Detailed curriculum outline of Third Year B.S. Honours Course

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

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

Introduction

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

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

Course objectives

- **(a)** Gather preliminary knowledge about environmental microbiology, habitat, niche etc.
- **(b)** Gather microbial interation and the interaction in between higher plants and microbes.
- **(c)** Know about extreme habitats and extremophiles.
- **(d)** Course is suitable to equip students with knowledge and solution to our environmental problems.

Course content

Units	Course content	No. of Lectures
1: Introduction to environmental microbiology	Definition; Brief historical development ; Scope and importance; Habitat; Ecological niche, Autochthonous vs Allochthonous	**3**
2: Microbiology of soil	Litho-ecosphere; Composition of soil; Roles of soil, Soil microbial communities; Humus and soil organic matter; Soil as a culture medium.	**4**
3: Microbiology of water	Hydro-ecosphere; Freshwater habitats; Neustone; Pleuston; Composition and activity of fresh and marine water microbial communities; Coliform bacteria in potable water versus microbial pollution.	**4**
4: Microbiology of air	Introduction to atmosphere; Types of microorganisms in air; Bioaerosal; Air pollution; Significance of air-borne microorganisms in human and plant diseases.	**4**
5: Microorganisms of extreme habitats	Introduction to extreme habitat ; Basic idea about extremophiles, thermophiles, psychrophiles, extremozymes and their importance.	**4**
6: Interactions among microbial populations	Positive and negative interaction; Neutralism; Commensalism; Synergism; Mutualism and Amensalism (antagonism).	**4**
7: Interactions between microorganisms and plants	Interactions among plant roots, rhizosphere and rhizoplane, plant root effects or microbial population. R:S ratio, effects of rhizosphere microbial population on plants, Nitrogen fixation in nodules, Nitrogen fixing association between rhizobia and legumes, Non-legumenous nitrogen fixing mutualistic relationships, Interactions of mcrobes with aerial plant structures.	**5**
8: Microorganisms and biogeochemical cycle	Introduction to biogeochemical cycles; Mineralization and immobilization; Role of microorganisms in nitrogen cycle and sulfur cycle with special reference to oxidative and reductive sulfur transformation; Winogradsky column.	**2**

Unit wise learning outcome

Units	Learning outcomes
1	• define and understand environmental microbiology • report key historical developments in the field of environmental microbiology by renowned scientists of this field • explain scope and importance of environmental microbiology • discuss and differentiate between habit and ecological niche • identify various habit and ecological niche for microbes • distinguish between autochthonous and allochthonous microbes
2	• explain litho-ecosphere • define soil from various perceptions • analyze composition and role of soil • identify soil microbial communities • describe and distinguish between humus and soil organic matter • enlist major microbial groups in soil • classify soil microbes based on their ecology

	• inspect the use of soil as a culture medium
3	• explain hydro-ecosphere and review freshwater habitats • discuss and compare between neustone and pleuston • analyze the composition and activity of fresh and marine water microbial communities • Importance of coliform bacteria in potable water • summarize microbial water pollution
4	• recall atmosphere, its characteristics and stratification • define aeromicrobiology and bioaerosol • categorize microorganisms in air • illustrate distribution of microbes in air • investigate sources of microorganisms in air • analyze the survival method of microbe spores in air and its relation to pigmentation • summarize air pollution • interpretsignificance of air-borne microorganisms in human and plant diseases
5	• identify extreme habitats • summarize basic idea about extremophiles • discuss and compare between thermophiles and psychrophiles • to know about extremozymes and their importance
6	• compare and categorize positive and negative interactions among microbes • recognize neutralism, commensalism, synergism, mutualism and amensalism (antagonism) • reference various practical examples in nature of different interactions between microbial communities
7	• relate interactions among plant roots, rhizosphere and rhizoplane • discuss bulk soil and rhizodeposition • inspect plant root effects on microbial population • explain R:S ratioand its importance • to know theeffect of rhizosphere microbial population on plants • describe Nitrogen fixation in nodules • illustrate Nitrogen fixing associations between rhizobia and legumes • relate non-leguminous nitrogen-fixing mutualistic relationships • explain interactions of microbes with aerial plant structures
8	• explain and list different biogeochemical cycles • describe and differentiate between mineralization and immobilization • to get a fair idea about the role of microorganisms in nitrogen cycle and sulfur cycle • analyze the Winogradsky column and an example of disigning an experiment on the study of different microbial groups

References

1. Alcamo IE 1994. Fundamentals of Microbiology (4th edn.). The Benjamin/Cummings Publishing Company, Inc.
2. Atlas RM and R Bartha 1997. Microbial Ecology: Fundamentals and applications. Benjamin/Cummings Science Publishing. California.
3. Madigan MT, JM Martinko and J Parker 1997. Brock Biology of microorganism (8^{th}edn.) Prentice Hall, Upper Saddle River, NJ 07458.
4. Pelczar MJ, ECS Chan and NR Krieg 1986. Microbiology. McGraw-Hill Book Company.
5. Tortora GJ, BR Funke and CE Case 1997. Microbiology - An Introduction. Addison Wesley Longman. Inc. California.

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.

