag analysis and ii) Microarray analysis.	**8**
8. Epigenetics and monoallelic gene expression	Epigenetic markers, Genomic imprinting, Phenotypic consequences of transposable elements, Epigenetic control of transposable elements, Allelic exclusion.	**8**

Unit wise learning outcome

Units	Learning outcomes
1	• Students will learn basic principles and application of the advanced molecular tools for studying gene functions.
2	• Know the basic mechanism of eukaryotic DNA replication and will be able to differentiate with mechanism operating in prokaryotic cells
3	• Learn the mechanism of homologous DNA recombination by RecBCD pathway in bacterial system.
4	• Know the Eukaryotic RNA polymerases and their promoters, general transcription factors in eukaryotes, transcription activators in eukaryotes.
5	• Learn the mechanism of iinitiation of translation in eukaryotes, eukaryotic initiation factors, eukaryotic translation control.
6	• Get fundamental ideas about the mechanism of regulation of eukaryotic gene expression.

7	• Know the basic principles of analysis of gene expression at transcript level.
8	• Get basic concept about epigenetic and monoallelic gene expression.

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3. Weaver RF 2005. Molecular Biology. Mcgraw-Hill International edition
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5. Malini GS 2000. Basic Genetics. Narosa Publishsing House
6. Gardner EJ, Simmons MJ and Snustad DP 1991. Principles of Genetics. John Wiley and Sons Inc.

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: Incourse examination will be taken after completing the lectures on units 1-3 and 4-6.

BOT. 518: Plant Genetic Engineering Credit hour: 4

Introduction

Modern plant breeding techniques, have been used to create new varieties adapted to specific environments or needs—such as crops that are easier to harvest or that are resistant to disease. These breeding practices have been augmented by chemical technology. Pesticides are now widely used to protect crops from insect infestations and fertilizer is routinely used to replenish the nutrients lost from the soil. These breeding strategies, agricultural chemicals, and improved cropping practices have boosted agricultural productivity in many countries of the world including Bangladesh.

In spite these successes, crops are still lost to pests, diseases and climatic extremes. Fertilizer and other chemicals are now consuming an increasing share of the production cost. At the same time, there is growing concern about the effect of these chemicals on the environment. Agricultural problems are more pronounced in the Third World, where the population is rising steadily. Without improvements in agricultural technologies, demand for food is expected to outrun supply early in the next century.

Molecular biology and genetic engineering offer new tools to meet these and other agricultural needs. Molecular biologists now know how to transfer foreign genes into plant cells. They are doing on a molecular level what plant breeders have been doing with whole plants for centuries: combining genes in new ways to create improved crops. Working with single genes, rather than whole plants, offers several advantages. One advantage is specificity. In a sexual cross, the entire genomes of two plants are combined even though the breeder may be trying to transfer a trait controlled by a single gene. It takes repeated back crosses to eliminate the extraneous genes and thus many years to create an improved variety. Using molecular techniques, a gene can be snipped from one plant and spliced into another in a single experiment. Genetic engineering opens up a new source of genetic variability that can be used in crop improvement. Breeders can work only with plants that are cross-fertile. By contrast, genetic engineering offers the promise of selecting valuable traits from any organism. For instance, insect resistant cotton as well as fruit and shoot borer resistant brinjal have been developed and commercialized taking a gene from a soil bacteria, *Bacillus thuringiensis*. Another approach might be the transfer of genes which will make crops tolerant to biotic and abiotic stresses.

This course has been designed to offer an in depth knowledge on the recent developments and applications of genetic engineering, the strategies and various methods needed for developing transgenic plants. Course contents also covers biosafety aspects as well as importance of bioinformatics and Intellectual Property Rights (IPR) in genetic engineering research. Both theoretical presentations and practical laboratory demonstrations will allow students to gain experience in different basic and applied concepts and methods of plant genetic

engineering, trials of genetically modified crops in contained, confined and open field conditions. Students will also compare the benefits and potential risks of genetically modified crops (GM crops).

Course objectives

(a) provide basic principles and historical background of plant genetic engineering.
(b) provide information on Genetic transformation methods.
(c) providelession on vectors and promoters needed for genetic engineering.
(d) methods of characterization of transgenic plants using molecular techniques.
(e) describe methods for Contained, Confined and Open field trials of biotech crops.
(f) provide knowledge on the requirements of biosafety for transgenic research
(g) familiarize the importance of bioinformatics and Intellectual Property Rights

Course content

Units	**Course content**	**No. of Lectures**
1. Plant genetic engineering	Historical background, global status of commercial biotech crops, transgene traits (insect resistance, herbicide tolerance, nutritional quality enhancement, virus resistance, etc.)	2
2.Genetic transformation methods	Direct transformation of protoplasts using PEG, electroporation, microinjection, transformation by particle gun bombardment; chloroplast transformation, *In planta* transformation, methodologies, advantages and disadvantages	3
3. Vectors for *Agrobacterium*-mediated genetic transformation	commonly used vectors, components of transformation vector, integrative and binary vectors	2
4. Promoters used in plant genetic engineering	constitutive, inducible and tissue specific promoters, their merits and limitations	3
5. *Agrobacterium*-mediated genetic transformation	*Agrobacterium* biology, crown gall and hairy root disease, Ti- and Ri-plasmids, vir gene induction and their function, mechanism of T-DNA transfer, binary vector	3
6. Plant tissue culture	as a basis for genetic engineering in plants	2
7. Transient and stable gene expression	Plant selectable markers, Reporter genes (GUS, GFP, Luciferase, etc.), selectable marker genes (Kanamycin, hygromycin, Bialaphos, etc.), elimination of selectable marker gene, transgene silencing	3
8. Molecular characterization of transgenes	PCR based, Southern, Northern and Western blotting	3
9. Contained, confined and open field trials of biotech crops	Requirements and precautionary principles	2
10. Biosafety concerns of transgenic plants	Elements of standard biosafety guidelines, structures and functions of Institutional Biosafety Committee (IBC), Biosafety Core Committee (BCC), Field Level Biosafety Committee (FBC) and National Committee on Biosafety (NCB) as described in the Biosafety Guidelines of Bangladesh 2008	2
11. Bioinformatics	Development of bioinformatics, Databases, Access to databases, online education	3
12.Intellectual property rights	Protection of intellectual property, Forms of protection, Patent application, Plant breeders rights, Farmers rights, Plant variety protection	2

Unit wise learning outcome

Units	Learning Outcomes
1	• Will know the importance and developmental history of plant genetic engineering, global status of commercially released biotech crops including the traits used for specific crops.
2	• Will know about different direct methods of genetic transformation including their advantages and disadvantages.
3	• students will know about the vectors needed for indirect methods of genetic transformation.
4	• Will know about the promoters used in plant genetic engineering including their characteristics.
5	• Students will be able to know the biology of *Agrobacterium*. They will compare the functionality of Ti- and Ri-plasmids, mechanisms of T-DNA transfer, etc.
6	• Will be able to know why plant tissue culture is the integral part of genetic engineering.
7	• Students will be able to compare the differences between transient and stable expression of inserted gene/s as well as they will familiar with the use of reporter and selectable marker genes in genetic transformation.
8	• Will be able to know how to characterize the transgenes through molecular techniques like PCR based, Southern, Northern and Western blotting.
9	• Will know the steps for releasing the genetically modified crops including contained, confined and open field trials as well as the precautionary principles needed to follow during these trials.
10	• Will know the importance of biosafety for transgenic research and the functions of various biosafety regulatory committees as mentioned in the Bangladesh Biosafety Guidelines.
11	• Students will know the developmental background of bioinformatics including its importance in biotechnology research. They will also know how to search the databases for gene sequences, etc.
12	• Will be able to know the importance of Intellectual Property Rights (IPR) for biotechnology research. They will also know the forms of IPR protection and how to protect the Rights of individual inventions

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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: Incourse examination will be taken after completing the lectures on units 1-6 and 7-12, respectively.

