Detailed curriculum outline of

Fourth Year B.S. Honours Course

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

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

Introduction

This is a basic theoretical course and prerequisite to complete the 4 year integrated B. S. (Honors) in Botany Degree. After completing two Microbiology courses in previous years (General Microbiology and Environmental Microbiology), students will learn basic laboratory techniques employed in the field of microbiology in this course and it mainly focuses onvarious culture media, cultivation, isolation and culture preservation methods, microbial growth measurement, microbiology of food, milk and water and finally various methods of controlling microbes.

Course Objectives:

(a) Describe how to cultivate various microorganisms in different media and growth conditions.
(b) Discuss and apply various methods of isolation techniques for bacteria.
(c) Explain different methods of culture preservation.
(d) Express bacterial growth and multiplication, relate to bacterial growth curve and effect of pH and temperature on bacterial growth.
(e) Exploit techniques related to measurement of microbial growth.

(f) Describe topics related to microbial assessment of food, food spoilage, food borne pathogenic microbes and their control.
(g) Summarize microorganisms associated with milk and pasteurization.
(h) Recognize microbial water pollution, indicator organism and coliform bacteria.
(i) Identify different practices for controlling of microbes.

Course content

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

Unit-wise Learning Outcomes

Units	Learning outcomes
1	• define and categorize diverse types of bacteriological culture media • identify uses of different bacteriological culture media and compare between them • explain function of media sterilization and autoclaving • analyze mechanism of an autoclave machine • execute nutrient agar preparation and sterilization by autoclaving in practical class • report aerobic and anaerobic bacterial culture techniques • discuss pure culture, mixed culture and contaminated culture

2	• explain and demonstrate Serial dilution technique • analyze and distinguish Pour plate and Spread plate technique • describe Membrane filtration technique • report and perform Mud-pie technique for isolation of *Azotobacter* sp. from soil • perform aseptic techniques for isolation of microbes • record and conduct streak dilution technique
3	• review importance of culture preservation • discuss different methods of bacterial culture preservation • compare between different methods of culture preservation • locate important bacterial type culture collections of the world
4	• explain growth and multiplication of bacteria • estimate bacterial growth in logarithmic scale • sketch and interpret a bacterial growth curve and its different phases • analyze and calculate generation time and Growth rate of a bacterial population • summarize effect of pH and temperature on bacterial growth • categorize bacteria based on their optimum growth pH and temperature
5	• describe method of direct microscopic count • calculate bacterial population using direct microscopic count • discuss viable cell count for plate technique and membrane filtration technique • Memorize process of dry weight measurement for microbial populations
6	• diagnose different food items for presence of microbes using various methods • explain microbial food spoilage basing on food biochemical types • express symptoms and reasons of food-borne infections and intoxications • discuss and imply methods of food preservation using heat, drying and chemicals
7	• categorize microorganisms associated with milk • determine milk quality using phosphatase enzyme test • practice methylene blue reduction test to investigate milk quality of various sources • explain principle of pasteurization • list and describe techniques used for milk pasteurization
8	• catalogue microbes responsible for water-borne diseases • identify indicator organism and its importance • differentiate and characterize total coliform and fecal coliform bacteria • estimate coliform bacteria from a water sample using mpn technique • recall membrane-filtration technique for testing the presence of coliform bacteria
9	• explain various physical methods for controlling a microbial population using heat, filtration and radiation • discuss different chemical methods for controlling a microbial population using phenol, halogen and alcohol • summarize control of microbes using chemotherapeutic agents and antibiotics • analyze modes of action of antibiotics on a bacterial cell • report on culture and Sensitivity (C/S) test and E (epsilometer) test

References

1. Tortora GJ, BR Funke and CE Case. 2016. Microbiology: an introduction (12th Edition). Pearson Education, Inc. USA.
2. Pelczar MJ, ECS Chan and NR Krieg. 1986. Microbiology (5th Edition). McGraw-Hill Book Company. USA.
3. Pommerville JC. 2018. Fundamentals of Microbiology (11th Edition). Jones & Bartlett Learning. USA.
4. Talaro KP and B Chess. 2018. Foundations in Microbiology (10th Edition). McGraw-Hill Education. USA
5. Madigan MT, KS Bender, DH Buckley, WM Sattley and DA Stahl. 2017. Brock Biology of Microorganism (15th Edition).Pearson Education, Inc. USA.

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

Assignment: Students will be given assignment on particular units

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

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

Introduction

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

Course objectives

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

Course content

Units	Course content	No. of Lectures
1	Introduction to Marine Botany: Marine ecology: (a) Chemical (nutrient elements, pH, salinity, Carbon cycle, etc.) and physical (light, temperature, waves and current, upwelling, density) properties of seawater. (b) Horizontal and vertical zonations of seas and oceans.	**6**
2	Diversity of (a) Marine phytoplankton: Classification and adaptation of phytoplankton, (b) Seaweeds, (c) Sea-grasses.	**6**
3	Factors affecting biomass of phytoplankton and seasonal variation of plankton.	**2**
4	Factors affecting seaweed and reef growth, biomass and phytogeography of seaweeds.	**2**
5	Estuarine ecology: Sundarbans and its reclamation.	**4**
6	Toxic Algae and human health.	**4**
7	Marine environment a balancing factor of the earth: Role of phytoplankton and seaweeds (Carbon sink, Cleanser of the atmosphere, cooling of the Earth, etc.).	**2**
8	Marine biotechnology: (a) Biofuel, (b) Seaweed cultivation, c) Extraction of phycocolloids and uses as food and industrial and pharmaceutical products.	**4**