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

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

Course objectives
(a) Know about the total losses of plant produces due to diseases in the world.
(b) Differentiate between healthy and infected plants.
(c) Explain how the plants are infected by fungi.
(d) Identify the causal organisms of respective plant diseases.
(e) Know about the diseases of different crops *viz.*, rice, wheat, jute, pulse and oil seed plants etc.
(f) Establish the control measures for the specific plant diseases

Course content

Units	Course content	No. of Lectures
1:Introduction:	Historical background, scope and importance of Plant Pathology.	**4**
2: Concept of plant disease	Causes of plant diseases, importance of plant diseases and diagnosis of plant diseases.	**4**
3: Parasitism and disease development	Parasitism and pathogenicity; stages in the development of plant diseases (inoculation, infection, growth and reproduction, dissemination, overwintering and/or oversummering) and symptomatology.	**8**
4: Plant disease control	Principles of plant disease control, regulatory, cultural and chemical methods.	**6**
5: Crop diseases	Symptoms, causal agent, disease cycle and control measures of the following crops: a) Rice: Blast, brown spot, stem rot, sheath blight, foot rot of banana and sheath rot. b) Wheat: Stem rust, leaf rust and loose smut. c) Pulses and beans: Rust of beans and lentil, leaf spot of bean and cow-pea, anthracnose of bean. d) Jute: Stem rot, black band, anthracnose and soft rot. e) Sugarcane: Red rot and whip smut. f) Groundnut: Tikka disease and rust.	**8**

Unit wise learning outcome

Units	Learning outcomes
1	• contribution of different scientists in the field of Plant Pathology. • Importance of plant diseases to mankind.
2	• to know the concept of plant diseases • gather types of plant diseases

	• diagnosis of plant diseases
3	• different stages of disease development
4	• different control measures of plant diseases such as regulatory, cultural and chemical methods
5	• etiology, life cycle of plant pathogens and control of selected plant diseases

References

1. Agrios GN 2002. Plant Pathology (5th edn.). Academic Press Inc., N.Y.
2. Lucas JA 1998. Plant Pathology and Plant Pathogens. Balckwell Science Ltd., London.
3. Mehrotra RS 1987. Plant Pathology, Tata McGraw-Hill Company, New Delhi.
4. Mundker BB and RS Singh 1984. Introduction to Principles of Plant Pathology (3rd edn.). Oxford IBH Publishing Co. Pvt. Ltd., New Delhi.

Instruction strategies and Learning experiences

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

Assignment: Students will be given assignment on particular units

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

BOT 303: Advanced Phycology **Credit hour**: 2

Introduction

This course will cover the Advanced Phycology and why algae are important for technological application, and why we are interested in them for both their environmental benefit, as well as some of their products, benefits, and challenges that impact our ability to make commercially viable products from algae. You will also explore the vast diversity of algae including the classifications, culture, growth and their evolution. Later you will learn about algal ecology and their interactions with environment. And finally you will study what types of algal researches were done in Bangladesh and its status in relation to world history.

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

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

Course content

Units	Course content	No. of Lectures
1:Classification of algae	Comparative study of classification of Fritsch 1935, Bold and Wynne 1985 and Lee 2008: Characterize the classes mentioned by Bold and Wynne (1985).	
2: Growth	Growth pattern and evolutionary trends in algae.	
3: Chloroplast	Ultra structure of chloroplasts in algae.	
4: Metabolites	Extracellular metabolites in algae.	
5: Algal culture and	Scope of algal culture; methods of algal culture (unialgal and axenic cultures); growth curve in batch culture and morphogenesis in blue	

morphogenesis	green algae	
6: Applications of algae	Technological applications of algae: Bio-diesel, oil and coal deposition, indicators of polluted water and algal toxicity, fossil diatoms and genetic engineering	
7:Phycological researches	Phycological researches in Bangladesh and its status in relation to world history	

Unit wise learning outcome

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

References

1. Aderson RA 2008. Algal cultural technique. Phycological Soc. America, Elsevier/Acad. Press.
2. Bold HC and MJ Wynne 1985. Introduction of the Algae. Prentice-Hall, New Jersey, USA
3. Fogg GE, WDP Stewart, P Fay and AE Walsby 1973. The blue-green algae. Acad. Press., London.
4. Hoek C, VDG Den and HM Jahns 1995. Algae: an introduction to Phycology. Cambridge Univ. Press, Cambrige.
5. Lee RE. 2008. Phycology. Cambridge Univ. Press, Cambridge.
6. Prescott GW 1970. How to know the freshwater algae. W.M.C. Brown Company Pub.
7. Round FE 1981. The ecology of algae. Cambridge Univ. Press, Cambridge.
8. Smith GM 1951. Manual of Phycology. Ronald, N.Y.
9. Stewart WDP 1974. Algal physiology and biochemistry. Blackwell Sci. Publ.

Instructional strategies/ Learning experiences

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

Assignment: Students will be given assignment on particular units
Assessment: Incourse examination will be taken after completing the lectures on units 1-3.

BOT 304: Physiological Ecology and Conservation Biology **Credit hour**: 2

Introduction

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

Course objectives

The objective of the course is to acquaint the students with the ……..

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

Course content

Units	Course content	No. of Lectures
	A. Physiological Ecology	
1: The Physical World	(i) Vertical structure of the physical world. (ii) Surface area of the globe, (iii) Water storage in the hydrosphere, (iv) Composition of sea water (v) Variation of atmospheric temperature and pressure with altitude.	**3**
2: The ecosystem	Interplay of biological and environmental factors. Growth of human population for the past half million years.	**2**
3	Physico-chemical aspects of waterlogged soils; Oxygen Diffusion Rate (ODR) and Oxidation-Reduction Potentials; Classification of saline habitats.	**3**
4	Effects of salt concentration on germination of halophytes. Ecotypic differentiation.	**2**
5	Greenhouse effect; Ozone layer depletion, Carbon dioxide and the world climate.	**3**
6	Methods of measurement of primary production; Factors limiting primary productivity in aquatic and terrestrial communities.	**3**
7	Pesticides and Related compounds, DDT and its effects; Lead and Mercury concentrations in the habitat.	**2**
8	World Forests. Total territory of forest land; Species diversity. Hot Spots and Megadiversity.	**3**
	B. Conservation Biology	
9	A Brief History of Conservation Biology. Conservation Biology and the Management of Natural Resources. Some characteristics of Conservation Biology. Threats to Biological diversity; Rates of extinction; Human caused extinctions.	**3**
10	Conservation values and Ethics. The value of Biodiversity; Instrumental value and intrinsic value.	**1**
11	Management of Genetic variation in Natural population. Contribution of Molecular Biology to Conservation.	**3**
12	Types of species and Communities most likely to be affected by global climate change. Common Problems in Conservation Biology. (2 classes).	**2**