BOT 519: Plant Breeding and Biometry **Credit hour**: 4

Introduction

Plant breeding is the process through which the characteristics of plants can be changed over time to make them better crops and more nourishing food. Plant breeding is significantly considered as art as well as science of genetics playing a pivotal role for the improvement of existing varieties of crops. Improved modern varieties of crops are required to feed the ever increasing population all over the world. The techniques of plant breeding are utilized for improving the genetic makeup of the crop plants. Moreover plant breeding provides opportunities in obtaining genetic gains for a particular crop plant for its improvement. Mostly desirable traits are incorporated to produce a new variety. This technique is mainly used to improve the quality of food crop, to produce high yielding crop varieties and also provide resistance to abiotic and biotic stresses. Plant breeding can also develop varieties to cope with climate change through many different techniques ranging from simply selecting plants in farmers fields with desirable traits for propagation, to more complex classical or molecular techniques. The science of plant breeding is not new where both conventional and modern methods of molecular breeding have been exploited. Apart from the modern techniques of breeding the knowledge of biometry and biometrical genetics is important for proper planning as well as evaluation of the materials raised through specific plant breeding experiments and programs. So far several improved varieties of large number of crops have been developed through plant breeding all over the world.

By taking this course students will have the opportunity to get an insight on the various principles and techniques through which they may obtain the ability to develop improved varieties of crops 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 on advanced plant breeding methods to be utilized for crop improvement. The students will also be able to gather knowledge for the development of crops resistant to biotic and abiotic stresses. They will also obtain practical knowledge on the application of molecular markers and maker-aided selection for plant breeding. They will also have exposure to the biometrical techniques applicable for plant breeding and crop improvement program.

Course objectives

a) To get clear idea about the origin and evolution of important cultivated crops.
b) Conservation and utilization of germplasm required for plant breeding.
c) To get clear understanding about various pollination control of flowering plants.
d) Breeding for resistance to abiotic and biotic stresses.
e) Application of various molecular markers and marker assisted selection for plant breeding.
f) To get clear idea about the quantitative inheritance and its utilization in plant breeding program.
g) Various biometrical techniques applicable for plant breeding programs.
h) Use of various experimental designs for the evaluation of materials developed through plant breeding programs.

Course content

Units	Course content	No. of Lectures
1	Plant Breeding: Nature, scope and achievements.	**1**
2	Origin and evolution of crop plants such as rice, wheat, maize and brassicas.	**2**
3	Germplasm conservation, characterization and their utilization; global system on conservation and utilization of germplasm.	**2**
4	Incompatibility system in plants, types of incompatibility, mechanism of self-incompatibility, structural and molecular basis of self-incompatibility; significance of self-incompatibility. Apomixis, genetics of apomixes, application of apomixes.	**3**
5	Breeding for resistance to abiotic stresses, acclimation and crop adaptation to water and salinity stress; development of salinity, flood and drought tolerant crop varieties.	**2**
6	Breeding for resistance to biotic stresses, plant response to pathogens; biochemical and molecular basis of host plant resistance; development of disease and insect resistance crop varieties.	**2**

7	Molecular markers- restriction enzyme and PCR based markers; DNA profiling using different assays- RFLP, RAPD, AFLP, SSR, etc.	**3**
8	Development of mapping populations; recombinant inbred lines (RILS), bulk segregant analysis (BSA), near-isogenic lines; marker assisted selection (MAS); mapping of genes; QTL mapping.	**3**
9	Experimental designs: CRD, RBD, Latin square design, factorial experiments and split plot design. Comparison of treatments by LSD test and Duncan's Multiple Range test.	**3**
10	Quantitative inheritance; components of variation; estimation of variation in F_2, F_3 and back-cross progenies; estimation of heritability and genetic advance.	**2**
11	Diallel analysis: principles of diallelanlysis, components of variation in diallels, analysis of variance in diallels, partial diallelanlysis; Wr -Vr graph.	**2**
12	Combining ability: estimation of general and specific combining ability.	**3**
13	Path analysis: theory, interpretation and application of path analysis	**2**

Unit wise learning outcome

Units	Learning outcomes
1	• Know the nature, scope and achievements of advanced plant breeding.
2	• Know the origin and evolution of important crops.
3	• Know the about the utilization and various germplasm for plant breeding • Characterization and various methods of conservation of germplasm
4	• Know the pollination control of flowering plants including the mechanisms of self-incompatibility systems and apomixis. • Also know the structural and molecular and genetic basis of self-incompatibility; and application and significance of self-incompatibility in plant breeding program. • Apomixis, genetics of apomixes, application of apomixes.
5	• . Know the advanced technique of breeding for the development of abiotic resistance crop plants. • Mechanisms for the development of abiotic stresses tolerance specially development of salinity, flood and drought tolerant crop varieties
6	• know the methods of development of biotic stress tolerant crop plants
7	• Know the application different molecular markers in plant breeding programs
8	• Know the techniques of molecular breeding including marker assisted selection and mapping of quantitative trait loci for crop improvement.
9	• Know the techniques of different experimental designs for their utilization in evaluating the materials developed through specific breeding programs.
10	• Know the various components of variation in various segregating generations, nature of quantitative traits and estimation of heritability and genetic advance.
11	• Know the biometrical techniques ofdiallel analysis and its utilization in plant breeding.
12	• Know the method of estimating the combining ability.
13	• Know the method of path analysis for the selection of yield components and characters for the selection of future breeding program

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Instruction strategies and Learning experiences

a) Lecture followed by Question-answer
b) Group discussion and presentation
c) Project discussion
d) Practical demonstration

Assignment: Students will be given assignment on particular units.

Assessment: Incourse examination will be taken after completing the lectures on units 1-5.