Unit wise learning outcome

Units	Learning outcomes
1	• Define and understand Marine Botany • Different factors including different chemical and physical properties of Oceans and seas • Horizontal and vertical zonations of Oceans and seas
2	• Know about the diversity of phytoplankton • Importance of phytoplankton, classification and adaptation • Seaweeds identification, cultivation and processing and uses in different types of industrial and pharmaceuticals products • Identify phycocolloids and their production • Sea grasses and their importance
3	• How different factors affects biomass of phytoplankton • Seasonal variation of plankton
4	• Factors affecting seaweed and reef growth • Biomass of seaweeds • Phytogeography of seaweeds
5	• Estuarine Ecology • Sundarbans and its reclamation
6	• Toxicity of algae • Human health and algae
7	• How a marine environment acts as a balancing factor of the earth • Role of phytoplankton and seaweeds • Carbon sink, cleanser of the atmosphere, cooling of the earth.
8	• Marine biotechnology • Potentiality of extraction of biofuels from algae • Seaweeds use as food, industrial and pharmaceuticals products

References
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2. Anon. 2016. Adaptive Trials on Seaweed Cultivation, BARC, Farmgate, Dhaka.
3. Bold HC and Wynne MJ 1985. Introduction of the Algae. Prentice-Hall, New Jersey, USA
4. Castro P and ME Huber 2003. Marine Biology. McGraw Hill. N.Y. 468 pp.
5. Dawes CJ 1998. Marine Botany. Willey and Sons, NY. 480 pp.
6. Lee RE. 2008. Phycology. Cambridge Univ. Press, Cambridge.
7. Levinto J 2009. Marine biology: function, biodiversity and ecology. Oxford Univ. Press, Oxford.
8. Speight M and P Henderson 2010. Marine ecology. Wiley-Blackwell, Sussex. 276 pp.

Instruction strategies

- 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 1-4.

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

Introduction

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

Course objectives

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

Course content

Units	Course content	No. of Lectures
1: Introduction	Definition and history, current scope and potential applications.	**4**
2:Traditional Botanical	Basic approaches to the study of traditional botanical knowledge (TBK) and subsistence, Wild plant resources, Domesticated	**4**

Knowledge (TBK)	plants and Traditional agriculture.	
3: Methods in ethnobotanical study	Research protocol, types of interviews and questions, techniques of inquiries for data collection, sampling and sample consideration, data reliability using models.	**5**
4:Ethnopharma-cology	Definition, novel compounds, sampling methods, types of screening, plant collection for phytochemical analysis, preserving the plants, field note and ethical issues.	**4**
5: Plants in material culture	Plants used as timber, in construction, in art and technology, ritual and symbolism, as fibers, plant extracts and exudates, managing resources for material culture.	**5**
6:**Understanding traditional plant use and management**	Understanding the decision making environment, factors affecting environmental perception, Ethnotaxonomy and perceived environment.	**2**
7:History of plant-human interaction	Palaeoethnobotanical evidence	**2**
8:**Applied and applying ethnobotany**	Practical applications of ethnobotanical data and Sustainability and viability of ethnobotany based projects, Legal mechanism and ethical codes.	**4**

Unit wise learning outcome

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

References

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3. Cotton CM 1996. Ethnobotany: Principles and Applications. John Wiley & Sons, Chichester, England.

4. Given DR and W Harris 1994.Techniques and Methods of Ethnobotany. Published by Commonwealth Secretariate, London.
5. Martin GJ 1995. Ethnobotany: A Methods Manual. Chapman & Hall, London.
6. Plotkin M 1994. Tales of a Shaman's Apprentice: An Ethnobotanist Searches for New Medicines in the Amazon Rain Forest. Penguin Books, New York.
7. Schultes Richard Evans and Siri Von Reis (eds.) 1995. Ethnobotany: Evolution of a Discipline. Timber Press.
8. Simpson Beryl B and Molly Connor-Ogorzaly 2000. Economic Botany: Plants in Our World. (3rd Ed.). McGraw Hill. 544 pp.

Instruction strategies

- 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 1-4.

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

Introduction

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

Course objectives

(a) Global climate systems

(b) Ocean structure and circulation

(c) Consequences of natural and anthropogenic processes on organisms, and complexity and functions of ecosystems

(d) Adaptation to climate changes

Course content

Units	Course content	No. of Lectures
1: Understanding global climate	Earth's climate system, atmospheric structure and circulation, Hadley cell, Ferrell cell, Polar cell, mean residence time (MRT), intertropical convergence zone (ITCZ), ocean structure and circulation, El-Nino and La-Nina.	**8**
2: Causes of global	Factors affecting the changes of earth's average temperature,	**5**

climate change	human drivers of change, terrestrial and marine sink of CO_2, CO_2 effects on climate. (5 classes)	
3: Climate change phenomena	Evidence and consequences of global climate change, projecting future changes in the earth's climate.	**4**
4: Landform effects and vegetation	Influence on climate, temporal variability in climate, long term change, anthropogenic climate change, relationship of climate to ecosystem distribution and structure.	**4**
5 :Impacts of global climate change	Responses of different organisms and ecosystems to climate change, extinction risks, challenges to agriculture in the context of Bangladesh.	**3**
6: Mitigation and adaption	Mitigation and adaptation mechanisms for the global climate change, C-sequestration, C-trading and global climate model (GCM), global initiatives.	**5**

Unit wise learning outcome

Units	Learning outcome
1	• will be able to acquire information on the complexity and function of the climate systems
2	• will be able to critically evaluate and synthesize their knowledge about the factors involved in global changes.
3	• will have knowledge about the future programs to mitigate climate change
4	• will have good understanding on the effects of different land uses and vegetation cover on climate
5	• will be able to evaluate the influence of climate changes on different organisms and ecosystems
6	• will have sufficient knowledge about the current trends of the world regarding climate change

References

1. Chapin III FS, PA Matson and PM Vitousek 2011. Principles of Terrestrial Ecosystem Ecology. 2nd Edition. Springer.
2. Dickens AF, Y Ge´linas, CA Masiello, S Wakeham and JI Hedges 2004. Reburial of fossil organic carbon in marine sediments. Nature 427: 336.
3. Gates DM 1967. Energy Exchange in the Biosphere. Harper International.
4. Gates DM 1993. Climate Change and its Biological Consequences. Sinauer Associates Inc.
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9. Sunderland Mintzer IM 1993. Controlling Climate Change. Cambridge University Press, Cambridge.
10. UNEP 1992. Climate Change and Energy Efficiency in Industries.
11.