Unit wise learning outcome

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

References

1. Bannister P 1976. Introduction to Physiological Plant Ecology. Blackwell Scientific Publications.
2. Barbour MG and Burk JH 1987. Terrestrial Ecology. The Benjamin Publishing Company
3. Etherington JR 1971. Environment and Plant Ecology. John Wiley & Sons.
4. Etherington JR 1976. Physiological Plant Ecology. John Wiley & Sons.
5. Lambers H and FS Chapin 1997. Plant Physiological Ecology. Springer.
6. Meffe GC 1994. Principles of Conservation Biology. Sinauer Associates, Sunderland.
7. Primack RB 1995. A Primer of Conservation Biology. Sinauer Associates Inc. Publishers. U. S. A.
8. Waisel J 1972. Physiological Ecology: Biology of Halophytes. Academic Press.

Instruction strategies and Learning experiences

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

Assignment: Students will be given assignment on particular units

Assessment: In-course examination will be taken after completing the lectures on units 1-4 or 9-12

BOT 305: Contemporary Systematics **Credit hour**: 2

Introduction

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

Course objectives

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

Course content

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

Unit wise learning outcome

Units	Learning outcomes
1	• understanding of nomenclature and be able to synthesize the principles, rules, regulations and provisions of ICN
2	• demonstrate deeper insights into different concepts of species, the fundamental unit of taxonomic hierarchy
3	• demonstrate ability to critically and systematically integrate knowledge and perspectives and to analyse, assess and deal with ecotype concept and biosystematics categories
4	• understand key methods and principles of phylogenetic classification ssystems along with their outlines, pros and cons
5	• be able to evaluate how chromosomal data, pollen characters and bio-chemical characters play vital role in plant systematics and phylogenetics
6	• recognize major patterns and processes of breeding systems in plants
7	• be able to retrieve and critically evaluate the status of Biodiversity in global and Bangladesh context, mode of biodiversity conservation as well as the scenario of the extinct, endangered and threatened plants of the country, and demonstrate an ability to reflect on their personal impact on biodiversity
8	• learn aquatic angiosperms of Bangladesh, their classification and how they can play an important role for ecosystems and human benefit.
9	• be able to recognize and identify important plant families with the use of identification keys, better understanding of plant morphology terminology and how to describe plant species profile scientifically, and economic importance of plants used in practical life.

References

1. Davis PH and VH Heywood 1963. Principles of Angiosperm Taxonomy. Oliver Boyd, Edinburgh & London.
2. Hassan MA and MK Alam 1997. Udvid Sreni Binnas Totta (3rd edn.), Hassan Book House, Dhaka.
3. Hooker JD 1872-1897. Flora of British India, Vols. 1-7. L. Reeve & Co. Ltd., England.
4. Khan MS and M Halim 1987. Aquatic Angiosperms of Bangladesh. BARC, Dhaka.
5. Khan MS (ed.) 1973-2002. Flora of Bangladesh. Fascicles 1-53. Bangladesh National Herbarium, Dhaka.
6. Lawrence GHM 1951. Taxonomy of vascular plants. The Macmillan Co., N.Y.
7. Prain D 1903. Bengal plants. vols. 1-2. Botanical Survey of India, Calcutta.
8. Radford AE, WC Dickison, JR Massey and CR Bell 1974. Vascular Plant Systematics, Harper & Row Publishers, N.Y.
9. Stace CA 1989. Plant Taxonomy and Biosystematics (2nd edn.), Edward Arnold, London.

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 some Units.

BOT 306: Plant Biochemistry **Credit hour**: 2

Introduction

This is a basic course in 4-years integrated BS (Hons) in Botany program. Plant Biochemistry is a science concerned with the chemical nature and chemical behaviour of the living matter. It brings biology and chemistry together. The coverage of the subject is divided into a few sections which include - primary metabolites (carbohydrate, protein and lipid); secondary metabolites (terpenoids,

alkaloids and phenolic compounds) and vitamins. It is one of the academic disciplines in life science that studies the structure, function, metabolism and the mechanism of the components in the cells; such as carbohydrates, proteins, lipids etc.

Course objectives

(a) The main focus of Plant Biochemistry is in understanding how biological molecules give rise to the processes that occur within living cells, which in turn relates greatly to the study and understanding of whole organisms.
(b) It focuses on what is happening inside the cells, studying components like carbohydrates, proteins, lipids etc.
(c) Successful completion of this course will provide students with fundamental knowledge of plant biochemistry and specific knowledge of molecules, compounds, structures and biochemical pathways that occur in plants.