BOT 520: Advanced Plant Nutrition Credit hour: 4

1. Diagnosis of deficiency and toxicity of mineral nutrients: Nutrient supply and growth response, diagnosis of nutritional disorders by visible symptoms, relation between growth rate and mineral nutrient content, nutrient efficiency, histochemical and biochemical methods for diagnosis of deficiency of mineral nutrients.
2. Function and metabolism of essential elements: Nutrient elements as constituents of metabolites and complexes, nutrients elements as activators and cofactors or regulators of enzymes, nutrients elements in physiological processes.
3. Ion uptake mechanism of individual cells and roots: Short distance transport- Pathway of solutes from the external solution into the cell, kinetics of transport, electrogenic proton pump.
4. Modern theories of ion absorption in plants: Dual mechanism of ion transport, chemiosmotic hypothesis.
5. Translocation of ions in plants: Symplastic and apoplastic pathway, endodermis as a barrier of translocation, radial migration of ions.
6. Kraft and Broyer hypothesis of translocation of ions.
7. Distribution and Redistribution of ions: Extraction of ions from the xylem, delivery of ions to the leaf, export of ions from the leaves, movement of ions within the leaves, redistribution of ions in relation to physiological processes.
8. Hydroponics:
9. Interaction of environmental stresses and ion transport in plants.
10. Hormonal regulation of ion transport.
11. Role of plant nutrition in Agriculture.

References

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BOT 521: Applied Cytogenetics Credit hour: 4

Introduction to the course/Course description

This is a basic course in MS (Masters) in Botany program. It will be very helpful to the students for developing clear knowledge about the different types of application of molecular cytogenetic methods. Moreover, students will able to describe the structure, structural and numerical abnormalities of sex chromosomes (X- and Y-chromosome). In addition, they will develop knowledge about X-and Y-chromosome related disorders and relation of X- and Y-chromosome aneuploidy with age and about different cytogenetical and genetical causes of male and female infertility. Further, students will able to describe causes and kinds of Cancer, microarray based

cytogenetics, “Fragile-X”-a family of disorders, genomic imprinting, uniparental disomy and genetic counseling.

Course objectives
• Students will get a brief idea about the application of molecular cytogenetic methods in cereal crop improvement, for studies in the crop-to-wild gene transfer route, to clarify apparently balanced complex chromosomal rearrangements and the study of reticulation (polyploidy/hybridization) by differential fluorescent banding.
• Students will able to describe the structure, structural and numerical abnormalities of sex chromosomes (X- and Y-chromosome). In addition, they will develop knowledge about X-and Y-chromosome related disorders and relation of X- and Y-chromosome aneuploidy with age.
• Students will obtain knowledge about different cytogenetical and genetical causes of male and female infertility. In addition, students can compare between different methods performed for prenatal genetic diagnosis.
• Students will get a brief idea about the discovery, origin, cytogenetical causes and kinds of Cancer.
• Students will develop knowledge about the clinical applications of Microarray based cytogenetics with special emphasis on Comparative Genomic Hybridization (CGH) and Single Nucleotide Polymorphism (SNP).
• Students will gather knowledge about “Fragile-X”-a family of disorders with changing phenotype (physical, behavioral and cognitive) in human.
• Students will able to describe genomic imprinting, uniparental disomy and genetic counseling.

Course content

Units	**Course content**
1.	Application of molecular cytogenetic methods: (a) in cereal crop improvement (b) for studies in the crop-to-wild gene transfer route (c) to clarify apparently balanced complex chromosomal rearrangements (d) to the study of reticulation (polyploidy/hybridization) by differential fluorescent banding. (6)
2.	Sex chromosomes: (a) X-chromosome - Structure, critical region of X-chromosome, X-chromosome inactivation, structural and numerical abnormalities in X-chromosome, X-chromosome related disorders, relation of X-chromosome aneuploidy with age. (b) Y-chromosome - Structure, critical region of Y-chromosome, Y-chromosome inactivation, structural and numerical abnormalities in Y-chromosome, Y-chromosome related disorders, relation of Y-chromosome aneuploidy with age. (5)
3.	Cytogenetics of infertility: (a) Causes of female infertility: (i) Ovarian dysfunction, (ii) Endometriosis, (iii) Hypothalamic and pituitary causes of female infertility, (iv) Cytogenetical, (v) Maternal age, (vi) Social causes (b) Causes of male infertility: (i) Number, morphology, concentration and motility of sperm, (ii) Cytogenetical – Translocation, Mosaicism, Micro-deletion and Inversion, (iii) Paternal age, (iv) Social causes.(6)
4.	Prenatal cytogenetics: Comparison between different methods performed for prenatal genetic diagnosis: (i) Amniocentesis, (ii) Chorionic Villus Sampling (CVS) and (iii) Percutaneous umbilical cord sampling (PUBS), Maternal age in relation to spontaneous abortions, stillbirths and neonatal deaths.(1)
5.	Cancer cytogenetics: Discovery, Origin, Kinds – (a) Solid tumors, (b) Myeloid Neoplasm (Myelo dysplastic syndrome, Myelo proliferative syndrome, Myeloid leukemia, B-cell neoplasm, T-cell neoplasm, Hairy cell leukemia, Mantle cell leukemia, Plasma cell myeloma). (2)
6.	Microarray based cytogenetics: Comparative Genomic Hybridization (CGH), Single Nucleotide

	Polymorphism (SNP), Clinical applications of microarray analysis (to detect cytogenetic abnormalities in children, fetal chromosome anomalies and in oncology). (2)
7.	Fragile X-A family of disorders: X-Linked mental retardation, Changing phenotype (physical, behavioral and cognitive). (2)
8.	Genomic imprinting and uniparental disomy. (2)
9.	Genetic counseling: Family history or clinical suspicion of a genetic syndrome or chromosome abnormalities. (1)

Unit wise learning outcome

Units	Learning outcomes
1	Students will get a brief idea about the application of molecular cytogenetic methods in cereal crop improvement, for studies in the crop-to-wild gene transfer route, to clarify apparently balanced complex chromosomal rearrangements and the study of reticulation (polyploidy/hybridization) by differential fluorescent banding.
2	Students will able to describe the structure, structural and numerical abnormalities of sex chromosomes (X- and Y-chromosome). In addition they will develop knowledge about X-and Y-chromosome related disorders and relation of X- and Y-chromosome aneuploidy with age.
3	Students will obtain knowledge about different cytogenetical and genetical causes of male and female infertility.
4	This unit will help the students to compare between different methods performed for prenatal genetic diagnosis.
5	Students will get a brief idea about the discovery, origin, cytogenetical causes and kinds of Cancer.
6	This unit will help the students to develop knowledge about the clinical applications of Microarray based cytogenetics with special emphasis on Comparative Genomic Hybridization (CGH) and Single Nucleotide Polymorphism (SNP).
7	Students will gather knowledge about “Fragile-X”-a family of disorders with changing phenotype (physical, behavioral and cognitive) in human.
8	Students will able to describe genomic imprinting and uniparental disomy.
9	Students will get a brief idea about the application of genetic counseling.

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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: Two in-course examination will be taken after completing the lectures on units 1-4 and 5-9, respectively.