Instruction strategies

- 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 405: Autecology and Environment Credit hour: 2

Introduction

Ecology is a branch of science that studies the interactions between living organisms and the non-living components of the environment. It studies the interactions that determine adaptation, distribution and abundance of organisms. Therefore, studying environment is important since the periphery of environment starts from the time of conception till the death of any living being. Environmental Science is such a field where numerous current significant subjects are being coincided in a single point. Environmental Science deals with important aspects like pollution, waste management, hydrology, atmospheric-oceanic environment and climate change, ecotourism and wildlife management, meteorology, biodiversity and conservation, environmental impact assessment, participatory technique in resource conservation, engineering, resource economics, the concept of public administration and human dimension in natural resource management, health and sanitation, and so on.

Course objectives

(a) Teach students basic understanding on plant ecology, environmental science and relevant research areas.
(b) Enhance knowledge on basic concepts of environments of plants, interactions among organisms, ecosystem stability and instability
(c) Update knowledge on nature, extent and consequences of environmental pollution.

Course content and learning outcomes

Unit	Course content	Learning outcomes	No. of Lecture
Section A: Autecology			
1: Introduction	Definition, historical development, contribution of the prominent Ecologists of the world	Learn the history of the development of the discipline	**2**
2:The environment of plants	The hydrosphere, the atmosphere, the biosphere.	Learn about the characteristics of ecospheres	**2**
3:The role of green plants in nature	The Sun-a thermonuclear energy source, radiant energy, human population and food supply.	Learn about the role of solar radiation on the growth of plants and the supply of foods	**3**
4;Energy environment	Energy exchange in the natural environment, energy budget of different climatic zones	Gain knowledge on the availability and exchange of energy	**2**
5:Salinity	Sources of salinity, salt cycles in nature, classification of saline habitats, features	Know extent and sources of salinity and the features of	**3**

	of halophytes	halophytic plants	
6:Interactions between organisms	Introduction, competition (competitive superiority; occurrence, extent and ecological effects), predation and parasitism (nature of attack, plant defense, plant responses), allelopathy (Mechanism, allelopatthy in perspective)	Students will learn about the community organization and interactions	**3**
Section B: Environment			
7:Marine environment	Classification, productivity in relation to the Bay of Bengal, mathematical models	Gain knowledge on the structure and productivity of marine environment	**3**
8:Soil environment	Physical aspects, chemical aspects	Know properties of soil in relation to the distribution of plants	**3**
9:**Ecosystem balance and imbalance**	Human impact on ecosystems, water resources and the global picture	Learn the factors that regulate ecosystem stability	**3**
10:Environmental toxicology	Toxicity, mechanism of toxicity toxic substances and their effects, extent of arsenic toxicity in water, soil and plants in Bangladesh	Enhance knowledge about the nature, types and mechanisms of toxicity as well as the extent of arsenic toxicity in Bangladesh	**3**
11. Plant and Pollution	Introduction, effects on individual plants and species Interactions, community-level effects, evolutionary responses	Learn about the environmental pollution and their effects on plants	**3**

Instructional strategies

An interactive approach will be followed where students will be encouraged to take part in discussion on the topic in each lecture. Students will be taught through both theoretical and practical classes. Students will have to maintain practical and field note books during the period of the course. English will be the medium of instruction.

Assessment

At least 1 In-course examination of 17.5 marks for 1.0 hour will be taken to assess the progress of the student at the middle of the period of the course. Final examination on both theoretical and practical contents of the course will be taken after finishing the deliberation of the course contents. Term final examination of 30 marks for 2 hours will be held. Besides, students will be assessed continuously during the period of the course through class attendance (2.5 marks, 5% of the total marks of the course) and other forms like maintaining and submitting practical and field note book, and collection and submission of specimens. Marks for practical examination and other segments of continuous assessment is included in the marks allocated for the practical course.

References

1. Bannister P 1976. Introduction to Physiological Plant Ecology. Blackwell Scientific Publications.
2. Barbour MG, JH Burk, WD Pitts, FS Gilliam and MW Schwartz MW 1999. Terrestrial Plant Ecology. Addison Wesley Longman.
3. Crawley MJ. 1997. Plant Ecology. Second Edition. Blackwell Science.
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8. Larcher WL 1975.Physiological Plant Ecology. Springer-Verlag.
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10. Waisel J 1972. Biology of Halophytes. Academic Press.

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

Introduction

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

Course objectives

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

Course content

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

Unit wise learning outcome

Units	Learning outcomes
1	• enhance knowledge on different pathways of photosynthesis in plants; state the

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

References

1. Devlin RM and FH Witham 1997. Plant Physiology. 4th Ed. CBS Publishers and Distributors, New Delhi.
2. Epstein E 1982. Mineral Nutrition of plants: Principles and Perspectives. John Wiley and Sons, New York.
3. Hewitt EJ and TA Smith 1974. Plant Mineral Nutrition. The English University Press, London.
4. Hopkins WG 1991. Introduction to Plant Physiology, 2nd Edn. John Wiley and Son, Inc.
5. Jain VK 2004. Fundamentals of Plant Physiology. 7th Edn. S.Chand and Company Ltd., New Delhi.
6. Salisbury FB and CW Ross 1995. Plant Physiology. 3rd Edn. CBS Publishers and Distributors, New Delhi, India.

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 1-4.

