

BROCHURE 2022



Department of Crop Botany
Bangladesh Agricultural University
Mymensingh-2202, Bangladesh
<https://cbot.bau.edu.bd/>

Department of Crop Botany

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Department of Crop Botany, BAU

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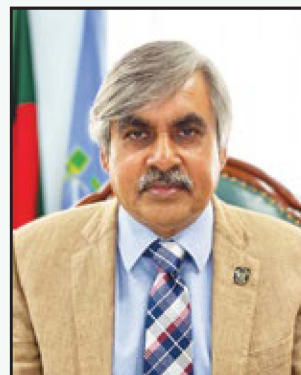
Department of Crop Botany

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Message by
Honorable Vice-Chancellor

Bangladesh Agricultural University, established in 1961, is the premier seat of agricultural education and research in the country. The vision of the University is to ensure food and nutrition security and socio-economic development of Bangladesh and beyond. The University consists of 6 faculties having 45 Departments and four institutes for academic programs. Currently, BAU offers nine undergraduate programs under six faculties and one institute; 42 Departments and two institutes offer masters and doctoral programs. Besides producing quality graduates, the highly qualified teachers of BAU have contributed to agricultural and social development through teaching, research and extension activities that also have led to having BAU in the global rankings of Times Higher Education (THE), Quacquarelli Symonds (QS) and Shanghai.

The Department of Crop Botany is one of the largest Departments of the University, having 22 teachers and 17 supporting staff, including three officers. Most of the teachers of the Department are well-equipped and trained from reputed universities in the world. They are trying hard to achieve the vision of BAU through quality teaching and high-quality research on plants and the environment, especially eco-physiological bases of crop resistance against abiotic stresses, climate change, biodiversity and conservation of rare and endangered plant species, medicinal plants, and functional minor crops, etc.

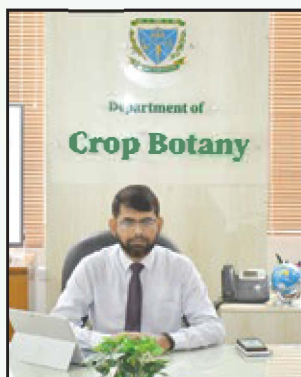
I am very pleased to learn about the initiatives of the Head, Department of Crop Botany to publish a brochure highlighting all courses offered by the Department along with ordinances for undergraduate and post-graduate programs.

I express my appreciation and gratitude to those involved in publishing this brochure. I believe this brochure will be very helpful for teachers, researchers and students interested in the Department.

I wish the success in publishing this brochure for the Department Crop Botany.

Professor Dr. Lutful Hassan
Vice-Chancellor
Bangladesh Agricultural University





Preface

The Department of Crop Botany is one of the mega Departments at Bangladesh Agricultural University. The majority of the teachers in the Department possess higher degrees from prestigious universities throughout the world. The Department offers 18 courses across four undergraduate programs in the Faculty of Agriculture, the Faculty of Agricultural Engineering and Technology, and the Interdisciplinary Institute for Food Security (IIFS). The Department also offers Master of Science and Doctor of Philosophy degrees in Crop Botany. The Department is responsible for providing 43 courses for post-graduate level programs. Crop Botany is concerned with all facets of plant life in crop production. The Department focuses on Plant Physiology, Plant Ecology, Plant Morphology and Taxonomy, Plant Tissue Culture, Plant Biodiversity and Conservation, and Medicinal Plants. The Department has well-equipped laboratories, a 6-acre field lab, and a highly developed Botanical Garden for undergraduate and post-graduate study.

The Department's well-trained and motivated faculty have been updating the course curricula at undergraduate and post-graduate levels. In recent years, the course syllabi of undergraduate programs have been revised to incorporate outcome-based education (OBE), and new courses have been added to PhD programs. The number of courses offered by the Department is currently 61, and all course profiles must be compiled in a booklet for the convenience of both teachers and students. In addition, the regulations for the programs we offer must be adhered to for the academic activities to run well. Keeping this in mind, the Department has taken the initiative to create and distribute a booklet. I feel this brochure will be helpful for the Department's professors as well as those of other Departments and students.

I extend my sincere appreciation to the members of the brochure publication committee for their tireless work to get this brochure printed. I would also like to express my appreciation to all recognized teachers for their recommendations and impulses to publish this booklet.

Professor Dr. Md. Alamgir Hossain
Head
Department of Crop Botany
Bangladesh Agricultural University



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About the Department of Crop Botany

Crop Botany is one of the largest departments within the Faculty of Agriculture at Bangladesh Agricultural University, Mymensingh. It was founded in March of 1963. The department provides 61 courses at the undergraduate and post-graduate levels. It provides 10 courses in the Bachelor of Science in Agriculture (Honours) program of the Faculty of Agriculture, 4 courses in the Bachelor of Science in Food Engineering, and Bachelor of Science in Bioinformatics Engineering programs of the Faculty of Agricultural Engineering and Technology, and 4 courses in the Bachelor of Science in Food Safety Management (Honours) program of the Interdisciplinary Institute of Food Security (IIFS). The Department provides 26 courses for the MS in Crop Botany degree and 17 courses for the PhD program. Currently, there are 22 teachers in the department, including 15 Professors and 7 Assistant Professors. Crop Botany covers all aspects of crop plant life. The department's core teaching and research areas include Plant Physiology, Plant Ecology, Plant Morphology and Taxonomy, Plant Tissue Culture, Plant Biodiversity and Conservation, and Medicinal Plants. The laboratories for Plant Physiology, Plant Ecology, and Plant Anatomy & Tissue Culture in this department are well-equipped. Additionally, there is a Field Lab with 6 acres of land. As a component of this Department, the Botanical Garden was founded in 1962 to serve as a field laboratory for undergraduate and post-graduate students. Approximately 1500 plant species are housed in this garden. Each year, the garden receives a large number of domestic and international tourists.

The mission and vision of the department

Vision:

Plant- and environment-focused education, research, and outreach to combat global climate change issue for maintaining food and nutritional security.

Mission:

1. Providing knowledge on Botanical aspects of important crop species and their adaptations strategies to cope up the changing climate.
2. Educating students with cutting-edge Plant Biology knowledge and expertise so that they can better comprehend the interplay between plants and their environments on a variety of geographic scales of the globe.
3. Conducting fundamental, demand-driven and problem-solving research on different field in Plant Biology.
4. Providing consultancy and community service in the area of Botany and Crop Science.
5. Developing leadership and environmental consciousness among students in order to protect plants and wildlife.

Current Teachers of the Department

Professors



Dr. A.K.M. Azad-ud-doula Prodhan



Dr. Md. Solaiman Ali Fakir



Dr. Md. Habibur Rahman Pramanik



Dr. Md. Obaidul Islam



Dr. Md. Shahidur Rahman



Dr. Md. Ashrafuzzaman



Dr. Md. Abdul Awal



Dr. A.K.M. Zakir Hossain



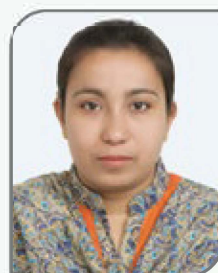
Dr. A.K.M. Golam Sarwar



Dr. Md. Alamgir Hossain-1



Dr. Md. Alamgir Hossain-2



Dr. Shahanara Begum

Current Teachers of the Department

Professors



Dr. Md. Nesar Uddin



Dr. Israt Jahan Shelley



Dr. Md. Sabibul Haque

Assistant Professors



Mr. Md. Masudul Karim



Mr. Md. Abdur Razzak



Mr. Ashaduzzaman Sagar



Mrs. Jannat-E-Tajkia



Mr. Md. Ashik Mia



Most. Morsada Khatun



Mrs. Sadiya Arefin Juthee

Former Teachers of the Department

Retired Teachers of the Department



Prof. Dr. S. H. Chowdhury
Retired on 01 July 1984
(died on 19.08.2008)



Prof. Dr. A. A. A. Muhsi
Retired on 29 December 1993
(died on 10.03.2008)



Prof. Dr. M. Arshad Ali
Retired on 31 July 1991
(died on 06.05.2004)



Prof. Dr. M. A. Halim Khan
Retired on 30 June 2014



Prof. Dr. M. Abdul Karim
Retired on 30 June 2015



Prof. M. Mustafizur Rahman
Retired on 30 June 2015



Prof. Dr. Subodh Chandra Sarker
Retired on 16 March 1995



Dr. Afsana Islam
Retired on 24 December 2016

Teachers who left the Job

Dr. Sharafat H. Khan - left BAU in 1967

Dr. Sanaullah - left BAU in 1972

Mr. Talukdar O. Haidar - Left BAU in 1968

Dr. Mahbulul Alam Hiro - Left BAU in 1991

Former Teachers of the Department

Teachers transferred to other Departments/Institute



Prof. Dr. Ashraful Haque
*Transferred to the GPB in 1974
as Professor & Founder Head*



Prof. Dr. C. A. Razzak
*Transferred to the GPB in 1974
as Associate Professor*



Prof. Dr. M. Abdul Haque
*Transferred to the Agroforestry in 1996
as Professor & Founder Head*



Prof. Dr. Lutfur Rahman
*Transferred to the GPB in 1974
as Assistant Professor*



Prof. Dr. Md. Amirul Islam
*Transferred to the GPB in 1974
as Lecturer*



Prof. Dr. Md. Ali Newaz
*Transferred to the GPB in 1974
as Lecturer*



Prof. Dr. M. Tajul Islam
*Transferred to the GTI in 1983
as Associate Professor*



Prof. Dr. M. Abul Hossain
*Transferred to the Agroforestry in 1997
as Professor*



Prof. Dr. M. Abdul Baten
*Transferred to the Environmental Science in 2002
as Associate Professor*



Prof. Dr. M. Shahidul Haque
*Transferred to the Biotechnology in 2004
as Associate Professor*

GPB = Dept. of Genetics and Plant Breeding, GTI = Graduate Training Institute

Heads of the Department

1	Dr. Shamsul Huda Chawdhury	22.03.1963–08.10.1964
2	Prof. Dr. Ashraful Haque	09.10.1964–29.08.1966
3	Dr. Shamsul Huda Chawdhury	30.08.1966–30.04.1967
4	Prof. Dr. Ashraful Haque	31.04.1967–09.10.1979
5	Dr. Shamsul Huda Chawdhury	10.10.1979–30.05.1982
6	Prof. Dr. Abu Ahmed Abdul Muhshi	31.05.1982–01.05.1984
7	Prof. Dr. Md. Abdul Haque	02.05.1984–03.05.1986
8	Dr. Md. Abdul Halim Khan	04.05.1986–08.07.1988
9	Md. Mustafizur Rahman	09.07.1988–04.03.1989
10	Dr. Md. Abdul Karim	05.03.1989–25.05.1989
11	Md. Mustafizur Rahman	26.05.1989–04.12.1989
12	Dr. Md. Abdul Karim	05.12.1989–04.12.1991
13	Dr. M. Abul Hossain	05.12.1991–04.12.1993
14	Dr. Subodh Chandra Sarker	05.12.1993–15.03.1995
15	Md. Mustafizur Rahman	16.03.1995–13.11.1995
16	Prof. Dr. Md. Abdul Halim Khan	14.11.1995–13.11.1997
17	Dr. Md. Solaiman Ali Fakir	14.11.1997–13.11.1999
18	Dr. A.K.M. Azad-ud-doula Prodhan	14.11.1999–13.11.2001
19	Dr. Md. Shahidul Haque	14.11.2001–12.04.2002
20	Prof. Dr. Md. Abdul Karim	13.04.2002–12.04.2004
21	Prof. Md. Mustafizur Rahman	13.04.2004–12.04.2006
22	Prof. Dr. Md. Habibur Rahman Pramanik	13.04.2006–12.04.2008
23	Prof. Dr. M. Obaidul Islam	13.04.2008–12.04.2010
24	Prof. Dr. Md. Shahidur Rahman	13.04.2010–12.04.2012
25	Prof. Dr. Md. Ashrafuzzaman	13.04.2012–12.04.2014
26	Prof. Dr. Md. Abdul Awal	13.04.2014–12.04.2016
27	Prof. Dr. A.K.M. Zakir Hossain	13.04.2016–12.04.2018
28	Prof. Dr. A.K.M. Golam Sarwar	13.04.2018–12.04.2020
29	Prof. Dr. Md. Alamgir Hossain-1	13.04.2020–12.04.2022
30	Prof. Dr. Md. Alamgir Hossain-2	13.04.2022– date

Teachers in dignified positions from the Department

Honorable Vice-Chancellors

	Name	University	Tenure
1	Prof. Dr. M. Abdul Haque	Bangladesh Agricultural University, Mymensingh	18.08.1993–23.08.1993
2	Prof. Dr. M. Abdul Halim Khan	Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur	12.12.2001–12.12.2005
3	Prof. Dr. A.K.M. Azad-ud-doula Prodhan	Pundra University of Science and Technology, Bogura	08.10.2017–31.08.2020
4	Prof. Dr. A.K.M. Zakir Hossain	Kurigram Agricultural University, Kurigram	08.05.2022–date

Deans of the Faculty of Agriculture

	Name	Tenure
1	Prof. Dr. M. Ashraful Haque	13.08.1969 –07.10.1971
2	Prof. Dr. Shamsul Huda Choudhury	01.01.1976 –31.12.1977
3	Prof. Dr. Abu Ahmed Abdul Muhshi	06.01.1986 –04.01.1988
4	Prof. Dr. M. Abdul Halim Khan	30.06.2007 –29.06.2009
5	Prof. Dr. M. Abdul Karim	30.06.2009 –29.06.2011

Students' Affairs Advisors

	Name	Tenure
1	Prof. Dr. M. Arshad Ali	07.03.1985 –07.03.1987
2	Prof. Md. Mustafizur Rahman	30.06.2010 –29.06.2012
3	Prof. Dr. Md. Solaiman Ali Fakir	08.10.2018 –08.10.2020
4	Prof. Dr. A.K.M. Zakir Hossain	09.10.2020 –07.05.2022

Statistics of staff, students and programs offered

Number of Staff

Teachers	22
Professors	15
Assistant Professors	7
Officers	3
Third Class Employees	3
Fourth Class Employees	5
MR/ Casual Labours	6

Current post-graduate students

Masters	60
Doctoral	07

Passed out post-graduates from the Department (up to June 2022)

Masters	934
Doctoral	32

Courses and programs offered from the Department

Name of programs	Compulsory	Elective	Total
Undergraduate	13	5	18
Bachelor of Science in Agriculture (Honours)	7	3	10
Bachelor of Science in Food Engineering	2	-	2
Bachelor of Science in Food Safety Management (Honours)	2	2	4
Bachelor of Science in Bioinformatics Engineering	2	-	2
Master of Science in Crop Botany	9	17	26
Doctor of Philosophy	6	11	17
Total:			61

Teachers' Profile

SL No.	Name of the teachers	Designation	Degrees Obtained & Specialization
1	Dr. A.K.M. Azad-ud-doula Prodhan	Professor	PhD (Hokkaido Univ, Japan) <i>Plant Anatomy, Plant Morphology, Plant Embryology</i>
2	Dr. Md. Solaiman Ali Fakir	Professor	PhD (UWI, Trinidad) <i>Under Utilized plants, Stress Physiology, Food and Nutrition Security</i>
3	Dr. Md. Habibur Rahman Pramanik	Professor	PhD (Shimane Univ, Japan) <i>Plant Ecology</i>
4	Dr. M. Obaidul Islam	Professor	PhD (Gifu Univ, Japan) <i>Plant Tissue Culture, Biotechnology</i>
5	Dr. Md. Shahidur Rahman	Professor	PhD (Nagoya Univ, Japan) <i>Plant Ecology (Salinity Stress)</i>
6	Dr. Md. Ashrafuzzaman	Professor	PhD (SNU, South Korea) <i>Plant Stress Physiology, Plant Biodiversity and Conservation, Ethnobotany</i>
7	Dr. Md. Abdul Awal	Professor	PhD (Niigata Univ, Japan) <i>Plant Ecology</i>
8	Dr. A.K.M. Zakir Hossain	Professor	PhD (Gifu Univ, Japan) <i>Plant Physiology, Biological Nitrification Inhibition</i>
9	Dr. A.K.M. Golam Sarwar	Professor	PhD (Hokkaido Univ, Japan) <i>Plant Morphology, Palynology and Plant Systematics; Biodiversity and Conservation</i>
10	Dr. Md. Alamgir Hossain-1	Professor	PhD (Gifu Univ, Japan) <i>Plant Stress Physiology, Medicinal Plants and Functional Food, Nanotechnology</i>
11	Dr. Md. Alamgir Hossain-2	Professor	MS (Yamaguchi Univ, Japan) PhD (Tottori Univ, Japan) <i>Stress Physiology in Cereals, Functional Food</i>
12	Dr. Shahanara Begum	Professor	MS & PhD (TUAT, Japan) <i>Plant Anatomy, Wood Biomass Formation</i>
13	Dr. Md. Nesar Uddin	Professor	PhD (JL Univ, Giessen, Germany) <i>Salinity and Drought Stress, Phytochemistry of Medicinal Plants</i>
14	Dr. Israt Jahan Shelley	Professor	PhD (Nagoya Univ, Japan) <i>Plant Biotechnology, Plant Adaptation and Tolerance to Abiotic Stress</i>
15	Dr. Md. Sabibul Haque	Professor	MS & PhD (Arhus Univ, Denmark) <i>Plant Eco-Physiology, Biodiversity and Conservation</i>
16	Mr. Md. Masudul Karim	Assistant Professor	PhD Fellow (Saitama Univ, Japan) <i>Plant Physiology</i>

17	Mr. Md. Abdur Razzak	Assistant Professor	PhD Fellow (Tottori Univ, Japan) <i>Plant Physiology</i>
18	Mr. Ashaduzzaman Sagar	Assistant Professor	PhD Fellow (Murdoc Univ, Australia) <i>Plant Physiology</i>
19	Mrs. Jannat-E-Tajkia	Assistant Professor	PhD Fellow (Ghent Univ, Belgium) <i>Plant Systematics</i>
20	Mr. Md. Ashik Mia	Assistant Professor	MS in Crop Botany (BAU)
21	Most. Morsada Khatun	Assistant Professor	MS in Crop Botany (BAU)
22	Mrs. Sadiya Arefin Juthee	Assistant Professor	MS in Crop Botany (BAU)

Officers and Employees of the Department

Sl. No.	Name of staff	Designation
1	Md. Anowarul Islam	Senior Demonstrator
2	Md. Didarul Haque	Demonstrator
3	Md. Ziaur Rahman	Assistant Accounts Officer
4	Md. Habibur Rahman	Senior Assistant-cum-Computer Operator
5	Akbar Hossain	Senior Assistant
6	Shuvra Chakraborty	Laboratory Technician
7	Md. Abdul Alim	Senior Helper to Lab. Technician (Special Grade)
8	Md. Jamal Uddin	Senior Helper to Lab. Technician (Special Grade)
9	Md. Amirul Islam	Office Attendant
10	Md. Gias Uddin	Senior Sweeper
11	Md. Mustafizur Rahman	Office Attendant
12	Md. Israfil Haque	MR Labour
13	Md. Abdul Mannan	MR Labour
14	Md. Moznu Mia	Casual Labour
15	Md. Jahangir Alam	Casual Labour
16	Md. Shahidul Islam	Casual Labour
17	Md. Habibur Rahman	Casual Labour

Departmental Laboratories/Research facilities

- Plant Physiology Lab
- Plant Ecology Lab
- Plant Anatomy & Tissue Culture Lab
- Field Laboratory
- Botanical Garden

Courses offered in B.Sc. Ag. (Hons.) Program

Program Learning Outcomes (PLO)

PLOs	Statement	LO Domains*
PLO 1	Apply substantial knowledge and skill on different aspects of sustainable crop production while discharging professional duties and responsibilities	FS, PS
PLO 2	Demonstrate basic knowledge and laboratory skills on crop production, protection and improvement.	FS, PS
PLO 3	Capacity to engage in critical thinking by problem solving with limited guidance, insight and field experience.	FS, TS, PS
PLO 4	Exhibit integrative skills and technical competences in utilizing existing and emerging technologies in agriculture.	PS
PLO 5	Develop and disseminate climate smart technologies to cope with the challenges of changing climate.	FS, TS, PS
PLO 6	Demonstrate leadership in technology transfer among farming communities and other stakeholders	SS
PLO 7	Communicate ideas, issues and solutions efficiently and effectively among the professionals, scientists and farmers	FS, SS, PS
PLO 8	Use tools for analyzing national agricultural policies and programs	FS, TS, PS
PLO 9	Show professional attitude in leadership, teamwork, communication, ethical and legal judgment.	SS, PS
PLO 10	Perform effectively as an individual, and member or leader in the diverse team for multidisciplinary areas.	SS

*FS=Fundamental skills, SS=Social skills, TS= Thinking skills, PS=Personal skills

Total Number of Courses for the program : 82 (Theory-44, Practical-38)

Total Credit hours in the program: 150 (Theory-107, Practical 38 & Internship-5)

Department of Crop Botany offers 6 theory and 4 practical course for B. Sc. Ag. (Hons.) program

Level	Semester	Compulsory Courses		Elective Courses
		Theory	Practical	Theory
L-1	S-2	-	CBOT 1222: Plant Morphology	-
L-2	S-1	CBOT 2121: Plant Anatomy, Systematics and Economic Botany	CBOT 2122: Plant Anatomy, Systematics and Economic Botany	-
L-3	S-1	-	-	CBOT 3101 Medicinal Plant and Bioresources
	S-2	CBOT 3221: Plant Physiology	CBOT 3222: Plant Physiology	-
L-4	S-1	CBOT 4121: Plant Ecology	CBOT 4122: Plant Ecology	CBOT 4103: Plant Stress Physiology
	S-2	-	-	CBOT 4221: Plant Biodiversity and Conservation

Course Code: CBOT 1222**Course Title: Plant Morphology**

Practical Course

Credit: 1

Contact Hours: 32

Level:1

Semester: 2

Rationale

The course has been designed to offer knowledge on plant morphology and its link to plant functioning and other aspects of crop production and improvement.

Course Learning Outcomes (CLO)

1. Illustrate the types, characters, modification and functions of roots, stems, leaves, flowers, fruits and seeds of plants
2. Explain the descriptors for morphological identification and characterization of crop plants
3. Prepare plant herbarium specimens and its preservation.
4. Show communicative and presentation skills

Mapping CLO with PLO

CLO \ PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	√	√								
CLO2	√	√	√	√						
CLO3	√	√					√			√
CLO4						√	√		√	√

Course Content

Course content	Aligned CLO	No of Lectures
Morphological Descriptors: Root, stem, leaf, inflorescence, flower, fruit and seed	1, 2	6
External morphology of the following crops and their relatives: Mustard, onion, groundnut, mungbean, brinjal, jute, cotton, cucurbits, sunflower, rice, wheat, maize, coriander, mango, and jackfruit	2	6
Herbarium sheet preparation and preservation	3	1
Botanical garden and different field laboratory visit	3, 4	2
Assignment and presentation	4	1

Teaching strategy <ul style="list-style-type: none"> ● Lectures ● Demonstrations ● Video clips ● Discussions ● Group work ● Question and answering ● Individual practice ● Field visit 	Assessment strategy <ul style="list-style-type: none"> ● Assignment ● Quiz ● Individual demonstration ● Viva-voce ● Presentation.
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Recommended books and other resources:

- Dodd, J.D. 1977. Course Book in General Botany. Ames Iowa State Univ. Press. Dutta, A.C. 1979. Botany for Degree Students. 5th ed. Oxford Univ. Press, Calcutta. Esau, K. 1965. Plant Anatomy. John Wiley, New York.
- Gupta, R.K. 1981. Textbook of Systematic Botany. Atma Ram and Sons, New Delhi. Hassan, M.A. (ed.). 1979. Botany Part II. Hasan Book House, Dhaka.
- Mitra, J.N. 1974. An Introduction to Systematic Botany and Ecology. The world press pub. Ltd., Calcutta.
- Purseglove, J.W. 1985. Tropical Crops. Vol. 1&2. Longmans, London.
- Robbins, W.W., Weier, T.E. and Stocking, C.R. 1966. Botany: In introduction to Plant Science, 3rd ed., John Willey and Son. Inc., New York.

Course Code: CBOT 2121 Course Title: Plant Anatomy, Systematics and Economic Botany

Theory Course Credit: 2 Contact Hours: 32 Level:2 Semester: 1

Rationale

This course has been designed to offer knowledge on plant taxonomy, anatomy and embryology, economically important plants and their uses.

Course Learning Outcomes (CLO)

1. Illustrate the structure and function of plant cells and tissues
2. Compare and contrast internal structures of field crops
3. Explain embryogenesis, fruit and seed development and in-vitro somatic embryogenesis for crop improvement
4. Characterize salient morphological features for plant classification and improvement
5. Evaluate economically important plants emphasizing on medicinal, fibre, beverage, sea weed etc., their functions and industrial uses
6. Outline wood formation and apply nanocellulose in agriculture

Mapping CLO with PLO

CLO \ PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	√	√	√		√		√			
CLO2	√	√	√		√		√			
CLO3	√	√	√		√	√	√			
CLO4	√	√	√		√		√	√	√	
CLO5	√	√	√				√	√		
CLO6	√	√						√		√

Course Content

Course content	Aligned CLO	No of Lectures
Cell and cell wall: Structure and functions of cell and cell organelles, plasma membrane, components, composition and thickening of cell wall, depolymerization of nanofibrils and application of nano-cellulose in agriculture.	1, 2 & 6	4



Tissue and Tissue culture: Classification, structure and functions of tissues, types of vascular bundles, epidermis and epidermal appendages; Tissue responses to stresses; <i>In-vitro</i> culture, somaclone and micro- propagation.	1	5
Primary and secondary growth: Primary and secondary growth of root and stem, structures of leaves; Normal and anomalous secondary growth, periderm and its functions, hard wood and soft wood.	1, 6	5
Anatomy of the following crops: 1) Sugarcane, 2) Mustard 3) Sweet potato	2	2
Embryology: Sporogenesis and gametogenesis, pollination, fertilization, development of embryo, endosperm, seed and fruit, parthenogenesis, <i>in- vitro</i> fertilization and embryo culture.	3	6
Plant Systematics: Taxon and botanical nomenclature, principles and systems of modern plant classification.	4	3
Characteristics of families: 1) Poaceae, 2) Fabaceae, 3) Solanaceae, 4) Cucurbitaceae, 5) Asteraceae, 6) Apiaceae, 7) Rutaceae, 8) Anacardiaceae, 9) Moraceae, 10) Orchidaceae, 11) Arecaceae, 12) Lamiaceae and 13) Cactaceae.	4	4
Economic Botany: Sources, uses, classification, conservation, factor affecting quality & yield of medicinal, timber, fibre, nut and beverage yielding plants; Blue economy concept, contribution of sea weed and micro- algae.	5	3

Teaching Strategy	Assessment Strategy
<ul style="list-style-type: none"> ● Lectures ● Discussion ● Video clips ● Question & answer ● Group studies 	<ul style="list-style-type: none"> ● Question & answer ● Assignment ● Quiz and ● Observation

Recommended books and other resources

- Brian, C. 2005. Botany for Gardeners. Timber Press, Inc., Cambridge. Esau, K. 1965. Plant Anatomy. John Wiley, New York.
- Evert, R. F. 2006. Esau's Plant Anatomy: Meristems, Cells, and Tissues of The Plant Body – Their Structure, Function, and Development. 3rd ed., John Wiley & Sons, New Jersey.
- Henry, R.J. 2005. Plant Diversity and Evolution Genotypic and Phenotypic Variation in Higher Plants. CABI Pub., Cambridge.
- Lersten, N.R. 2004. Flowering Plant Embryology. Blackwell Pub., Oxford. Pandey, B.P. 2000. Economic Botany. 6th ed. S. Chand & Co., New Delhi. Purseglove, J.W. 1985. Tropical Crops. Vol. 1 & 2. Longmans, London.
- Simpson, M.G. 2010. Plant Systematics. 2nd ed., Elsevier Acad. Press, New York.