BOT. 522: Molecular and Applied Phycology Credit hour: 4

Introduction

The MS in Molecular and Applied Phycology provides students with the opportunity to develop their specialist knowledge in modern molecular and applied level of phycology. Identification of algae used to be confined to the light microscope, resulting in some inaccuracies. Accurate identification can only be achieved by careful observation of features and structures at both the light and electron microscope level.Nowadays, molecular analyses along with light and electron microscopy techniques make the identification of organisms more reliable than before.

A series of lectures and practical sessions cover key themes in molecular and applied phycology including identification of algae with light and electron microscopy along with molecular bases, different characters considers for the identification, algal diversity and relationships on the basis of molecules, origin, endosymbiosis and diversification of algae, phylogeny and molecular evolution of algae, study of phytoplankton, the most important part of algae and the aquatic ecosystems, algal culturing methods and their application, algal incredible uses in industrial and technological sites. Laboratory sessions allow students to gain experience in isolation, culture, and subculturing techniques of algae, preparation of media for marine and freshwater algae, DNA extraction and PCR techniques of algae, techniques of electron microscopy, preparation of phylogenetic trees by different methods and cultivation of algae, produce different commercially important foods, industrial and pharmaceuticals products. The Molecular and Applied Phycology aims to equip graduates with knowledge of advanced phycological researches that understanding, practical, research, professional and transferable skills to enable them to undertake further postgraduate training (i.e. Ph. D. level) and/or employment within academic research and in industrial settings at home and abroad.

Course objectives

(a) To gather advanced knowledge in molecular and applied phycology.
(b) To know about the importance of algae with special reference to its industrial and technological applications.
(c) Uses of electron microscopy and molecular evidence for the identification and applications of algae
(d) To know different characters considered for proper identification of macro algae and micro algae
(e) To know the origin of algae, symbiosis, algal diversity and relationships with each other
(f) Obtain knowledge in phylogeny and molecular evolution
(g) Phytoplanktons, their, and role in oceans and seas, primary production, food chain and factors affecting phytoplankton population and abundance
(h) Methods of algae including collection, isolation, cultivation, purification and preservation
(i) The course is suitable to equip students with the advanced knowledge in molecular and applied level of phycology

Course content

Units	Course content	No. of Lectures
1. Introduction	Algal research from ancient to present time, introduction and application of molecular concept in the algal identification and uses. Identification of algae including light, electron microscopy [Transmission Electron Microscopy (TEM) and Scanning Electron Microscopy (SEM)] and	**4**

	molecular bases, limitations and advantages of identifying algae with light microscope, advantages of identifying algae with electron microscope and molecular bases, processes of DNA extraction, sequencing, PCR, electrophoresis, electron microscopy (TEM and SEM) and primer selection / preparation for algae.	
2. Identification of Algae	Characters considered for the identification of algae- structure & ultra-structure of cell, cell coverings, flagella and flagellar apparatus, pigments, chloroplast, nucleus, nuclear division and cell division, mitochondria, pyrenoid and its numbers and positions, the transition region, the basal body, the basal apparatus, micro tubular roots, micro body, cytoskeleton microtubules, molecular characters - e.g. Ribosomal DNA, Rubisco.	**3**
3.Algal diversity and relationships	the diversity and importance of algal species, Molecular phylogenetic approaches, molecular markers for phylogeny construction, Phylogenetic trees - acquiring and aligning the sequences, major methods for making phylogenetic trees (e.g. maximum likelihood (ML), Bayesian inference of trees with Mr. Bayes, etc.), Reconstructing ancestral DNA sequences, application of phylogeny.	**3**
4. Endosymbiosis and diversification of eukaryotic algae:	Origin of eukaryotic algae, Fossil evidence for early events in the diversification of eukaryotic algae, Molecular evidence bearing on the origin of eukaryotic cells and mitochondria, Origin of plastids, Endosymbiosis in the modern world, Prokaryotic endosymbionts, primary, secondary and tertiary endosymbiosis.	**3**
5 Phylogeny and molecular evolution of algae:.	The nature and origin of green algae and land plants. Green lineage relationships- (a) Morphology, Ultra-structure, and Molecules, (b) Phylogeny of the Green Lineage. Green algal evolution: Insights from Genes and Genomes- (**I**) Organelle Genome Evolution, (**II**) Role of Prasinophytes in the evolution of algae, Ecology and Molecular Evolution of Oceanic PicoplanktonicPrasinophytes, (**III**) Genomic insights into Evolution of Complexity in Volvocine Green algae, (**IV**) Genetic code and the translation apparatus in green Seaweeds, ((**V**)) Molecular evolution in the Streptophyta and the origin of Land plant. Spread of green genes in other eukaryotes.	**4**
6. Phytoplankton and the aquatic ecosystems:	Food webs in the oceans, The physical environment, The Chemical environment, Growth and external nutrient supply and uptake, Growth processes of phytoplankton population, Phytoplankton and global climate change, UV radiation effects on phytoplankton (metabolism and development; motility, orientation and vertical distribution, protective strategies), Loss in biomass production and effects on food web, Change in species composition.	**3**
7 Methods of algae	Algal Methods of collection, Isolation, cultivation, purification, and preservation of macro and microalgae. Different culture media- for fresh and marine water algae, their composition, selection of medium for optimum growth of algae.	**3**
8.Algae in industrial uses	Macro and Microalgae as good sources of sustainable Human foods and nutrients, Feeds, Food supplements, Stabilizing agents, promising and exciting source of Bio-fuels, Cosmetics, Beta-carotene, Phycocolloids and Gelling agents (Alginates, Carrageenans, Agars, Algal Cellulose etc.), Antibiotics and medicines in pharmaceutical industries, Chemical dyes and coloring agents in textile, leather and brewing industries, their Extraction processes and uses, Use of algae as organic fertilizer.	**3**
9. Technological Applications of	Algae as research tools, Algal genomics, and proteomics, Algae in bioassay, Algae in space research, Genetic engineering of algae, Algae as pollution	**4**

Algae	controlling agent, the role of algae in land reclamation, algae as cleaners of the world, Algal toxins.	