BOT 407: Genomics, Proteomics and Bioinformatics **Credit hour**: 2

Introduction

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

Course objectives

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

Course content

Units	Course content	No. of Lectures
1: Genomics	**Gen**Organization and structure of genomes- Genome size, Sequence complexity, Genome structure in viruses and prokaryotes, the organization of nuclear DNA in eukaryotes. Subdividing the genome- Fragmentation of DNA with restriction enzymes, Separating large fragments of DNA, Isolation of chromosomes, Chromosome micro-dissection, Vectors for cloning DNA, Choice of vector. Genome sequence acquisition and analysis- Physical mapping of genomes, sequencing whole genomes- sequencing methods and strategies, Benefits of genome sequencing.	**10**
2:Proteomics	Introduction to Proteomics, Protein Structures and folding, Protein-protein interaction study: Yeast-2-hybrid systems. Protein separation for sequencing: 2-D gel electrophoresis, mass spectrometry/MALDI-TOF. Analysis of protein Sequences: Identification of Protein families and evolutionary relationships, Basic principles of protein sequence comparison, finding distant relationships, revealing protein motifs, 3D structural comparisons.	**10**
3: Bioinformatics	Introduction of Bioinformatics, Similarity Searches on Sequence Databases, Pair-wise alignments, multiple sequence alignment, Phylogenetic analysis, Application of bioinformatics. Networks in Bioinformatics/proteomics**:** Biological networks (Protein interaction networks, gene regulation networks), Bioinformatics Databases and search tools, Genomics circuits in single gene. Functional genomics: Identification and characterization genes from newly sequenced genome, Drug design based on bioinformatic tools.	**10**

Unit wise learning outcome

Units	Learning outcomes
1	• understand the Organization and structure of genomes of prokaryotes, eukaryotes and archea. • learn process of isolation is single chromosome and segment of a particular chromosome. • learn the techniques of subdividing the genome and know about the vectors for cloning DNA • learn the high throughput Genome sequencing techniques and analysis of the sequences.
2	• know the types of Protein Structures and folding and the importance of protein folding related to specific function. • learn the techniques of protein separation, studying protein-protein interaction and sequencing of peptide. • learn the study of phyllogenetic relationship among members of different protein families. • learn the use of softwares to predict protein 3D structure and finding the domains and motifs.
3	• know the different bioinformatic databases. • learn the principles and application procedure of different tools for analysis of DNA,

	RNA and Proteins. • know the different alignment techniques for nucleotide or peptide sequences with their principles. • identify the unknown nucleotide or peptide sequences through blast search analysis as well as the principles of similarity search tools. • learn the study of Phylogenetic analysis and functional genomic analysis of unknown gene sequences. • know the principles of drug design based on bioinformatic tools.

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Instruction strategies

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

Assignment: Students will be given assignment on particular units

Assessment: Incourse examination will be taken after completing the lectures on units 1-2.

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

Introduction

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

The Green Revolution contributed significantly towards increasing the yields of major crops have dramatically changed over the years. However, the productivity of most of the major crops are almost in the peak and there is a little scope to increase the productivity further using conventional breeding techniques. Another major concern is that most of the population growth will occur in developing

countries where food needs are currently most serious, and where resources for feeding people are already most severely strained, because of natural or human-made disasters, or ineffective political systems. It is under this background the application of plant tissue culture and modern biotechnology may play a vital role towards development of high yielding, abiotic and biotic stress tolerant crops which could be grown in stress prone areas like salinity and drought.

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

Course objectives

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

Course content

Units	Course content	No. of Lectures
1	Historical background of plant tissue culture and biotechnology.	**2**
2	Laboratory organization, plant tissue culture media and other nutritional and hormonal supplements, sterilization of tissue culture media, equipments and plant materials.	**5**
3	Cellular totipotency, establishment and maintenance of callus, cell suspension culture.	**4**
4	*In vitro* organogenesis and somatic embryogenesis.	**4**
5	Micro-propagation and its commercial application.	**2**
6	Production of disease free plants through meristem culture, virus indexing using ELISA test.	**2**
7	Somaclonal and gametoclonal variations: causes, stability and applications.	**2**
8	Anther and pollen culture for haploid, factors affecting haploid production and application of haploid in crop improvement.	**3**
9	Isolation and culture of protoplasts, somatic hybridization and cybridization.	**2**
10	Production of secondary metabolites through *in vitro* culture techniques.	**2**
11	Plant genetic engineering, concepts, methods and applications.	**2**

Unit wise learning outcome

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

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6. Gamborg OL and Philips GC.1995. Plant Cell Tissue and Organ Culture: Fundamental Methods. Springer.
7. Geroge ED and Sherrington PD.1984. Plant Propagation by Tissue Culture. Exgetics Publ. Ltd. England.
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9. Pierik RLM. 1997. In Vitro Culture of Higher Plants. Kluwer Academic Publishers. Dordrecht/Boston/London.
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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.

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

Introduction

This is a basic course in 4-years integrated BS (Hons) in Botany program. It is structured in a way that the students develop clear understanding of the concept of horticulture and agronomy, scopes of horticulture in Bangladesh, classification of horticultural plants and vegetables, seed bed preparation, propagation of horticultural plants, fertilizer and irrigation. Students also learn about horticultural aspects and cultivation of viz. vegetables (Olericulture), fruits (Pomology) and flowers (Floriculture).

Course objectives

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

Course content

Units	Course content	No. of Lectures
1: Introduction	Definition, historical background, branches of horticulture, Distinguishing features of horticulture and agronomy, Objectives and scope of horticulture, urban horticulture.	**2**
2: Classification of horticultural plants	Botanical classification, Agronomic classification, Classification based on uses.	**2**
3: Classification of vegetables	Classification based on different criteria with examples especially from Bangladesh.	**4**
4: Preparation of seedbed:	Seed bed, soil type, location and its classification, Preparation of an ideal seed bed, Seed rate calculation, Seed sowing method, pre- and post-transplanting care of seed and soil before sowing.	**5**
5: Propagation of horticultural plants	Classification with examples, Advantages and disadvantages of vegetative propagation, Details about cutting, layering and grafting.	**5**
6: Fertilizer	Types and classification of fertilizer, Composition, dosage, time and methods of fertilizer application.	**4**
7: Irrigation	Methods and importance of irrigation, Sources, quality and quantity of irrigation water.	**4**
8: Olericulture	Horticultural aspects and cultivation of different vegetable in Bangladesh. e.g. tomato, brinjal, lady's finger.	**2**
9: Pomology	Horticultural aspects, plantation and cultural practices of fruit yielding plants. e.g. mango, pineapple, lemon.	**1**
10: Floriculture	Floricultural aspects and cultivation of the following plants: rose, tuberose, chrysanthemum.	**1**