Course Code: CBOT 2122 Course Title: Plant Anatomy, Systematics and Economic Botany

Practical Course

Credit: 1

Contact Hours: 32

Level:2

Semester: 1

Rationale

This course has been designed to offer hands-on practices on internal structures and functions emphasizing plant identification and ideotype development.

Course Learning Outcomes (CLO)

1. Prepare and demonstrate temporary and permanent slides for microscopy
2. Identify plant cell and tissues, cell organelles, pollen and placenta
3. Characterize anatomical features of root, stem and leaves of crops
4. Apply tissue culture technique for in situ conservation of threatened species
5. Integrate and apply software and computer aided tools for plant classification and biodiversity management
6. Show communicative and presentation skills

Mapping CLO with PLO

CLO \ PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1		√		√						√
CLO2	√	√	√	√			√			√
CLO3	√	√	√	√			√			√
CLO4		√		√						√
CLO5				√	√	√	√	√	√	√
CLO6						√	√		√	√

Course Content

Course content	Aligned CLO	No of Lectures
Slide preparation: Sectioning, demonstration of microtome and maceration techniques, staining and mounting, temporary and permanent slides.	1, 2, 3	1
Demonstration of the following: Cell and cell organelles, components of different tissues. Structure of anther, pollen grain, pollen germination, artificial pollination, ovary, ovule and placenta. Internal structures of isobilateral and dorsiventral leaves, stomatal distribution.	1, 2, 3	2
Preparation of tissue culture media and its application in plant conservation	4	2
Anatomy of crops: Rice, wheat, maize, cucurbit, groundnut, country bean, jute and sweet potato.	1, 2, 3	4
Extraction and characterization of nanocellulose from agro-wastes and forest biomass.	2	1
Identification of major families and preparation of phylogenetic tree.	5	1

Medicinal Plant: Bioactive markers for characterization of medicinal plants.	5	1
Field Visit to different botanical gardens, national herbarium, specialized mono-crop research institute to observe the morphological variation in plants.	5	3
Assignment and presentation	2, 3, 5, 6	1

Teaching strategy <ul style="list-style-type: none"> ● Lecture ● Demonstration and practice ● Group discussion ● Visit to different Institutions 	Assessment strategy <ul style="list-style-type: none"> ● MCQ ● Short question ● Practical job ● Assignment
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Recommended books and other resources

- Brian, C. 2005. Botany for Gardeners. Timber Press, Inc., Cambridge. Esau, K. 1965. Plant Anatomy. John Wiley, New York.
- Henry, R.J. 2005. Plant Diversity and Evolution Genotypic and Phenotypic Variation in Higher Plants. CABI Pub., Cambridge.
- Lersten, N.R. 2004. Flowering Plant Embryology. Blackwell Pub., Oxford. Pandey, B.P. 2000. Economic Botany. 6th ed. S. Chand & Co., New Delhi. Purselglove, J.W. 1985. Tropical Crops. Vol. 1 & 2. Longmans, London.
- Simpson, M.G. 2010. Plant Systematics. 2nd ed., Elsevier Acad. Press, New York.

Course Code: CBOT 3221 Course Title: Plant Physiology

Theory Course Credit: 2 Contact Hours: 32 Level:3 Semester: 2

Rationale

The course has been designed to offer knowledge on plant functions for maximizing natural resources utilization in relation to plant growth, development, yield and quality.

Course Learning Outcomes (CLO)

1. Analyze physiological aspects of water absorption, osmoregulation, water-use efficiency (WUE) and dry matter (DM) production
2. Evaluate photosynthetic pathways, carbon use efficiency, metabolic limitations to DM yield, bioreduction of nanomaterials and antioxidant properties of pigments
3. Explain energy expenditure during respiration & growth and evaluate modified atmospheric conditions for handling and storability of plant products
4. Assess radiation use efficiency, growth parameters, assimilate partitioning and yield attributes
5. Outline flowering physiology in relation to photo- and thermo-periodism, application of PGRs on plant growth and development
6. Narrate the causes of dormancy with remedial measures and explain the physiological aspects of osmopriming for germination
7. Integrate the stress-specific responses of plants with physiological, biochemical and molecular means of overcome and explain auto immune system in plants

Mapping CLO with PLO

CLO \ PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	√	√	√							
CLO2			√	√	√		√			
CLO3		√		√						
CLO4	√	√			√					
CLO5	√		√							
CLO6	√	√								
CLO7					√					√

Course content

Course content	Aligned CLO	No. of Lectures
Plant water relationship: Water potential and osmotic diffusion of water in plants, water absorption mechanisms and factors, ascent of sap-theories and factors, transpiration and guttation, stomatal movement-mechanisms and factors, Significance in crop production.	1, 2, 7	4
Photosynthesis and Pigment Biology: Energy conversion, quantum yield and chlorophyll fluorescence, pathways for C fixation, ROS generation and detoxification, metabolic manipulation for C4 rice, bio-reduction of nano particles (NPs) and antioxidant properties of pigments in relation to quality improvement.	2, 7	5
Transport and partitioning of assimilates: Types, phloem loading and unloading, source-sink relationships, assimilate partitioning, harvest index, yield analyses techniques.	2, 4, 7	3
Respiration and Post-harvest Physiology: Types, mechanisms, anaerobiosis and Gamma Amino Butyric Acid (GABA) shunt, Physio-chemical changes during fruits ripening, Climacteric vs. non-climacteric fruits, pigments changes and value added traits, control of ripening processes and enhanced shelf-life, using NPs, factors for storage and handling of harvested products.	3, 5, 7	4
Plant Growth Regulators: Classification, functions and applications of phytohormones for growth & development of plant both <i>in vivo</i> and <i>in vitro</i> .	5, 4	2
Physiology of flowering: Transition to flowering, photo-periodism, photo-inductive cycles, night breaks, factor modifying photo-inductive cycle and vernalization.	5	2
Seed and seedling physiology: Sources of assimilate, seed growth and maturation, seed reserves and mobilization during germination and seedling growth, dormancy- causes, releases and its significance.	6, 3	2
Growth and development: Concept, growth phases, correlation and growth dynamics, growth curves	2, 3, 4, 5	3
Stress Physiology: Types, Physiological markers of different stresses, defense mechanisms and survival.	7, 2	5
Secondary metabolites: Types, pathways, functions and importance for auto immune system.	7, 2	2

<p>Teaching Strategy</p> <ul style="list-style-type: none"> ● Lectures ● Discussion ● Video clips ● Question & answer ● Group studies 	<p>Assessment Strategy</p> <ul style="list-style-type: none"> ● Question & answer ● Assignment ● Quiz and observation
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Recommended books and other resources

- Bewley, J.D. and Black, M. 1994. Seeds: Physiology of Development and Germination. 2nd ed. Plenum Press, New York.
- Datta, S.C. 1994. Plant Physiology. Wiley Eastern Ltd., Calcutta, India.
- Fosket, D.E. 1994. Plant Growth and Development. Academic Press Inc. California.
- Gardner, F.P., Pearce, R.B. and Mitchell, R.L. 1985. Physiology of Crop Plants. Iowa State Univ. Press, USA.
- Hall, D.O., Scurlock, J.M.O., Bolhar-Nordenkampf, H.R., Leegood, R.C. and Long, S.P. 1993. Photosynthesis and Production in a Changing Environment: A Field and Laboratory Manual. Chapman and Hall, U.K.
- Hans, M. 1984. Class experiments in plant physiology. George Allen & Unwin Pub. Ltd., London.
- Hunt, R. 1982. Plant growth curves: The functional approach to plant growth analysis. Edward Arnold, London.
- Levit, J. 1980. Response of Plants to Environmental Stresses, Academic Press, New York.
- McDonald, M.B. and Copeland, L.O. 1989. Seed Science and Technology: Laboratory manual. Iowa State Univ. Press, USA.
- Mohr, H. and Schopfer, P. 1994. Plant Physiology. Springer, Berlin.
- Nilsen, E.T. and Orcutt, D.M. 1996. The Physiology of Plants under Stress. John Wiley and Sons, New York.
- Pandey, S.N. and Sinha, B.K. 1986. Plant Physiology. Vikas Pub. House Pvt. Ltd., New Delhi.
- Pudake R.N., Chauhan N and Kole C. (Edt). 2019. Nanoscience for Sustainable Agriculture. Springer Nature Switzerland AG.
- Salisbury, F.B. and Ross, C.W. 1986. Plant Physiology. Wadworth Pub., USA.

Course Code: CBOT 3222

Course Title: Plant Physiology

Practical Course

Credit: 1

Contact Hours: 32

Level:3

Semester: 2

Rationale

The course has been designed to offer practical knowledge on plant functions in relation to plant growth, development, yield and quality in field condition.

Course Learning Outcomes (CLO)

1. Analyze water relations in plants to enhance crop production
2. Distinguish among C_3 , C_4 and CAM plants, and integrate their production efficiency
3. Demonstrate basic phenomena on photosynthesis and respiration
4. Separate and quantify photosynthetic pigments under different environmental condition to stabilize food and nutrition safety
5. Examine the influence of different stresses and plant growth regulators on growth and yield of crops in relation to changing climate
6. Perform oral and visual presentation

Mapping CLO with PLO

CLO \ PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1		√	√	√						
CLO2	√	√	√	√						
CLO3	√	√								
CLO4	√	√			√					
CLO5	√	√			√					√
CLO6		√					√			√

Course content

Course content	Aligned CLO	No of Lectures
Experiments to demonstrate- osmosis, plasmolysis, transpiration and ascent of sap.	1	3
Measurement of water status and water potential in plant tissues.	1	1
Study of anatomical structures of leaves in C ₃ , C ₄ and CAM plants.	2	1
Experiments to demonstrate photosynthesis and respiration.	3	2
Experiments on plant pigments: separation, quantification and chlorophyll stability index, nanoparticles synthesis using leaf pigments and food safety.	4	2
Experiments on ecophysiological aspects of imbibition and germination of seeds, methods of breaking seed dormancy.	1, 5	2
Demonstration of the effects of different stresses on growth and yield in crops.	5	2
Demonstration of the effects of different PGRs on growth and yield in crops.	1, 5, 6	1
Field /Physiological laboratory visit and presentation.	4, 5, 6	2

Teaching strategy	Assessment strategy
<ul style="list-style-type: none"> ● Lectures ● Demonstrations ● Video clips ● Discussions ● Group work ● Question and answering ● Individual practice ● Field visit 	<ul style="list-style-type: none"> ● Assignment ● Quiz, ● Individual demonstration ● Viva-voce ● Presentation.

Recommended books and other resources

- Bewley, J.D. and Black, M. 1994. Seeds: Physiology of Development and Germination. 2nd ed. Plenum Press, New York.
- Datta, S.C. 1994. Plant Physiology. Wiley Eastern Ltd., Calcutta, India.
- Fosket, D.E. 1994. Plant Growth and Development. Academic Press Inc. California.
- Gardner, F.P., Pearce, R.B. and Mitchell, R.L. 1985. Physiology of Crop Plants. Iowa State Univ. Press, USA.

- Hall, D.O., Scurlock, J.M.O., Bolhar-Nordenkamp, H.R., Leegood, R.C. and Long, S.P. 1993. Photosynthesis and Production in a Changing Environment: A Field and Laboratory Manual. Chapman and Hall, U.K.
- Hans, M. 1984. Class experiments in plant physiology. George Allen & Unwin Pub. Ltd., London.
- Hunt, R. 1982. Plant growth curves: The functional approach to plant growth analysis. Edward Arnold, London.
- Levit, J. 1980. Response of Plants to Environmental Stresses, Academic Press, New York.
- McDonald, M.B. and Copeland, L.O. 1989. Seed Science and Technology: Laboratory manual. Iowa State Univ. Press, USA.
- Mohr, H. and Schopfer, P. 1994. Plant Physiology. Springer, Berlin.
- Nilsen, E.T. and Orcutt, D.M. 1996. The Physiology of Plants under Stress. John Wiley and Sons, New York.
- Pandey, S.N. and Sinha, B.K. 1986. Plant Physiology. Vikas Pub. House Pvt. Ltd., New Delhi.
- Pudake R.N., Chauhan N and Kole C. (Edt). 2019. Nanoscience for Sustainable Agriculture. Springer Nature Switzerland AG.
- Salisbury, F.B. and Ross, C.W. 1986. Plant Physiology. Wadworth Pub., USA.

Course Code: CBOT 4121**Course Title: Plant Ecology**

Theory Course

Credit: 3

Contact Hours: 48

Level:4

Semester: 1

Rationale

The course has been designed to enrich knowledge on interactions between plant and environment emphasizing plant adaptation and distribution and their management and improvement for food security under global climate change.

Course Learning Outcomes (CLO)

1. Discuss ecological impacts and significances of light, temperature, water, wind, physiographic and biotic factors on plant responses for better crop production.
2. Classify world and Bangladesh climates with crops and vegetation suitable therein.
3. Distinguish cultivated and natural ecosystems and biotic association therein.
4. Predict the causes and consequences of various pollutions, greenhouse effects, global warming and climate change with adaptation and mitigation strategies.
5. Integrate knowledge of GIS and remote sensing towards climate smart agriculture for optimization of crop production and resource management.
6. Illustrate adaptive features of plants in different habitats.
7. Explain successional processes, phytogeography and vegetation regions of world and Bangladesh along with forest and biodiversity losses and conservation strategies.

Mapping CLO with PLO

CLO \ PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	√	√	√	√						
CLO2	√	√								
CLO3	√	√								
CLO4	√	√			√		√			
CLO5	√	√		√	√		√	√		
CLO6	√	√			√					
CLO7	√				√					

Course content

Course content	Aligned CLO	No of Lectures
Agro-climatological parameters and plant responses: <i>Solar radiation:</i> Laws, spectra, quantity, Daily Light Integral (DLI), distribution and utilization. <i>Temperature:</i> Cardinal temperatures, degree-days, daily and seasonal patterns, profile and fluxes. <i>Water:</i> Forms, precipitation, evapotranspiration and energy relation, atmospheric circulation, cyclones, dust, dry wind, storms and hails. <i>Wind:</i> Profiles, windbreak and shelter effects. <i>Micro- and macroclimate:</i> Concept, modification for better crop production. Climatic classification – the world and Bangladesh.	1 & 2	12
Physiographic and biotic parameters: Effects of altitude, latitude, slope and aspects on microclimate and crop production; species interactions and their types, effects on vegetation and crop production, principles of crop-weed association.	1 & 2	4
Ecosystems: Structure, components, classification and functions of natural and cultivated ecosystems, flow of energy and matter, biogeochemical and nutrient cycling.	3	3
Environmental pollution: Types, causes and consequences on agro- ecosystem with remedies.	4	4
Greenhouse effect and climate change: Greenhouse gasses - sources, sinks, effects; carbon footprint- carbon calculators, CO ₂ reduction, carbon offsetting and caring for the climate; slow onset and extreme climates, global warming- causes, consequences and remedies.	4	6
Climate smart agriculture (CSA): Risk and challenges of agriculture in changing climate, principles and pillars of CSA, strategies for adaptation, mitigation and food security.	5	2
Phytogeography: Principles, vegetation regions of Bangladesh and world, ecologically critical areas of Bangladesh and crop suitability.	7	4
Ecology of crops: Cereals, sugar crops, pulses and oils, beverage, fibres, vegetables and fruits.	1, 3 & 6	3
Terrestrial and wetland ecology: Plant succession-causes, process, types and vegetation formation; ecological features of mangroves, coast, <i>haor</i> and hills vegetation, and adaptation of species therein.	3, 6 & 7	5
Biodiversity and conservation: Concept, biodiversity hotspots, drivers of vegetations and biodiversity depletion, conservation and management strategies, national conservation policy.	7	2
System ecology: Concept, components and prospects of GIS and remote sensing and their application in agriculture and resource management.	5 & 7	3

<p>Teaching Strategy</p> <ul style="list-style-type: none"> ● Lectures ● Discussion ● Video clips ● Question & answer ● Group studies 	<p>Assessment Strategy</p> <ul style="list-style-type: none"> ● Question & answer ● Assignment ● Quiz and ● Observation
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Recommended books :

- Ambasht, R.S. and Ambasht, P.K. 1999. Environment and Pollution. 3rd ed. CBS Pub., New Delhi.
- Chang, J.H. 1971. Climate and Agriculture. Aldine Pub., Chicago. Deshmukh, I. 1986. Ecology and Tropical Biology. Blackwell, Oxford.
- Dimond, J. and Case, T.J. 1980. Community Ecology, Harper & Row, New York.
- রহমান, মোঃ. আ. এবং উজ্জল, এম. এন. কে. কে. 2003. জলবায়ু বিদ্যা (Climatology). Perfect Publications. Dhaka.
- Jackson, I.J. 1982. Climate, Water and Agriculture in Tropics. Longman, London. Kumar, H.D. 1995. General Ecology. Vikas Pub. House, New Delhi.
- Odum, E.P. 1971. Fundamentals of Ecology. Saunders, Philadel.
- Rosenberg, N.J., Blad, B.L. and Verma, S.B. 1983. Microclimate: The Biological Environment. John Wiley, New York.
- Santra. S.C. 2012. Environmental Science. New Central Book Agency (P) Ltd. New Delhi.
- Sarwar, A.K.M. Golam. 2019. Plant Biodiversity and Conservation of Higher Plants in Bangladesh: Present Status and Future Prospects. In: Sangeetha J, Thangadurai D, Goh HC, Islam S. (eds). Biodiversity and Conservation: Characterization and Utilization of Plants, Microbes and Natural Resources for Sustainable Development and Ecosystem Management. AAP/CRC, Florida, USA. pp. 259-288.
- Shukla, R.S. and Chandel, P.S. 2014. A Textbook of Plant Ecology including Ethnobotany and Soil Science (Twentieth Revised & Enlarged Edition). S. Chand & Company Pvt. Ltd. New Delhi.
- UNESCO. 1987. Mangroves of the Asia and Pacific: Status and Management, technical report of the UNDP/UNESCO research and training pilot programme on mangrove ecosystems in Asia and the Pacific. UNESCO, Paris.

Course Code: CBOT 4122**Course Title: Plant Ecology**

Practical Course

Credit: 1

Contact Hours: 32

Level:4

Semester: 1

Rationale

The course has been designed to cover practical knowledge on plant adaptation and biotic relations in different habitats; and to analyze field data in relation to eco-physiological aspects.

Course Learning Outcomes (CLO)

1. Illustrate morphological, anatomical and eco-physiological adaptive features of plants in aquatic, xeric, shade and saline habitats
2. Demonstrate and explain the different types of biotic relations in agro-ecosystems.
3. Assess species association and competition within plant communities
4. Analyze community structure and predict vegetation values and stability
5. Quantify agro-climatological parameters and interpret plant growth analysis
6. Apply GIS and remote sensing in vegetation study and mapping
7. Compare and contrast different ecological zones of Bangladesh and perform oral and visual presentation

Mapping CLO with PLO

CLO \ PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	√	√	√				√			
CLO2	√	√								
CLO3	√	√	√							

CLO4	√	√	√							
CLO5	√	√								
CLO6	√	√		√	√					
CLO7	√	√					√	√		√

Course content	Aligned CLO	No of Lectures
Study on adaptive features of different ecological plant types such as hydrophytes, xerophytes, halophytes, heliophytes, sciophytes, etc.	1	3
Study on biotically related plants - commensals, ammensals, parasites, symbionts, etc.	2	2
Methods of ecological survey of plant communities and field study of plant habitats.	4	2
Experiments on species interactions and their effects on plant growth.	3	2
Experiment on crop growth analysis.	5	2
Practices on GIS and remote sensing, vegetation mapping.	6	1
Quantification of light reflectance, absorbance and transmittance to relate bio-energy production.	5	1
Field visit to important ecological zones of Bangladesh.	7	2
Assignment and presentation.	1-7	1

Teaching strategy	Assessment strategy
<ul style="list-style-type: none"> ● Lectures ● Demonstrations ● Video clips ● Discussions 	<ul style="list-style-type: none"> ● Group work ● Question and answering ● Individual practice ● Field visit.
	<ul style="list-style-type: none"> ● Assignment ● Quiz ● Individual demonstration ● Viva-voce, presentation.

Recommended books

- Bhatta, B. 2011. Remote Sensing and GIS. Second Edition. Oxford University Press.
- Campbell, G.S. and Norman, J.M. 1998. An Introduction to Environmental Biophysics. Second Edition. Springer.
- Gilbertson, M. et al. 1996. Practical Ecology for Geography and Biology: Survey, Mapping and Data Analysis. Springer.
- Hunt, R. 1982. Plant Growth Curves: The Functional Approach to Plant Growth Analysis. Edward Arnold, London.
- Jones, H.G. and Vaughan, R.A. 2010. Remote Sensing of Vegetation: Principles, Techniques, and Applications. Oxford University Press.
- Kent, M. 2011. Vegetation Description and Data Analysis: A Practical Approach. Second Edition: Wiley-Blackwell.
- Shukla, R.S. and Chandel, P.S. 2014. A Textbook of Plant Ecology including Ethnobotany and Soil Science (Twentieth Revised & Enlarged Edition). S. Chand & Company Pvt. Ltd. New Delhi.
- Wheater, C.P., Bell, J.R. and Cook, P.A. 2011. Practical Field Ecology: A Project Guide. Wiley- Blackwell.

Course Code: CBOT 3101**Course Title: Medicinal Plants and Bioresources**

Theory Course

Credit: 2

Contact Hours: 32

Level: 3

Semester: 1

Rationale

The course has been designed to cover the botanical aspects of medicinal plants and nutraceuticals, and their uses for disease prevention, health promotion and well being.

Course Learning Outcomes (CLO)

1. Describe the diversity of medicinal plants in Bangladesh and in the globe
2. Outline the occurrence, distribution and main categories of constituents of bioresources and bioactive compounds considered to be therapeutic importance
3. Evaluate the laboratory techniques for extraction, characterization, purification and related issues concerning the safety and toxicity of medicinal plants and bioresources
4. Apply tissue culture techniques for exploiting value added products development and conservation of medicinal plants
5. Justify the formulation and preparation of herbal medicine and its phytotherapeutic uses to health promotion and disease prevention
6. Show communicative and presentation skills

Mapping CLO with PLO

CLO \ PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	√	√								
CLO2	√		√		√					√
CLO3			√	√						
CLO4	√	√			√					√
CLO5		√	√				√	√		
CLO6						√	√		√	√

Course Content

Course content	Aligned CLO	No of Lectures
Introduction: Important medicinal plants of the world and Bangladesh; national demand and international trade; Ethnobotany	1	2
Medicinal & Aromatic plants: Sources, conservation, health promoting herbal products, importance of culinary herbs, global and national scenario of herbal products, WHO guidelines on good manufacturing practices (GMP) for herbal medicine.	1, 2, 6	4
Botanical aspects of medicinal plants: Classification, physico-chemical traits for species identification, collection, cultivation and conservation including IUCN guidelines for medicinal plant species especially rare and endangered ones.	1, 2, 4	4
Bioresources and nutraceuticals: Scope and concept, primary and secondary metabolites, plant's pigments, dietary fiber, phyto-salt and phyto-oils, phyto-sterol, polyphenols and others for health benefit.	3, 6	4



Plant tissue culture: Concept, laboratory design, application, in vitro techniques for production of food colorants, food flavors, preservatives, essential oils and high valued health promoting components.	4	3
Herbal medicinal preparations: Collection, processing, extraction – parameters for selecting an appropriate extraction method, steps, methods; purification and evaluation.	5	4
Safety, risk and toxicity: Global database, national reports, xenobiotics metabolism and detoxification, model animals and human subjects.	5, 6	3
Phytotherapy: Special herbs/plants related to anti-diabetic, anti-inflammatory, anti-ageing and degenerative disease, diuretic, anti-carcinogenic, cardiac remedies.	6	4
Farm visit and report presentation: Visit to herbal gardens, conservation centers, Unany and Ayurvedi industries.	1, 3, 5	4

Teaching Strategy <ul style="list-style-type: none"> • Lectures • Video clips • Group studies 	<ul style="list-style-type: none"> • Discussion • Question & answer 	Assessment Strategy <ul style="list-style-type: none"> • Question & answer • Assignment and Presentation • Quiz and Observation
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Recommended books and other resources

- Franca, A.S. and Nollet, L.M.L. 2017. Spectroscopic Methods in Food Analysis. 1st ed., CRC Press.
- AAPI. 2017. Functional medicine and nutritional Genomics (Part III).
www.aapiusa.org
- Hill, A.F. 1952. Economic Botany. 2nd ed., McGraw-Hill, New York.
- Pandey, B.P. 2000. Economic Botany. 6th ed., S. Chand & Co., New Delhi.
- Pradhan, S. 1995. Economic Botany, Haranand Pub., India.
- Purseglowe, J.W. 1985. Tropical Crops. Vol. 1 & 2, Longmaus, London.
- Misra, R. (ed). 2011. Indian Foods: AAPI's Guide Indian Foods: AAPI's Guide to Nutrition, Health and Diabetes. 2nd ed., Allied Pub. Pvt. Ltd., Chennai, India.

Course Code: CBOT 4103	Course Title: Plant Stress Physiology
Theory Course Credit: 2 Contact Hours: 32 Level: 4 Semester: 1	

Rationale

The course has been designed to offer knowledge on plant responses to abiotic and biotic stresses and their tolerance mechanisms.