Course content

Units	Course content	No. of Lectures
1 Sugar and their derivatives	Chemistry and distribution of (a) Monosaccharides, (b) Oligosaccharides (sucrose, maltose and cellobiose) and (c) Polysaccharides (starch, glycogen and cellulose).	**6**
2 Amino acids and Protein	Chemical nature, properties, classification with examples and structure..	**4**
3: Fatty acids and Lipids	(a) Chemical nature, properties, distribution, classification with examples and structures, (b) β-oxidation.	**4**
4:Terpenoids	(a) Chemistry and distribution, (b) Classification, (c) The pathway of terpenoid biosynthesis in plants, (d) Essential oils.	**4**
5: Alkaloids	(a) Chemistry and distribution, (b) Classification, (c) Plant families with alkaloids.	**4**
6: Phenolic compounds	(a) Shikimic acid pathway, (b) Flavonoid pigments: chemistry, distributions and properties..	**4**
7: Vitamins	(a) Chemistry and distribution, (b) Importance of vitamins in plants and animals..	**4**

Unit wise learning outcome

Units	Learning outcomes
1	• list the different classes of carbohydrate with examples, write the molecular formulae and the structures of the examples, state functions of carbohydrate and differentiate the different classes of carbohydrate
2	• classify amino acids and proteins according to structure, size, composition etc, describe the different structures of proteins
3	• define fatty acids and lipids, state the constituents of lipids, classify lipids, describe the functions and properties of triglycerides, phospholipids and glycolipids, fatty acid degradation
4	• clarify the concept of primary and secondary metabolites and their importance; explain chemistry, distribution and classification of terpenoids and biosynthesis of terpenoids
5	• impart knowledge about chemistry, distribution and classification of alkaloids
6	• explore chemistry, distribution and classification of phenols; biosynthesis of shikimic acid; and itemize flavonoid pigments
7	• elucidate the sources, function and deficiency symptoms of water and fat soluble vitamins

References

1. Conn EE and PK Stumpf 1972. Outlines of Biochemistry (3rd Ed), John Wiley and Sons. Inc.
2. Goodwin TW and EL Mercer 1983. Introduction to Plant Biochemistry (2nd Ed), Pergamon Press.
3. Harborne JB 1973. Phytochemical methods. Chapman and Hill, London.
4. Krogmann DW 1977. The Biochemistry of green plants. Prentice-Hall of India Pvt. Ltd., New Delhi.
5. Lehninger AL 2005. Principles of Biochemistry (4th Ed), Freeman and Company, N.Y.
6. Hopkins WG 1991. Introduction to Plant Physiology, 2nd Edn. John Wiley and Son, 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.

BOT. 307: Molecular Genetics **Credit hour**: 2

Introduction

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

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

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

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

Course objectives

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

Course contents

Units	Course content	No. of Lectures
1: Nucleic acids	(a) Nucleic acid as genetic material of living organisms: evidences to prove the genetic nature of DNA; RNA as the genetic material in viruses; (b) DNA: chemical composition and structure, Watson-Crick model, general features of DNA; (c) RNA: chemical composition, structure, types of RNA and their characteristics.	**6**
2: Replication of DNA	Mechanism of DNA replication; Meselson-Stahl experiment, Cairns' autoradiography experiment; replication of circular DNA molecules.	**2**

3: DNA repair mechanism	Photoreactivation, excision repair, post replication recombination repair and SOS repair.	**2**
4: Mutation	Nature and types of mutations, molecular basis of mutation, point mutation, physico-chemical mutagens, detection of mutation in *Drosophila* by *ClB* and attached-X methods: isolation of mutants in *Neurospora.*	**2**
5: Transposable genetic elements	Genetic instability and discovery of transposable elements; transposable elements in bacteria and eukaryotes; significance of transposable elements.	**2**
6 : Fine structure of genes	Classical versus molecular concept of genes, cis-trans, complementation test, fine structure of the phase T4 rII locus, the nature of mutations in the rII region.	**2**
7: Recombination in Bacteria	Transfer of genetic materials; transformation, transduction and conjugation; genetic mapping in *E. coli* by conjugation.	**2**
8 : Gene expression	Protein synthesis apparatus - structure of tRNA and ribosome; mechanism of transcription; post- transcriptional modifications of mRNA, tRNA and rRNA; genetic code: characteristics of genetic code, deciphering the code, degeneracy and wobble, initiation and termination codons, universality of the code, the code dictionary; mechanism of translation.	**6**
9:Regulation of gene expression in prokaryotes	General features of gene regulation; induction and repression: operon concept; *lac*, *ara* and *trp* operons.	**2**
10:Gene cloning	Recombinant DNA and gene cloning, plasmid and phage vectors, restriction enzymes, restriction maps and their properties, recombinant selection and screening.	**2**
Unit 11 Polymerase Chain Reaction (PCR) technology:	Methodology and various applications of PCR technology.	**2**

Unit wise learning outcome

Units	Learning outcomes
1	• know the structure and biochemical properties of DNA and RNA molecules as well as the genetic properties of DNA and RNA molecules.
2	• know the mechanism of replication of linear and circular DNA molecules.
3	• know the various mechanisms of damaged DNA molecules.
4	• know the concept of nature and types of mutations, molecular basis of mutation, various detection methods and applications of mutation.
5	• know the discovery of transposable elements, significance of transposable elements.
6	• Know the classical and molecular concept of genes, fine structure of genes.
7	• know the various methods for the exchange of genetic materials in bacteria.
8	• know the mechanism of gene expression, protein synthesis, transcription and translation mechanisms, role of genetic code in protein synthesis.
9	• know the mechanism of regulation of gene expression in prokaryotic organisms.
10	• know the mechanism of gene cloning and development of recombinant DNA

	molecules and their role.
11	• know the Polymerase Chain Reaction (PCR) technology, its methodology and various applications of this technology.