Unit wise learning outcome

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

References

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Instruction strategies and Learning experiences

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

Assignment: Students will be given assignment on particular units

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

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

Introduction

This course is taught in the 4th year classes of four years integrated BS (Hons) degree program in Botany under the University of Dhaka. The students learn Fundamentals of Limnology in their 3rd Year Honors Course. So, the present course has been designed to offer the students an up to date knowledge on the organisms of inland aquatic ecosystems together with their functional behavior. Contribution of organisms in the energy pipeline of biological production systems is also highlighted. The goal could be best achieved via introducing the students with the qualitative and to some extent quantitative aspects of aquatic biodiversity of inland waters. The 'Grasses of water' i.e., the phytoplankton community is explained following their types, pattern, biological role and their adaptive features in the liquid environment. The methods to achieve a quantitative value in terms of organic carbon in the food chain by phytoplankton are also elaborated. Furthermore, the presence and role of aquatic angiosperms and other groups of plants in the aquatic ecosystem has been clarified. Particular emphasis has been given to the ecophysiological adaptations such as heterophilly for

carrying out photosynthesis in aquatic medium by aquatic macrophytes. Some details on the geographical distribution, dispersal, endemism and example of fossil of hydrophytes have been given. The obnoxious and beneficial roles of aquatic weeds have been highlighted. After visiting this course every student will get knowledge on the biological part of limnology.

Course objectives

(a) Know diversity of aquatic organisms, their environmental set up and classification
(b) Learn plankton, their function, settling velocities and adaptive mechanisms
(c) Plankton distribution versus time and space, measurements of primary productivity
(d) Assess the role of various nutrients on plankton and eutrophication
(e) Characterize tracheophytes, know their evolution, classification and adaptation
(f) Study relationships of heterphilly and photosynthesis, their dispersal and colonization
(g) Learn geographical distribution, endemism and fossil hydrophytes
(h) Aquatic weeds, their control, beneficial and harmful sides, economics of water plants

Course content

Units	Course content	No. of Lectures
1: The diversity of Limnological organisms	setting the environment in water, creation of biotic community, classification of organisms depending on function, trophic state, habitat and natural classification.	**3**
2: Planktonic organisms	general features, composition, suspension mechanism in water, settling velocities and adaptive mechanisms.	**4**
3 Primary productivity	spatial and temporal distribution and measurement of primary productivity of phytoplankton.	**3**
4:Nutrient requirements of phytoplankton	limiting nutrients, phytoplankton biomass and nutrient conditions, phosphorus, nitrogen, silicon and other nutrients, nutrient interactions. Eutrophication causes, classification, demerits and control.	**6**
5: Biological characteristics of tracheophytes	Classification, evolution, adaptation in four main categories (emergent, floating leaved, submerged, free floating)	**2**
6: Photosynthesis and heterophilly:	relationship between photosynthesis and leaf morphology of aquatic plants, morphological adaptation promoting under water photosynthesis, dispersal of aquatic plants, quantitative aspects and colonization.	**6**
7: Geography of hydrophytes:	types, extensive, continental ranges, endemic, discontinuous, adventives and fossil hydrophytes.	**4**
8: Aquatic weeds:	definition, control, aesthetic and economic value.	**2**

Unit wise learning outcome

Units	Learning outcomes
1	• environmental set up under which aquatic plants usually grow • biotic community • organism's classification depending on function and trophic state • natural classification and classification based of habitats

2	• define and characterize plankton • composition of plankton • how do they remain suspended in water and what is the necessity • settling velocities of planktonic organisms in water • adaptive features and mechanisms to overcome settling problem
3	• define the concept of primary productivity of lakes • their distribution over time and space in aquatic ecosystems • measurements of planktonic primary productivity • estimation of their seasonal and annual rates
4	• scale of nutrient requirements by phytoplankton, limiting nutrients • phytoplankton species biomass variation in relation to P, N and Si • phytoplankton and other nutrients and interactions • eutrophication causes, classification, merits and demerits • eutrophication control
5	• tracheophytes and macrophytes, renowned publications on this • evolution of aquatic plants in truly aquatic medium, hypothesis • classification based on their adaptive features • adaptive groups, emergent, floating leaved, submerged, free floating • comments on their anatomical and physiological features
6	• what is heterophilly, where it is found and why • relationship between photosynthesis and heterophilly • how morphological adaptation promotes underwater photosynthesis • dispersal of aquatic plants, means and ways, colonization principle • quantitative aspects and colonization
7	• phytogeographic aspects of aquatic plants • extensive, continental, endemic • discontinuous, adventive and fossil hydrophytes
8	• definition of weeds, name aquatic weed species with their role • suggest control measures on aquatic weeds • knowledge on aesthetic and commercial benefits of aquatic plants

References

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Instruction strategies and Learning experiences

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

Assignment: Students will be given assignment on particular units

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

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

Introduction

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

Course objectives

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

Course content

Units	Course content	No. of Lectures
1: Numerical aberration	An introduction	**1**
2: Aneuploid: (a) Hyperploid:	**Trisomics -** Definition, origin, sources, kinds, identification, cytological behaviour, phenotypic expression, segregation and genetic ratio of different types of trisomic. **(b) Hypoploid: monosomics and nullisomics -** introduction, origin, occurrence, identification, cytological and breeding behaviour.	**8**
3: Euploid:	**(a) Haploid -** Definition, origin, classification, phenotypic characters, cytological behavior and economic importance, **(b) Polyploids:** Definition, identification, origin, types, cytological behaviour, phenotypic characters of triploid, autotetraploid, allopolyploid, autoallopolyploid and segmental allopolyploid, synthetic classification of polyploidy, application in agriculture.	**10**
4: Speciation through allopolyploidy and segmental allopolyploidy:	(i) *Primulakewensis,* (ii) *Spertinatownsandii,* (iii) *Raphano-brassica,* (iv) *Nicotianatabacum,* (v) *Brassica* spp., (vi)*Gossypium*spp., (vii) *Triticumaestivum,* (viii) *Triticale*, (ix) *Crepisfoetida-rubra*and (x)*Setcreaseapurpurea*.	**7**
5: Human cytogenetics:	Brief introduction, Down's syndrome, Patau's syndrome, Edward's syndrome, Klinefelter's syndrome, Triplo X/Trisomy syndrome, XYY syndrome and Turner's syndrome.	**4**

Unit wise learning outcome

Units	Learning outcomes
1	• will get idea about numerical aberrations of chromosomes.