Course Learning outcomes (CLO)

1. Relate different abiotic and biotic stresses which limit growth and development in plants.
2. Evaluate physiological, biochemical and molecular responses in plants to drought & flooding, heat & cold, salinity & toxic ions, radiation, and biotic stresses.
3. Recognize the significance of ROS formation and its role in anti-oxidative defense.
4. Assess the physiology of plant tolerance to different stresses.
5. Interpret different techniques for conducting plant stress research.
6. Integrate and apply obtaining knowledge of stress physiology for analytical thinking and solving practical field problems experienced in vulnerable ecosystems.



Mapping CLO with PLO

CLO \ PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	√	√			√					
CLO2		√	√	√	√		√			
CLO3		√		√	√					
CLO4	√		√	√						√
CLO5		√		√	√			√		
CLO6	√				√	√		√		√

Course Content

Course content	Aligned CLO	No of Lectures
Introductions: Abiotic and biotic stresses, stressed prone areas in Bangladesh, potential yield losses.	1, 2	2
Drought and anoxia stress: Causes, stomatal and metabolic limitation in relation to growth and yield and tolerance mechanism to survive.	2, 3	5
Heat and cold stress: Responses of plants to the stresses, nature of injuries, sensitive stages, and resistance mechanisms.	2, 3	4
Salinity and ionic stress: Causes, limits, osmotic and hyperosmotic challenges, disturbance of ion homeostasis, omic approaches for salinity tolerance.	2, 3	5
Oxidative stress: Reactive Oxygen Species (ROS)–formation and oxidative stress, antioxidative defense system and stress tolerance.	2, 3	3
Radiation Stress: Causes, plant responses to infra red, UV light, anthocyanin and other biomolecules (natural sunscreen) accumulation to adapt to the changing environment.	2, 3	3
Biotic Stress: Causes, responses of plants and defense mechanisms.	2, 3	3
Fundamentals of stress research: Techniques of imposing different stresses on plants, measurement of stresses–chlorophyll content, fluorescence, and stomatal conductance.	4, 5, 6	4
Field visit: Field trip to different stress-prone areas for cropping pattern analysis and report presentation.	5, 6	3

<p>Teaching strategy</p> <ul style="list-style-type: none"> ● Lecture ● Tutorial ● Self study/e-learning 	<p>Assessment strategy</p> <ul style="list-style-type: none"> ● MCQ ● Short question ● Essay type question ● Assignment
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Recommended books and other resources

- Lauchli, A. and Lutge, U. 2002. Salinity: Environment, Plants and Molecules. Kluwer Academic Publishers, Netherlands.
- Boyer, J.S. 1996. Advances in drought tolerance in plants. Adv. Agron. 56: 187-218.
- Nilsen, E.T. and Orcutt, D.M. 1996. The Physiology of Plants under Stress. Abiotic Factors. Virginia Polytechnic Institute and State University, USA.

Filter, A.H. and Hay, R.K.M. 1983. Environmental Physiology of Plants. Aca. Press, New York.
 Gupta, U.S. (ed.) 1979. Physiological Aspects of Dry Land Farming. Oxford and IBH Pub. Co., New Delhi.
 Hossain, M.A. and Uddin S.N. 2011. Mechanisms of waterlogging tolerance in wheat: Morphological and metabolic adaptations under hypoxia or anoxia. Aust. J. Crop Sci. 5(09): 1094-1101.
 Karmer, P.J. 1949. Plant and soil water relationships. McGraw-Hill Book Co., New York.
 Kozlowski, T.T. (ed.) 1968. Water deficits and plant growth. Vol. 1 & 2. Academic Press, NY.
 Levit, J. 1980. Response of plants to environmental stresses, Academic Press, New York.
 Mussell, H. and Staples, R.C. (ed.) 1979. Stress Physiology in Crop Plants. John Wiley and Sons, New York.
 Raper, C.D. and Kramer, P.J. 1983. Crop reaction of water and temperature stresses in humid, temperature climates. Westview Press/Bouldev, Colorado, USA.
 Salisbury, F.B. and Ross, C.W. 1986. Plant Physiology, CBS Pub. Dist., New Delhi.
 Singh, K.B. and Saxena, M.C. 1993. Breeding for stress Tolerance in cold season Food legumes. John Wiley and Sons., U.K.

Course Code: CBOT 4201 Course Title: Plant Biodiversity and Conservation

Theory Course Credit: 2 Contact Hours: 32 Level:4 Semester: 2

Rationale

The planet has a great diversity of biota but the anthropogenic activities and global climate change imparting a significant threat to their existence. Thus the course is designed to focus on the causes and consequences of biodiversity loss, conservation strategies and sustainable use of plant genetic resources.

Course Learning Outcomes (CLO)

1. Describe the status and importance of biodiversity and ecosystem services, and values of biodiversity including sustainable use of natural resources
2. Outline the drivers of biodiversity depletion and species extinction and demonstrate the differences among different IUCN red list categories
3. Formulate current and future conservation strategies for threatened plant species at national, regional and international levels
4. Discuss current regulation, strategies and economic concerns of conservation, the players involves and their roles
5. Evaluate the impact of global climate change on biodiversity and relate ecological knowledge to environmental management practices
6. Analyze the biodiversity of different ecosystems using different methods and assess the indicators of measuring biodiversity
7. Show written and oral argumentative skills through paper assignment and in-class presentations.

Mapping CLO with PLO

CLO \ PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	√									
CLO2	√	√								
CLO3	√	√	√	√	√					
CLO4	√	√	√	√	√	√				
CLO5	√	√			√					
CLO6	√	√	√							
CLO7	√	√	√		√		√		√	

Course Content

Course content	Aligned CLO	No of Lectures
Plant diversity and ecosystem functioning: Nature, levels, importance and values of biodiversity, biodiversity hotspots, present status of plant diversity in Bangladesh and worldwide.	1	3
Threats to biodiversity and species extinction: Global habitat classification, drivers in biodiversity depletion, consequences of biodiversity degradation, causes of species extinction, IUCN red list categories, threatened plant species in Bangladesh.	2	5
Biodiversity conservation: Legal framework, national strategies and action plan, methods of plant protection and conservation - <i>in situ</i> and <i>ex situ</i> , current practices and recent advances in biodiversity conservation, convention on biodiversity - CBD and CITES, roles and activities of IUCN, SSC, WWF, WCMC, etc., roles of local communities on biodiversity conservation.	3 & 4	7
Climate change and biodiversity: Climate change risk and vulnerability to ecosystem and biodiversity, management and challenges of biodiversity and its conservation in changing climate.	4 & 5	2
Crops and medicinal plants diversity in Bangladesh: Present state, diversity trend and conservation status of major crops, threats of genetic vulnerability and genetic erosion of PGR in Bangladesh, extinction of native and wild relatives, threatened medicinal plants and their conservation in Bangladesh.	1-5	3
Floristic diversity and vegetation analysis: Methods of floristic diversity and vegetation analysis, species area curve, quantitative structures of plant community - total basal cover (TBC) and importance value index (IVI), Indices of biodiversity measurement - Shannon-Weiner, Simpson's and similarity indices, alpha, beta and gamma diversity.	6	4
Germplasm exploration, collection and documentation: Principles and practices of germplasm exploration and collection, plant documentation - herbarium, e-herbarium, monographs, computer based identification systems	3 & 6	3
Field visit: Field trip to different protected areas and botanical gardens for data collection, vegetation analysis and biodiversity measurement, assignment and presentation	3, 6 & 7	5

Teaching strategy <ul style="list-style-type: none"> ● Lecture ● Tutorial ● Self study/e-learning 	Assessment strategy <ul style="list-style-type: none"> ● MCQ ● Short question ● Essay type question ● Assignment
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Recommended books and other resources

- Arora, R.K. and Ramanatha, V. 1997. Tropical Fruits in Asia- Diversity, Maintenance, Conservation and Use, International Plant Genetic Resources.
- Arora, R.K. and Rao, V.R. (edited). 1995. Proceedings of the South Asia National Coordinators Meeting on Plant Genetic Resources. 10-12 January 1995. BARC, Dhaka.
- CBD. 1999. Convention on Biological Diversity- Text and Annexes. Montreal, Canada.
- FAO. 1996. Global Plan of Action for the Conservation and Sustainable Utilization of Plant Genetic Resources for Food and Agriculture, and the Leipzig Declaration, Rome, Italy.
- Glowka et al. 1994. A Guide to the Convention on Biological Diversity. IUCN, Switzerland.
- Gurung, J.D. (ed). 1994. Indigenous Knowledge Systems and Biodiversity Management. Proceedings of a MacArthur Foundation, ICIMOD Seminar, 13-15 April. Kathmandu, Nepal.
- Hossain, M.G, Arora, R.K. and Mathur, P.N. (ed) 1997. Plant Genetic Resources-Bangladesh Perspective. Proceedings of a National Workshop on Plant Genetic Resources, 25-29 August. BARC, Dhaka.
- Jeffrey et al. 1997. Conserving the World's Biological Diversity. IUCN, WRI, CI, WWF-US, the World Bank. Gland, Switzerland, and Washington, D.C.
- Mugabe et al. 1997. Access to Genetic Resources- Strategies for Sharing Benefits, IUCN
- Pareek, O.P., Sharma, S. and Arora, R.K. 1998. Underutilized Edible Fruits and Nuts- An inventory of Genetic Resources in Their Region of Diversity
- Paroda, R.S. and Arora, R.K.1991. Plant Genetic Resources-Conservation and Management, International Board Plant Genetic Resources, international Plant Genetic Resources.
- Sarwar, A.K.M. Golam. 2019. Plant Biodiversity and Conservation of Higher Plants in Bangladesh: Present Status and Future Prospects. InSangeethaJ, Thangadurai D, Goh HC, Islam S. (eds). Biodiversity and Conservation: Characterization and Utilization of Plants, Microbes and Natural Resources for Sustainable Development and Ecosystem Management.AAP/CRC, Florida, USA. pp. 259-288.
- Thrupp, L.A. 1998. Cultivating Diversity- Agrobiodiversity and Food Security, World Resources Institute
- WRI, IUCN, UNEP, FAO, UNESCO. 1992. Global Biodiversity Strategy- Guidelines for action to save, study, and use earth's biotic wealth sustainably and equitably. Gland, Switzerland.

Courses offered in B.Sc. Food Safety Management (Hons.)

CBOT1105: Introduction to Plant Biology and Physiology

Theory Course Credit: 2 Contact Hours: 32 Level: 1 Semester: 1

Course Overview:

This course will give learners the fundamentals of scientific knowledge on the structure, life processes, biology and breeding of plants required at this stage of their development as food safety regulators. This knowledge will be given to the students in a way that emphasises its practical nature and application in the role as a food safety officer.

Learning Outcomes (LO):

On completion of this module, the learner will be able to

- 1 Explain the fundamentals of plant science including cell structure, plant life cycle and plant physiology
- 2 Integrate the concepts of structure and function at biological levels of organisation
- 3 Describe the metabolism and functions of plant processes such as photosynthesis, transpiration and respiration.
- 4 Acquire a conscientious and responsible attitude to the recording of experimental data
- 5 Describe the conditions necessary for plant growth and recognise the symptoms of plant stress and nutrient deficiency.
- 6 Exhibit proficiency in microscopy with the ability to identify and use their theoretical knowledge gained in lectures to understand cellular structures and microscopic organisms.
- 7 Explain the mechanisms of reproduction in plants, sexual and asexual, fertilisation and germination
- 8 Understand evolution, the role of humans in plant breeding, the basics of genetics and the inheritance of characteristics

Indicative Syllabus:

Plant Physiology:

Plant Structures: Study of plant life forms to include algae, fungi, lichen and micro-organisms. the structure of the plant cell and cell tissues including the cell membrane, the nucleus, protein synthesis and the secretion of protein from cells. The role of vacuoles and mitochondria, the anatomy of plants and plant structural components. Morphology and the structure and physiology of plants and plant parts such as leaves, flowers and fruits, monocotyledons and dicotyledons.

Plant Processes: The metabolism and functions of plant processes, photosynthesis, transpiration, respiration, photoperiodism, dormancy, juvenility, germination, pollination and fertilisation. Water transport through the xylem, the cohesion-tension theory and the movement of products through the phloem.

Plant water relationship: Concept and measurement of water potential, absorption mechanism, path of absorption and water movement along with the factors affecting absorption. The physical challenges of water movement, water absorption from soil and the nature of hydrostatic pressure in soil water and water absorption by roots (osmosis).

The absorption of minerals by the roots and the symptoms of mineral deficiency in plants.

Plant Development: The life cycle and development of plants, shoot and leaf initiation, root growth and the nature of phytochromes and light control of plant development. Blue light, bending and asymmetric growth. Detection of light direction in plants. Senescence and cell death.

Plant Breeding: The mechanisms of reproduction in plants, sexual and asexual. The selection of seeds and pollination.

Methods of tissue culture and its basis in plant biology. The basis of genetics and the inheritance of characteristics. The historical evolution of plants under human

Plant Ecology: Concept of plant ecology, fundamentals of ecology, ecological factors – biotic, abiotic and edaphic.

Essential Reading: (author, date, title, publisher)

Chang, J.H. 1971. Climate and agriculture. Aldine Pub., Chicago.

Datta, S.C. 1994. Plant physiology. Wiley Eastern Ltd., Calcutta, India.

Hans, M. 1984. Class experiments in plant physiology. George Allen & Unwin Pub. Ltd., London.

Jackson, I.J. 1982. Climate, water and agriculture in tropics. Longman, London.

Mohr, H. and Schopfer, P. 1994. Plant physiology. Springer, Berlin.

Pundey, S.N. and Sinha, B.K. 1972. Plant physiology. Vikas Publishing House Pvt. Ltd., New Delhi.

Rosenberg, N.J. 1985. Microclimate: The biological environment. John Wiley, New York.

Rosenberg, N.J.; Blad, B.L. and Verma, S.B. 1983. Microclimate: The biological environment. John Wiley, New York.

Salisbury, F.B. and Ross, C.W. 1986. Plant physiology. Wadworth Pub., USA.

CBOT 1106: Introduction to Plant Biology and Physiology

Practical Course

Credit: 1

Contact Hours: 32

Level: 1

Semester: 1

Course Overview:

This course will give learners the fundamentals of scientific knowledge on the structure, life processes, biology and breeding of plants required at this stage of their development as food safety regulators. This knowledge will be given to the students in a way that emphasises its practical nature.

Learning Outcomes (LO):

On completion of this course, the learner will be able to

1. Exhibit proficiency in microscopy with the ability to identify and use their theoretical knowledge gained in lectures to understand cellular structures and microscopic organisms
2. Conduct experiments to demonstrate- osmosis, plasmolysis, transpiration and ascent of sap.
3. Measure water potential in plant tissues
4. Study anatomical structures of leaves in C3, C4 and CAM plants
5. Conduct experiments to demonstrate photosynthesis and respiration
6. Conduct experiments on plant pigments: separation, quantification and stability index.
7. Study of adaptive features of different ecological plant types e.g. mesophytes, xerophytes, hydrophytes, halophytes, heliophytes and sciophytes
8. Perform hybridization techniques in crop plants, such as rice, wheat maize, tomato, beans, peas, groundnut, mustard and jute.

9. Demonstrate skills in the preparation of tissue culture media, sterilization techniques and handling of equipment related to tissue culture

Indicative Syllabus:

Slide preparation techniques

Demonstration of different types of cell and tissues

Experiments to demonstrate osmosis, plasmolysis, transpiration and ascent of sap.

Measurement of water status and water potential in plant tissues.

Study of anatomical structures of leaves in C3, C4 and CAM plants.

Separation and quantification of plant pigments, chlorophyll stability index, nanoparticles synthesis using leaf pigments.

Experiments to demonstrate photosynthesis and respiration

Study on adaptive features of different ecological plant types such as hydrophytes, xerophytes, halophytes, heliophytes, sciophytes, etc.

Hybridization techniques of different crop plants

Tissue culture techniques

Farm visit, assignment preparation and presentation

Essential Reading: (author, date, title, publisher)

Old, R. W. and Primrose, S. B. 1994. Principles of Gene Manipulation- An introduction to Genetic Engineering. Blackwell Scientific Publications. London. 5th edition.

Poehlman, J. M. and Sleeper, D. A. 1995. Breeding Field crops. Panima Pub. Cor., New Delhi.

Sharma, J. R. 1994. Principles and Practice of Plant Breeding. Tata McGrawHill Pub, New Delhi.

Singh, B. D. 1986. Plant Breeding. Kalyani Publishers, India.

Allard, R.W. 1960. Principles of Plant Breeding. John Wiley and Sons, Inc. New York.

Bhojwani, S. S. and Razdan, M. K. 1983. Plant Tissue Culture: Theory and Practice. Elsevier Science Pub. Amsterdam.

Bhuiya, M. S.R. 1999. Udvid Projanan. 2nd edn. Bangla Academy, Dhaka (In Bangla).

Chopra, V. L. 1989. Plant Breeding: Theory and Practices. Oxford and IBH Pub., New Delhi.

Chopra, V. L. and Nasim, A. 1990. Genetic Engineering and Biotechnology. Oxford and IBH Pub., New Delhi.

David, W. R. 1995. Pollination of Cultivated Plants in the Tropics. FAO, Rome.

Falconer, D.S. and Mackay, T. F. C. 1996. Introduction to Quantitative Genetics. Longman Essex, UK.

Ferhr, W.R. and Hadley, H.H. 1980. Hybridization in crop plants. American Soc. Agron. & Crop Sci. Soc. America, Madison.

Gamborg, O.L. and Phillips, G.C. 1995. Plant cell, tissue and organ culture, Fundamental methods. Narosa Pub. House, New Delhi.

IPGRI. 2000. Cryopreservation of Tropical Plant Germplasm - Current Research Progress and Application. Florent Engelmann and Hiroko. Takagi, Rome.

Islam, M. A. 1998. Udvid Projanan. Private Pub., BAU, Mymensingh (In Bangla) Primrose, S. B. 1987. Modern Biotechnology. Backwell Scientific Pub., London

Course Code: CBOT 3223 Course Title: Safety Aspects of Herbal Products and Health Promotion

Theory Course

Credit: 2

Contact Hours: 32

Level: 3

Semester: 2

Course overview

The course has been designed to cover the botanical and safety aspects of herbs, aromatic herbs (spices), medicinal plants and nutraceuticals, and their uses for disease prevention, health promotion and well being.

Learning Outcomes (LO)

On completion of this course, the students will be able to

1. Explore the diversity of herbs, aromatic herbs (spices), medicinal plants & their conservation strategies.
2. Bioactive compounds and their properties for disease prevention, health promotion and boosting up immune system.
3. The basics of risks as they are related to issues concerning the safety and toxicity of herbs, aromatic herbs (spices) and medicinal plants.
4. Explore the formulation and preparation of herbal medicine or herbal products.

Inductive Syllabus

Herbs: Concept, types, historical and cultural uses of herbs, health promoting herbs globally, importance of culinary herbs, global and national scenario of herbal products, WHO guideline for good manufacturing practices (GMP)

Botanical aspects of medicinal herbs and aromatic plants: Classification, morphological and biochemical markers for species identification, collection and cultivation by following good agricultural practices (GAP), exotic species collection, cultivation and conservation according to IUCN guidelines

Health promoting phytonutrients: Shikimic acid pathway, secondary metabolites; phenolics, alkaloids, terpenoids, plant's pigments, dietary fiber, omega-3 fatty acids, In vitro techniques for production of high value health promoting bioactive compounds, phytochemicals richness in grass-fed animal products

Vegan based diet variety and diversity: Composition of healthy eating plate, role of herb/aromatic herbs in Western diet, DASH diet, Mediterranean and Okinawa diet.

Extraction and evaluation: Suitable solvents for efficient extraction of bioactive compounds, formulation (lives, powder, tablet, liquid forms), quantitative and qualitative tests of phytochemicals of health promoting herbs and their products

Herbal action/phytotherapy: Special emphasis on collection, cultivation and processing of the herbs related to anti-diabetic, anti-inflammatory, diuretic, anti-carcinogenic, cardiac remedies.

Safety, risk and toxicity: Global database, national reports, xenobiotics metabolism and detoxification, model animals and human subjects.

Farm visit and report presentation: Visit to herbal gardens, conservation centers, Unany and Ayurvedi industries

Recommended books and other resources

Franca, A.S. and Nollet, L.M.L. 2017. Spectroscopic Methods in Food Analysis. 1st ed., CRC Press.

AAPI. 2017. Functional medicine and nutritional Genomics (Part III). www.aapiusa.org

- Hill, A.F. 1952. Economic Botany. 2nd ed., McGraw-Hill, New York.
- Pandey, B.P. 2000. Economic Botany. 6th ed., S. Chand & Co., New Delhi. Pradhan, S. 1995. Economic Botany, Haranand Pub., India.
- Purseglowe, J.W. 1985. Tropical Crops. Vol. 1&2, Longmaus, London.
- Misra, R.(ed). 2011. Indian Foods: AAPI's Guide Indian Foods: AAPI's Guide to Nutrition, Health and Diabetes. 2nd ed., Allied Pub. Pvt. Ltd., Chennai, Ind

Course Code: FSM 4107 Course Title: Climate Change and Food Security

Theory Course Credit: 2 Theory Course Level: 4 Semester: 1

Course Overview:

The course is designed mainly to understand the ways of adapting to climate change in maintaining the food security and to gain good understanding of interrelationship between climate change and food security at global and regional levels. The module will also discuss the opportunities in agriculture regarding adaptation and mitigation strategies. There will also be option for gathering practical knowledge from surveying climate affected communities.

Learning Outcomes (LO):

On completion of this course, the learner will be able to

1. Describe concepts of climate, trends and projections of climate change.
2. Explain components of food security.
3. Describe impacts of climate change on food security.
4. Elaborate adaptation and coping strategies to climate change.
5. Describe impacts of abiotic stress and environmental pollutants on quality and safety of foods.

Indicative Syllabus:

Concept of climate: Concepts of climate and weather, weather Parameters- temperature, humidity, precipitation, sunlight and wind.

Climate change: Concept, trends and projections of climate change, Impact of climate change on food production; climate variability and climate change; acclimatization, mitigation and adaptation.

Global warming: Greenhouse gases- their sources and sinks; impacts of global warming on crop production. Adjustments to potential global warming.

Concept of food security: Definition of food security, types of food insecurity, poverty, hunger and malnutrition, Interrelationship between climate change and food security.

Food distribution under changed climate: Food supply chain, harvesting, transportation, storage, marketing and equitable distribution of food, impact of changing climate on equitable distribution of food. Impact of climate change on food security, food availability, food accessibility, food utilization and food system stability; Impact of climate change on Agriculture and Livelihood; vulnerability to climate change.

Climate change management: 1(K)/211 199 Strategies for crop, fisheries and livestock improvement for food security, Climate resilient variety, sustainable agriculture, resource management; protecting food security through adaptation (strengthening resilience and

managing risks) and mitigation (reducing emissions and carbon sequestering) to climate change

Food safety and climate change: Nutritional security, balanced diet, impacts of abiotic environmental pollutants and stresses on quality of food crops, impact on health of farmers.

Institutional setting for addressing food security and climate change linkage: Inter-governmental Panel on Climate change; United Nations Framework Convention on Climate change.

Case studies and report presentation

Essential Reading: (author, date, title, publisher)

Botkin, D. B. and Keller, E. A. 1997. Environmental Science – Earth as a Living Planet. Second Edition. John & Wiley Sons, Inc. New York.

Khuda, Z. R. M. M. 2001. Environmental Degradation – Challenges of the 21st Century. Environmental Survey and Research Unit, Dhaka, Bangladesh.

Miller, Jr., G. T. 1985. Living in the Environment – An Introduction to Environmental Science. Fourth Edition. Wadsworth Publishing Company. 561p.

Turk, A.; Turk, J.; Wittes, J. T. and Wittes, R. E. 1978. Environmental Science. Second Edition. W. B. Saunders Company.

Courses offered in B.Sc. Food Engineering

Course No. CBOT 1201 Course Title: Crop Physiology and Food Quality

Theory Course Number of Credit: 2 Contact hours: 32 Level-1 Semester-2

Rationale:

The course has been design to enable the students with adequate knowledge and skills on morphological and physiological aspects of plants and plant products as well as quality improvement during their pre- and post-harvest handling and storage.

Course Learning Outcomes (CLO):

1. Explain basic eco-physiological processes and functions of plants related to plant products and food quality
2. Characterize different plant tissues and their functions
3. Evaluate plant pigments, food colorants, flavours and preservatives and their uses & abuses
4. Analyze the factors affecting quality of fruits, seeds and storage organs of plants during pre- and post-harvest and
5. Identify the major applications of good agricultural practices and design Plant Tissue Culture Laboratory with modern facilities required for Food Industry

Mapping CLO with PLO

PLO \ CLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11
CLO 1		√		√							
CLO 2		√		√							
CLO 3		√		√							
CLO 4		√	√	√		√					
CLO 5		√		√	√					√	

Course Content

Course Content	Aligned CLO	No. of Lecture
Plant morphology: Morphology of vegetative and reproductive organs: root, stem, leaf, inflorescence, flower, fruits and seed as foods, feeds and medicine.	1	3
Membrane biology: Membrane-composition and function, diffusion, osmosis, reverse osmosis, osmotic dehydration in food industry; Transpiration - types, mechanism, significance in relation to storage.	1	3
Tissue and dietary fibre: Types and function, cell wall structure and composition, fibre- classification, sources and importance of digestible fibre and prebiotics.	2	2
Plant tissue culture in food industry: Types, laboratory requirements, application and significance, <i>In vitro</i> techniques for quality food colorants, food flavours, preservatives, and food components production from botanical sources.	2	4

Photosynthesis and respiration: Sites, types, mechanisms, factors involved in dry matter production, significances during growth, harvest and storage.	3	6
Natural plant pigments and Bioreduction of nanomaterials: Types, distribution; chlorophylls, carotenoids, flavonoids and their extraction, quantification, biosynthetic pathways and antioxidant properties; photomorphogenesis, light emitting diode for pigment enhancement and vertical agriculture.	3	5
Post harvest physiology: Concept, physio-chemical changes during fruits ripening and seed maturation, factors controlling ripening, shelf-life enhancement and post-harvest losses during handling and storage. Dormancy - causes, breaking and its significance.	4	6
Specialty crops: Scope, good agricultural practices for enhancing nutraceuticals of baby corn, mushroom, bean sprout, microgreen, sorrel, microalgae, chia, seaweed, red amaranth, garden cress and oat.	5	3

Teaching Strategy

Lectures, Discussion, Video clips, Question & answer, Group studies

Assessment Strategy

Question & answer, Assignment, Quiz and Observation

Recommended Books and other resources

Brian, C. 2005. Botany for Gardeners. Timber Press, Inc., Cambridge.