Unit wise learning outcome

Units	Learning Outcomes
1	▪ Algal research from ancient to present time ▪ Identification of algae with scanning and transmission electron microscopy ▪ Identification of algae with molecular bases ▪ Processes of DNA extraction, sequencing, PCR, electrophoresis, and primer selection/preparation
2	▪ Structure and ultra-structure of cell useful for the identification of algae ▪ Important characters such as cell coverings, flagella, pigments, chloroplast, nucleus, mitochondria, pyrenoid, transition region, basal body, basal apparatus, microtubular roots, microbody, cytoskeleton microtubules ▪ Ribosomal DNA and Rubisco
3	▪ The diversity and relationships of algal species ▪ Molecular phylogenetic approaches ▪ Acquiring and aligning the sequences for making phylogenetic trees ▪ Construction of different types of phylogenetic trees ▪ Application of phylogeny
4	▪ Endosymbiosis and diversification of eukaryotic algae ▪ Origin of eukaryotic algae and fossil and molecular evidence of it ▪ Origin of plastids, mitochondria ▪ Endosymbiosis in the modern world
5	▪ The nature and origin of green algae and land plants ▪ Green lineage relationships ▪ Green algal evolution ▪ Molecular evolution in the streptophytes ▪ The spread of green genes in other eukaryotes
6	▪ Phytoplankton and their role in food webs in oceans and seas ▪ The Physical and chemical environment that affects the growth, distribution, and abundance in oceans and seas ▪ The relationship between phytoplankton and global climate change, ▪ Loss in biomass production and effects on food web ▪ Changes in species composition of phytoplankton
7	▪ Algal methods of collection, isolation, cultivation, and purification ▪ Preservation of micro and macro algae ▪ Composition and preparation of Different culture media for algal growth ▪ Selection of medium for optimum growth
8	▪ Algal uses as foods, feeds, food supplements, stabilizing agents, cosmetics, Beta-carotene etc. ▪ Extraction of phycocolloids such as alginates, carrageenans, agar etc. ▪ Production of antibiotics and medicines in Pharmaceutical industries, ▪ Chemical dyes and coloring agents in textile, leather and brewing industries, their extraction processes and uses ▪ Use of algae as organic fertilizer
9	▪ Algae as research tools such as in space research, genetic engineering etc. ▪ Algal genomics and proteomics ▪ Algae in bioassay ▪ Algae as cleaners of the world ▪ Role of algae in land reclamation

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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: Incourse examination will be taken after completing the lectures on units 1-14 and 15-

BOT. 523 Advanced Plant Anatomy Credit hour: 4

Introduction

Plant anatomy, or the developmental and comparative study of plant cells, tissues and organs, is a botanical discipline with a long tradition. Plant anatomy is both a descriptive and experimental science that employ critical and extensive observation, resulting in the compilation, codification and analysis of descriptive data, as well as use of analytical methods of experimental science. For better understanding of plant physiology, their growth and adaptation to diverse environments including stress, breeding purposes, structural biology and molecular biology aspects of plant anatomy play an inevitable role. Clearly, a solid foundation in plant anatomy is required in order for students to fully participate in the diversity of modern interdisciplinary studies. During BSc (Hons.) 2nd year students have gained basic knowledge on cells, tissues, tissue systems and organs in sequence whereas the present course both throwbacks to those topics with wider knowledge and to advanced and applied aspects of plant anatomy.

Course objectives

- To gain insight on cellular organization of plant body and how that correlate with their varied size and structure during their growth and developmental stages.

- To have knowledge on vascular tissue system that make plants possible long distance transport of water and nutrients.
- To know the anatomical architecture of important organs including flower, fruit and seed.
- To develop perception on how plants are adopted to diverse ecological areas as well as modified their structure to defense or overcome biotic and abiotic stresses.
- To differentiate economically valued different wood on the basis of anatomical characters.
- To know in detailed the basic and advanced experimental tools applied for plant anatomy.

Course content

Unit 1: Cellular complexity of plants	Origin, types, arrangements, shape, development, function and adjustment during growth.
Unit 2: Cell wall gross structure	Classification of wall layers, wall pits,plasmodesmata, organization of wall, orientation of microfibril, formation of wall, formation of intercellular space, non-protoplasmic mineral deposition.
Unit 3: Meristem and meristematic tissue	Origin, development, cytological and morphological characters, cellular basis of differentiation, causal aspects and internal factors of differentiation.
Unit 4: Apical meristem	Definition, delimitation, structure, different growth zones initials and their derivatives, vegetative and reproductive apical meristem, origin and development of leaves, buds, flowers and inflorescence from apical meristem.
Unit 5: Organization of root and shoot apices	Theories of apical organization in plants.
Unit 6: Pattern of vascular differentiation in higher plants	Origin, structure and functions of pro-cambium. Differentiation of vascular tissues from pro-cambium ring.
Unit 7: Vascular cambium	Origin, structure, location, function and cytoplasmic structure of vascular cambium.
Unit 8: Secondary structure of the plant body	Anomalous growth and structures in *Chenopodium*, *Dracaena* stem and *Tinospora* root.
Unit 9: Nodal anatomy	Node-petiole anatomy, additional vascularization pattern, leaf traces, leaf gaps, branch traces and branch gaps.
Unit 10: Anatomy of floral parts	Introduction, anatomical features of floral plants, vascular anatomy and modifications in vascular systems.
Unit 11: Anatomy of fruit wall and seed coat	Fruit walls of dry and fleshy fruits, seed coat.
Unit 12: Ecological anatomy:	Mechanical adaptations, anatomical adaptations to diverse ecological habitat.
Unit 13: Defense mechanisms of plants	Structural response of plants to diseases, pests and mechanical injury, abscission, tissue regeneration and structural basis to resistance.
Unit 14: Anatomical adaptation to abiotic stress	Salinity, drought, heavy metal toxicity.
Unit 15: Wood Anatomy	Soft and Hard wood, properties of wood moisture, density, strength, conductivity, heat and energy, growth ring, grain texture, color and odor, identification of timber.

Unit 16: Practical techniques	A general knowledge of collection, preserving (killing and fixing), staining and mounting of plant materials.
Unit 17: Microtomy	A detailed knowledge of microtomy.

Unit wise learning outcome

Units	Learning outcome
1	• Intricate knowledge on how higher plants are organized and develop based on cellular architecture during their life.
2	• Detailed structural knowledge on one of the most disparate features of plant cells i.e. cell wall.
3	• Knowledge on plant morphogenesis and growth focusing the study of meristematic tissue, their differentiation and development.
4	• Study on how different plant organs have been advanced from shoot and root apical meristem.
5	• Lesson on different theories describing apical organization.
6	• Understanding the discernment of primary vascular tissue: an vital system of plant life.
7	• Detailed structural study of vascular cambium that is responsible for plant secondary growth.
8	• Organization of cellular organization during anomalous secondary growth of several plant species.
9	• Knowledge on additional vascularization pattern from nodal anatomy study
10	• Insight on how floral organ is anatomically different from other organs.
11	• Fundamental knowledge on the anatomy of economically valued fruits and seed coat
12	• Gain knowledge on anatomical as well as mechanical adaptation of different plant tissue system in diverse ecological environment.
13	• Discernment on the anatomical defense of plants to resist or overcome different biotic stresses.
14	• Understand the plant anatomical organization and changes under abiotic stressed conditions.
15	• Specific knowledge on wood anatomical properties to identify and use them more efficiently.
16	• Have insight on how to prepare plant materials for anatomical study under laboratory condition.
17	• Attain theoretical knowledge on how microtomy is worked and handled during plant anatomy experiments.

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BOT 524: General seminar presentation (all students): Nature of topics of the seminar will be decided by the Examination Committee Credit :2

BOT 525: Practical Credit : 6

A student has to take 5 courses each having 30 marks.