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

References

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Instruction strategies and Learning experiences

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

Assignment: Students will be given assignment on particular units

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

BOT 412: Microbial Plant Pathology Credit hour: 2

Introduction

Microbial plant pathology is one of the basic course in 4-years BS (Honors) in Botany program. The course aims to provide the concept of plant diseases, causes, types, impact of pathogens on crops. Basic methods of plant pathology is focused. It also focuses on the symptoms and control measures of plant diseases caused by Mycoplasma, Virus, Bacteria and Nematode.

Course objectives

(a) To be introduced with the basic principles and concept of plant pathology.
(b) Learn the explanation of infection of plants by different pathogens.
(c) Identify mycoplasma, bacteria, virus and nematode diseases of plants.
(d) Learn the methods of investigation of unknown diseases of plants.
(e) Learn the preventive measures of plant disease control
(f) Learn to avoid epidemic diseases of plants.

Course content

Units	Course content	No. of Lectures
1: Mycoplasma diseases:	Introduction, characteristics of phytopathogenic Mycoplasma and importance; Causal organism, symptoms and management of Rice yellow dwarf and Little leaf of brinjal.	**5**
2: Viral diseases:	Introduction; characteristics and symptoms of plant viruses. Translocation and distribution of viruses in plants; transmission of plant viruses; virus-vector relationship; physiology of virus infected plants; control of viral diseases, purification of plant viruses and serology of viruses. Causal organism, symptoms and management of selected diseases of plants. (i) mosaic of bean; (ii) potato leaf roll, (iii) vein clearing of bhendi, (iv) tungro disease of rice, and (v) bunchy top of banana.	**9**
3: Bacterial diseases:	troduction, characteristics and classification of plant pathogenic bacteria; methods of investigation of bacterial diseases; mode of entry of bacteria into the host; action of bacteria on plant tissue; symptoms and control of bacterial diseases. Causal organism, symptoms, development of disease and control measures of the following plant diseases: (i) bacterial blight of rice, (ii) gummosis of sugarcane, (iii) citrus canker, (iv) wilt of tomato, (v) soft rot of potato,(vi) angular leaf spot of cotton (vii) scab of potato.	**9**
4: Nematode diseases:	roduction, characteristics of plant pathogenic nematodes, isolation of nematodes; phytopathogenic nematodes; control of nematode diseases, symptoms and infection process. Causal organism, symptoms, and control measures of root-knot of vegetables and ufra disease of rice.	**7**

Unit wise learning outcome

Units	Learning outcomes
1	• Will be able to know the characteristics of phytopathogenic Mycoplasma. • Learn the importance of Mycoplasma. • Able to identify and control Mycoplasma diseases of plants.
2	• Able to identify viral diseases of plants. • Will identify translocation and distribution of viruses in plants. • Learn about transmission of plant viruses; virus-vector relationship. • Learn to control plant viral diseases. • Know the methods of purification of plant viruses.
3	• Able to identify plant pathogenic bacteria. • Learn the methods of investigation of bacterial diseases of plants. • Gather knowledge about the entry of bacteria into the host. • Learn the mechanism of action of bacteria on plant tissue. • Capable of identify causal organism, symptoms and control measures of bacterial diseases of plants.
4	• Able to identify nematodes. • Capable to isolate nematodes • Will be able to control nematode diseases of plants.

References

1. Agrios GN 2005. Plant Pathology (5th ed.). Academic Press Inc., New York
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3. Fahy PC and GJ Persley 1983. Plant Bacterial Disease. A diagnostic guide. Academic Press, 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 units 1-2.

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

Introduction

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

Course objectives

(a) Discuss about the total losses of seed production due to diseases in the world.
(b) Differentiate between healthy seeds and infected seeds.
(c) Explain how the seeds are infected by fungi.
(d) Identify the causal organisms of respective seed borne diseases.
(e) Know about the field standards and seed standards of different crops *viz.*, rice, wheat, jute, etc.
(f) Apply the quarantine rules or seed health regulations during seed exchange in national level as well as international level.
(g) Discuss how the seed borne fungi reduce the seed quality as well as how they cause harmful effect on human and animal by producing different kind of mycotoxins.
(h) Establish the control measures for the specific seed borne diseases in storage
(i) Justify the rules and regulation for commercial seed certification
(j) Discuss about the "Seed ordinance, 1977

Course content

Units	Course content	No. of Lectures
1 : Introduction	Historical background, scope and prospects of Seed Pathology, economic significance of seed-borne diseases.	**4**

2: Seed diseases	Seed abortion, discoloration, stromatization, necrosis, rot, physiogenic disease (marsh spot, hollow heart) etc.	**4**
3: Location of fungal hyphae in seeds	Seed infestation, infection, location of Oomycetes, Ascomycetes, Basidiomycetes and Deuteromycetous fungi in seeds of crop plants, colonization of seed tissues.	**6**
4: Seed health testing	Objectives of seed health testing, Methods of seed health testing and identification of seed-borne diseases of fungal origin.	**2**
5 : Histopathology	Microtechniques in seed histopathology: Histological methods.	**4**
Unit 6: Seed-plant-seed transmission	Types of development of seed transmission, Methods of seed-plant-seed transmission.	**2**
7: Seed certification	Methods of seed certification, field standards and seed standards for rice, wheat and jute.	**2**
8; Storage diseases	Effects of storage on seed quality, human, cattle etc.; storage facilities in Bangladesh with remedies.	**2**
9: Control of seed borne diseases	Seed treatment with special references to chemicals; integrated control and seed quarantine.	**4**

Unit wise learning outcomes

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

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3. Anonymous 1976. Seed Certificate Agency. Ministry of Agriculture, Bangladesh.
4. Singh D and SB Mathur 2004. Histopathology of Seed-borne Infections. CRC Press Publ.