Brown, W.H. 1965. The plant kingdom: A text Book of general Botany, Vakils, Feffer & Simons Pvt. Ltd., India.

Esau, K. 1965. Plant Anatomy. John Wiley, New York.

Lal, G., Diddara, G.S. and Tandon, G.L. 1985. Preservation of fruit & vegetables. Indian Council of Agricultural Res. (ICAR).

Pandey, B.P. 2002. Plant Anatomy. Chand & Co., Delhi.

Purseglove, J.W. 1985. Tropical crops (Monocot). ELBS reprinted, Vol. I & II Combined, Longman.

Robbins, W.W., Weier, T.E. and Stocking, C.R. 1966. Botany: An Introduction to Plant Science, John Wiley & Sons. Increased, New York.

Salisbury, F.B. and Ross, C.W. 1986. Plant physiology. Wadsworth Pub. Co., USA.

Yahia, E.M.(ed.) 2019. Postharvest Physiology and Biochemistry of Fruits and Vegetables. Wood Publ., New York.

Course No. CBOT 1202 Course Title: Crop Physiology and Food Quality

Practical Course Number of Credit: 1 Contact hours: 2 Level-1 Semester-2

Rationale:

The course has been design to enable the students with adequate knowledge and skills on morphology, physiological processes, extraction techniques of plant pigments and bioactive compounds, and storage part of plants so that they will be able to apply their knowledge on food technology.

Course Learning Outcomes (CLO):

1. Identify different plant parts specially storage organs.
2. Explain the effects of environmental factors on seed quality and germination.
3. Apply the concept of water potential in food processing.
4. Evaluate extraction methods and quantify plant pigments and bioactive compounds.
5. Design modern plant tissue culture laboratory with required facilities and understand good agricultural practices for specialty crop production

Mapping CLO with PLO

PLO \ CLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11
CLO 1		√		√							
CLO 2		√		√		√					
CLO 3		√		√							
CLO4		√	√	√		√					
CLO5		√		√	√					√	

Course Content

Course Content	Aligned CLO
Study of different storage organs- root, stem, fruits and seeds.	1
Demonstration of different types of cell and tissues.	1
Osmotic dehydration of plant tissues by weighing method.	2
Determination of transpiration rate in different plant materials.	3
Demonstration of respiration in plant materials.	3
Extraction and quantification of natural plant pigments.	4
Study on seed germination and good agricultural practices (GAP) for specialty crops.	5
Study on laboratory requirements for tissue culture techniques.	5
Farm visit, assignment preparation and presentation	5

Teaching Strategy:

Lectures, Discussion, Demonstration by video, Question & answer (QA), Self Study, Case Studies, Practice, Group Studies.

Assessment Strategy:

Question & answer (QA), Assignment, Quiz, and Observation

Recommended Books and Other resources

- Brian, C. 2005. Botany for Gardeners. Timber Press, Inc., Cambridge.
- Brown, W.H. 1965. The plant kingdom: A text Book of general Botany, Vakils, Feffer & Simons Pvt. Ltd., India.
- Esau, K. 1965. Plant Anatomy. John Wiley, New York.
- Lal, G., Diddara, G.S. and Tandon, G.L. 1985. Preservation of fruit & vegetables. Indian Council of Agricultural Res. (ICAR).
- Pandey, B.P. 2002. Plant Anatomy. Chand & Co., Delhi.
- Purseglove, J.W. 1985. Tropical crops (Monocot). ELBS reprinted, Vol. I & II Combined, Longman.
- Robbins, W.W., Weier, T.E. and Stocking, C.R. 1966. Botany: An Introduction to Plant Science, John Wiley & Sons. Increased, New York.
- Salisbury, F.B. and Ross, C.W. 1986. Plant physiology. Wadsworth Pub. Co., USA.
- Yahia, E.M.(ed.) 2019. Postharvest Physiology and Biochemistry of Fruits and Vegetables. Wood Publ., New York.

Courses offered in B.Sc. in Bioinformatics Engineering

Course No. CBOT 3101 Course Title: System Biology

Theory Course Number of Credit: 2 Contact hours: 32 Level-3 Semester-1

Rationale

This course explores the use of mathematical and computational models to rigorously account for the inherent complexity of biological systems. This complexity arises from the diversity of components (genes, proteins, metabolites and pathways). Systems biology can be done by breaking down each system (cellular, tissue-level, organism-level and ecosystem) into modules. Each system has methods for modeling and technologies to study the systems at different levels (genomic, transcriptomics, proteomics and metabolomics). Actually, systems approaches provide a deeper understanding of diverse physiological and biochemical processes, from individual metabolic pathways, to signaling networks, to genome-scale metabolic networks. The ultimate goal of biology and bioinformatics is to tie all together and understand the system to forecast future needs and capabilities for better yield.

Course Learning Outcomes (CLO)

Upon successful completion of this course, the student will be able to:

1. Understand the entire biological system and its mathematical relationships
2. Integrate morpho-physiological data and computational models for species/plant diversities
3. Evaluate diversified physiological and metabolic processes at different levels and systems
4. Apply system approaches for better yield and quality products in changing climate
5. Construct phylogenetic tree, species characterization and geographic distribution

Mapping CLO with PLO

PLO \ CLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO 1		✓					✓			
CLO 2							✓			
CLO 3		✓					✓			
CLO 4		✓					✓			
CLO 5		✓					✓			

Course Content	Aligned CLO	No. of Lectures
Introduction to Systems biology: Concept, Importance, Advanced physiological techniques: genomic, transcriptomic, proteomic, metabolomic, and ionic aspects of molecular physiology.	1	4
Morphometrics: Morphometrics of leaves, flowers and other plant parts, Geometric morphometric methods, Visualisation and quantification of morphological variation with multivariate analyses, Protocols for imaging and collecting landmark data on flowers. Machine Learning for Plant Leaf Analysis.	2	6

Metabolomics and Metabolic engineering: Metabolism, metabolome, metabolic profiling, metabolic fingerprinting, metabolome informatics, Resources/databases of metabolomics; Omic approaches for stressed tolerance variety development, Signaling pathways and autoimmune system, Metabolic pathways and metabolic engineered crop varieties: C ₄ rice, golden rice, Lys038 maize; Secondary metabolites, reduction of nanoparticles and nanotechnology in crop yield improvement.	3	9
Phylogenetics: The terminology of phylogenetics- Trees, Root, branches, Node, Leaf, Clade, lineage sorting, orthology, paralogy, xenology; "basal" lineages, crown vs. stem groups, Phylogram vs. cladogram. Constructing molecular phylogenetic trees and its application on classification, landscape planning, plant genetic resources and their conservation in changing climate.	4	7
System Ecology and Biodiversity: Ecosystem stability, critical transitions, and the maintenance of biodiversity, the neutral theory of ecology, dynamics of population in space, survival in fluctuating environments. Biodiversity informatics initiatives – PlantList, CBOL, CBIF, GRIN, PGRIMS, etc.	2, 5	6
Total		32

Teaching Strategy

Lectures and discussion, Demonstration by video, Self-study, Case Studies, Practice, and Group Studies

Assessment Strategy

Question & answer (QA), Assignment, Quiz, and Observation

Recommended Books

Baginsky, S. and Fernie, A.R. 2007. Plant Systems Biology. BirkhäuserVerlag, Berlin.

Bu Z, Callaway DJ (2011). "Proteins MOVE! Protein dynamics and long-range allostery in cell signaling". Protein Structure and Diseases. Advances in Protein Chemistry and Structural Biology. 83: 163–221.

Chiara Romualdi; Gerolamo Lanfranchi (2009). "Statistical Tools for Gene Expression Analysis and Systems Biology and Related Web Resources". In Stephen Krawetz (ed.). Bioinformatics for Systems Biology (2nd ed.). Humana Press. pp. 181–205.

Hennig, W. 1966. Phylogenetic Systematics. University of Illinois Press.

Ivan V. Maly, 2009. System Biology, Methods in Molecular Biology. Springer Protocols, Humana Press, UK.

Kholodenko, Boris N; Sauro, Herbert M (2005). "Mechanistic and modular approaches to modeling and inference of cellular regulatory networks". In Alberghina, Lilia; Westerhoff, Hans V (eds.). Systems Biology: Definitions and Perspectives. Topics in Current Genetics. 13. Berlin: Springer-Verlag. pp. 357–451.

Longo, Giuseppe; Montévil, Maël (2014). Perspectives on Organisms - Springer. Lecture Notes in Morphogenesis.

Remagnino, P., Mayo, S., Wilkin, P., Cope, J. and Kirkup, D. 2017. Computational Botany. Springer-Verlag GmbH, Germany.

Sneath, P.H.A. and Sokal, R.R. 1973. Numerical Taxonomy. W.H. Freeman, New York.

Stace, C.A. 1989. Plant Taxonomy and Biosystematics. Edward Arnold, London.

Stephen Krawetz, 2009. Bioinformatics in System Biology, Humana Press, UK.

Wiley, Siegel-Causey, Brooks and Frunk. 1991. The Complete Cladist, University of Kansas.

Williams, D.M. and Ebach, M.C. 2008. Foundations of Systematics and Biogeography. Springer, London

Course No. CBOT 3102 Course Title: System Biology and Bioinformatics (Practical)

Practical Course Number of Credit: 1 Contact hours: 32 Level-3 Semester-1

Rationale

This course has been designed to offer hands practices on data mining from biological systems for mathematical and computational models. These models will be used for classification, landscape planning, plant genetic resources and their conservation in changing climate.

Course Learning Outcomes (CLO)

Upon successful completion of this course, the student will be able to:

1. Collect data from different biological systems/sources
2. Analyze data and make different models for identification and classification of plants.
3. Utilized knowledge for landscape planning and biodiversity conservation related issues.
4. Handle different software for data processing and presentation.

Mapping CLO with PLO

CLO \ PLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1		√					√			
CLO 2			√		√					
CLO 3		√					√			
CLO 4				√	√				√	

Course Content	Aligned CLO	No. of Lectures
Data Sources: Collecting and recording specimens, methodologies and character gathering – external & internal morphology, reproductive organs; Nucleic acids as a data source, DNA fingerprinting of plant populations. Building data matrix.	1	4
Data Processing: Phonetic and Cladistic analyses – distance and similarity based data analysis, tree building and comparison, Cladistic Classification and Phylogeny, biogeography and evolution.	2, 3	6
Systems Biology tools and standards: MATLAB – Systems Biology toolbox; SBML (Systems Biology Markup Language); SBGN (Systems Biology Graphical Notation); Tools for systems Biology – Cell designer; Cytoscape.	4	6

Recommended Books

- Funahashi, A., Matsuoka, Y., Jouraku, A., Morohashi, M., Kikuchi, N., Kitano, H. 2008. CellDesigner 3.5: A Versatile Modeling Tool for Biochemical Networks. Proc IEEE 96(8): 1254–1265.
- Hennig, W. 1966. Phylogenetic Systematics. University of Illinois Press.
- Hucka, M. et al. 2003. The systems biology markup language (SBML): A medium for representation and exchange of biochemical network models. Bioinformatics. 19 (4): 524–531.

- Remagnino, P., Mayo, S., Wilkin, P., Cope, J. and Kirkup, D. 2017. *Computational Botany*. Springer-Verlag GmbH, Germany.
- Romualdi, C., Lanfranchi, G. 2009. Statistical Tools for Gene Expression Analysis and Systems Biology and Related Web Resources. In Stephen Krawetz (ed.). *Bioinformatics for Systems Biology* (2nd ed.). Humana Press. pp. 181–205.
- Shannon P, Markiel A, Ozier O, Baliga NS, Wang JT, Ramage D, Amin N, Schwikowski B, Ideker T. 2003. Cytoscape: a software environment for integrated models of biomolecular interaction networks. *Genome Research* 13(11): 2498–504.
- Sneath, P.H.A. and Sokal, R.R. 1973. *Numerical Taxonomy*. W.H. Freeman, New York.
- Stace, C.A. 1989. *Plant Taxonomy and Biosystematics*. Edward Arnold, London.

Courses offered in MS in Crop Botany

MS Courses Layout

Total Credits: 42 (Courses-26, Research-16)

Winter (October–March) Semester		
Compulsory Courses		(8 Credits)
Course No.	Title of Courses	Credits
CBOT 501	Plant Morphology & Phylogeny	2
CBOT 503	Plant Physiology	2
CBOT 505	Plant Ecology	2
CBOT 507	Environmental Pollution & Agriculture	2
Elective courses		(4 Credits)
Course No.	Title of Courses	
CBOT 519	Economic Botany	2
CBOT 521	Developmental Plant Physiology	2
CBOT 523	Mangrove Ecology	2
CBOT 525	Plant Nutrition	2
CBOT 527	Crop Physiology	2
CBOT 529	Crop Research Methodology	2
CBOT 531	Plant Biodiversity & Conservation	2
CBOT 533	Advanced Plant Systematics	2
CBOT 535	Radiation Ecology	2
CBOT 502	Research Work	3 (S/ U)
Total Credits		15
Summer (April–September) Semester		
Compulsory Courses		(10 Credits)
Course No.	Title of Courses	Credits
CBOT 509	Plant Anatomy	2
CBOT 511	Plant Metabolism	2
CBOT 513	Agro-climatology	2
CBOT 515	Stress Physiology	2
CBOT 517	Seed Biology	2
Elective courses		(4 Credits)
Course No.	Title of Courses	
CBOT 537	Developmental Plant Anatomy	2
CBOT 539	Crop Ecology	2
CBOT 541	Developmental Agroforestry	2
CBOT 543	Crop Biotechnology	2
CBOT 545	Plant Tissue Culture	2
CBOT 547	Phytochemical Ecology	2
CBOT 549	Plant Molecular Physiology	2
CBOT 551	Pollination Biology	2
CBOT 502	Research Work	3 (S/U)
Total Credits		17
Thesis Semester		
CBOT 502 : Research Work		2 (S/U)
CBOT 504 : Thesis Evaluation		5
CBOT 506 : Thesis Defense		3
Total Credits		10
GRAND TOTAL		42

S = Satisfactory, U = Unsatisfactory

CBOT 501: Plant Morphology and Phylogeny

Credit hour: 2 (Total Marks: 100, Class Exam.: 20 (10+10); Final Exam.: 60; Assignment: 20)

Salient features of Cryptogams and Gymnosperms: Algae, Fungi, Bacteria, Bryophytes, Pteridophytes and Gymnosperms – relationships, significance and industrial & agricultural uses.

Evolution of reproductive organs: Development of flower, floral parts and spikelets.

Evolutionary concept of different crop plants: Phylogenetic development of rice, wheat, potato, cotton & Brassica from their wild relatives to their modern forms/ types.

Crop morphology: Morphological variations of different crop plants in relation to their improvement with special reference to economic traits.

Rice: HYV and traditional varieties/cultivars of rice including deep water strains.

Sugarcane: vegetative traits of important varieties/cultivars.

Wheat: modern and traditional species/varieties.

Pulse & oil: important species/cultivars.

Tea & Coffee: different species/cultivar/clone.

References

- Ahmed, K.U. 1977. Potatoes for the Tropics, Dhaka.
- Anonymous. 1974. Morphology of deep water rice, Proc. Int. Seminar on Deep Water Rice, BRRI, Joydebpur.
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- Bowes, B.G. 1997. A colour Atlas of Plant Structure, Manson Publishing Ltd.
- Elliot, F.C. 1968. Cotton. Iowa State Univ. Press, Iowa.
- Hawkes, J.W. and Hjerling, J.P. 1969. The Potatoes of Argentina, Brazil etc.- a biosystematic study, Clarendon Press, Oxford.
- Hutchinson, J. 1959. The Application of Genetics to Cotton Improvement. Cambridge Univ. Press, Cambridge.
- Khan, M.R.I. and Podder, B.P. 1982. Sugarcane varieties in Bangladesh. Sugarcane Research and Training Institute (SRTI), Ishurdi, Bangladesh.
- Oka, H.I. 1988. Origin of Cultivated Rice. Elsevier Sci. Soc. Press, Amsterdam.
- Oka, H.I. 1991. Genetic diversity of wild and cultivated Rice, In: Rice Biotechnology. IRRI, Los Banos.
- Poehlman, J.M. et al., 1959. Breeding Asian Field Crops with Special Reference to Crops of India. Oxford B.H. Pub., Delhi.
- Rendle, A.B. 1959. The Classification of Flowering Plants, Vol. I. Gymnosperm and Monocotyledons, Cambridge Univ. Press, Cambridge.
- Sana, D.L. 1989. Tea Science. Ashrafia Boi Ghar, Dhaka.
- Simmonds, N.W. 1976. Evolution of crop plants, longman group limited.
- Simpson, M.G. 2006. Plant Systematics. Elsevier-Academic Press.
- Smith, G.M. 1955. Cryptogamic Botany, Vol. I and II McGraw-Hill, New York.
- Sundararaj, W.W. and Thulasidas, G. 1976. Botany of Field Crops. Macmillan, Delhi, India.

CBOT 503: Plant Physiology

Credit hour: 2 (Total Marks: 100, Class Exam.: 20 (10+10); Final Exam.: 60; Assignment: 20)

Water relation: Plant and soil water status, water content, water potential, water use efficiency (WUE) and its significance, stomatal conductance and its significance.

Translocation of solutes: Path of movement, phloem loading & unloading, nature of solution in transport, mechanisms of translocation, factors affecting translocation.

Photophysiology: Radiation and its nature; light interception & DM production; quantum efficiency; photochemical reaction, role of the chemical agents; photocontrol of germination, vegetative and reproductive growth.

Growth correlation and growth periodicity: Periodicity of vegetative and reproductive growth, correlations between vegetative and reproductive development.

Plant growth regulator: Bioassay, chemistry, mechanism of action, translocation and practical implication of PGR.

References

- Bewly, J.D. and Black, M. 1994. Seeds : Physiology of development and germination, Plenum Press, New York.
- Buchanan, B.B., W. Gruissem and R.L. Jones (2000) Biochemistry and molecular biology of plants, The American society of plant physiologists, Rockville, Maryland
- Datta, S.C. 1994. Plant physiology, Wiley Eastern Ltd. New Delhi.
- Donald, C.M. and Hamblin, J. 1976. The biological yield and harvest index of cereals as agronomic and plant breeding criteria. *Adv. Agron.*, 28: 361-405.
- Gardner, F.P.; Pearce, R.B. and Mitchell, R.L. (eds.). 1985. Physiology of Crop Plant, Iowa State Univ. Press: Ames.
- Gifford, R.M. and Evans, L.T. 1981. Photosynthesis, carbon partitioning and yield. *Ann. Rev. Plant Physiol.*, 32: 485-509.
- Hall, D.O., Scurlock, J.M.O., Bolhar-Nordenkamp, H.R., Leegood, R.C. and Long, S.P. 1993. Photosynthesis and production in a changing environment. A field and laboratory manual, Chapman and Hall, U.K.
- Hunt, R. 1982. Plant growth curves: The functional approach to plant growth analysis, Edward Arnold, London.
- Mohr H. and P. Schopfer 1995. Plant Physiology, Springer.
- Radford, P.J. 1967. Plant growth analysis formula their use and abuses *Crop Sci.* 7: 171-175.
- Salisbury, F.B. and Ross, C.W. 1986. Plant Physiology. Wadworth Pub. Co. USA.
- Sinha, R.K. 2004. Modern Plant Physiology, Alpha Science International Ltd, Pangbourne, England
- Squire, G.R. 1993. The Physiology of Tropical Crop Production, CAB International, U.K.
- Taiz L. and Zeiger U. 1991. Plant Physiology. The Benjamin/ Cummings Publishing Company, Inc. 390 Bridger Parkway.

CBOT 505 : Plant Ecology

Credit hour: 2 (Total Marks: 100, Class Exam.: 20 (10+10); Final Exam.: 60; Assignment: 20)

Systems ecology:

Conceptualization, problems and prospects, application of remote sensing and GIS in agriculture and resource management.

Natural selection and population biology:

- Acclimatizing and naturalization, forces of selection, fitness, adaptation and productivity ;
- Species interaction- Plant competition (inter and intra-specific), predation, mutualism, micorrhiza, Myrmecochory & other biotic interactions,
- Population regulation & oscillations.

Ecosystems and community dynamics:

- Composition, classification, structure and functioning of natural and cultivated ecosystems;
- Community diversity-analysis, species diversity, elements contributing to diversity;

- c) Marine, estuarine and terrestrial ecosystems of the World with special reference to Bangladesh;
- d) Measurement of primary productivity in different ecosystems and e) Bio-diversity and conservation analysis of cultivated & natural ecosystems.

Phytogeography:

Principles, causes of depletion of biota with their ecological implications and remedies. Dynamic changes in floral distribution pattern with special reference to Bangladesh.

References

- Ambasht, R.S. 1978. A Text Book of Plant Ecology. Students Friends & Co. Lanka, Varanasi (India).
- Ambashts, R.S. and Ambashts, N.K. 2002. A Textbook of Plant Ecology, CBS Publication and distributor, India.
- Deshmukh, I. 1986. Ecology and Tropical Biology. Blackwell, Oxford.
- Dimond, J. and Case, T.J. (eds). 1980. Community Ecology, Harper & Row, New York.
- Etherington, J.R. 1973. Environment and Plant Ecology, John Wiley and Sons, New York.
- Fenchel, T. 1987. Excellence in Ecology. Ecol. Inst., Oldendorff, Germany.
- Gopal, B. and Bhardwaj, N. 1979. Elements of Ecology. Vikas Pub. Ghaziabad (U.P.).
- Harper, J.L. 1977. Population Biology of Plants. Acad. Press, New York.
- Ismail, et al. 1989. Ecosystems of the World. Vol. 15. Elsevier Sci. Pub., Amsterdam.
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- Lambers, H., Chapin F.S. and Thijs, L.P. 2008. Plant Physical Ecology. 2nd Ed. Amazon.com
- Odum, E. Barrett, G.W. 2004. Fundamentals of Ecology. Fifth edition, W.B. Saunders Company.
- Sandhu. 1995. Text Book of Agriculture Community, UBSPD, New Delhi.
- Schulze, E.D., Erwin Beck, Hohenstein, K.M. and Lawlor, D. 2005. Plant Ecology. Amazon.com
- Silvertown, S.W. 1987. Introduction of Plant Population Ecology. Longman/ELBS. Harlow.
- Singh, J, 1998. Agriculture Community, UBSPD, New Delhi.
- Wilson, O.E. (ed). 1988. Biodiversity. Nat. Acad. Press. Washington, DC.

CBOT 507: Environmental Pollution and Agriculture

Credit hour: 2 (Total Marks: 100, Class Exam.: 20 (10+10); Final Exam.: 60; Assignment: 20)

Aspect of environmental pollution: Causes and impacts of air, water, soil, noise, radiation and other environmental pollution on vegetation, forest and agriculture and remedies to overcome them.

The greenhouse effects: Factors contributing to greenhouse effects- their sources and sinks; impacts of global and local climatic changes on vegetation, forest and agriculture with special reference to Bangladesh and remedies thereon.

Depletion of ozone layer: Causes and nature of depletion; impacts on environment, lives and agricultural productivity with suggested remedial measures.

Waste disposal and management: Industrial, agricultural, urban and rural wastes- their disposal, recycling and impacts on environment and agriculture.

Hazards and pollution: Causes and effects of major hazards like cyclone, hail-storm, tornado, flood, fire, earth quake, land-slide etc. and their management.

Industrial Agro-ecology: Concept, energy efficiency, ecological and agro-industrial clean technologies for sustainable crop & food production.

References

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- Ausbel, J.H. and Sladovitch, H.E. (eds) 1989. Technology and Environment. Natl. Acad. Press. Washington.
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- Warrick, R.A. and Jones, P.D. 1988. The greenhouse effect: Impact and Policies. Forum for Applied Res. & Public Policy/Fall.

CBOT 509 : Plant Anatomy

Credit hour: 2 (Total Marks: 100, Class Exam.: 20 (10+10); Final Exam.: 60; Assignment: 20)

Conducting tissues: Type and characteristics of conducting tissues. From phylogenetic and ontogenic point of view morphological differences between tracheid and vessel, sieve tube and sieve cell.

Mechanical tissues: Type and characteristics of mechanical tissues with reference to crop plants.

Stele: Type and evolution.

Transition: Anatomy of the transition region, root-stem transition, stem-leaf transition etc.

Epidermis: General characteristics, epidermal tissues of different plant and plant parts, trichomes, glands and epidermal appendages, their role against environmental stress, pests and diseases.

Secretory structures: Important secretory structures, their characteristics and functions, secretory substances of agricultural importance.

Internal structures: Anatomy of the leaves in C3, C4 and CAM plants, stem and root of potato, sweet potato, legume, cucumber, seed and fruit. Structures of soft wood and hard wood with special reference to fruit and timber yielding trees.

Reaction wood: Tension wood and compression wood, their formation in relation to stresses. Role of plant cytoskeleton during wood formation.

References

- Carlquist, S. 1961. Comparative Plant Anatomy, Holt, Rinehart & Winston, New York.
- Cutter, E.G. 1971. Plant Anatomy. Vol. 1 & II. Edward Arnold, London.
- Eames, A.J. and MacDaniels, L.H. 1949. An Introduction to Plant Anatomy. McGraw-Hill, New York.
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- Stevens, W.C. 2007. Plant Anatomy. Foster Press.
- Nick, P. 2008. Plant Microtubules: Development and Flexibility. Heidelberg: Springer.

CBOT 511: Plant Metabolism

Credit hour: 2 (Total Marks: 100, Class Exam.: 20 (10+10); Final Exam.: 60; Assignment: 20)

Photosynthesis: Mechanism of photosynthesis. Carbon metabolism in plants and their photosynthetic efficiency and adoption. Mechanism of photorespiration and its significance in photosynthesis. Plant development and source sink relationship. Prospect for crop improvement through the manipulation of photosynthesis.

Respiration: Respiratory metabolism of carbohydrates, respiration and growth process, environmental condition and respiratory process, climacteric respiration, practical importance of respiration in handling plant products and its significance, storage of grain, potatoes, vegetables and fruits.

Nitrogen assimilation: Nitrogen fixation and nitrogen assimilation, relationship between nitrite reductase photosynthesis, protein synthesis and protein yield relationship.

Enzymes and bioenergetics: Mechanism of enzyme action, kinetics and regulation of enzymes, classification, enzyme engineering, enzymatic control in plant metabolism. Industrial aspect of emzymology. Concept of free energy, standard free energy, biological oxidation-reduction reactions, redox potentials, redox components and processes of electron transport proteins, thermodynamic principles of biological energy conversion.

Metabolic engineering of secondary metabolites: Origin, structures, biosynthesis and properties of secondary metabolites in plants, and, functional roles of the major secondary metabolites in plant metabolism.