Angiosperm Systematics

Units	Title	Learning outcomes
1	Angiosperm flora of Dhaka University campus	Be able to identify the angiospermic flora of Dhaka University campus and its surroundings
2	Studies on complex angiosperm families	Students will be able to identify and recognize complicated angiosperm families and their complex structures
3	Relationships of different plant groups	Gain in-depth knowledge about relationships of common angiosperm families
4	Preparation of Taxonomic keys	Learn how to differentiate species, genera and families using dichotomous key.
5	Isolation of DNA from plant tissues.	Be able to learn the technique how to isolate DNA from leaf.

Medicinal Plants and Herbal Medicines

Units	Contents
1.	Each student should submit herbarium sheets of at least 25 plants along with a field notebook.
2.	Each student or group of students should submit a live medicinal plant with a record book on germination/ propagation, distribution, abundance and medicinal uses.
3.	Identification of medicinal plants and uses of each of them.
4.	Laboratory test for alkaloid/ saponins.
5.	Visit to any herbal productions unit of any standard Pharmaceutical Company

Conservation Biology

Units	Title	Learning outcome
1	Introduction to research protocol	Students will be learned how to develop research proposal
2	Field visits, ecosystem and habitat assessment	Students will be learned how to collect data from the fields. They will also get opportunity to test natural hypothesis
3	Measuring biodiversity (species, ecosystem and genetic diversity)	Students will be learned some techniques of biodiversity measurement
4	Project work	They will get opportunity to conduct individual research project

		independently

Applied Phycology

Units	Title	Learning outcome
1	Effects of light intensity on biomas, pigmentation and nitrogenase activity (Acetylene Reduction Assay technique) of Azolla-Anabaena complex.	
2	Visit to Industries to see the preparation of Navit, Icecream, etc	
3	Field trips to St. Martin's Island/Sundarban Mangrove Forests.	
4	Measuring salinity, specific gravity, conductivity, turbidity, TDS and pH of seawater.	
5	Systematic study of some common phytoplankton and seaweeds.	
6	Commercially important algae.	
7	Commercial products of algae.	

Applied Limnology

Units	Title	Learning outcomes
1	Biological analysis of contaminated waters (both plankton and macrophytes)	By selecting and studying few bodies of contaminated waters, knowledge on quality and quantity of phytoplankton as well as macrophytes will be gathered
2	Determination of photosynthetic active radiation (PAR) by using quantum meter and calculation of vertical extinction co-efficient	By visiting a water body having a depth of about 5-10 m, light measurements in μE/m2/sec at various water depths will be carried out. With the help of this field data and by using the Lambert Beer's law, the vertical extinction coefficient will be calculated. This provides a knowledge on the state of underwater light climate of a lake
3	Biovolume determination of phytoplankton and biomass determination of aquatic macrophytes.	After carrying out the qualitative and quantitative analysis of phytoplankton collected under Unit No. 1, and by identifying the species of dominant phytoplankton, the biovolume of each species will be calculated with the help of literature information
4	Calculation of daily and annual productivity of phytoplankton	With the help of field data as collected from the incubation of Light and Dark Bottle technique, the daily rates of productivity of phytoplankton will be calculated as carbon values over unit time and area of a particular water body.

Hydrobiology

Units	Title	Learning outcomes
1	Collection, identification and characterization of aquatic macrophytes.	-To know about the aquatic macrophytes, their habitats and how to collect the samples from different habitats
2	External and internal morphology of different aquatic macrophytes.	To observe different floristic study - To observe different wetland habitats -- To know the different algal habits and identify algae - To know qualitative and quantitative aspect of phytoplankton
3	Floristic study of haor, baor, river, ponds and lakes in Bangladesh.	
4	Comparison of qualitative and quantitative aspect of phytoplankton in different aquatic habitats of Bangladesh.	
5	Short project on a selected topic (10-15 marks)	- Short project will be made in different unexplored natural habitats and their ecological study
6	Field visit of different wetland habitats, ex-situ culture and herbarium preparation of aquatic plants	-To expedition of collection of hydrobiological materials from natural habitats and herbarium of aquatic plants-detail techniques

Physiological Ecology

Units	Title	Learning outcomes
1	Determination of field capacity in a range of soil types and to calculate the various moisture percentages to set up an experiment.	
2	Determination of organic carbon in soil by Walkly and Black Method.	
3	Study of exchangeable cations in soils.	
4	Study of stomatal frequency and index and stomatal movement in relation to environmental condition.	
5	Determination of conductivity in soil and water samples.	
6	Determination of total alkalinity in Water samples.	
7	Dominant plant species of the Sundarban Mangrove forests and Modhupur Sal Forest.	
8	Measuring moisture status of plant materials and relative turgidity.	
9	Experiments with germination ecology and stomatal movement in a range of plant Species & Report Preparation.	

Natural Resource Management

Units	Title	Learning outcomes
1	Practical training in handling natural resource data	Students will be able to critically evaluate different forests/habitats.
2	Student will submit a term paper on Natural resource management	Will have in hand experience in managing different ecosystems.
3	Determination of species diversity (alpha, beta and gamma diversity)	Will be able to measure and compare diversity of the same as well as different adjacent areas.
4	Determination of Carrying Capacity of different habitats	Will have experience to determine the capacity of an area for better management.
5	Determination of Organic Matter of soil of different habitats	Will have clear concept about the fertility and hence the productivity of the land.
6	Determination of Nitrogen of soil	Will have clear concept about the limiting factor of the land.
7	Student will submit a report on how to restore of a degraded ecosystem in and around Dhaka city	Will have in hand experience in restoring different ecosystems.

Plant Molecular Ecology

Units	**Title**	**Learning outcomes**
1	Extraction and purification of DNA from environmental samples (Plant, soil and microbes)	Students will learn collection, extraction, purification and preservation of DNA samples obtained from the environmental sources
2	Polymerase Chain Reaction and agarose Gel electrophoresis	Learn how to do PCR and gel electrophoresis
3	Use of computer-based softwares for interpreting molecular data (NCBI Blast, RDP, CLC etc).	Learn use software for molecular data and how to interpret molecular data
4	Multiple alignments of the supplied sequences	Know how to interpret molecular data

5	Analysis of digital images (DNA band pattern and community analysis)	Know how to use software in analyzing DNA band profiles and how to analyze community evaluated by molecular methods

Advanced Plant Physiology

Units	Title	Learning outcomes
1	Quantitative determination of photosynthetic pigments by spectrophotometer	• Distinguish the presence of different pigments (e.g. chlorophyll a, chlorophyll b and carotenoid contents) in plant tissue;
2	Extraction and determination of Ca^{2+}, Mg^{2+} and Fe^{3+}in plant tissue	• visualize simple technique for making the importantmeasurements of calcium, magnesium and iron ion in root tissue by spectrophotometer;
3	Extraction and determination of phosphate in plant tissue	• extract and analysis the amount of phosphate in plant tissue using spectrophotometer;
4	Measurement of carbohydrate in plant tissue	• learn about extraction and chemical separation technology, specifically, how to do a liquid phase-extractionin order to separate a mixture of molecules;
5	Determination of total amino acids in plant tissue	• extract and analysis the amount of total amino acids in plant tissue using spectrophotometer;
6	Effect of different chemicals on germination.	• evaluate the effectiveness of different chemicals on seed germination.