References

1. Akhtaruzzaman M 2000. Bangshagati bidhya. Hassan Book House, Dhaka.
2. Avers CJ 1980. Genetics, Willard Grant Press, Boston.
3. Ayala FJ and JA Kiger 1980. Modern genetics. The Benjamin/Cummings Publishing Company Inc., London.
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6. Lehninger AL 1982. Principles of Biochemistry, Worth Publication, N.Y.
7. Lewin Benjamin 1994. Genes V. Oxford University Press.
8. Watson JM 1976. Molecular Biology of gene (3rd edn.), Benjamin Inc.
9. Watson JD, TA Baker, SP Bell, A Gann, M Levine and R Losick 2009. Molecular Biology of the gene. Pearson Education, Inc.

Instructional strategies/ Learning experiences

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

Assignment: Students will be given assignment on particular unit.

Assessment: Incourse examination will be held after completion unit 1 to 5 (following 7 lectures)

BOT 308: Principles of Crop Improvement **Credit hour**: 2

Introduction

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

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

Course objectives

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

Course content

Units	Course content	No. of Lectures
1: Self- and cross incompatibility	Self- and cross incompatibility in cultivated plants: Mechanism of self- and cross incompatibility, methods of overcoming incompatibility barriers.	**4**
2: Male sterility systems:	Cytoplasmic, genetic and genetic cytoplasmic, use of male sterility in crop improvement.	**2**
3:Heterosis breeding	Basis of heterosis and inbreeding depression, use of heterosis in plant breeding.	**2**
4: Polyploidy:	Definition, classification, characteristic features of polyploidy, use of polyploidy in crop improvement.	**4**
5: Haploid breeding	Development of haploids through conventional breeding and tissue culture methods, significance of haploid breeding.	**2**
6: Development of crop varieties	Development of disease resistant, salt and drought tolerant crop varieties through hybridization.	**3**
7: Embryo rescue	Embryo rescue technique in overcoming barriers of distantly related crosses.	**3**
8: Germplasm conservation	*In situ* and *Ex situ* germplasm conservation and cryo-preservation, importance of germplasm conservation in crop breeding.	**4**
9: Agricultural research institutes	Introduction to different national and international agricultural research institutes engaged in the development of improved varieties of different crop plants.	**6**

Unit wise learning outcome

Units	Learning outcomes
1	• know the mechanisms of self- and cross incompatibility systems and their use in plant breeding
2	• know different male sterility systems and their applications in plant breeding
3	• know basis of heterosis and inbreeding depression and their use in plant breeding
4	• know the concept of polyploidy and its use in crop improvement
5	• know the methods of production and significance of haploids in crop improvement
6	• know the methods of development of biotic and abiotic stress tolerant crop plants
7	• know how to recover hybrids resulted from distantly related crosses using embryo culture techniques
8	• know how to conserve germplasm using different methods and their utilization in crop breeding
9	• know the contribution of different national and international agricultural research centres towards development of improved crop varieties

References

1. Allard RW 1964. Principles of Plant Breeding. John Willey & Sons, N.Y.
2. Briggs FN and PF Knowles 1978. Introduction to Plant Breeding. Reinhold Publishing Corporation, N.Y., London.
3. Chaudhari HK 1976. Elementary principle of plant breeding. Oxford & IBH Publishing Co., New Delhi.
4. Frey JJ 1966. Plant breeding. Iowa State University Press, Amsterdam, Iowa.
5. Islam AS 1995. Bangshagati bidyar mulkatha, Bangla Academy, Dhaka.
6. Pochlman JM 1979. Breeding Field Crops. Avi Publ. Co., New Delhi.
7. Pochlman JM and DN Bharthakur 1968. Breeding Asian field crop. Oxford IBH Publ. Co., New Delhi.
8. Simmonds NW 1979. Principles of crop improvement, Longman, London.

9. Simmonds NW 1984. Evolution of crop plants. Longman, London.
10. Van der Have DJ 1979. Plant Breeding perspectives. Centre for Agricultural Publishing, Documentation, Wageningen.

Instruction strategies and Learning experiences

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

Assignment: Students will be given assignment on particular units

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

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

Introduction

Pteridophytes constitute a significant and important group in the plant kingdom since they have made the colonization of land Pteriodophyta is considered possible for the plants and evolutionary link between spore bearing and seed plants. Therefore, undeniably one of the fundamental courses for four-years integrated BS (Hons) in the Department of Botany. The course presents the origin and evolution of important aspects of pteridophyta with the description of taxonomy, morphology, reproductive processes, life cycle, economic importance and phylogenetic relationships of the varied groups, both living and extinct, proceeding from the simple to the complex. All the major groups of living and common pteridophytes will be described for better understanding of the group of plants as well as their evolutionary progression.

Course objectives

(a) differentiate pteridophyta from other groups of plant and thereby learn the importance of studying pteridophytes.
(b) develop a sense of origin and evolutionary progression of leaf, stele and overall sporophytic body among different groups of pteridophytes .
(c) attain the knowledge of seed habit in relation to heterospory nature of pteridophytes.
(d) know the diversity of sporophytic and gametophytic structure of existing groups of pteridophytes along with their reproduction, life cycle and economic importance.
(e) gain a general knowledge of transition in plant phylogeny from lower to higher gradation.