References

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- Datta, S.C. 1994. Plant Physiology. Wiley Eastern Limited, Calcutta, India.
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- Salisbury, F.B. and Ross, C.W. 1978. Plant Physiology. Wordsworth, California
- Street, H. E. 1966. Plant Metabolism. Pergamon Press.

CBOT 513 : Agro-climatology

Credit hour: 2 (Total Marks: 100, Class Exam.: 20 (10+10); Final Exam.: 60; Assignment: 20)

Weather and climate: Climatic classification – humid and dry climates, continental, maritime and desert climates. their characteristics and impact upon vegetation with special reference to crop plants.

Climates of Bangladesh: Distribution of solar radiation, length of the day, degree days, temperature, rainfall, arid and semi-arid regions, evaporation, dew, dust, hailstorms, cyclones and their effects upon crop production.

Climate and agriculture: Atmospheric and soil dryness indices, climate and crop scheduling, water, drought and irrigation scheduling, climatological forecasting system and yield assessment. Climatological factors affecting outbreak of pest and diseases in agricultural crops.

Bioclimatology and agriculture: Influence of topography and micro-climate on crop and domestic animal production. The climates of trees, orchards and forests, and their alteration for better productivity.

Barrage and dams: Impact on the climatic and riverian ecosystem of Bangladesh with special reference to rainfall, irrigation and drainage, flooding, land formation, salinity, vegetation and desertification.

References

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- Chang, J.H. 1971. Climate and Agriculture. Aldine Pub. Chicago.
- Cox, G.W. and Atkins, M.D. 1979. Agricultural Ecology. Freeman & Co. San Francisco.
- Ganesaraja, et al. 2011. Agro-climatology: Principles and Prediction. AGROTECH.
- Gates, D.M. 2003. Biophysical Ecology. Springer-Verlag, Berlin.
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- Jackson, I.J. 1982. Climate, Water and Agriculture in Tropics, Longman, London.
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- Seemam, J., Chirkov, Y.I., Lomas, J. and Primantl, B. 1979. Agro-Meteorology. Springer-Verlag. Berlin.

CBOT 515: Stress Physiology

Credit hour: 2 (Total Marks: 100, Class Exam.: 20 (10+10); Final Exam.: 60; Assignment: 20)

Introduction: Stress environments, basis of yield variation under different stresses.

Water stress: Morpho-physiological changes in relation to growth and yield under flood & drought conditions. Mechanisms of injury and resistance, and their remedial measures.

Temperature stress: Causes and nature of primary and secondary injuries, sensitive stages, effects on physiological processes, resistance mechanisms in high and low temperature stresses.

Salinity and toxic stress: Causes, limits, plant diversity: halophytes and glycophytes, osmotic and hyperosmotic challenges, disturbance of ion homeostasis, osmolytes and osmotolerance, mechanism in crop plants.

Oxidative stress: Site and mechanisms of reactive oxygen species generation, action on biomolecules, antioxidant defense system and stress tolerance.

References

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CBOT 517: Seed Biology

Credit hour: 2 (Total Marks: 100, Class Exam.: 20 (10+10); Final Exam.: 60; Assignment: 20)

Seed Formation: Floral structures & reproductive cycle. Modes of pollination, steps of fertilization.

Growth & Development of Fruit: Embryos and ovary development physical & chemical changes during seed & fruit development. Factors affecting seed & fruit development.

Chemical Composition: Genetic and environmental factors; carbohydrate, protein, fats & oils, lipid and other chemical compounds of seeds and fruits.

Seed Dormancy & Germination: Biological role, classification, mechanisms and release of dormancy; morphology of germination, seed metabolism and reserve mobilization, factors affecting seed germination

Seed Longevity & Deterioration: Life span of seeds, concept & predicting seed deterioration, factor influencing seed life span, principles of seed drying and storing, symptoms and causes of seed deterioration

Seed Enhancements: Seed hydration and priming, priming types, factor affecting priming; biological seed treatments, synthetic seeds- principles and cenges

Quality Seed: Concept, components, equilibrium moisture content, moisture and temperature effect on quality seed; postharvest factors affecting quality seed.

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- হোসেন, ম. সো. ২০০৫. বীজ উৎপাদন সংরক্ষণ ও বিপণন প্রযুক্তি, প্রকাশনায়: ডা: ম. ই. হোসেন এবং ম. ই. হোসেন ২৭/১, উত্তর পীরের বাগ, মীরপুর, ঢাকা-১২১৬।

CBOT 519 : Economic Botany

Credit hour: 2 (Total Marks: 100, Class Exam.: 20 (10+10); Final Exam.: 60; Assignment: 20)

Introduction: Plant, botany and economy. Plant and plant products as food, clothing, herbal medicine, drug and shelter. Geological time scale and evolutionary trend in plant kingdom.

Cryptogams: Economically important bacteria, algae, lichens, yeast, bryophytes and pteridophytes their product and byproducts.

Gymnosperms: Economically important gymnosperms, their products and value added products.

Angiosperms: Economically important angiosperms– industrial, wood and wood products, medicinal, flavouring, beverage plants, their products and value added products.

Symbiosis: Association of blue-green algae with pteridophytes and other higher plants and their role in different products.

References

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CBOT 521: Developmental Plant Physiology

Credit hour: 2 (Total Marks: 100, Class Exam.: 20 (10+10); Final Exam.: 60; Assignment: 20)

Physiology of Development: Basic aspects, growth, differentiation, pattern formation and morphogenesis, tumour formation in plants, factors affecting vegetative and reproductive growth.

Photomorphogenesis: Action spectra, pigments, phytochrome, Mode of action of phytochrome in photomorphogenesis. Molecular and photobiological characteristics of phytochrome.

Senescence, aging, and programmed cell death: Senescence: introduction, types, mechanisms, theories, Aging, factors affecting aging and senescence, programmed cell death and adaptation.

Physiology of flowering and fruiting: Photoperiodic induction, factors modifying photoinduction, mechanism of flowering, nature and mechanism of thermoperiodism in plants, Physiological aspects of maturation and ripening of fruits.

References

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CBOT 545 : Plant Tissue Culture

Credit hour: 2 (Total Marks: 100, Class Exam.: 20 (10+10); Final Exam.: 60; Assignment: 20)

Introduction: Principles of Plant Tissue Culture, Terminologies, Totipotency, Competency, Determinism, background, Physical facilities of modern tissue culture lab.

Tissue culture laboratory: A view about tissue culture laboratory, Requirement of equipment, principals of equipment working, general lab plan.

Culture preparation: Preparatory steps for Tissue Culture, Requirements for tissue culture, sterilization techniques, Procedure for aseptic tissue transfer, Inoculation of culture, establishing callus, Dynamics of callus growth, subculture and maintenance, Harvesting and growth Measurements.

Culture Medium: Medium composition and components (Vitamins, supplements, carbohydrates, Nitrogen sources and organic supplements, Complex substances, Activate charcoal), An appraisal of different media, ionic balance, pH and selection of media.

Culture technique: Cell suspension culture, Semi-solid culture, Organ micro culture, reproductive organs culture. Androgenesis and Gynogenesis, Protoplast isolation, culture and plant regeneration, protoplast fusion.

Plant Growth Regulators (PGR): Growth hormones (auxin, antiauxin, cytokinins, growth adjuvants and their role on culture growth, regulation and physiology. Interaction of PGR to media, explants, light, Temperature, Polarity, Genotype, season, juvenility and growth phases.

Organogenesis and morphogenesis: Organogenesis, Embryogenesis, Somaclonal variation, Somatic embryogenesis, its genetic basis and application in crop improvement. Factors affecting Tissue Culture.

Application of Plant Tissue Culture: Role of tissue culture in: micropropagation, production of somaclones, "synthetic seeds", disease free plants, secondary metabolites, haploid and crop improvement, Cell/callus line selection for stress resistant plants, somatic hybrids, Specific gene transfer. Cryopreservation, in vitro conservation and bio-safety. Role of plant tissue culture in genetic transformation.

References:

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CBOT 525: Plant Nutrition

Credit hour: 2 (Total Marks: 100, Class Exam.: 20 (10+10); Final Exam.: 60; Assignment: 20)

Nutrition in plant: Nutrients in the soil, Essential nutrients, Nutrient uptake by the plant, Nutrient groups and their functions. organic nitrogen compound, complex substances.

Mineral nutrition: Macronutrients and micronutrients, Role of macro and micro nutrients in plant metabolism. Plant adaptations to mineral nutrition – symbioses, Nutrition of plants in the wild. Techniques in nutrient analysis. Foliar analysis for the nutrient status.

Mineral salt absorption: Nutrient solution, Nutrient movement through the soil, Availability of mineral salts, mechanism of mineral salt absorption, passive absorption, theories of mineral salt absorption, mobility of different labeled nutrients, factors affecting salt absorption.

Membrane and Nutrient uptake: Transport in the plant, Nature and role of membrane in nutrient uptake, Mechanism of nutrient uptake in plants. Factors affecting plant nutrition, Eco-physiological aspect of plant nutrition.

Nutritional distribution: The distribution of chemical compounds in cells within plants. Functional importance of the substances in plant. Total metabolism and enzymatic reaction in plant, Nutritional efficiency, Plant growth and yield in response to nutrient content.

Nutritional Balance: Deficiency and toxicity problems, Metabolism of green and green- ing shoot system. Antagonism and nutritional balance in plant.

References

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CBOT 527 : Crop Physiology

Credit hour: 2 (Total Marks: 100, Class Exam.: 20 (10+10); Final Exam.: 60; Assignment: 20)

Introduction to crop physiology: Aims and objectives, energy relation and production factors in crop physiology.

Physiological basis of crop yield: Plant characters, photosynthetic and respiratory mechanisms, source-sink relation, carbohydrate translocation, mobilization & partitioning.

Physiology of crops: Rice, wheat, maize, sugarcane, jute, potato, cotton, important oils, pulses and important horticultural crops.

Plant ideotype: Concept, modeling crop ideotypes in rice, wheat sugarcane, jute, and important pulses and horticultural crops.

Plant growth analysis: Classical and functional growth analysis, components, different techniques, their uses and abuses.

References

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CBOT 531: Plant Biodiversity and Conservation

Credit hour: 2 (Total Marks: 100, Class Exam.: 20 (10+10); Final Exam.: 60; Assignment: 20)

Nature and Value of Plant Biodiversity: Plant diversity and its importance, assessing the value of species and species diversity. Status of Plant genetic resources in Bangladesh.

Losses of Biodiversity and their Causes: Dimensions of the problems, factors stimulating losses of biodiversity and the threats from their loss.

Approaches to Plant Biodiversity Conservation: National biodiversity conservation strategy, In situ, and Ex situ conservations.

PGR Conservation in Bangladesh: Biodiversity of major crop plant species and their conservation- Rice, jute and allied fibre crops, pulses, oil seeds, wheat, sugar crops, root, tuber crops, spices, beverages, vegetables and fruit plant resources, wild plant genetic resources and their conservation- forest plant genetic resources, medicinal, aromatic and ornamentals.

Plant Collection and Management: Inventory, collection, documentation, evaluation, data management and access to PGR.

References

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- CBD. 1999. Convention on Biological Diversity- Text and Annexes. Montreal, Canada.
- FAO. 1996. Global Plan of Action for the Conservation and Sustainable Utilization of Plant Genetic Resources for Food and Agriculture, and the Leipzig Declaration, Rome, Italy.
- Glowka, L. et al. 1994. A Guide to the Convention on Biological Diversity. IUCN, Switzerland.

- Gurung, J.D. (edited). 1994. Indigenous Knowledge Systems and Biodiversity Management. Proceedings of a MacArthur Foundation, ICIMOD Seminar, 13-15 April 1994, Kathmandu, Nepal.
- Hossain, M.G, Arora, R.K. and Mathur, P.N. (edited) 1997. Plant Genetic Resources-Bangladesh Perspective. Proceedings of a National Workshop on Plant Genetic Resources, 25-29 August, 1997. BARC, Dhaka.
- Jeffrey et al. 1997. Conserving the World's Biological Diversity. IUCN, WRI, CI, WWF-US, the World Bank. Gland, Switzerland, and Washington, D.C.
- WRI, IUCN, UNEP, FAO, UNESCO. 1992. Global Biodiversity Strategy- Guidelines for action to save, study, and use earth's biotic wealth sustainably and equitably. Gland, Switzerland.

CBOT 537: Developmental Plant Anatomy

Credit hour: 2 (Total Marks: 100, Class Exam.: 20 (10+10); Final Exam.: 60; Assignment: 20)

Meristems: Differentiation and specialization. Apical organization of root and shoot apices with special reference to crop plants.

Procambium: Procambium and primary vascularisation with special reference to crop plants.

Secondary growth: Structure and function of cambium, secondary growth in vine and herbs and its impact on crop protection, anomalous secondary growth.

Protective tissues : Protective tissues with special reference to crop plants, development of periderm and related tissues.

Vascularization: Vascularization in young seedling. Graft union and cellular interlocking.

Morphogenesis and abscission: Morphogenesis in plant. Abscission in plants and their relevance to protection.

Development of shoot and root: Structural differentiation of vegetative and reproductive organs. Mechanism of cambial reactivation, factors affecting cambial reactivation and dormancy, relationship between cambial activity and storage substances. Impact of global warming on wood formation.

References

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CBOT 539: Crop Ecology

Credit hour: 2 (Total Marks: 100, Class Exam.: 20 (10+10); Final Exam.: 60; Assignment: 20)

Light: Classification of crops based on quality and quantity of light energy, environmental and plant factors affecting penetration and absorption of light into crop canopy, modification of light environment for the improvement of crop production.

Temperature: Temperature fluxes in the atmosphere, plant canopy and the soils, thermal properties of soil and their effects on crop production, methods of modifying soil temperature for the crop improvement.

Wind: Effect of wind on crop growth, atmospheric stability and instability, wind profiles over the growing crops, wind breaks and shelter effects on crop production.

Soil-Plant-Water Relation: Energy balance, evapotranspiration and water balance. Assessment of water requirements for crop production. Causes and effects of drought on crop production, tolerance, avoidance and measures to overcome drought. Ecology of dryland, wetland and flooded ecosystems.

Fire: Kinds, direct and indirect effects, ecological implications and practical values of fire on vegetation and crop production.

Topography: Effects of altitude, latitude, slope and aspects on crop production.

References

- Chang, J.H. 1971. Climate and agriculture- an ecological survey. Aldine, Chicago.
- Cox, G.W. and Atkins, M.D. 1979. Agricultural Ecology. Freeman, Sanfransisco.
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- Williams, C.N. and Josheph, K.T. 1979. Climate, Soil and Crop Production in the Tropics, Butterworth, London.

CBOT 541 : Developmental Agroforestry

Credit hour: 2 (Total Marks: 100, Class Exam.: 20 (10+10); Final Exam.: 60; Assignment: 20)

Agroforestry Principles : Review of agroforestry as practiced in Bangladesh and in South Asia and Africa.

Interactions in Agroforestry : Choice of species, species composition, component interactions and bioproductivity.

Production Agroforestry: Biology of alley cropping, forest farming, silvoagriculture system, silvopastoral systems, Fuelwood/biomass

Conservation Agroforestry: Riparian filter/buffer strips, windbreak system (field, livestock, farmstead), waterbreaks (managed trees for flood plains), wildlife habitat enhancement (biodiversity and ecosystem management)

Special Applications of Agroforestry Technologies: Soil desalinization, wastewater disposal, live fences, non-wood Forest Products (medicine, spices, aromatics and other natural products).



Agroforestry Modeling: Coupling forest and crop models, below-ground coupling of MAESTRO and PARCH models, approaches to modeling the uptake of nutrient and water, nutritional content and decomposition rates of agroforestry leaves.

References

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- Zhaohua, Z. et. al. (Ed.). 1991. Agroforestry Systems in China. The Chinese Academy of Forestry and International Development Research Centre, Canada.

CBOT 543 : Crop Biotechnology

Credit hour: 2 (Total Marks: 100, Class Exam.: 20 (10+10); Final Exam.: 60; Assignment: 20)

Introduction: Historical background of plant biotechnology. Biotechnology and Plant Tissue Culture.

Haploid production: In vitro androgenesis, isolated microspore and pollen culture, diploidization, cytology of pollen embryoids and plantlets, factors affecting haploid production and its significance.

Protoplast culture and somatic hybridization: Isolation of protoplast, culture, cell wall formation and division, morphogenesis and regeneration protoplast fusion, somatic hybridization, cytoplasmic hybrids/cybrids, somaclonal variation and crop improvement and gene transfer.

Recombinant DNA technology: Cloning vehicles, plasmid: cosmid, phage, phagemid, transposon etc., cloning strategies, genomic and DNA libraries, isolation and purification of DNA from plant cells, target cells, gene construction, vectors, Agrobacterium mediated and direct gene transfer techniques, integration and inheritance, detection by southern western & northern blotting/bioassay, cutting and joining of DNA molecules, DNA sequencing by molecular techniques & markers.

Genetic transformation and crop improvement: Crop improvement by introducing, drought, salinity, disease, pest and herbicide resistance genes. Modification of seed protein quality, chloroplast and mitochondrial functions and yield.

Biosafety: Biotechnology in relation to environment and human health. Risk for human and animal, food quality, allergies. Risk of pollution through dispersal of seeds pollen, transgene or new virus/microbs.

References

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- Gatehouse, A.M.R.; Hilder, V.A. and Boulter, D. (ed.). 1994. Plant genetic manipulation for crop protection. CAB International, Bristol, UK.
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CBOT 523: Mangrove Ecology

Credit hour: 2 (Total Marks: 100, Class Exam.: 20 (10+10); Final Exam.: 60; Assignment: 20)

Introduction: Historical background and distribution of mangrove in the world and of Bangladesh, significance and values of mangroves.

Mangrove environment: Coastal physiography, climate, tides, waves, current, soil, salinity, dissolved oxygen and nutrients with special reference to Bangladesh.

Mangrove ecosystem and productivity: Structure and functions of mangrove ecosystem, adaptivity of the flora and fauna, and their productivity.

Depletion and degradation: Present status of world and Bangladesh mangroves, factors causing depletion and their impacts on agriculture, aquaculture, urbanization, industries & other activities.

Mangrove management & policies: Silvicultural practices for natural and plantation mangroves, policies and management plan for resources of the mangrove, laws, regulations and organizational set-up for mangrove management in Bangladesh.

Field trips: Studying of different mangrove vegetation of Bangladesh.

References

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- Hamilton, L.S. and Snedaker, S.C. 1984. Handbook for Mangrove Area Management. United Nations Environment Programme and East-West Center Environment and Policy Institute. COE/IUCN, Gland-Switzerland.
- Hussain, M.Z. 1991. The Management of Sundarbans Forest, Bangladesh. Paper presented at the International Workshop on Wetlands and Waterfowl Conservation in South and West Asia. Karachi, Pakistan (Dec. 1991).
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- UNESCO. 1987. Mangroves of the Asia and Pacific: Status and Management. Technical Report of the UNDP/UNESCO Research and Training Pilot Programme on Mangrove Ecosystems in Asia and the Pacific. UNESCO, Paris.

CBOT 547 : Phytochemical Ecology

Credit hour: 2 (Total Marks: 100, Class Exam.: 20 (10+10); Final Exam.: 60; Assignment: 20)

Natural Plant Products: Types; allelochemicals, kinds, distribution, synthesis and release; factors affecting their exudation.

Isolation and Identification: Methods of extraction, isolation and identification of phytochemicals from plants; their bioassays and use in agriculture.

Chemical interaction: Allelochemicals and allelopathic phenomena in different ecosystems; mechanism of plants- plants interactions: effects of plant exudates, and/ or residues on plant physiological processes; and plants chemical defense against their natural enemies in a plant community; practices to exploit biochemical interaction for crop improvement; accumulation of biomolecules and heavy metals, their movement and fate in soil and water, and remedial measures of their toxicities.

Chemical stress: Chemical stress on biogeocycles, nitrogen fixation, floristic composition and structures in plant community; causes of replant problems in agriculture and their remedial measures.

References:

- Harborne, J. B. 1972. *Phytochemical Ecology*. Academic Press, London. 272p.
- Harwood et al. 1993. *Sustainable agriculture and the environment in the humid tropics*. National Academy Press, Washington. 702p.
- Indrajit, Dakshini, K.M.M and Einhellig, F. A. 1995. *Allelopathy : Organisms, processes and applications*. American Chemical Society, Washington, D.C.
- Levin, S. A., Harwell, M. A., Kelly, J. R. and Kimball, K. D. 1989. *Ecotoxicology: Problems and approaches*. Springer-Verlag, New York. 547p.
- Manuel J. Reigosa, Nuria Pedrol and Luis Gonzalez. 2010. *Allelopathy: A Physiological Process with Ecological Implications*. Springer Pub. New York.
- Pramanik, et al. 2000. Effects of temperature and photoperiod on phytotoxic root exudates of cucumber (*Cucumis sativus*) in hydroponic culture. *J. Chem. Ecol.*, 8: 1953-1967.
- Putnam, A. R. and Tang, C. S. 1986. *The science of allelopathy*. John Wiley and Sons. New York.
- Ran Sen Zeng, Azim U. Mallik and Shiming Luo. 2010. *Allelopathy in Sustainable Agriculture and Forestry*. Springer-Verlag, New York.
- Rice, E. L. 1974. Allelopathy –Aw update. *Bot. Rev.* 45 : 15-109.
- Rice, E. L. 1984. *Allelopathy* . Academic Press. Orlando, Florida. 422p.
- Rice, E. L. 1995. *Biological control of weeds and plat diseases: Advances in applied allelopathy*. University of Oklahoma Press, Norman, 439p.
- Rizvi, S. J. H. and Rizvi, V. 1992. *Allelopathy: Basic and applied aspects*. Chapman and , London. 480p.
- Sondheir, E. and Simeone, J.B. 1970. *Chemical Ecology*. Academic Press, NY. 336p.
- Swain, T. 1963. *Chemical Plant Taxonomy*. Academic Press, London. 543p.
- Thompson, A.C. 1985. *The chemistry of allelopathy: Biological Interaction among plants*. American Chemical Society, Washington, D.C.

CBOT 529 : Crop Research Methodology

Credit hour: 2 (Total Marks: 100, Class Exam.: 20 (10+10); Final Exam.: 60; Assignment: 20)

Identification of problems and prioritization: Steps and features of research project preparation.

Experimental design and field plot technique: Principles and types, layouts of different types of experimental designs, their application and merits and demerits; data collection

and analysis, transformation, presentation and interpretation; correlation and regression analysis, modelling; increasing precision of experiment.

Determination of dry mass (DM), moisture and area of plant parts; selection of morpho-physiological parameters in different crops; determination of economic yield, biological yield, harvest index and their relationships with physiological processes; measurement of photosynthesis, respiration and stomatal conductance etc. and their relationships with DM production and yield.

Null hypothesis, importance of preliminary observation/trial; selection of treatments, locations and designs; data collection and analysis; treatment comparison and interpretations.

Techniques of growth, yield and yield component analysis.

Plant growth analysis (PGA): Classical and functional approach, fitting curves, analysis of yield.

References

- Anonymous, 1967. Style Manual for Biological Journals (2nd ed.), American Institute Biol. Sci., Washington.
- Anonymous, 1991. Resource Manual: Research planning and evaluation training course, Bangladesh Agric. Res. Council (RARC) and Bangladesh Agric. Res. Institute (BARI), Joydebpur, Gazipur, Bangladesh.
- Anonymous, 2001. Effective project proposal preparation: Log from approach. BAURES, Bangladesh Agric. Univ./DFID, Bangladesh.
- Gomez, K.A. and Gomez, A.A. 1984. Statistical procedures for Agricultural Research. John Wiley and Sons, New York.
- Kothari, C.R. 2001. Research Methodology, Wishwa Prakasan, New Delhi.
- Lauckner, F.B. and Fielding, W.J. 1992. Biometric notes for Agric. Res. in the Caribbean. Caribbean Agricultural Research and Development Institute (CARDI), Univ. West Indies (UWI) Campus, St. Augustine, Trinidad.
- Mead, R.; Curnow, R.N. and Hasted, A.M. 1993. Statistical methods of Agriculture and Experimental Biology, Chapman and , London.
- Misra, R.P. 2001. Research Methodology: A Handbook, Concept Pub. Co., New Delhi.
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- Siddique, M.A. 1985. Practical aspect of Thesis writing. Dept. Horticulture, Bangladesh Agric. Univ., Mymensingh.
- Silverman, D. 2001. Doing Qualitative Research: A Practical Handbook, SAGE Publications, London.
- Zaman, S.M.H.; Rahid, K. and Howladar, M. 1982. Simple lesson from Biometry. Bangladesh Rice Research Institute, Joydebpur, Dhaka.

CBOT 533: Advanced Plant Systematics

Credit hour: 2 (Total Marks: 100, Class Exam.: 20 (10+10); Final Exam.: 60; Assignment: 20)

Introduction: The conceptual and biological basis of species, taxonomic experiments design, role of herbaria, arboreta and botanic gardens.

Field and herbarium technique: Sample collection and methods of preparation of samples for herbarium specimens and preservation.

Data sources and records: Library resources – major botanical works, collecting and recording specimens, methodologies and character gathering – external & internal morphology, reproductive organs; Building data matrix.

DNA: Nucleic acids as a data source, DNA fingerprinting of plant populations.

Data Processing: Phonetic and Cladistic analyses – Basic philosophy and concepts, distance and similarity based data analysis, tree building and comparison, biogeography and evolution.

Taxonomic outcome: Identification – dichotomous and multi-access keys, monographs and floras.

The flora of Bangladesh: An overview, weed flora of the following families- Chenopodiaceae, Compositae, Leguminosae, Gramineae and Cyperaceae.

References:

- Beck, C.B. 2009. An Introduction to Plant Structure and Development. Cambridge Univ. Press, UK.
- Cronquist, A. 1988. The Evolution and Classification of Flowering Plants, 2nd ed., New York.
- Hennig, W. 1966. Phylogenetic Systematics. University of Illinois Press.
- Lawrence, G.H.M. 1951. Taxonomy of Flowering Plants. MacMillan Co., New York.
- Mamun, A.A. 1989. Morphology and growth characteristics of common weeds of the three selected villages in the Eastern part of Bangladesh.
- Prain, D. 1903. Bengal Plants Vol. I & II. Reprinted, Botanical Survey of India, Calcutta.
- Sarwar, A.K.M. Golam. 2011. Pollen Morphology of Ericaceae and its Systematic significance. Lambert Academic Press, Germany.
- Simpson, M.G. 2006. Plant Systematics. Elsevier-Academic Press.
- Sivarajan, V.V. 1991. Introduction to the Principles of Plant Taxonomy. 2nd ed. Cambridge.
- Sneath, P.H.A. and Sokal, R.R. 1973. Numerical Taxonomy. W.H. Freeman, New York.
- Taktakajan, A.J. 1980. Outline of the Classification of Flowering Plants (Magnoliophyta). Bot. Rev. 46(3): 169-217.
- Taktakajan, A.J. 1997. Diversity and Classification of Flowering Plants. Columbia Univ. Press, New York.
- Wiley, Siegel-Causey, Brooks and Frunk. 1991. The Complete Cladist, University of Kansas.