Applied Mycology

Units	Title	Learning outcomes
1	Preparation of culture media: PDA. WA, Host extract agar, Oat meal agar	To know about the preparation of different media for isolation of fungi.
2	Common techniques practiced in Mycology Laboratories: Isolation and purification of fungi	Acquire knowledge to isolate economically important fungi following different methods of isolation *viz*. a. tissue planting method, b. botter method and c. serial dilution dilution method.
3	Collections, identification and preservation of fungi	To know about the technique of preservation of fungi.
4	Selected techniques of mushroom cultivation	Acquire knowledge about mushroom cultivation.
5	Preparation of dichotomous key to the fungi studied in the practical course	Acquire knowledge for identification and classification of fungi.
6	Visit to Mushroom cultivation centre, Savar, Dhaka.	Acquire knowledge about mushroom cultivation and its important in agriculture.

Plant Pathology and Plant Protection

Units	Title	Learning outcomes
1	Isolation, purification and identification of plant pathogens obtained from diseased plant parts.	Acquire knowledge to isolate plant pathogens. Develop methodology for identification of unknown fungi.
2	Counting of fungal spores.	Learn the techniques to count fungal spores which is necessary for pathogenicity.
3	Pathogenicity test with fungal isolates obtained from diseased plant parts.	Pathogenicity is necessary to do research in the laboratory. Able to learn methods of pathogenicity.
4	Evaluation of fungicides and plant extracts.	Learn the techniques to find out the best fungicides and plant extract against plant pathogens.

5	Demonstration of dual culture technique	Learn screening techniques to sort out the antagonist for doing research in biological management.
6	Demonstrations of fungistasis	Learn to reduce or kill the number of pathogen in the environment.
7	Collections, identification and preservation of diseased plant specimens.	Know the techniques of collection and preservation of diseased samples in t he laboratory.
8	Visit to plant pathology laboratories of BJRI, BRRI and BARI.	Will be able to observe the diseased materials in the field and laboratories of Bangladesh.

Seed Pathology

Units	Title	Learning outcomes
1	Seed sampling, Dry seed examination, Examination of seed-wash and enumeration of spore load, use of graticules.	
2	Detection of seed-borne fungi by Blotter method, Agar plate, 2,4-D blotter, Deep freezing method.	
3	Identification of different species of seed-borne *Alternaria, Colletotrichum, Drechslera, Fusarium, Macrophomina, Phoma* and other important fungal species.	
4	Detection of important seed-borne pathogens by non-destructive methods.	
5	Determination of seed and seedling quality.	
6	Control of seed-borne pathogen by physical, chemical and biological methods.	
7	Visit to seed production field and seed testing laboratory	

Environmental Microbiology and Biotechnology

Unit No.	Title	Learning outcomes
1	Preparation of common culture media	• Enable to prepare culture media for bacterial culture from samples collected from environments
2	Isolation of microorganisms from different environmental sources	• Isolate bacteria from different environmental samples • Enumerate bacterial culture count in the environmental samples
3	Subculture, pure culture and stock culture	• Prepare subculture of bacteria isolated from different environmental samples • Prepare pure culture of the isolates from the environments • Preserve the bacterial culture isolated from the environments
4	Total microbial counts by epifluorescence microscopy after staining with fluorescence dyes	• Enumerate total bacterial count in the environmental samples
5	Test for protease, oxidase and catalase.	• Isolate bacteria having proteolytic activities • Determine bacteria of oxidase positive • Determine bacteria of catalase positive
6	Isolation of metabolically active bacteria	• Isolate bacteria enable to degrade hazardous wastes • Screening the bacterial isolates from the environment that can be used for degradation of domestic and industrial wastes

Microbial Biotechnology

Units	Title	Learning outcome
1	Introduction	To know about microorganisms and their biotechnological importance.
2	Isolation of biotechnologically important bacteria from nature.	Acquire knowledge to isolate biotechnologically important bacteria from the nature viz. enzyme producing, antibiotic producing bacteria from the nature.
3	Demonstration of fermentation using different carbohydrates.	To know the fermentation capabilities of the bacteriaas well as the interpretation of the fermentation.
4	Laboratory scale of yoghurt production.	Acquire practical knowledge on the lab scale production of yoghurt.
5	Acquaintance with different groups of antibiotics.	Get a brief idea about the commercially available antibiotics used in our country.
6	Work out of Culture and Sensitivity (C/S) test.	The interaction in between bacteria and the commercially available bacteria as well as the interpretation of sensitivity or resistantpattern that is what kind antibiotic will be effective against particular bacteria.
7	Microbial hydrolysis of starch and protein	To know about the presence of enzyme in the microorganisms and their performances on the specific substrate as well as the interpretation of the enzyme action.
8	Measurement of microbial biomass (dry weight).	Acquire knowledge about microbial growth and interpretation of the growth measurement in the form of biomass.

Molecular Cytogenetics

Units	Title	Learning outcomes
1	Preparation of different pre-fixatives (PDB, 8-hydroxyquinoline, colchicines, α-bromonapthalene) and fixatives (acetic acid, Carnoy's fluid, modified Carnoy's fluid, propionic acid alcohol solution).	This unit will help the students to develop expertise in preparation of different frequently used pre-treating agent and fixatives.
2	Use of different pre-fixatives on the chromosomes of *Allium cepa* for a comparative chromosome morphology study.	After attentive response of this unit, students will be able to compare chromosomal morphology after using different pre-fixatives.
3	Photomicrography of well-spread mitotic metaphase plates.	This unit will enable the students to take photo micrographs of well-spread mitotic metaphase stage.
4	Preparation of karyotype and idiogram from those photomicrographs.	This unit will help the students to learn basic techniques in preparation of karyotype and idiogram.
5	Comparative karyotype analysis among different species from the supplied data	Upon successful completion of this unit, students will be able to do comparative karyotype analysis among different species
6	Study of chromosomal aberration and phylogenetic relationship by CMA- and DAPI-karyotype analysis from the supplied data.	This unit will help the students to develop knowledge about chromosomal aberration and phylogenetic relationship by CMA- and DAPI-karyotype analysis from the supplied data.

Plant Molecular Genetics

Units	Title	Learning outcome
1	Isolation and purification of genomic DNA from plant or bacteria using various techniques	Students will be capable of isolation of good quality genomic DNA RNA and Proteins from both prokaryotic and eukaryotic cells. They will also learn the techniques of estimating quality and quantity using modern equipment as well as well conventional laboratory methods.
2	Isolation of RNA from bacteria or plant samples	
3	Total protein isolation and quantification by Bradford and Lowry methods	

4	Prepare a restriction map of supplied DNA sample through restriction digestion, gel electrophoresis and imaging of the gel	Students will learn physical mapping of genome by restriction digest of DNA, running agarose gel and taking image thereafter.
5	Preparation of vector and insert DNA for cloning	Students will learn the recombinant DNA technology which includes- - vector and insert DNA preparation though restriction digestion and purification. -preparation of chemically competent *E.coli* cells. - setting ligation and transformation of the ligation products to obtain recombinant clone using *E.coli* competent cells. -Analysis of clones through PCR and restriction digestion.