Course content

Units	Course content	No. of Lectures
1: Introduction and importance	Definition, general characters, characters resembling and disassembling pteridophytes from other groups of plants. Importance of studying pteridophytes.	**2**
2: Classification	Classification proposed by different pteridologist and discussion on general characters of four main divisions of pteridophyta.	**2**
3: Origin and evolution	Theories and debates regarding the origin of pteridophytes from algae and bryophytes, evolution among different groups of pteridophytes.	**4**
4: Types of stele and their evolution	Stelar theory, different types of stele found in pteridophytes and their evolution to more diversification and complex structure.	**4**
5: Detailed study of	Distribution, habitats, external and internal features, reproduction, life cycle and economic of different important genera: The	**16**

important genera	following genera will be discussed:(a) *Psilotum*, (b) *Lycopodium*, (c) *Selaginella*, (d) *Equisetum*, (e) *Ophioglossum* (Eusporangiate),(f) *Pteridium* (Leptosporangiate), (g) *Marsilea* (Leptosporangiate).	
6: Heterospory and seed habit	Definition, importance and origin of heterospory, heterospory and seed habit, origin of seed habit, seed habit in *Selaginella*.	**2**

Unit wise learning outcome

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

References

1. Emes AJ 1964. Morphology of vascular plants. Tata McGraw-Hill Publishing Co., Ltd., Bombay.
2. Pandey SN, SP Misra and PS Trivedi 2016. A text book of Botany, vol.II, Vikas Publishing, India.
3. Parihar NS 1956. An Introduction to Embryophyta vol. I & II. Central Book Depot, Allahabad.
4. Smith GM 1955. Cryptogamic Botany, vol. II. McGraw-Hill Book Company Inc. N.Y., London.
5. Vashista PC 1993. Botany for Degree Students: Pteridophyta, S.Chand and Company Ltd., Ramnagar, New Delhi.

Instruction strategies and Learning experiences

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

Assignment: Students will be given assignment on particular units.

Assessment: In-course examination will be taken after completing the lectures on units 1-3 with

- Multiple choice questions
- Fill in the blanks
- Diagram drawing
- Short questions
- Broad questions

- Course Final examination with
  - Broad questions
  - Short Notes

BOT 310: Introductory Limnology **Credit hour**: 2

Introduction

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

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

Course objectives

(a) Define Limnology and learn about its placement in the biological sciences, historical backgrounds and scopes.
(b) Acquire knowledge about the cyclic rotation of water and the relationship between water and population growth on a global perspective.
(c) To know about the origin of lakes, global lake ecosystems, their freshwater reserves.
(d) Learn physicochemical properties of water how and why plants and animals live in it.
(e) Evaluate that the light as the mother of all governing and metabolic forces in natural water.
(f) Learn about the inflow and out flow of the materials in the aquatic ecosystems, conversion of energy into biological production and destruction and mineralization.

Course content

Units	Course content	No. of Lectures
1: Introduction to Limnology	Placement of Limnology in Natural Science. definition of Limnology, early landmarks in limnology, key early inventions and techniques, limnology turning as a science, current trend, development of limnology in Bangladesh, scopes.	**5**
2: Water	Its origin, cycle, a valuable resource and its future, demophoric growth principle, concept of energy slaves, bodies of inland water, distribution and origin, lakes, distribution, origin of lake basins, seven special lake types, natural lakes of Bangladesh.	**5**
3: Fundamental characteristics of water	As a substance, the dihydride of oxygen, liquid nature of water, water related factors, effects of temperature and salinity on water density, adhesion and cohesion, viscosity, surface tension and neuston community.	**5**
4: Light	Its sources, quality, role of light in aquatic ecosystems, light and water, underwater light climate, heat budget, calculation in lentic and lotic waters, albedo, water color, thermal stratification and mixing, classification of lakes depending mixing, water movement and flow.	**5**
5: Material budget of natural waters	Chemical factors, dissolved oxygen, salinity, conductivity, origin and assimilation of inorganic carbon, pH, nitrogen, phosphorus, sulfur, iron and manganese, silica and diatom growth, trace elements, biological production, consumption and destruction, nutrient demand and material balance.	**5**
6: Biomass destruction and energy flux	Distribution and destructive roles of microbes, biomass destruction, autolysis, bacterial decomposition, important groups of aquatic bacteria, material transport and energy flux in the ecosystem.	**5**

Unit wise learning outcome

Units	Learning outcomes
1	• define Limnology and place it in natural science • early history of limnology • early key invention of techniques related to limnology • turning limnology as a science and its current trend • scopes of limnology and its development in Bangladesh
2	• water, liquid of life, its origin, cyclic rotation and future

	• demophoric growth principles and concept of energy slaves • inland water bodies, origin, distribution, classification • natural lakes, definition, origin of basins, distribution, water renewal rate • seven special lake types of the world • natural lakes of Bangladesh
3	• water as a substance, its relation with other dihydrides of oxygen • three states of water • density of water and factors affecting it • adhesion, cohesion and viscosity factors of water, biological relations • surface tension of water and development of Neuston community
4	• solar radiation, its physical properties, governing force in aquatic habitats • how light relates water surface, underwater light climate • heat budget, albedo and water color factors • thermal stratification and circulation, causes and consequences • global lake classification depending on mixing and stratification • waves and currents, their types and biological and physicochemical role
5	• growth limiting factors, biogenic gases, major, minor and trace elements • dissolved oxygen and carbon dioxide, their distribution and role • pH, salinity and conductivity of water • nitrogen and phosphorus cycle • sulfur, iron, manganese and trace metals • silica and diatom growth • biological production, consumption and destruction • nutrient demand by aquatic plants and material balance
6	• microbes in aquatic habitats, its destructive role • biomass destruction and autolysis • bacterial destruction and important groups of aquatic bacteria • material transport and energy flow in the aquatic ecosystem

References

1. Cole GA 1979. Text book of Limnology. 2nd Edn. The Mosby Co. London.
2. Dodson S 2005. Introduction to Limnology. Mc-Graw Hill, Boston. pp. 400.
3. Khondker M 1994. Limnology. Mowla Brothers, Dhaka. pp. 464.(in Bangla).
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5. Odum EP 1971. Fundamentals of Ecology. W.B. Saunders Co. Philadelphia. pp. 574.
6. Ruttner F 1975. Fundamentals of Limnology. 3rd Edn. Translated from German by DG and FG Fry, Univ. of Toronto Press. Toronto.
7. Schwoerbel J 1987. Handbook of Limnology. Ellis Horwood Ltd. Chichester. pp. 228.