CBOT 535: Radiation Ecology

Credit hour: 2 (Total Marks: 100, Class Exam.: 20 (10+10); Final Exam.: 60; Assignment: 20)

Introduction: Sources, types and laws of radiation.

Radiation spectra and their effects on biota: Theories of biological activation of radiation, spectral composition and their impacts on plants, and animals.

Solar radiation: Origin, physical and chemical nature, energy balance, radiation transmission and extinction, factors affecting quality, quantity and distribution of radiation in earth-atmospheric system, water bodies and vegetation.

Nuclear radiation: Nature, types and carry over effects on climate and agriculture with their remedial measures.

Radiation utilization: Monteith's concept and radiation-use efficiency, partitioning of radiant energy in different strata of vegetation and optimization for production.

Adaptation of plants to radiation: Adaptation of plants to light environment- photohomeostatic, modulative, modificative, evolutionary and chromatic. Impact of ultraviolet, infra-red and low intensity radiations on vegetative and reproductive development in plants and animals, and their mitigation.

References

- Alpen, E.L. 1998. Radiation Biophysics. Second Edition. Academic Press, New York
- Campbell, G.S., Norman, J.M. 1998. An Introduction to Environmental Biophysics. 2nd edn. Springer-Verlag, New York, Inc.

- Glaser, R. 2010. Biophysics: An Introduction. Springer-Verlag Berlin, Heidelberg.
- Hessen, D.O. 2002. UV Radiation and Arctic Ecosystems (Ecological Studies, Vol. 153). Springer Verlag Berlin, Heidelberg, New York
- Larcher, W. 2003. Physiological Plant Ecology. Second edition, Springer-Verlag, New York.
- McDonald, M.S. 2003. Photobiology of Higher Plants. John Wiley and Sons Ltd. England.
- Montieth, J.L., Unsworth, M.H. 2007. Principles of Environmental Physics. Edward Arnold, UK.
- Odum, E. Barrett, G.W. 2004. Fundamentals of Ecology. Fifth edition, W.B. Saunders Company.
- Rosenberg, J.N., Blad, B.L. and Verma, S.B. 1983. Microclimate: The Biological Environment. John Wiley & Sons, New York.
- Rozema, J., Manetas, Y. and Björn, L.O. 2010. Responses of Plant to UV-B Radiation (Advances in Vegetation Science). Volume 18. Kluwer Academic Publishers, London.

CBOT 549: Plant Molecular Physiology

Credit hour: 2 (Total Marks: 100, Class Exam.: 20 (10+10); Final Exam.: 60; Assignment: 20)

Signal perception and Transduction: Overview of signal transduction; Types of signaling molecules and associated networks; Intercellular second messengers: calcium, calmodulin and MAPK cascade

Molecular physiology of membrane transport: Molecular basis of active and passive transport, membrane phospholipids and transport proteins: ATPases, channel proteins and cotransporter, aquaporins and water flux, Physiological, biochemical and biophysical approaches, cloning and characterization of genes encoding K⁺ and NH₄⁺ transporters, molecular regulation of plant Pi acquisition and nutrition.

Molecular physiology of abiotic stress tolerance: Stress specific molecular responses, the regulation of gene expression under abiotic stress in plants, role of plant transcription factors, synthesis of stress-defensive metabolites, molecular chaperons and environmental stresses, Isolation, characterization and exploitation of regulatory genes.

System biology: Concept, Importance, Advanced physiological techniques: genomic, transcriptomic, proteomic, metabolomic, and ionic aspects of molecular physiology.

References

- Buchanan, B.B., W. Gruissem and R.L. Jones (2000) Biochemistry and molecular biology of plants, The American society of plant physiologists, Rockville, Maryland
- Datta, S.C. 1994. Plant physiology, Wiley Eastern Ltd. New Delhi.
- Donald, C.M. and Hamblin, J. 1976. The biological yield and harvest index of cereals as agronomic and plant breeding criteria. *Adv. Agron.*, 28: 361-405.
- Evans, L.T. 1975. *Crop Physiology: Some case histories*, Camb. Univ. Press., U.K.
- Gifford, R.M. and Evans, L.T. 1981. Photosynthesis, carbon partitioning and yield. *Ann. Rev. Plant Physiol.*, 32: 485-509.
- Hunt, R. 1982. *Plant growth curves: The functional approach to plant growth analysis*, Edward Arnold, London.
- Mohr H. and P. Schopfer 1995. *Plant Physiology*, Springer
- Salisbury, F.B. and Ross, C.W. 1986. *Plant Physiology*. Wadworth Pub. Co. USA.
- Sinha, R.K. 2004. *Modern Plant Physiology*, Alpha Science International Ltd, Pangbourne, England
- Squire, G.R. 1993. *The Physiology of Tropical Crop Production*, CAB International, U.K.

CBOT 551: Pollination Biology

Credit hour: 2 (Total Marks: 100, Class Exam.: 20 (10+10); Final Exam.: 60; Assignment: 20)

Floral Biology: Floral structures and their functions, modification of floral structures related to pollination; pollination regulation of floral development – e.g. perianth senescence, floral pigmentation changes, pollination signals, ethylene biosynthesis etc., different breeding systems.

Pollen grains: Morphology, structure and their role in pollination biology.

Mode of pollination: Spore and pollen dispersal in Lower plants and Gymnosperms; Angiosperms- Different types (e.g. Anemophily, Hydrophily, Melittophily, Ornithophily, Chiropterophily etc.) and related plant adaptations.

Pollination syndromes: Floral specialization and their evolution, causes of syndromes and their management.

Pollination biology of different plant/group(s): Cereals, Cucurbits, Legumes, Orchids, etc.

References:

- Faegri, K. and Pijl, L.V. 1971. *The Principles of Pollination Ecology*. Pergamon Press, New York.
- Franke, R. and Galun, E. 1977. *Pollination Mechanisms, Reproduction and Plant Breeding*. Springer Verlag, New York.
- Free, J.B. 1970. *Insect Pollination of Crops*. Academic Press.
- Harder, L. and Spencer C.H.B. (eds.) 2006. *Ecology and Evolution of Flowers*. Oxford University Press, New York.
- Husband, B.C., Kevan, P.G. and Dafni, A. 2005. *Practical Pollination Biology*. Enviroquest Ltd.
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- Kapil, R.K. (eds.) 1986. *Pollination Biology- An Analysis*. Inter-India Pub., New Delhi.
- Kearns, C.A. and Inouye, D.W. 1993. *Techniques for Pollination Biologists*. Univ. Press, Colorado.
- Linskens, H.F. (ed.). 1974. *Fertilization in Higher Plants*. North-Holland Pub. Co., Amsterdam.
- Real, L.A. 1983. *Pollination Biology*, Academic Press.
- Sarwar, A.K.M. Golam. 2011. *Pollen morphology of Ericaceae and its systematic significance*. Lambert Academic Press, Germany.
- Simpson, M.G. 2006. *Plant Systematics*. Elsevier-Academic Press.

Course Profiles for PhD Program

PhD courses layout

April – September Semester

<p>Compulsory Courses CBOT 601: Plant Morphometrics and Systematics CBOT 603: Plant Physiology CBOT 605: Plant Ecology and Phytoclimate</p>	<p>Elective Courses CBOT 607: Biodiversity and Conservation CBOT 609: Systems Ecology CBOT 611: Phyto-Nanotechnology CBOT 613: Crop Physiology CBOT 615: Crop Phylogeny and Evolution CBOT 617: Research Methodology and Report Writing</p>
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October – March Semester

<p>Compulsory courses CBOT 602: Medicinal Plants CBOT 604: Plant Stress Physiology CBOT 606: Eco-efficient and Climate Smart Agriculture</p>	<p>Elective courses CBOT 608: Data Analysis and Visualization CBOT 610: Climate Change Impact Assessment CBOT 612: Internet of Things in Agriculture CBOT 614: Photophysiology and Vertical Agriculture CBOT 616: Applied Plant Tissue Culture CBOT 618: Plant Ecophysiology</p>
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Item	Credit	Means of evaluation
Compulsory courses (6 courses, each of 3 credits)	18	Grading
Elective courses (2 to 3 courses, each of 2 to 3 credits)	6	Grading
Seminars (2)	2 + 2 = 4	Satisfactory
Research reports (end of first and third year)	2 + 2 = 4	Satisfactory
Research	23	Satisfactory
Dissertation evaluation	15	Satisfactory
Dissertation defense	6	Satisfactory
Total=	76	

Course No. & Title- CBOT 601: Plant Morphometrics and Systematics (Compulsory)

Credit hour: 3 (Total Marks: 100, Class Exam.: 40; Final Exam.: 40; Assignment: 20)

Introduction: Concept and its usage in plant research**Data acquisition and feature Extraction:** Morphological, anatomical and embryological descriptors, data - landmark, outline and allied**Morphometric analyses:** Multivariate statistical methods, geometrical methods, size and allied**Anatomical traits:** Mechanisms of plant cell morphogenesis, cell wall thickening, cytoskeleton and plant cell polarity, programmed cell death and heartwood formation, cellular response on plant hormone; cellular function, differentiation and adaptation under stresses**Plant systematics:** Principles and systems of modern classification**References**

- Bell, A.D. 1991. *Plant Form: An Illustrated Guide to Flowering Plant Morphology*. Oxford University Press.
- Chuanromanee, T.S., Cohen, J.I. and Ryan, G.L. 2019. Morphological Analysis of Size and Shape (MASS): An integrative software program for morphometric analyses of leaves. *Applications in Plant Sciences* 7(9): e11288. doi:10.1002/aps3.11288
- Cope, J.S., Corney, D., Clark, J.Y., Remagnino, P. and Wilkin, P. 2012. Plant species identification using digital morphometrics: A review. *Expert Systems with Applications* 39: 7562-7573. doi: 10.1016/j.eswa.2012.01.073
- Parés-Casanova, P.M. 2017. Morphometric Studies: Beyond Pure Anatomical Form Analysis. In *New Insights into Morphometry Studies*, Pares-Casanova, P.M. (ed). IntechOpen, DOI: 10.5772/intechopen.69682
- Rohlf, F.J. 1990. Morphometrics. *Annu. Rev. Ecol. Syst.* 21: 299-316.
- Savriama, Y. 2018. A Step-by-Step Guide for Geometric Morphometrics of Floral Symmetry. *Front. Plant Sci.* 9:1433. doi: 10.3389/fpls.2018.01433
- Simpson, M.G. 2019. *Plant Systematics*. 3rd ed., Elsevier-Academic Press.
- Viscosi, V. and Cardini, A. 2011. Leaf morphology, taxonomy and geometric morphometrics: A simplified protocol for beginners. *PLoS ONE* 6(10): e25630. doi:10.1371/journal.pone.0025630

Course No. & Title- CBOT 602: Medicinal Plants (Compulsory)

Credit hour: 3 (Total Marks: 100, Class Exam.: 40; Final Exam.: 40; Assignment: 20)

Medicinal & Aromatic plants (MAP): Classification, sources, collection, utilization, scenario of herbal products, WHO guidelines for herbal medicine**Bioresources and nutraceuticals:** Secondary metabolites, pigments, antioxidants, phytonutrients and their health benefits**Herbal medicinal preparations:** Traditional & modern medicine, collection, extraction, purification and evaluation**Phytotherapy:** Plants related to anti-diabetic, anti-inflammatory, anti-ageing and degenerative diseases, diuretic, anti-carcinogenic, cardiac remedies**Conservation:** Strategies, MAPs conservation and development areas, kitchen/home herbal garden, *in situ* conservation, role of Botanic garden and other conservatories**Safety, risk and toxicity:** Global database, national reports, xenobiotics metabolism and detoxification, model animals and human subjects

References

- Akbar S. 2020. Handbook of 200 Medicinal Plants: A Comprehensive Review of Their Traditional Medical Uses and Scientific Justifications Springer, Stockton, CA, ISBN 978-3-030-16807-0 (eBook)
- Joshee N, Dhekney S and Parajuli P (ed). 2019. Medicinal Plants: Farm to Pharmacy, Springer, ISBN 978-3-030-31269-5 (eBook)
- Suleria A H R and Barrow C (ed). 2020. Bioactive Compounds from Plant Origin: Extraction, Applications, and Potential Health Benefits, Apple Academic Press Inc., US Aand CRC Press Taylor & Francis group
- Wart C. 2019. Medicinal Plants of Bangladesh and West Bengal: Botany, Natural Products, and Ethno pharmacology, CRC Press Taylor & Francis group, Boca Raton, NY

Course No. & Title- CBOT 603: Plant Physiology (Compulsory)

Credit hour: 3 (Total Marks: 100, Class Exam.: 40; Final Exam.: 40; Assignment: 20)

Photosynthesis: Quantum yield, carbon, light, water and nitrogen use efficiency (CUE, LUE, WUE & NUE), yield processing, source-sink, and harvest index (HI)

Respiration and post harvest physiology: Energy metabolism, controlled atmosphere and modified atmosphere (CA, MA), Quality attributes

Growth analysis: Growth and yield attributes.

Reproductive Physiology: Hormones, photoperiodism, vernalization

Seed Physiology: Maturity, dormancy, priming technology.

Secondary metabolites: Signaling networks and autoimmune system, Quality attributes

References

- Bewley, J.D. and Black, M. 1994. Seeds: Physiology of Development and Germination. 2nd ed. Plenum Press, New York.
- Hall, D.O., Scurlock, J.M.O., Bolhar-Nordenkamp, H.R., Leegood, R.C. and Long, S.P. 1993. Photosynthesis and Production in a Changing Environment: A Field and Laboratory Manual. Chapman and Hall, U.K.
- Hunt, R. 1982. Plant growth curves: The functional approach to plant growth analysis. Edward Arnold, London.
- Kochhar, S.L. and Gujral, S.K. (Eds). 2020. Plant Physiology Theory and Application. Cambridge University, Press
- Pagageorgiou, G.C. and Govindjee (Eds). 2004. Chlorophyll a Florescence. Volume 19. Advances in Photosynthesis and Respiration. All Rights Reserved @2004 Springer.
- Salisbury, F.B. and Ross, C.W. 1986. Plant Physiology. Wadworth Pub., USA

Course No. & Title- CBOT 604: Plant Stress Physiology (Compulsory)

Credit hour: 3 (Total Marks: 100, Class Exam.: 40; Final Exam.: 40; Assignment: 20)

Water stress: Drought, desiccation and submergence tolerance mechanisms, Physiological Traits Affecting Crop Response to Drought and submergence, Drought and submergence evaluation methods.

Salinity Stress: Biphasic model, salt transportation and tissue tolerance mechanisms, osmolytes homeostasis, Cellular redox regulation, Omic approaches for salt tolerance

Ionic stress: Uptake and root to shoot translocation, cellular physiology under excess Al, As, Pd, Cd, Cr and other ions. Organelles and compartments involved to metabolize.

Temperature stress: Consequences and Strategies for Protecting cellular Machinery under high and low temperatures, influence on gas exchange physiology

Light stress: Photoinhibition, photodamage and PSII health, D1 & D2 repair cycle

Cellular redox regulation: Oxidants under abiotic stresses and their role in cell functioning, enzymatic and non-enzymatic strategy to regulate redox potential

References:

- Hossain MA and Sarder NU. 2011. Mechanisms of waterlogging tolerance in wheat: Morphological and metabolic adaptations under hypoxia or anoxia. *Aust J Crop Sci* 5(9):1094–1101.
- Marschner H. 2011. *Marschner's Mineral Nutrition of Higher Plants*. Academic Press; 3rd edition
- Nobel PS. 1991. *Physicochemical and Environmental Plant Physiology*. Academic Press, London
- Pareek A, Sopory SK, Bohnert HJ and Govindjee (Eds). 2010. *Abiotic Stress Adaptation in Plants: Physiological, Molecular and Genomic Foundation*. Springer, Dordrecht.
- Rao KVM, Raghavendra AS and Reddy KJ (Eds). 2006. *Physiology and Molecular Biology of Stress Tolerance in Plants*. Springer, Dordrecht, The Netherlands.
- Shabala S. 2017. *Plant Stress Physiology*, 2nd Ed. CABI Intl. Oxford.
- Tuteja N and Gill SS (Eds). 2013. *Plant Acclimation to Environmental Stress*. Springer-Verlag New York

Course No. & Title- CBOT 605: Plant Ecology and Phytoclimate (Compulsory)

Credit hour: 3 (Total Marks: 100, Class Exam.: 40; Final Exam.: 40; Assignment: 20)

Ecosystem dynamics: Structure and functioning of different ecosystems, mangrove and marine ecosystems, blue economy, biotic associations and invasive species.

Biogeochemical cycling: Different cycles and their modeling, ecotoxicology, bioindicators, biomonitoring, and bioremediation.

Phytogeography: Principles, species richness and diversity, vegetations of world and of Bangladesh.

Climate and agriculture: Climatic elements and their distribution, crop scheduling, weather forecasting and yield assessment, factors affecting outbreak of plant pest and diseases.

Phytoclimate and microclimate: Light, heat and humidity fluxes in plant canopies; climates of crop fields, orchards and forests, and their management for better productivity.

References

- Ambasht, R.S. and Ambasht, N.K. 2019. *A Textbook of Plant Ecology*. Fifteenth Edition. C.B.S. Publishers & Distributors Pvt Ltd.
- Bishnoi, O.P. 2010. *Applied Agroclimatology*. Oxford, London.
- Das, P.C. 2007. *Plant Ecology*. AITBS Publishers, India.
- Kumar, H.D. 1995. *General Ecology*. Vikas Pub. House, New Delhi.
- Mavi, H.S. 2001. *Introduction to Agrometeorology*. Oxford & IBH Publishing Co.Pvt. Ltd., New Delhi.
- Odum, E.P. and Barrett, G.W. 2005. *Fundamentals of Ecology*. Fifth edition, W.B. Saunders Company.
- Rosenberg, J.N. 1985. *Microclimate: The Biological Environment*. John Wiley Sons, New York.
- Schulze, E.-D., Beck, E., Buchmann, N., Clemens, S., Müller-Hohenstein, K., Scherer-Lorenzen, M. 2019. *Plant Ecology*. Springer Verlag, GmbH Germany.
- Seemann, J., Chirkov, Y.I., Lomas, J. and Primault, B. 1979. *Agrometeorology*. Springer-Verlag, Berlin Heidelberg, New York.

Course No. & Title- CBOT 606: Eco-efficient and Climate Smart Agriculture (Compulsory)

Credit hour: 3 (Total Marks: 100, Class Exam.: 40; Final Exam.: 40; Assignment: 20)

Components of CSA: Scope, principles and pillars of climate smart agriculture (CSA), CSA in food security and livelihood development.

Climate change and agriculture: Risk and challenges of agriculture in changing climate, resilience and coping strategies, community knowledge and context-specific measures to climate change.

CSA in Bangladesh: Problems and prospects, and policy gaps for CSA; technologies of CSAs in hill, coastal, flooded/water-logged and dry land ecosystem; climate-smart village and sustainable agriculture.

Global warming: Sources and emission of greenhouse gasses, causes and consequences of global warming and climate change, adaptation and mitigation approaches- agricultural practices, green technologies and farmlands management; conservation policies to combat global warming.

References

- Brammer, H. 2014. Climate Change, Sea-level Rise and Development in Bangladesh. The University Press Limited, Dhaka, Bangladesh.
- CIAT; World Bank. 2017. Climate-Smart Agriculture in Bangladesh. CSA Country Profiles for Asia Series. International Center for Tropical Agriculture (CIAT); World Bank. Washington, D.C. 28 p.
- Hadgu, K.M., Bishaw, B., Liyama, M., Birhane, E., Negussie, A., Davis, C.M. and Bernart, B. 2019. Climate-Smart Agriculture: Enhancing Resilient Agricultural Systems, Landscapes, and Livelihoods in Ethiopia and Beyond. World Agroforestry.
- Hasan, W., Swami, S., Naz, H. and Singh, H. 2020. Climate Smart Agriculture. Biotech Books, New Delhi, India.
- Islam, T. and Neelim, A. 2010. Climate Change in Bangladesh. The University Press Limited, Dhaka, Bangladesh.
- Lipper, L., McCarthy, N., Zilberman, D., Asfaw, S., Branca, G. (Eds.). 2018. Climate Smart Agriculture: Building Resilience to Climate Change. Natural Resource Management and Policy. Open access book. Springer.

Course No. & Title- CBOT 607: Biodiversity and Conservation

Credit: 2 (Total Marks: 100, Class Exam.: 40; Final Exam.: 40; Assignment: 20)

Biodiversity and ecosystem services: Levels and values of biodiversity, biodiversity hotspots, national and global biodiversity pattern.

Biodiversity depletion and species extinction: Key drivers for biodiversity loss and species extinction, IUCN red list, threatened plant species in Bangladesh.

Global climate change and biodiversity: Climate change risk and vulnerability to biodiversity, management and challenges of biodiversity and its conservation in changing climate.

Approaches to conservation: Legal strategies and action plan, current practices and recent advances in biodiversity conservation, convention on biodiversity, roles of IUCN and local communities on biodiversity conservation, nature based solution.

Species diversity measurement and Herbarium: Methods of floristic structure and vegetation analysis, species diversity measuring techniques - Shannon-Weiner's, Simpson's and similarity indices. Techniques of herbarium, e-herbarium and monographs preparation, computer-based identification systems.

References

- CBD. 1999. Convention on Biological Diversity- Text and Annexes. Montreal, Canada.
- FAO. 1996. Global Plan of Action for the Conservation and Sustainable Utilization of Plant Genetic Resources for Food and Agriculture, and the Leipzig Declaration, Rome, Italy.
- Gurung, J.D. (ed). 1994. Indigenous Knowledge Systems and Biodiversity Management. Proceedings of a MacArthur Foundation, ICIMOD Seminar, 13-15 April. Kathmandu, Nepal.
- Hossain, M.G, Arora, R.K. and Mathur, P.N. (ed) 1997. Plant Genetic Resources-Bangladesh Perspective. Proceedings of a National Workshop on Plant Genetic Resources, 25-29 August. BARC, Dhaka.
- Jeffrey et al. 1997. Conserving the World's Biological Diversity. IUCN, WRI, CI, WWF-US, the World Bank. Gland, Switzerland, and Washington, D.C.
- Mugabe et al. 1997. Access to Genetic Resources- Strategies for Sharing Benefits, IUCN
- Paroda, R.S. and Arora, R.K.1991. Plant Genetic Resources-Conservation and Management, International Board Plant Genetic Resources, international Plant Genetic Resources.
- Sarwar, A.K.M. Golam. 2019. Plant Biodiversity and Conservation of Higher Plants in Bangladesh: Present Status and Future Prospects. In Sangeetha J, Thangadurai D, Goh HC, Islam S. (eds).Biodiversity and Conservation: Characterization and Utilization of Plants, Microbes and Natural Resources for Sustainable Development and Ecosystem Management.AAP/CRC, Florida, USA. pp. 259-288.
- Thrupp, L.A. 1998. Cultivating Diversity- Agrobiodiversity and Food Security, World Resources Institute WRI, IUCN, UNEP, FAO, UNESCO. 1992. Global Biodiversity Strategy- Guidelines for action to save, study, and use earth's biotic wealth sustainably and equitably. Gland, Switzerland.

Course No. & Title- CBOT 608: Data Analysis and Visualization

Credit hour: 2 (Total Marks: 100, Class Exam.: 40; Final Exam.: 40; Assignment: 20)

Analytical tools and techniques: Cloud computing, sharing files and folders. Application and uses of Microsoft Excel, Sigma Stat, Minitab and R

Data processing and analysis: Data entry, organization and descriptive statistics using MS Excel. Inferential statistics - Analysis of variance, t-test, correlation and regression analyses, multivariate and cluster analyses

Imaging tools and techniques: Experimental photography and image processing using web tools and software

Data visualization: Basic principles, mapping of data onto aesthetics, tabular and graphical representation of statistical data, data filtering, common errors in data visualization

Presentation and citation: PowerPoint slide and videography preparation, virtual presentation, handling reference managers, structuring PhD dissertation using MS-word template

References:

- Hofmann A H. 2019. Scientific Writing and Communication: Papers, Proposals, and Presentations. 4th ed., Oxford University Press.
- Kirk A. 2019. Data Visualisation: A Handbook for Data Driven Design. 2nd Ed. SAGE Publications Ltd.
- Schwabish J. 2021. Better Data Visualizations: A Guide for Scholars, Researchers, and Wonks. Columbia University Press.

Course No. & Title- CBOT 609: Systems Ecology

Credit hour: 2 (Total Marks: 100, Class Exam.: 40; Final Exam.: 40; Assignment: 20)

Introduction: Concept, scope and importance of system ecology in agriculture.

Ecosystem ecology: Basic principles, bioenergetics, transfer of energy and matter across trophic level in different ecosystems, carbon and nutrient cycling in the context of climate change and other global change drivers.

Resource management: Problems and prospects, GIS and remote sensing, and their application in agriculture and resource management.

Crop responses to environment: Crop responses to ecological factors, and their computer simulation.

Simulation and crop modeling: Concept, principles of crop modeling and simulation, different types of models and their uses, limitations and applications in ecosystem functioning and crop production.

References

- Ambasht, R.S. and Ambasht, N.K. 2019. A Textbook of Plant Ecology. Fifteenth Edition. C.B.S. Publishers & Distributors Pvt Ltd.
- Bhatta, B. 2011. Remote Sensing. Second Edition. Oxford University Press.
- Dimond, J. and Case, T.J. 1980. Community Ecology, Harper & Row, New York.
- Halfon, E. 1979. Theoretical Systems Ecology: Advances and Case Studies. First Edition. Elsevier.
- Hunt, R. 1982. Plant Growth Curves: The Functional Approach to Plant Growth Analysis. Edward Arnold, London.
- Jorgensen, S. 2012. Introduction to Systems Ecology. First Edition. CRC Press.
- Kumar, H.D. 1995. General Ecology. Vikas Pub. House, New Delhi.
- Montague, C.L. 2016. Systems Ecology. Oxford Bibliographies.
- Odum, H.T. 1983. Systems Ecology: An introduction. Wiley, New York.

Course No. & Title- CBOT 610: Climate Change Impacts Assessments

Credit hour: 2 (Total Marks: 100, Class Exam.: 40; Final Exam.: 40; Assignment: 20)

Introduction: Conceptualization of climatic parameters and variables for climate change impacts assessments.