5. Jha DK 1995. A Text Book on Seed Pathology, Vikash Publ. House Pvt. Ltd.
6. Suryanarayana D 1978. Seed Pathology. Vikash Publ. House, New Delhi.

Instruction strategies and Learning experiences

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

Assignment: Students will be given assignment on particular units

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

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

Introduction

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

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

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

Course objectives

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

Course content

Units	Course content	No. of Lectures
1: Introduction	Origin versus creation, theory of special creation, concepts regarding origin and back ground of evolution.	**2**
2: **Pre-Darwinian concepts**	Buffon, Saint Hilaire, Robert Chambers, Herbert Spencer, Franz Unger, Lamarck, Lamarckism, criticism of Lamarckism and Neo-Lamarckism.	**2**
3: **Darwin-Wallace theory**	Brief life sketch of Charles Darwin and R. A. Wallace, voyage of the HMS Beagle by Darwin, development of the theory, essence of Darwinism, criticism of Darwinism (emotional and scientific) and Neo-Darwinism.	**4**
4: **Evidences of evolution**	Paleontological, missing link, living fossil, biogeographical and ecological regions of world, adaptive radiation, comparative anatomy, vestigial organs, embryological, cytological, biochemical and molecular evidences.	**4**
5: **Synthetic theory of evolution**	Stebbins' proposal, evolution process, genetic explanation, Hardy-Weinberg law, static and dynamics of gene in population, genetic death and genetic drift.	**4**
6: Natural selection	Types: stabilizing, directional, disruptional, sexual, frequency dependent, kin and reproductive selection.	**4**
7: Speciation	Species concept, characteristics of species, steps of evolution: micro-, macro-, mega-evolution, patterns of evolution: adaptive divergence, adaptive radiation, parallel, iterative, convergence, anagenesis, cladogenesis, stasigenesis, Isolation: pre-mating, post-mating, sympatric- and allopatric isolation.	**4**
8: **Chemical theory of origin of life**	(a) Experimental evidences-Operin-Haldane hypothesis, Miller-Urey experiment. (b) Stages of chemical evolution-origin of carbohydrate, fatty acids, purine, pyrimidine, polypeptide, pre-organic condensation, organic compound, formation of polymer (protenoid microsphere). (c) Origin of prokaryotes and eukaryotes.	**4**
9: **Human evolution**	Man's place in nature, relation with other primates, some special features of human, comparative karyotype and molecular analysis between ape and human, fossil evidences.	**1**
10: Cosmology	A brief structure of the universe and big bang theory.	**1**

Unit wise learning outcome

Units	Learning outcomes
1	• know about the concept of evolution and back ground information about evolution, understand that by biological evolution indicating that many of the organisms that inhabit the Earth today are different from those that inhabited it in the past
2	• Know about Pre -Darwinian concepts of evolution including Lamarckism and Neo-Lamarckism
3	• Know about life sketch of Charles Darwin, voyage of the HMS Beagle by Darwin,

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

References

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2. Case CJ 1986. Cosmology. The search for order of the universe. Tata Books @ Inc.
3. Darwin C 1992. The origin of species (ed. G.K. Burrow). Penguin Books.
4. Dobzhansky Th, FJ Ayala, GL Stebbins and JW Valemteni 1990. Evolution. W.H. Freeman, San Francisco, Surjeet Publication
5. Lewin R 1984. Human evolution. Blackwell Science Publication.
6. Rastogir VB 1990. Organic evolution. Keder Nath Ram Nath., New Delhi.
7. Stebbins GL 1971. Process of organic evolution. Prentice-Hall Inc., New Jersey.
8. Strickberg MQ 1990. Evolution. Jones-Bartlet publication, Boston.

Instruction strategies and Learning experiences

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

Assignment: Students will be given assignment on particular units

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

Practical

BOT 415: Practical - 1 Credit hour: 2

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

A. Microbiological Techniques

Units	Title	Learning outcomes
1	Preparation and sterilization of culture media	• Acquire knowledge about preparation culture media and sterilization by autoclaving.
2	Isolation of bacteria from soil by serial dilution method	• Development of knowledge to perform serial dilution technique to isolate bacteria from soil sample
3	Isolate pure cultures by streak dilution technique	• Purification of isolated bacteria using streak dilution technique.
4	Methylene blue reduction test	• Acquire knowledge about methylene blue reduction test used in milk quality test.
5	Isolation and observation of *Azotobacter* by mud-pie technique	• Learn about a very simplified culture technique to isolate a free living nitrogen fixing bacteria*Azotobacter*from soil.
6	Preparation of bacteriological stains	• Know about the preparation about different basic bacteriological stains *viz.* Crystal violet, Safranin, Lugol's Iodine solution etc.