Instruction strategies and Learning experiences

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

Assignment: Students will be given assignment on particular units

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

BOT 311: Structural Cytogenetics **Credit hour**: 2

Introduction

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

Course objectives

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

Course content

Units	Course content	No. of Lectures
1:Eu chromosome	**A. Physical structure**: (i) Primary constriction or centromere - ultrastructure and chemical properties, classification of chromosomes on the basis of centromeric position and number, procedure for chromosome classification, (ii) Secondary constriction - NOR, SAT and their chemistry, (iii) Arms, (iv) Telomere - function and chemistry, (v) Chromomere (in meiotic chromosome). **B. Chemical structure:** (i) Chromatin - physical and chemical nature, (ii) Eu-chromatin and heterochromatin, role of heterochromatin in chromosome pairing, (iii) Nucleosome model.	**3**
2: Karyotype and idiogram	Karyotype and idiogram in brief, symmetric, asymmetric, monomodal and bimodal karyotype and significance.	**3**
3: Genome analysis	(i) Genome in respect of Cytogenetics, (ii) karyotype analysis, (iii) chromosome association in meiosis, (iv) chromosome banding - CMA, DAPI and C banding, (v) Fluorescent *In situ* Hybridization (FISH) and Genomic *In situ*Hybridization (GISH).	
4: Abnormalities in cell division	(i) Non-disjunction - genetic control of disjunction, ii) endopolyploidy or endoreduplication, (iii) polyteny, (iv) cytomixis, (v) formation of cross-spindle, (vi) elimination of single or set of chromosomes in insects (Sciaridae).	**6**
5: Chromosomal aberrations	General account and classification.	**2**
6: Structural aberration	(i) Deletion - Definition, identification, kinds, detection, genetic effect, meiotic behavior, breakage - fusion - bridge cycle, (ii) Duplication - Definition, identification, kinds, detection, genetic effect, meiotic behavior, breakage - fusion - bridge cycle, (iii) Inversion - definition, kinds, synapsis, results of double crossing over in intra- and extra-loop, consequence of chromatid bridge,	**16**

	(iv) Translocation - definition, kinds, Robertsonian translocation - helps in altering karyotype, meiosis in translocation heterozygote, consequences of crossing over at the interstitial and differential regions of interchange complex, breeding behavior and identification of chromosomes involved in translocation.	

Unit wise learning outcome

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

References

1. Akhtaruzzaman M 2008. Kosh-bangshagatibidhya (3rdedn.), Bangla Academy, Dhaka.
2. Garber ED 1992. Cytogenetics, McGraw-Hill Inc, N.Y.
3. Schulz-Schaeffcr J 1980. Cytogenetics, Springer- Verlag, N.Y.
4. Sumner AT 2003. Chromosome - organization and function. Blackwell Pub. U.K.
5. Swanson CP 1965. Cytology and Cytogenetics. MacMillan & Co. Ltd., London.
6. Swanson CP, V Merz and YZ Young 1982. Cytogenetics. Prentic Hall Inc. New Jersey, UGC.
7. Singh RJ 2005. Plant Cytogenetics (2ndedn.), CRC Press.

Instruction strategies and Learning experiences

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

Assignment: Students will be given assignment on particular units

Assessment: In-course examination will be taken after completing the lectures on units 1-3.

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

Introduction

A rudimentary course in four-years integrated BS (Hons) for the Department of Botany. Embryology of angiosperms centered on the study of the structures and processes leading to seed formation. This is a fascinating subject because it encompasses many unique developmental events of generative and embryological structures of flowering plants (e.g. sporogenesis, gametogenesis, zygogenesis,

endospermogenesis, embryogenesis, apomixes). The study of angiosperm embryology will lead to a better understanding of reproduction, growth and development of plant. Therefore, this subject offers inevitable and fundamental knowledge for plant breeding, seed biology, plant systematic and biotechnological applications in plant development.

Course objectives

(a) identify and describe development of male reproductive organ of angiosperms.
(b) recognize different types of ovules along with development of female reproductive organ and their structural organization.
(c) explain fertilization process leading to zygote formation.
(d) describe two most striking parts of angiosperm reproduction i.e. endosperm and embryo development and their classification.
(e) define what is apomixis (asexual reproduction) and their applications.
(f) understand polyembryony development.
(g) know and apply the knowledge of embryology for experimental and practical purposes.