Climate change models: Types of climate models and their limitations. IPCC climate model for projections of climate change at global and local levels, its implications and potential for future risks and challenges of global climate.

Climate impact and vulnerability assessment: Assessment of key changes in climate, climate change impacts on different sectors and agriculture, and livelihoods vulnerability.

Methods of impact assessment: Designing climate impact and vulnerability assessments using Scoping (e.g. checklists), Qualitative analysis (e.g. focus groups), Quantitative analysis (e.g. life-cycle assessment, material flow accounting, modelling), Aggregation and Comparison of options (e.g. cost-benefit analysis), Analyzing coherence (e.g. Gender IA) methods. Climate change impacts in Bangladesh agriculture and their assessments.

References

- Ahmed, I., Ullah, A., Rahman, M.H., Ahmad, B., Wajid, S.A., Ahmad, A. and Ahmed, S. 2018. ClimateChange Impacts and Adaptation Strategies for Agronomic Crops. DOI: <http://dx.doi.org/10.5772/intechopen.82697>.
- Balbus, J., Cohen, S., Brody, M. and Essink, G.H.P.O. 2014. Handbook on Methods for Climate Change Impact Assessment and Adaptation Strategies. Edited by Feenstra, J.F., Burton, I., Smith, J.B. and Tol, R.S.J. United Nations Environment Programme (UNEP), Institute for Environmental Studies, Amsterdam.
- Bosello, F. and Zhang, J. 2005. Assessing Climate Change Impacts: Agriculture CIP – Climate Impacts and Policy Division. Working Paper N. 02.2007. Venezia.
- Brammer, H. 2014. Climate Change, Sea-level Rise and Development in Bangladesh. The University Press Limited, Dhaka, Bangladesh.

- Islam, T. and Neelim, A. 2010. Climate Change in Bangladesh. The University Press Limited, Dhaka, Bangladesh.
- Simelton, E., Gammelgaard, J. and Le, T.T. 2018. Guide for impact assessment of agro-climate information services. CCAFS Working Paper no. 242. Wageningen, the Netherlands: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Available online at: www.ccafs.cgiar.org.
- Thathe, A.D. 2014. Lecture Notes on Climatology. India Meteorological Department. Pndia. 45p.

Course No. & Title- CBOT 611: Phyto-nanotechnology

Credit hour: 2 (Total Marks: 100, Class Exam.: 40; Final Exam.: 40; Assignment: 20)

Introduction: Concept, history and importance

Plant-based nanoparticles: Phytoresources, bioreducing and capping agents, factors, advantages

Characterization techniques: Visual, UV-vis, FTIR, XRD, SEM, TEM, DLS

Industrial application of biogenic NPs: Agriculture, Food, Environment, Biomedical & Healthcare

Toxicity and risk assessment: Soil, plant, animal & human ecosystem

References

- Axelos, M.A.V. and van de Voorde, M. (eds). 2017. Nanotechnology in Agriculture and Food Science. Wiley-VCH Verlag GmbH & Co., Weinheim, Germany.
- Hossain MA, Karim MM and Juthee SA. 2020. Postharvest physiological and bio-chemical alterations in fruits: a review. *Fundamental and Applied Agriculture* 5(4): 453-469. doi:10.5455/faa.22077
- Juthee SA. 2021. Phytofabrication, characterization and application of silver nanoparticles for improving vase life of cut flower. M.S. Thesis. Department of Crop Botany, Bangladesh Agricultural University, Mymensingh.
- Kamel AA-E and Prasad R (Eds). 2018. Nanobiotechnology applications in plant protection. © Springer International Publishing AG, part of Springer Nature 2018.
- Rai M, Mattoso CRL and Duran N (Eds). 2015. Nanotechnologies in Food and Agriculture. Springer Cham Heidelberg New York Dordrecht London © Springer International Publishing Switzerland 2015.
- Theis F, Styczynski M, Nash M and Shoseyov O (Eds). 2016. Systems biology • Nanobiotechnology © 2016 Elsevier Ltd. All rights reserved.

Course No. & Title- CBOT 612: Internet of Things in Agriculture

Credit hour: 2 (Total Marks: 100, Class Exam.: 40; Final Exam.: 40; Assignment: 20)

Introduction: Concepts and uses of Internet of Things (IoT) in agriculture, impacts of IoT on agro-farming and industry

GIS and remote sensing: Concept, electromagnetic spectrum, spectral signatures, Normalized Difference Vegetation Index (NDVI), remote sensing platforms

Components of IoT: Sensors and devices, networks and applications, data acquisition and processing of bigdata, cloud platforms, decision support system.

Application of IoT in agriculture: Monitoring of crop growth, irrigation, biotic and abiotic stress, crop & yield forecasting, challenges and remedial measures

IoT in smart farming: Climate-smart agriculture, precision agriculture, modern agriculture business

References

- Annamaria C, Khosla R, Moshou D, Buttafuoco G, Mouazen A M and Naud O (eds). 2000. Agricultural Internet of Things and Decision Support for Precision Smart Farming. Elsevier Inc.
- Khan J Y and Yuce M R (eds.). 2019. Internet of Things (IoT) Systems and Applications (1st Edition). Jenny Stanford Publishing
- Pattnaik P K, Kumar R and Pal S (Eds.). 2020. Internet of Things and Analytics for Agriculture, Volume 2. Springer, Singapore.
- Singh R. 2018. Internet of Things (IoT) Enabled Automation in Agriculture. New India Publishing Agency.

Course No. & Title- CBOT 613: Crop Physiology

Credit hour: 2 (Total Marks: 100, Class Exam.: 40; Final Exam.: 40; Assignment: 20)

Crop Growth and Developmental: Seed formation and seedling growth, Lag, log and stationary phases of growth (growth curve). Phenology of rice plant, Source strength on leaf developmental programme, fruit development, and ripening, dormancy, senescence and abscission in some major crops.

Canopy architecture and resource utilization: Crop ideotype, root architecture for maximizing nutrient acquisition, theories of growth and yield component analysis, Harvest index and yield maximization.

Physiology of cereals, legumes, sugar crops, tubers and oil yielding crops:

Processes controlling growth and yield, Nutritional influence, source-sink manipulation, radiation and water use efficiencies, response to abiotic stresses and adaptation strategies

References:

- Hay, RKM and Porter, JR. 2006/ The Physiology of Crop Yield. 2nd ed., Wiley-Blackwell
- M Pessaraki, Handbook of Plant and Crop Physiology, 2001. 2nd Ed, Univ. Arizona, Tucson, Arizona, Marcel Dekker, Inc. New York
- Marschner H. 2011: Marschner's Mineral Nutrition of Higher Plants. Academic Press; 3rd edition
- Pessaraki, M. 2014. Handbook of plant and crop physiology, CRC Press; 3rd edition.
- Sadras, V. and Calderini, D 2020. Crop Physiology Case Histories for Major Crops. Academic Press, 1st edition.

Course No. & Title- CBOT 614: Photophysiology and Vertical Agriculture

Credit hour: 2 (Total Marks: 100, Class Exam.: 40; Final Exam.: 40; Assignment: 20)

Vertical Agriculture (VA): Concept and scope, design in closed and open spaces, multi-strata in hydroponic, aeroponic & rooftop gardening, plant factory, VA for food and nutrition security in Bangladesh

Photophysiology: Light sources – solar and artificial, factors affecting photosynthetic photon flux density and spectral distribution, physiological processes involved in VA, physical, physiological and environmental factors affecting growth & biomass, nutritional aspects and yield of sprouts and micro-greens

Light regulated bioactive compounds: Secondary metabolites- types, synthesis, extraction and determination; pigments, antioxidants, phytochemicals and their health benefits

References

- Abel C 2009 *The Vertical Garden: Towards a new Urban technology*, Univ. Sydney & Univ. NSW, 13/80 New Dapto Road, Wollonong, NSW 2500, Australia,
- Eigenbrod C and Gruda N 2015 Urban vegetable for food security in cities. A review, *Agron. Sustain. Dev.* (2015) 35:483–498
- Garg A, Balodi R 2014 Recent Trends in Agriculture: Vertical Farming and Organic Farming. *Adv Plants Agric Res* 1(4): 00023.
- Muraus J and Wijaya D 2016 *Energy Design Vol. IV/II - “Vertical Farms”*, Seminar Energy Design, course number 159.801, summer semester 2016, Institute of Buildings and Energy (IGE), Graz Univ. Technol., Rechbauer strasse 12/2, 8010 Graz, Austria, t: +43(0)316/873-4751,
- Ng J 2014 *Agrocropolis: Vertical Farming in Toronto’s Distillery District*. Masters Thesis, M. Arch., Carleton University, Ottawa, Ontario.

Course No. & Title- CBOT 615: Crop Phylogeny and Evolution

Credit hour: 2 (Total Marks: 100, Class Exam.: 40; Final Exam.: 40; Assignment: 20)

Molecular techniques for evolutionary study: Nuclear and extra nuclear genetic materials, markers in molecular systematics and phylogenetics, DNA barcoding and community structure assessment, cutting-edge DNA sequencing technologies and high-performance computing

Reproductive biology: Flowering phenology, diversity of pollination syndromes

Volatile Compounds and Evolution: Collection of volatile compounds and GC-MS analysis

Software for phylogenetic analysis: PAUP, Bayesian inference Maximum Parsimony, Distance matrix, maximum likelihood

DELTA (Description Language for Taxonomy) system: Coding and manipulating the taxonomic data

References

- Bhattacharya, B and Johri, B.M. 2000. *Taxonomy and Phylogeny*. Narosa Publishing House, New Delhi, India.
- Buchanan, B.B., Gruissem, W. and Jones, R.L. (eds) 2015. *Biochemistry & Molecular Biology of Plants*. 2nd ed., Wiley Blackwell.
- Freeman, S. and Herron, J.C. 2001. *Evolutionary Analysis*, 2nd ed., Prentice Hall, NJ.
- Graur, D. and Li, W.H. 2000. *Fundamentals of Molecular Evolution*. University of Chicago.
- Harder, L. and Spencer, C.H.B. (eds.) 2006. *Ecology and Evolution of Flowers*. Oxford University Press, New York.
- Hillis D.M., Moritz C. and Mable B.K. 1996. *Molecular Systematics*. 2nd ed, Sinauer Associates, Sunderland Massachusetts.
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- Page R.D.M. and Holmes E.C. 1998. *Molecular Evolution, a Phylogenetic Approach*. Blackwell Science, Oxford.
- Sharma, O.P. 2004. *Plant Taxonomy*. Tata McGraw-Hill Company Limited, New Delhi, India.
- Simpson, M.G. 2019. *Plant Systematics*. 3rd ed., Elsevier-Academic Press.
- Stace CA 1989. *Plant Taxonomy and Biosystematics* (2nd ed.), Edward Arnold, London.

Course No. & Title- CBOT 616: Applied Plant Tissue Culture

Credit hour: 2 (Total Marks: 100, Class Exam.: 40; Final Exam.: 40; Assignment: 20)

Tissue culture laboratory: General lab plan, equipment required and working principles

Culture preparation: Steps and requirements for tissue culture, sterilization techniques, aseptic tissue transfer, establishing callus, harvesting and growth measurements.

Culture Medium: Composition and components, ionic balance, pH and selection of media.

Culture technique: Cell suspension culture, Semi-solid culture, Organ micro culture, reproductive organs culture; androgenesis and gynogenesis, protoplast isolation, protoplast fusion, growth hormones, organogenesis, factors involved.

Application of Plant Tissue Culture: Disease free plants, secondary metabolites and functional bioactive compounds, stress resistant plants development, in vitro conservation and bio-safety

References:

Bottom of Form

American Horticultural Society-Plant Propagation. 1999. Alan Toogood. Dorling Kindersley Publishers, NY.

Arbury et al. 1997. The Complete Book of Plant Propagation. The Taunton Press, Newtown, CT

McMahon et al. 2011. Plant Science. Growth, Development and Utilization of Cultivated Plants. 5th edition. Pearson Edition, Inc.

Smith M. 2007. Plant Propagator's Bible. Rodale Inc., Emmaus, PA.

Syer R C and Koranski D S. 1997. Plug and Transplant Production-A Grower's Guide. Ball Publishing, Batavia, IL.

Thompson P. 2005. Creative Propagation. A Grower's Guide. Timber Press, Inc., Portland.

Trigiano R N and Gray D J (eds.) 2000. Plant Tissue Culture Concepts and Laboratory Exercises. CRC Press.

Vasil I K and Thorpe T A (Eds). 1994. Plant Cell and Tissue Culture. Kluwer academic publisher, The Netherlands.

Course No. & Title- CBOT 617: Research Methodology and Report Writing

Credit hour: 3 (Total Marks: 100, Class Exam.: 40; Final Exam.: 40; Assignment: 20)

Introduction: Problem identification, prioritization and preliminary observation.

Experimental designs and experimentation: Types and application of designs in agriculture, steps in experimentation, layout and setting of appropriate design, project concept note/synopsis.

Data recording and analysis: Tagging and sampling techniques, data collection and recording, descriptive and inferential data analysis using statistical software.

Report writing: Types, contents of a scientific report, principle and practices of writing thesis, manuscript and project report. Plagiarism, Research and publication ethics.

Presentation: Methods and practices of quality presentation.

References

Ghoojani A 2018 Advanced Statistical Methods and Applications, McGill University

Gomez, K.A. and Gomez, A.A. 1984. Statistical procedures for Agricultural Research. John Wiley and Sons, New York.

- Lauckner, F.B. and Fielding, W.J. 1992. Biometric notes for Agric. Res. in the Caribbean. Caribbean Agricultural Research and Development Institute (CARDI), Univ. West Indies (UWI) Campus, St. Augustine, Trinidad.
- Mead, R.; Curnow, R.N. and Hasted, A.M. 1993. Statistical methods of Agriculture and Experimental Biology, Chapman and , London.
- Siddique, M.A. 1985. Practical aspect of Thesis writing. Dept. Horticulture, Bangladesh Agric. Univ., Mymensingh.
- Silverman, D. 2001. Doing Qualitative Research: A Practical Handbook, SAGE Publications, London.
- The Chicago Manual of Style 17th edition 2017 Univ. Chicago, USA
- Zaman, S.M.H.; Rahid, K. and Howladar, M. 1982. Simple lesson from Biometry. Bangladesh Rice Research Institute, Joydebpur, Dhaka

Course No. & Title- CBOT 618: Plant Ecophysiology

Credit hour: 2 (Total Marks: 100, Class Exam.: 40; Final Exam.: 40; Assignment: 20)

Natural resources: Types, Liebig law and plants response to limited nutrient availability, root systems for water and nutrient capture.

Water relations: Water transport, stomatal regulation, leaf and canopy transpiration.

Radiation utilization: Laws of radiation; reflection, absorption and transmission by plant canopy; radiation balance and leaf energy budget; radiation-use efficiency in primary and net biomass production.

Carbon fixation: Photosynthetic responses to light and temperature, photosynthetic plant types and productivity, photosynthetic pathways and their advantages to elevated CO₂ and use of FACE in crop production.

Plants adaptation to radiation climate: Functional flexibility, phenotypic and genotypic plasticities, and chromatic adaptation; plants response to short- and long- wave radiation, sunny and shady habitats, and their management.

Plants and stress environment: Acclimatization and adaptation of plants to fire, extreme temperature, drought and salinity.

References

- Alastair, H. Fitter and Robert, K.M. Hay. 2002. Environmental Physiology of Plants. Third Edition. Academic Press.
- Jones, H. G. 2013. Plants and Microclimate: A Quantitative Approach to Environmental Plant Physiology. Third Edition. Cambridge, UK: Cambridge Univ. Press.
- Lambers, H., F.S. Chapin III, and T.L. Pons. 1998. Plant Physiological Ecology. New York: Springer.
- Lambers, Hans and Oliveira, Rafael S. 2019. Plant Physiological Ecology. Springer International Publishing, Springer Nature Switzerland AG.
- Pearcy, R.W., J. Ehleringer, H.A. Mooney, and R.W. Rundel, (editors). 2000. Plant Physiological Ecology. Chapman and Hall, New York, USA.
- Walter Larcher. 2003. Physiological Plant Ecology: Ecophysiology and Stress Physiology of Functional Groups. Fourth Edition. Springer-Verlag Berlin, Heidelberg, New York.

Ordinance for Course-Credit Semester System of Undergraduate Studies at BAU (Fourth Amendment)

In pursuance of the powers and functions of Academic Council and Syndicate as per statutes of the University the ordinance for course-credit semester system of undergraduate studies (fourth amendment) has been approved with effect from the date of its approval by the Syndicate in its 299th meeting, held on 29-06-2012.

1. Degrees offered

The following undergraduate degrees will be offered by different Faculties of the University:

DVM (Doctor of Veterinary Medicine)

B.Sc. Ag. (Hons.) (Bachelor of Science in Agriculture)

B.Sc. A.H. (Hons.) (Bachelor of Science in Animal Husbandry)

B.Sc. Ag. Econ. (Hons.) (Bachelor of Science in Agricultural Economics)

B.Sc. Ag. Engg. (Bachelor of Science in Agricultural Engineering)

B.Sc. Fisheries (Hons.) (Bachelor of Science in Fisheries)

B.Sc. Food Engg. (Bachelor of Science in Food Engineering)

B.Sc. Food Safety Management (Hons.)

B.Sc. in Bioinformatics Engineering

2. Curricula and Syllabi for the degrees

- (a) For each of the degrees mentioned in clause 1, there must be specific curricular layout and syllabi developed initially by the BOS, recommended by the Faculty, and approved by the Academic Council for adoption by the Syndicate as Curricula and Syllabi for that degree.
- (b) The approved curricular layout and syllabi for each of the degree offered shall be updated in regular interval.
- (c) Any corrections/modifications/amendments of the curricular layout and syllabi shall be proposed by the Faculty to the Academic Council as per provisions of the University Statutes.

3. Medium of instruction

The medium of instruction and assessment are both in English.

4. Definition

- (a) **Course:** A course is a set of lectures on a specific subject developed to offer in a semester period based on the approved syllabus.
- (b) **Course teachers(s):** A person or persons assigned responsibility by the Board of Studies (BOS), to design, develop and offer a course.
- (c) **Semester:** An academic year or level is divided into two semesters: Semester-1 and Semester-2 each covering twenty four weeks of course instruction including class test, semester final examination and preparation of results.
- (d) **Credit:** A credit means 1 contact hour per week for theory and 2 contact hour per week for practical.
- (e) **Contact hour:** Means number of hours of 60 min. (55 min. + 5 min. gap in between for venue change) per week needed to complete a theoretical course of instruction. The practical and laboratory classes of 2 hours duration will be taken as one credit hour, while practical classes of 3 contact hours will be considered as 1.5 credit hours. The home assignments of 0.5 credit hour may be combined with a practical course, if required by a BOS/Faculty. Five working days will be considered as one academic week. One working day may have eight contact hours with a recess of 1.5 hours after the 5th hour. Classes may be held between 08.00-13.00 and 14.30-17.30 hours. However, a Faculty may arrange its class routine using needed contact hours per day.

- (f) **Course load:** A maximum of 24 credit hours without more than 12 courses (theory/practical) may be allowed in a semester.
- (g) **GPA/CGPA:** Means the weighted average of grade points obtained in all the courses undertaken by a student in a semester/all semesters of a study programme, calculated on a 4-point scale. The result of an optional course will not be used in GPA/CGPA calculation but it will be shown on the student's transcript with letter grade

5. Course designation and title

- 5.1. Each course shall be designated by a course identification number referring to the offering Department, level/semester of study and the nature of course (theory/practical). The course identification number shall consist of two parts. The first part – “Departmental code” shall have 2-5 capital letters. The second part – “Course number” shall have 4 Numerical digits. The first digit shall indicate the level (1/2/3/4/5), the second digit shall indicate the “Semester number” (either 1 or 2 as January-June or July-December, respectively), the third and fourth digit (01, 02, 99) shall indicate the “Course number” of respective department, where the odd numbers shall indicate “Theory” and even numbers as “Practical” courses of particular level and semester. A new course No. will have to be introduced for any change in the course title or switching the course from one semester to other.
- 5.2. The theory and practical courses of same subject matter may share the common title but they shall be considered independent courses with separate numbers for the purpose of evaluation and grading, and GPA/CGPA calculation.

6. Credit requirement and duration of study

- 6.1. Credit hour: Based on course content and weightage, individual courses will have different credit hour (or simply credit) as defined in clause 4 (d and e).
- 6.2. The total credits required to be earned or fulfilled for obtaining an undergraduate degree at BAU will be 150 or more depending on the respective Faculty Curricula as approved by the Academic Council for the degree.
- 6.3.
 - i. The duration of study for the faculties of Agriculture, Agricultural Economics & Rural Sociology, Agricultural Engineering & Technology and Fisheries shall be 4 (four) academic years (levels) or 8 semesters; and the maximum admissible time limit is 7 (seven) years or 14 semesters; beyond which the study will end unsuccessfully.
 - ii. The duration of study for the Faculty of Veterinary Science shall be 5 (five) academic years (levels) or 10 semesters and the maximum admissible time limit is 8 (eight) years or 16 semesters; beyond which the study will end unsuccessfully.
 - iii. The duration of study for the Faculty of Animal Husbandry shall be 4 (four) years and 6 (six) months (levels) or 9 semesters and the maximum admissible time limit is 7 (seven) years and 6 (six) months or 15 semesters; beyond which the study will end unsuccessfully.

7. Faculty degree programme

The Faculty shall decide a set of core, collateral and elective courses required for the Faculty degree programme.

- (a) **Core courses:** The courses generally offered by the Departments of the Faculty and are needed to be taken by the students as compulsory.
- (b) **Collateral courses:** Those that the Faculty considers as essentially required (compulsory) for the degree programme, but are offered by the Departments of other Faculties. The syllabi of such courses shall be prepared by the BOS of the concerned Departments, and may be revised, if necessary, on the basis of the suggestions made by the Faculty which offers the degree and recommends these syllabi to the Academic Council for approval.
- (c) **Elective courses:** Those that are considered part of the degree requirement. The student

shall choose and undertake the instructed number of elective course(s) for the fulfillment of the degree programme.

- (d) Besides, there shall be provision for a student to take some courses from within or outside his/her faculty as optional courses depending on the aptitude and load-bearing ability of the student. For optional courses(s) the student will attend class and seat for the examination but the results of the course(s) shall not be incorporated in GPA though shall be presented in the transcript in grade. Optional courses must be completed in regular eight semesters of four year period counted from the first admission.

8. Admission requirement

- 8.1. The students shall be admitted as per the existing rules of the University to the level-1, semester-1.
- 8.2. (a) If a student fails to attend the classes within the first two weeks of the L-1, S-1, his/her admission shall be cancelled automatically.
- (b) A student after admission into L-1, S-1 shall have to sit for the class test in all courses with the requisite class attendance of minimum of 60%, failing which his/her admission shall be cancelled. However, Dean may consider the case if the average class attendance of all courses of the student becomes 60%.
- 8.3. A student under certain specific condition might be allowed withdrawal from a semester and re-admission in the next academic year as detailed in clause 19.
- 8.4. A student shall get registered in each of the semesters on payment of necessary fees and shall be entitled to Course Record Card issued by the Dean of the Faculty.
- 8.5. Each student shall be given an ID number with seven digits - first two digits referring to the year of admission (e.g. 03 for 2003), next two digits the degree code of different faculties, such as -

DVM	:	01
B.Sc. Ag. (Hons.)	:	02
B.Sc. A.H. (Hons.)	:	03
B.Sc. Ag. Econ. (Hons.)	:	04
B.Sc. Ag. Engg.	:	05
B.Sc. Fisheries (Hons.)	:	06
B.Sc. Food Engg.	:	07

and the last three digits (commencing with 001) will be the roll number given to a student on first admission. The ID number of a student shall be carried in all semesters as his/her permanent class and exam roll number.

9. Semester course plan

A Course plan card delivered by the Dean of the Faculty shall be filled-in by every student following his/her first admission into level-1, semester-1 in consultation with his/her advisor assigned by the Dean of the Faculty. The card shall be checked by the respective Dean's office. A student will choose elective courses carefully from the approved faculty programme and curricula (clauses 2 and 7), so that the minimum course-credit requirements for the degree are eventually fulfilled. The courses planned, chosen and written on the card could be changed through application to the respective Dean of the Faculty within 10 days of the commencement of the semester classes.

10. Distribution of semester activities

Each semester shall have 24 working weeks distributed as follows:

- (a) Classes including class test : 16 weeks

- (b) Semester final examination including preparatory recess : 6 weeks
 (c) Preparation and publication of results : 2 weeks

11. Course registration

At the time of registration in a particular semester each student shall complete five copies of a Course Record Card as designed by the Dean of the Faculty. After countersignature of the Dean, the card shall be maintained by the student himself/herself, the office of the Dean, Academic Section and Controller of Examinations shall keep a copy.

12. Marks distribution

12.1. Each course, Theory or Practical, irrespective of credit hours shall be evaluate on 100 marks basis for the convenience of assigning letter grade and grade point. The distribution of marks for a given course will be as follows:

i.	Class attendance	10	Marks
ii.	Class test(s)	20	"
iii.	Final examination	70	"
Total :		100	Marks

12.2. Marks for class attendance shall be allotted on the basis of the following criteria:

Attendance*	Marks
90% to 100%	10
80% to 89%	9
70% to 79%	8
60% to 69%	7
Less than 60%	0

*Percentage of attendance shall be calculated in round figures. A fraction of 0.5% or above shall be considered as 1%.

13. Classes and teaching of courses

- 13.1. The size of the theory class/section and practical group will be determined on the basis of the number of the students admitted into study programme by the respective Faculty.
 13.2. A particular course (theory/practical) shall be taught by one or two course teachers per class/section or practical group as decided by the relevant Board of Studies.
 13.3. The contact hour/frequency of classes per week for a theory/practical course will be according to credit hour (clause 4 d/e), as mentioned in the approved curricula layout for the course.

14. Examinations

14.1. Exam committee: In each concerned Department maximum a four-member Examination Committee (EC), will be proposed, as under, by the BOS for approval of the Dean of the Faculty with intimation to the Controller of Examinations by the Dean.

Composition of EC:

1.	Head of the Department	--	Chairman
2.	A Senior Teacher of the Department	--	Member
3.	One of the relevant Course Teachers	--	Member
4.	External member of the BOS	--	Member

The tenure of the Examination Committee (EC) will be 2 years

14.2. Major functions of EC: The EC shall-

- i. finalize/moderate the question paper for semester final examination as received from the paper setter;
- ii. get the questions printed and packed under security seal for sending it to the controller of examinations at least 3 days before the date of the final examination of particular theory course;
- iii. receive the evaluated scripts and mark sheets of final exam of Theory and Practical courses from the examiners, the marks and scripts of the class test, and marks of class attendance from the course teachers(s);
- iv. compile the course results (Grade sheet) in quadruplicate of both Theory and Practical courses in letter grade and grade point based on overall score (marks) of individual students in class test, class attendance and final examination;
- v. keep one copy of compiled grade sheet for future office use and references by the EC, and send three copies under sealed cover along with relevant papers/scripts to the Controller of Examinations for central tabulation of the results of all the courses and publication of semester results.