B. Marine Botany

Units	Title	Learning Outcomes
1	Field trips to St. Martin's Island/Sundarbans/Patuakhali Mangrove Forests- the collection of Phytoplankton, Seaweeds and salt marsh plants.	▪ Gain preliminary knowledge o**f** marine and estuarine ecology, its structure. Acquire knowledge on marine and estuarine ecology of St. Martin's Island, Sundarbans and Patuakhali Mangrove Forest. To know about the diversity and classification of algae, phytoplankton, seaweeds, sea grasses, flowering plants, salt marsh plants, mangroves etc. and their distribution
2	Measuring pH, salinity, specific gravity and NTU of marine water.	▪ Marine ecology and different physicochemical factors affecting the marine environment
3	Systematic study of some common phytoplankton, seaweeds, and sea-grasses/salt marsh plants.	▪ Know about the diversity of phytoplankton ▪ Importance of phytoplankton, sea weeds and sea grasses classification and adaptation ▪ Seaweeds identification, cultivation and processing and uses in different types of industrial and pharmaceuticals products ▪ Sea grasses, salt marshes and their importance. ▪ Explore to produce new products from marine plants
4	Commercially important seaweeds	▪ Identified seaweeds that are suitable for foods, biofuels, industrial and pharmaceutical products.
5	Commercial products of seaweeds.	▪ Marine biotechnology ▪ preparation of foods, industrial and pharmaceuticals products from seaweeds ▪ Potentiality of extraction of biofuels, phycocolloids and other products. ▪ Learn various uses of seaweeds in commercial point of view.

6	Determination of chlorophyll *a* and *b* in a green alga and phycobilins in red algae.	▪ Determination of different pigments in algae.

C. Biological Limnology

Units	Title	Learning outcomes
1	Study on the morphology and anatomy of some selected aquatic plants covering different taxonomic groups.	Know the morphology and anatomical peculiarities of different macrophytes. Identify the specific adaptive features
2	Calculation of phytoplankton primary productivity by applying Talling's Model	Practice the calculation of different model parameters of Tallings Integration Model on primary productivity by using the measured field data
3	Study of different life forms of aquatic plants	Learn the life forms of aquatic plants, particularly buds, turions and bulbils and also identify morphological reduction processes under adverse condition of some macrophytes
4	Qualitative aspects of pelagic phytoplankton	Collect, sediment and obtain a plankton concentrate from a pond water sample. Identify them and quantify them per unit volume of pond water sample.

D. Ethnobotany

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

BOT 416: Practical - 2 Credit hour: 2

E. Climate Change Biology F. Microbial Plant Pathology G. Seed Pathology

E. Climate Change Biology

Units	Title	Learning outcomes
1	Measurement of spatial and temporal atmospheric temperature variation of Dhaka city and adjacent areas	• Students will be able to recognize the changes in the temperature of atmosphere due to different human activities and natural phenomena.
2	Measurement of wetlands temperature variations in and around Dhaka city	• Students will be able to recognize the changes in the temperature of freshwater ecosystems due to different human activities and natural phenomena.

3	Measuring C-sequestration of different plant species	• Students will be able to assess the capacity of different plants species to capture and store C from the atmosphere in different parts of its body.
4	Estimation of C-reserve of soil of different places/forest lands	• Students will be able to assess the stocks of C of different terrestrial habitats and their roles in mitigation to climate changes.
5	Students will present a topics related to climate change issues (Subject matter will be determined with discussion to the course teacher).	• Students will be able to address different climate related issues and role of different world organization in combating climate changes. They will also be able to communicate different climate issues at different levels.

F. Microbial Plant Pathology

Units	Title	Learning outcomes
1	Study of common viral, mycoplasma, bacterial and nematode diseases of plants.	• Able to identify plant diseases caused by different types of causal organisms on the basis of disease symptoms.
2	Study of disease symptoms and etiology of bacteria of diseased tomato, potato, carrot and citrus.	• Able to identify the bacteria and disease of tomato, potato, carrot and citrus
3	Culturing of bacterial pathogens.	• Learn the preparation and sterilization of culture media for bacterial growth.
4	Pathogenicity test of bacterial pathogens.	• Able to isolate bacteria from diseased plant parts following tissue planting and dilution plate methods. • Learn the techniques of inoculation and re-isolation of bacteria from plant materials.
5	Demonstration of nematodes associated with plant specimens.	• Able to observe living nematode from gall diseases of vegetables.

G. Seed Pathology

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

BOT 417: Practical - 3 Credit hour: 2

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

H. Horticulture and Agronomy

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

I. Autecology and Environment

Units	Title	Learning outcomes
1	Students will maintain a field note book to study vegetation types and habitats of the University campus and from local excursion	• Understand natural vegetation of different habitats as well as the components and functions of the ecosystems
2	Determination of minimal sample area (Quadrat size) by species-area curve method	• Understand how to determine sample size and analyze/ survey vegetation
3	Study of stomatal types by various methods	• Learn mechanisms of adaptation of plants through leaf traits
4	Plants of halophytes and pneumatophores	• Know the mangrove vegetation and their adaptation through roots
5	Plants of wetland habitats	• Know the aquatic vegetation of Bangladesh
6	Determination of soil texture	• Learn how to study soil properties
7	Study of pollution level in water by determining BOD and COD	• Know how to determine the level of environmental pollution (e.g. water quality etc.)

J. Plant Physiology and Plant Nutrition

Units	Title	Learning outcomes
1	Determination of osmotic pressure by plasmolytic method	• Understand the concepts of plasmolysis, deplasmolysis and also the cause of plasmolysis in peels of *Rhoeo discolor* in hypotonic and hypertonic solutions using salt solution;

2	Separation of pigments by separating funnel	• Learn about extraction and chemical separation technology, specifically, how to do a liquid phase-extraction in order to separate a mixture of molecules;
3	Determination of presence of enzymes in plant tissue	• Detect the presence of different enzymes (e.g. catalase, oxidase, peroxidase and dehydrogenase) in plant tissue;
4	Extraction and measurement of K^+ and Na^+ in plant tissue	• Visualize simple technique for making the important measurements of sodium and potassium ion in root tissue using a calibration curve by flame photometer;
5	Extraction and measurement of Cl^- in plant tissue	• Extract and determine chloride ion in plant tissue through standard titrametric method;
6	Extraction and measurement of NO_3^- in plant tissue	• Extract and analysis the amount of nitrate in plant tissue using spectrophotometer.

BOT 418: Practical - 4 Credit hour: 2

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

K. Plant Tissue Culture and Biotechnology

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

L. Genomics, Proteomics and Bioinformatics

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

M. Numerical Cytogenetics

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

BOT 419: Viva-Voce Credit hour: 2