Course content

Units	Course content	No. of Lectures
1: Historical background	Discovery of pollen tube, Schleiden's theory of origin of embryo, discovery of true relationship between pollen tube and embryo, discovery of nature and development of male and female gametophyte, discovery of syngamy, chalazogamy, double fertilization and parthenogenesis.	**2**
2:Microsporangium	Wall layers of microsporangium, sporogenous tissue, cytokinensis and microspore tetrad.	**4**
3: Male gametophyte	Microspore, formation of vegetative and generative cells, division of generative cell, vegetative nucleus and embryo sac like pollen grain.	**2**
4. Megasporangium	Integuments, micropyle, nucellus, integumentary tapetum, archesporium, megasporogenesis and functioning megaspore.	**2**
5: Female gametophyte	Monosporic, biosporic and tetrasporic embryo sacs, organization of mature embryo sac, embryo sacs with disturbed polarity and embryo sac haustoria.	**4**
6: Fertilization	Germination of pollen, course of pollen tube, entry of pollen tube into embryo sac, growth rate of pollen tube and gametic fusion.	**2**
7: Endosperm	Type of endosperm formation - free nuclear endosperm, cellular endosperm, helobial endosperm, relationships between different types of endosperm.	**2**
8: Embryo	Dicotyledons - Crucifer type, asteroid type, solanoid type, chenopodiad type, caryophylad type, development of monocot embryo and modifications of suspensor.	**4**
9 : Apomixis	Non recurrent apomixis, recurrent apomixis, gametic and somatic apospory and adventive embryony.	**2**
10:Polyembryony	Cleavage polyembryony, origin of embryos from cells of embryo sac other than egg, embryos arising from cells outside embryo sac, embryos originating from other embryo sacs in ovule.	**2**
11;Experimental	Control of fertilization, embryo culture, induced parthenogenesis,	**4**

Embryology	production of adventives embryos and induced parthenocarpy.	

Unit wise learning outcome

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

References

1. Maheswari P 1950. An Introduction to the Embryology of Angiosperms. Tata McGraw-Hill Publishing Co. Ltd., Bombay, New Delhi.
2. Nels R. Lernsten 2008. Flowering Plant Embryology. Blackwell Publishing.
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4. Bhojwani SS and WY Soh 2001. Current Trends in the Embryology of Angiosperms. Springer Netherlands.
5. Bhojwani SS, SP Bhatnagar and PK Dantu 2015. The Embryology of Angiosperms (6th ed.), Vikas Publishing House Pvt. Ltd., New Delhi, India.

Instruction strategies and Learning experiences

Assignment: Students will be given assignment on particular units.

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

BOT 313: Practical - 1 **Credit**: 2

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

A. Environmental Microbiology

Units	Title	Learning outcomes
1	Isolation of air borne bacteria by air exposure plate technique	• Acquire practical knowledge to isolate microscopic bacteria in the form of colony.
2	Isolation of soil bacteria by potato culture technique	• Development of simplified isolation technique of bacteria from soil.
3	Observation of different microbial colonies	• Acquire knowledge about different type of microbial colonies *viz.* bacteria, actinomycetes etc.
4	Observation of legume nodule and nodule bacteria	• Acquire knowledge about bacteria associated with legume nodule and their morphological characteristics.
5	Microscopic study of bacteria by Gram staining method	• Development of knowledge about key procedure of identification of bacteria based on identification using microscope.
6	Culture and sensitivity (C/S) test	• Interpretation of sensitivity test that is what kind antibiotic will work to control particular bacteria.

B. Plant Pathology

Units	Title	Learning outcomes
1	Laboratory studies of common diseases and pathogenic fungi covered in theory: Major rice, jute and rust diseases, Tikka disease of groundnut, Smut disease, Anthracnose of bean, Red rot of sugarcane, Leaf spot, rot and blight diseases, Black spot or rose	• Know the practical knowledge about the selected diseases
2	Preparation and sterilization of culture media for fungal growth	• Know the types of plant diseases • Diagnosis of plant diseases
3	Isolation of fungal organisms from diseased plant parts following blotter and tissue planting methods	• Isolation of fungal organisms from diseased plant parts following blotter and tissue planting methods
4	Demonstration of pathogenicity test with soil borne and leaf pathogens	• Isolation of fungal organisms from diseased plant parts following blotter and tissue planting methods
5	Processing and preservation of pathogenic fungal specimens for phytopathological herbarium	• Studies of plant diseases in nature
6	Local and long excursions to collect fungal specimens	

C. Advanced Phycology

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

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

D. Physicological Ecology and Conservation Biology E. Contemporary Systematics F. Plant Biochemistry

D. Physicological Ecology and Conservation Biology

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

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

E. Contemporary Systematics

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

F. Plant Biochemistry

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

BOT 315: Practical - 3 **Credit hour**: 2

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

G. Molecular Genetics

Units	Title	Learning outcomes
1	Isolation and estimations of proteins from various plant tissues.	• Will be able to isolate protein from plant tissue and be able to estimate the amount of protein using specific quantity of plant tissue.
2	Analysis of plant proteins, sodium dodecyl sulphate polyacrylamide gel electrophoresis (SDS-PAGE) of proteins.	• SDS-PAGE is a useful molecular technique for the analysis of plant proteins. Will be able to learn the procedure for the preparation of proteins samples for SDS-PAGE.
3	Estimation of molecular weight of polypeptides using SDS-PAGE.	• Characterization of proteins from various plants samples particularly through the estimation of molecular weights of polypeptides.
4	Native gel electrophoresis, detection of isoenzymes using enzyme location gels.	• Through this experiment various plant materials including genotypes, germplasm, various species can be characterized.
5	Isolation of DNA from plant tissues.	• Will be able to learn the technique for the isolation of DNA from plant tissue.
6	Agarose gel electrophoresis of DNA and characterization of various DNA samples.	• Will be able to learn the technique of gel electrophoresis for the molecular characterization of various DNA samples.

H. Principles of Crop Improvement

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

I. Pteridophyta

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

BOT 316: Practical - 4 **Credit hour**: 2

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

J. Introductory Limnology

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

K. Structural Cytogenetics

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

L. Embryology of Angiosperms

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

BOT 317: Viva-Voce **Credit hour**: 2