Plant Genetic Engineering

Units	Title	Learning outcome
1	Explant preparation from various plant materials for transformation	Through this topic students will know how to prepare suitable explants for transformation from different crop of interest.
2	*Agrobacterium*-mediated genetic transformation using marker gene	Students will know the steps of Agrobacterium-mediated genetic transformation including transformation, incubation, co-culture and set up regeneration experiments following transformation.
3	Transient gene expression through histo-chemical assay	Students will know preliminary screening of the transformation experiments to select proper conditions for transformation, namely, incubation period, OD of the bacterial suspension, duration of co-cultivation, etc. through histo-chemical assay.
4	PCR based techniques for the detection of transgene following transformation	Through this topic students will know how confirm the integration of transgene through PCR experiments of genomic DNA.
5	Agarose gel electrophoresis	Students will have the opportunity to prepare agarose gel and set experiments for the separation of DNA.

Plant Breeding and Biometry

Units	Title	Learning outcomes
1	Study of pollen-pistil interactionsusing fluorescent microscope.	• Students will study the post pollination events using fluorescence microscope following various self- and cross-pollinations in available crop plants
2	Identification of self- and cross-incompatibility types in crop plants.	• Students will carry out several self- and cross-pollinations using different plant materials. With the help of fluorescent microscope the will identify the nature of self and cross pollinations.
3	Characterization of various germplasms using isozyme and DNA markers.	• Students will learn how to characterize different germplasm using isozyme markers using Poly acrylamide gel electrophoresis and enzyme localization on gel. • They will also use DNA markers for characterization of important germplasm.
4	Construction of different experimental designs. Analysis of variance following experimental designs.	• Students will learn to prepare lay out for different experimental designs. • Students will also perform analysis of variance following various experiments. They will use modern scientific calculator for this perpose.
5	Determination of heritability	• Students will estimate heritability using data from

	from various segregating populations.	segregating populations with the help of specific biometrical technique.
6	Working out the problems involving path-coefficient analysis	• Students will carry out the path analysis for the selected plant materials using advanced calculators and will be able to make comments on the result obtained.
7	Study tour to research institutes like, BARI, BRRI, BINA, BJRI, BSRI, BTRI, BFRI, etc.	• Through these tour program students will be acquainted with the research activities of the respective institutes as well as their achievements in various fields of plant breeding.

Advanced Plant Nutrition

Units	Title	Learning outcomes
1	Extraction and determination in Fe^{3+}, Ca^{2+} and Mg^{2+} plant tissue.	
2	Extraction and determination of phosphate in plant tissue by spectrophotometric method.	
3	Effects of abscisic acid on Na^{+}, K^{+}, transport.	
4	Effects of gibberelic acid on K^{+}& Na^{+} transport.	
5	Effects of Kinetin on K^{+}& Na^{+} transport	
6	Growing plants in hydroponics.	

Applied Cytogenetics

Units	Title	Learning outcomes
1	Study of various human diseases caused by chromosomal abnormalities from supplied karyotypes	After attentive response of this unit, students will be able to compare various human diseases caused by chromosomal abnormalities from supplied karyotypes.
2	Preparation of ice-dry slides for chromosome banding	This unit will help the students to develop expertise in preparation of ice-dry slides for chromosome banding.
3	Observation and interpretation of different chromosome bands	This unit will enable the students to observe and interpret different chromosome bands.
4	Physical mapping by FISH with known probes	This unit will help the students to learn basic techniques of performing FISH analysis.

Molecular and Applied Phycology

Units	Title	Learning outcomes
1	Isolation, culture and sub-culturing techniques of micro- and macro algae	Gain advanced knowledge on the methods of collection, isolation, purification, culture, sub-culture, cultivation, and preservation of micro and macro algae.
2	Media preparation for marine and freshwater algae	Learn techniques for preparing different types of stock and culture media. Acquire knowledge on the composition and preparation of different culture media for the growth of algae and selection of media for optimum growth of algae.
3	DNA extraction and PCR techniques of algae.	Students will be trained with advanced knowledge on the processes of DNA extraction, sequencing, PCR, electrophoresis, and primer selection / preparation for algae.
4	Techniques of electron microscopy (TEM and SEM) of algae	Gain advanced knowledge on the uses of scanning and transmission electron microscopes to know the structure of algal cell that are very much useful for the accurate identification of algae.
5	Preparation of phylogenetic trees of algae by major methods (e.g. maximum likelihood and Bayesian inference of trees with Mr. Bayes, etc.) depending on their DNA	Acquire knowledge on molecular phylogenetic approaches, acquiring and aligning the sequences for making phylogenetic trees and construction of different types of phylogenetic trees to know the diversity and relationships among different algal species.

6	Cultivation of algae, their products, and uses.	Gather knowledge about cultivation methods of commercially important algae and the extraction procedures of different products collected from various types of algae that are being used as foods, feeds, food supplements, stabilizing agents, cosmetics, beta-carotene, phycocolloids, antibiotics, medicines, chemical dyes, coloring agents, organic fertilizers, etc.

Advanced Plant Anatomy

Units	Title	Learning outcomes
1	Cell maceration techniques (Schultz's method).	Assist students to practically isolate, observe and differentiate among different types of cell and tissue of plant body.
2	Internal structures of different types of leaves.	Gain insight on anatomical features of photo-synthetically important organ i.e. leaf.
3	Different types of stomata (Dicot and Monocot) from leaves.	Detailed study of structural organization of different types of stomata that generally found on leaf to help maintain gas and water exchange with environment.
4	Secondary structure of *Chenopodium*, *Piper* and *Tinospora* stem.	Observation of anomalous secondary structure of stem from different important plant species to understand how they deviate from normal structure.
5	Preparation of permanent slide (free hand section) by using double stain – Safranin and Fast green.	Skills to prepare permanent slide of anatomical sections and learn to delineate different tissue types depending on stain.
6	Study of shoot apex - Dissection of shoot with the help of fine blade by removing the young leaf primordia and exposing the apical meristem.	Techniques to dissect and study apical meristem from shoot apex.
7	Microtomy: a) Types of microtome machine. b) Collection, killing and fixing materials in a fixative. c) Preparation of paraffin blocks of the fixed materials. d) Section cutting (both T.S. and L.S.) of the paraffin blocks with the help of microtome machine and mounting ribbons on slides. e) Staining of paraffin slides with suitable stain and preparation of permanent slide.	Basic knowledge on microtomy, hands-on training for preparation of plant anatomical slides using microtomy and finally trouble shooting of the technique.

BOT 526: Thesis (60% Thesis Examination+ 40% Presentation) **Credit : 6**

BOT 527: Viva-Voce **Credit : 2**