14.3. Class test:

- (a) The class test shall normally take place during 10-12 week of the semester. The course teachers may at their convenience conduct more than one class test. However, the cumulative value shall not exceed 20% of the total marks.
- (b) In case of double course teachers for a course in a theoretical class/section or a practical group, the question for the class test may be set mutually by both course teachers relevant to that class/section/group.

14.4. Class attendance: The total class attendance of students as compiled by the course teacher(s) shall be sent to the Dean within 3 days of class suspension. A student having less than 60% class attendance, in a particular course of a semester shall not be allowed to sit for the final exam for the said course. However, the Dean, before notification about the disqualification of such student from semester final examination, may consider his/her average class attendance covering all courses in that semester and allow him/her to sit for, if satisfied, with intimation to the Chairman, EC. But he/she will not get any marks for class attendance of that course.

14.5. Semester final Exam

- (a) The Semester final examinations of all levels shall take place simultaneously and shall be conducted centrally by the Controller of Examinations in collaboration with the Dean of the concerned Faculty.
- (b) The Controller of Examination shall announce the date and schedule for the final examination on recommendation of the Dean, ordinarily one month prior to the commencement of the examinations.
- (c) Appointment of paper setter/examiners: The concerned BOS will propose, as communicated by its Chairman, a panel of question paper setter and examiners for Theory and Practical courses to the Dean of the Faculty (the degree offering Faculty) as per following guidelines:

Theory: One question paper setter and required number of examiner(s) from amongst course teacher(s).

Practical: One or two internal examiners from amongst the course teachers, and an external examiner other than the course teacher from within or outside the Department.

The appointment of examiners will be issued by the Controller of Examination, as approved by the Dean of the relevant Faculty

- (d) For semester final exam the question-setter will set the question paper covering the whole of the syllabus of the course with different types of questions and submit it under sealed cover to the Chairman of the Examination Committee for moderation and necessary action as per schedule announced by the controller of Examinations.

14.6. Examination procedure (Final):

- (a) The Controller of Exam shall conduct the Semester Final Examinations after collecting the printed question papers from the Chairman, Examination Committee in sealed cover.
- (b) The duration of a theory examination will be 2 hours for courses of 1-2 credits and 3 hours for courses of 3 or more credits. The duration of practical examination for courses of 1.5-2 credits will be 3 hours and that of 1 credit will be 2 hours.
- (c) The Controller, after completing the final examinations, shall distribute the scripts immediately to the paper setter/examiners for evaluation of the same.
- (d) The examiner(s) shall examine the final answer scripts awarding numerical marks and send two copies of mark sheet under separate sealed cover; one copy to the Chairman EC and the other copy to the Controller of Examination. The evaluated scripts shall be sent to Chairman, EC also in separate sealed cover.
- (e) For practical examination the internal and external examiners shall mutually give the marks (numerical). The mark-sheet (duplicate) must be signed by all or two examiners. The evaluated scripts and mark-sheet should be sent as stated in clause 14.6 (d) concerning theory examination.
- (f) In the absence of an appointed examiner for practical examination the Chairman of the respective BOS shall appoint a new examiner with intimation to the Dean of the Faculty and Controller of Examinations for the record.

- 14.7. Results preparation: Having received the score sheets (marks) and scripts from the paper setter/examiners of the semester final examinations, compilation for the course(s) will be completed by the EC in letter grade and grade point based on score of the final examination, class test and attendance. The grade sheets of the course(s) will be compiled in quadruplicate, but triplicate copies along with all examined scripts and documents of class tests and semester final examinations and signed marks sheets for class attendance shall be sent to the Controller of Examinations by the Chairman, EC for necessary action for tabulation and publication of the results covering all courses taken by individual students.

15. Grading system

- 15.1. A letter grade having a specified number of grade point shall be awarded to each student for individual courses following conversion of numerical marks as shown below:

Numerical Grade*	Letter Grade		Grade Point
80% and above	A ⁺	(A Plus)	4.0
75% to less than 80%	A	(A regular)	3.75
70% to less than 75%	A ⁻	(A minus)	3.5
65% to less than 70%	B ⁺	(B Plus)	3.25
60% to less than 65%	B	(B regular)	3.0
55% to less than 60%	B ⁻	(B minus)	2.75
50% to less than 55%	C ⁺	(C Plus)	2.5
45% to less than 50%	C	(C regular)	2.25
40% to less than 45%	D		2.0
Less than 40%	F		0

*Total marks for each course shall be compiled in round figures. A fraction of 0.5 or above shall be considered as next higher number (marks).

*In the Transcript/Grade sheet, only the Letter Grade and the Corresponding Grade points, and finally the CGPA, not the numerical marks will be shown.



- 15.2. Grade D is the minimum passing grade. If a student gets D or a higher grade in a course he/she will be considered to have earned the requisite credit assigned for that course.
- 15.3. Absence in semester final exam for a course/courses will result in F grade in the concerned course(s).
- 15.4. Grade Point Average (GPA):

The following formula shall be used for calculation of semester GPA

$$GPA = \frac{\sum (G_i \times C_i)}{\sum C_i}$$

Where,

\sum = Sum of,

G_i = Grade point obtained in individual course(s) passed/completed,

C_i = Credit earned of respective courses.

15.5. Cumulative Grade Point Average (CGPA):

Cumulative Grade Point Average (CGPA) which is the weighted average of the GPAs of a student in all concerned semesters shall be calculated as follows:

$$CGPA = \frac{\sum (GPA_i \times TC_i)}{\sum TC_i}$$

Where,

\sum = Sum of,

GPA_i = Grade Point Average obtained in individual semesters earned

TC_i = Total credits earned of respective semesters.

Both GPA and CGPA shall be calculated up to three decimal places.

16. Tabulation and publication of results

- (a) The Dean shall nominate three tabulators to the controller of Examinations for tabulating the results of different courses undertaken by both regular and repeater students in particular semester, and compilation of overall final results (Clause 21/a).
- (b) The tabulation of results shall be done in a way that transcripts of academic records of the candidates can be conveniently issued with provision of office records for future uses and references.
- (c) The controller of examinations upon receipt of tabulated results shall present them to the Examination Controlling Committee of the Faculty for reviewing the same and making recommendation for publication. The results shall be published by the controller of Exams after necessary approval by the Vice-Chancellor.

17. Academic progress, course registration at higher semester and probation

- 17.1. Students must maintain a GPA of 2.00 or more in each semester with at least D grade in all compulsory and elective courses. A student having GPA of 2.00 or more in a semester final result and no F grade in any course will be eligible for registration in the next higher semester as regular student.
- 17.2. A student who has obtained F grade in a course or courses of any semester may be allowed to register for courses in the next semester subject to clause of probation (17.3).
- 17.3. Academic probation: If a student is found to have accumulated, or at his/her disposal, ten or



more courses (theory/practical) with F grade at the end of Level 2 or Level 3, he/she shall be placed under academic probation. During probation the student is debarred from enrolment for course registration at higher semester so as to enable him/her to devote full time to clear (pass) backlog courses with course repetition and repeat exam as applicable. However, when academic probation holder students will be able to lessen his/her repeat courses below 10 (ten), then he/she will be eligible for enrolment for course registration at higher semester.

17.3.1. A student under probation may be allowed to take repeat exam (clause 18) by the Dean in specific course(s) in which he/she has not taken any repeat exam earlier.

18. Repeat examination and course repetition

- 18.1. A student may be allowed to take repeat exam (final) to clear F grade in a course/courses in the next available semester when the concerned course(s) will be offered on regular basis (with retention of earlier in-course marks for class tests and class attendance).
- 18.2. The final exam for regular and repeat-students will be held on same question paper. If however it is required to be conducted on the modified and original syllabi to cater to both groups of students (regular and repeater), necessary options may be provided for in the questions by the question paper setter/EC.
- 18.3. If a student fails in a repeat exam he/she shall be required to enroll for course repetition without retaining any in-course marks; however, he/she may be allowed additional repeat exam by the Dean, if satisfied, subject to fulfillment of clauses of probation (17.3) and maximum time-limit for the study (6.3- i, ii, iii).
- 18.4. A student shall not be permitted to take a repeat exam for the purpose of improving a grade other than F.
- 18.5. A student completing all the repeat courses (if any) at the time of final examination (level-4 semester-2 for the Faculties of Agriculture, Agricultural Economics and Rural Sociology, Agricultural Engineering & Technology & Fisheries; level-5 semester-2 for the Faculty of Veterinary Science and level-5 semester-1 for the Faculty of Animal Husbandry) he/she will be treated as a regular student. On the other hand, a student failing to complete the courses as specified in level-4 semester-2; level-5 semester-2 and level-5 semester-1 respectively he/she will be treated as a repeat student.
- 18.6. A student having F grade in an elective or optional course may register for a substitute course if available or if situation permits instead of resorting to repeat exam or course repetition.
- 18.7. All necessary steps have to be taken towards holding all repeat examinations from the date of publication of the results of examinations (level-4 semester-2 for the Faculty Agriculture, Agricultural Economics and Rural Sociology, Agricultural Engineering & Technology, Fisheries; level-5 semester-2 for the Faculty of Veterinary Science and level-5 semester-1 for the Faculty of Animal Husbandry) within the period not exceeding 60 (sixty) days. It may be mentioned here that the students who have become unsuccessful in the said repeat examination are required to sit for the examination in the next available semester.

19. Withdrawal from a semester and re-admission

- 19.1. After filling the Examination Entry Form if a student owing to serious illness or an acceptable ground fails to sit for final exam in all courses of a semester or gets F grade in all courses, he/she may apply to the Dean of the Faculty through the Controller of Examination with supporting evidence within one week after the end of the semester final exam or within one week of the publication of the result respectively for total withdrawal from the semester with provision of re-admission/re-enrolment in it in the next semester.
- 19.2. A student who has been granted withdrawal from a semester, as spelled in clause 19.1, shall not be eligible for course registration in the next upper semester (of the same or different level); however, he/she can take repeat exam or enroll for course repetition to clear F grade(s), if any, of earlier semester(s).



- 19.3. If a student gets F grade in all courses of the first semester of level-1, he/she may apply to the Dean within one week of the publication of the results, for re-admission (in the level-1, semester-1) in the next academic year.
- 19.4. The student re-admitted/re-enrolment on any ground will not get extra time beyond the maximum limit, counted from the date of his/her first admission to complete the study as elaborated within the clause 6.3-i, ii & iii.
- 19.5. In case of break of study if a student apply to continue his/her study, he/she may be allowed for re-admission by the Dean of the faculty considering the reasonable ground if he/she can possibly cover with in maximum admissible time limit of the study, clause 6.3-i, ii & iii.

20. Boycotting of an examination, adoption of unfair means and breach of discipline in an examination.

- 20.1. The followings shall be considered as examination offences:
 - i. Copying from incriminating documents or from other’s script,
 - ii. Possession of incriminating documents,
 - iii. Communicating with other(s),
 - iv. Smuggling in/out of answer script(s),
 - v. Using abusive language or holding out threat to Invigilator/Chief Invigilator,
 - vi. Creating obstruction or disturbances inside examination hall,
 - vii. Assault or attempt to assault an Invigilator/Chief Invigilator,
 - viii. Possession of arms or other lethal weapons inside the examination hall,
 - ix. Using cell-phone inside examination hall, and
 - x. Any other offences not mentioned specifically above but considered by the Chief Invigilator as breach of discipline in the examination.
- 20.2. For any offence mentioned in 20.1, the concerned course-examination of the examinee who committed the offence shall be cancelled by the Chief Invigilator subject to report to the Examination Discipline Committee through the Controller of Examinations. The result of the said course shall be finalized with “F” grade.
- 20.3. Depending on the gravity of the offence, the Chief Invigilator may refer the case(s) to the Examination Discipline Committee for further disciplinary action.

Disciplinary action shall be taken by the Examination Discipline Committee and that shall be reported to the Syndicate. The decision of the Examination Discipline Committee shall stand final. The Committee shall comprise as follows:

i)	Vice -Chancellor	Chairman
ii–iii)	Two Deans to be nominated by the Vice-Chancellor	Member
iv)	One non -salaried member of the Syndicate to be nominated by the Vice-Chancellor	Member
v)	Student’s Affairs Advisor	Member
vi)	Proctor	Member
vii)	Registrar	Member
viii)	Controller of Examinations	Secretary

Nominated members shall hold office for a term of two years. Four members shall form quorum in the meeting.



- 20.4. Students who either individually or jointly boycott the examination unlawfully shall be marked absent by the Chief Invigilator and the matter shall be referred to the Examination Discipline Committee for further disciplinary action.
- 20.5. The Chief Invigilator shall submit the report on the offence committed by the examinee(s) to the Controller of Examinations in the prescribed form under sealed cover packet. The Controller of Examinations shall place the cases of unfair means along with relevant documents before the Examination Discipline Committee.
- 20.6. Before taking any disciplinary action by the Examination Discipline Committee, a notice shall be served upon the examinee found guilty of examination offences to show-cause. The Examinee shall be given a time not less than 72 hours for replying the notice.
- 20.7. The examinee who is identified in copying from incriminating documents or from other's script or found creating disturbances inside the examination hall or found possessing incriminating documents may be debarred from appearing at examinations in the current semester.
- 20.8. The examinee who uses abusive languages or holds threat in the Examination Hall to the Chief Invigilator or Invigilator(s) or other persons engaged in the examination shall be debarred from appearing at examinations for not more than 3 (three) semesters.
- 20.9. The examinee who assaults or attempts to assault the Chief Invigilator or Invigilator(s) or any other person(s) engaged in the examination shall be liable to a maximum punishment of debarment from subsequent examinations of the University and expulsion for good from the University.
- 20.10. Any examinee found guilty of disclosing his/her identity or deliberately making symbolic marks in his/her answer script, the answer script shall be cancelled by script examiner and the matter be reported to the Controller of Examinations.
- 20.11. The script of the examinee who has committed an Examination offence other than that defined in 20.10 shall not be sent to the Examiner for evaluation.
- 20.12. A student expelled for adopting unfair means, shall not get extra time beyond the time limit as clarified vide clause 6.3-i, ii & iii to complete his/her study, if allowed re-admission.
- 20.13. Any other cases not covered by the above rules shall be dealt by the Examination Discipline Committee in such a manner as it deems fit.

21. Final results, degree and certificate

- (a) At the end of level-4 semester-2; level-5 semester-1 and level-5 semester-2 (where applicable), the results of successful regular students of that semester and that of overall final results for graduation shall be published separately. The overall final results covering all semester results of regular successful students will be declared in order of merit based on CGPA, the transcript shall show the course number, course title, credits, contact hours, grade and grade point of individual courses, and GPA of each semester.
- (b) The final results of the repeater or irregular students after level-4 semester-2; level-5 semester-1 and level-5 semester-2 (where applicable) will be published on clearance of the course with F grade(s) and fulfillment of necessary course-credit requirement, without assigning and merit order.
- (c) The course number, course title, credits, contact hours, and letter grade obtained by the student in optional course(s), if any, will be shown on the transcript. However, the results of optional course(s) shall not be considered in calculation of the GPA and CGPA.
- (d) The registrar may issue the provisional certificate to a successful candidate on demand. The original certificate of the degree shall normally be issued during convocation of the University.

22. Vice-Chancellor's merit list and award

A student securing highest CGPA in his/her degree program will be eligible to obtain Vice-chancellor's merit award in recognition of his/her outstanding performances with provisions of free studentship and special merit scholarships tenable for eighteen months. A student with record of "repeat" results and misconduct will not be considered for this merit award.

23. Dean's merit list and award

Names of students having GPA of Top 3 percent (decimal will be considered as full number) amongst the students passed in a level (academic year) will be included in the Dean's list published every year in recognition of their outstanding performances with provisions of free studentships and special merit scholarships tenable for twelve months. A student with record of "repeat" results and misconduct will not be considered for this merit award.

24. Anything not covered by this ordinance and that may arise in course of time in the implementation of the ordinance, shall be referred to the Academic Council for resolution and disposal.



Ordinance for the Award of Master of Science (M.S.) Degree

(Effective from July 2012; amended in 2020)

1. Degrees offered

- 1.1. The degree of Master of Science (M.S.) will be offered by the Bangladesh Agricultural University (BAU), Mymensingh to a candidate subject to the fulfillment of the requirements prescribed hereunder. The admitted candidate shall have to abide by the rules and regulations that are currently in force and that will be promulgated by the University authority from time to time.
- 1.2. The Master of Science (M.S.) degree will be offered in the following subjects of specialization :

Agricultural Chemistry, Agricultural Extension Education, Agricultural Economics (Finance & Banking), Agricultural Economics (Agribusiness and Marketing), Agricultural Economics (Production Economics), Agricultural Statistics, Agroforestry, Agronomy, Anatomy, Animal Breeding and Genetics, Animal Nutrition, Animal Science, Aquaculture, Biochemistry and Molecular Biology, Biotechnology, Computer Science, Crop Botany, Dairy Science, Entomology, Environmental Science, Farm Power and Machinery, Farm Structure & Environmental Engineering, Fisheries Biology and Genetics, Fisheries Management, Fisheries Technology, Food Engineering, Food Technology, Genetics and Plant Breeding, Horticulture, Irrigation and Water Management, Medicine, Microbiology, Parasitology, Pathology, Pharmacology, Physiology, Plant Pathology, Poultry Science, Rural Sociology, Soil Science, Surgery, Seed Science and Technology, Theriogenology, Veterinary Public Health and Food Hygiene.

The Institution's language of instruction and assessment are both in English.

2. Admission requirement

- 2.1. Candidates for admission into MS study programme must possess a Bachelor of Science or DVM degree from this University or an equivalent degree from other University except students of Open University/ National University/ Private University including an MBBS/BDS degree.
- 2.2. Candidates having passed a Bachelor degree in Credit-Course system must have secured a minimum GPA of 2.5 out of 4.0 or 3.5 out of 5.0 and a B grade/50% marks in annual system in the pre-requisite course(s) on average. The Board of studies will determine the pre-requisite course(s) in which the candidate must have B grade on an average.
- 2.3. The eligibility of a candidate having degree from other University shall be assessed by an Eligibility Committee consisting of the proposed Supervisor, the concerned Head of the Department and the Coordinator, Committee for Advanced Studies and Research (CASR). The Coordinator, CASR will act as the convener of the Committee.
- 2.4. A candidate for admission into MS programme for specialization in Agricultural Extension Education, Agricultural Statistics, Biochemistry & Molecular Biology and Rural Sociology must have studied and passed the relevant paper/course(s) carrying at least 4 credit hours (150 marks in Annual System), at the Bachelor of Science/DVM degree of this University or an equivalent degree including MBBS/ BDS degree from other recognized institutions except students of Open University/ National University/ Private University.
- 2.5. An in-service candidate, if selected for admission, must obtain necessary clearance and study leave or deputation for the stipulated period from his/her employer to be eligible for admission.
- 2.6. Candidates shall apply for admission in prescribed form of the University.
- 2.7. Each student shall fill in five prescribed Enrolment Cards for each semester to have a coded

Roll Number to carry through all Semesters in order to maintain records in the offices of the Coordinator, CASR; the Controller of Examinations; the Head of the Department; the Registrar; and the student himself/herself.

- 2.8. Admission of students to M.S. study programme shall be approved by the Coordinator, CASR on recommendation of the respective Board of Studies on the basis of academic performance and satisfactory conduct at the Bachelor degree study/in a service.
- 2.9. The number of students to be admitted in a department in any particular semester will be decided by the respective Board of Studies on the basis of availability of teaching and research facilities in the Department.
- 2.10. Candidates for admission into M.S. degree programme shall get themselves admitted in the months of April (April to September as “Summer” Semester) and October (October to March as “Winter” Semester) in a year and shall pay the necessary fees including examination fees as per University rules.
- 2.11. An admitted student to a subject in particular semester (clauses 2.10 & 3.1) may be allowed new admission to another subject for academic reasons, in the next semester. In such case he/she will have to take permission from the existing supervisor and Head of the relevant department. This can be exercised for one time only.
- 2.12. Resolved that the second Master’s degree admission to the different courses in this University be not allowed as a general policy. However, in some exceptional cases, the CASR will consider the merit of individual case for such admission on the basis of the recommendations of their respective appointing authorities.

3. Duration of study

- 3.1 An academic year shall consist of two semesters of six months each extending from “October to March” as “Winter” Semester and from “April to September” as “Summer” Semester. There shall be 18 working weeks in each semester covering instructions, assignments and examinations.
- 3.2. The duration of the study for the degree of M. S. shall be three consecutive semesters. However, two additional consecutive semesters may be allowed to a student if the supervisor or supervisory committee (consisting of a Supervisor and a Co-supervisor) and the Head of the relevant Department of BAU/ Principal of affiliated colleges/ Director of institutes recommend such extension and the recommendation is approved by the Co-ordinator, CASR.
- 3.3. If a student fails to obtain an M.S. degree in five consecutive semesters, his/her admission shall stand cancelled automatically.

4. Course-credit requirements

- 4.1. Sixteen lectures/contact hours of one-hour duration for a theoretical course and of two-hour duration for a practical course in a semester shall be considered as one credit hour.
- 4.2. The number of credits for course work required for each candidate shall be specified by the relevant Board of Studies. Minimum total credit requirement shall be 40. Out of this at least 24 credits shall be for course work and 16 credits for the research work.
 - 4.2.1. The supervisor may propose a Co-supervisor if it is necessary for the research programme.
 - 4.2.2. A student shall be required to complete two types of courses as follows :

a.	Compulsory courses	--	16 credits or more
b.	Elective courses	--	8 credits or more

However, a candidate may be required to take one or more audit courses as desired by his/her supervisor under intimation to the Co-ordinator, CASR.

- 4.3. 4.3.1. Generally a student shall be required to register for research work in the “Thesis” semester usually third semester. But total credits for research work (16 credits) may have the following distribution (clause 6.5), with provision of semester adjustment if needed and suggested by the supervisor:

First Semester	--	3 credits
Second Semester	--	3 credits
Thesis Semester	--	2+8=10 credits (For research and thesis)

- 4.3.2. Earning of research credits: Of the 16 research credits, 8 credits will be earned by a student upon "Satisfactory" grading of research by the supervisor. The remaining 8 credits will be earned through the successful presentation of Thesis quality of which shall be evaluated as under and shall be linked with GPA and CGPA calculation:

Evaluation of Thesis	--	5 credits
Thesis Defense	--	3 credits

- 4.4. The Supervisor shall recommend a research programme for a student to the Co-ordinator, CASR for approval by the middle of the first semester. Any subsequent change in the programme shall have to be recommended by the Supervisor and be approved by the Coordinator, CASR.
- 4.5. A particular course shall be taught by one or two teachers and evaluated accordingly as decided by the relevant Board of Studies.
- 4.6. A student shall be required to enroll for a minimum of 12 credits of courses in one of the two “course” semesters.
- 4.7. The performance of a student in an audit course shall be marked as satisfactory/unsatisfactory. The details of such audit courses shall be recorded in the grade card and in the transcript.
- 4.8. A student shall have to enroll himself/herself in each semester on payment of necessary fees as per University rules. The fees are:

a.	Course fee per credit hour	--	@ Tk.25/-
b.	Examination Entry Fee	--	@ Tk.75/-

5. Examination procedure

- 5.1. There shall be at least two classroom examinations and one final examination for each course in a semester. The classroom examinations shall carry 20 (10+10 marks) percent and the final examination covering the entire course shall carry 60 percent of the total marks carried by a particular course. The remaining 20 percent of the marks shall be assigned to report writing, homework or any other assignments given by the course teacher(s). Assignments should be presented before the course teacher(s) using standard presentable form..
- 5.2. The duration of final examination shall be of 3 hours for 3 or 4 credit courses and it shall be of 2 hours for 1 or 2 credit courses. Regardless of differences in credits and exam duration all courses will be evaluated conveniently on 100 marks in total (covering class tests, assignment and final exam).
- 5.3. In order to qualify for final examination, a student must have attended at least 75 percent of the classes for the course included to the programme of courses recommended for him/her. Student must have to submit the examination entry forms to the Controller of Examinations through the relevant Head of the Department and Co-ordinator, CASR.

- 5.3.1. The Supervisor shall make his recommendation on the stipend bill form on the basis of 75% of attendance and send it to the Co-ordinator, CASR through the Head of the Department. The Head of the Department shall also make his recommendation on the examination entry form on the basis of 75% of attendance.
- 5.3.2. Fulfillment of the residential requirement of each student shall be ensured by the relevant Board of Studies.
- 5.4. All examinations shall be conducted and evaluated by the course teacher(s). The final Examinations shall commence at least 30 days before the end of the semester and shall be completed within 10 working days. The course teacher(s) shall also evaluate the home assignments, report writing etc. and shall submit the marks to the Head of the Department and with a copy to the Controller of Examinations soon after evaluation under intimation to the Co-ordinator, CASR for further necessary action. The Heads of the relevant Departments shall preserve all such records for a period of three years.
- 5.5. The relevant Head of the Department shall prepare and circulate the schedule for final examinations of the courses offered by different teachers in a particular semester at least 4 weeks before the commencement of the examinations.
- 5.6. The Head of the Department along with course teacher(s) shall tabulate the results of the semester final examinations and send it to the Controller of Examinations for publication. The results of the examination shall be published at least a week before the end of the semester.
- 5.7. 5.7.1. If a student has not sat for the classroom examination(s) for reasons satisfactory enough to the course teacher(s), the course teacher(s) may give him/her another chance for such examination(s) during the semester but it must be held before the semester final examination.
- 5.7.2. If a student fails to appear at the semester final examination marks obtained by him in the class room examination and the assignments will be forfeited.
- 5.8. Numerical marks given on all component examinations/evaluations (for a course, thesis, thesis defense, etc) shall be finally pooled and converted to letter grade and grade point (4-point scale) as follows:

<i>Marks obtained</i>	<i>Letter Grade</i>	<i>Grade Point</i>
80% and above	A ⁺	4
75% to 79%	A	3.75
70% to 74%	A ⁻	3.50
65% to 69%	B ⁺	3.25
60% to 64%	B	3.00
55% to 59%	B ⁻	2.75
50% to 54%	C	2.50
<50%	F	0

Percentage of numerical marks shall be calculated in round figures. A fraction of 0.5 or above shall be considered as next higher number.

- 5.9. The grade C shall be regarded as the minimum passing grade. A student shall be considered to have earned the requisite credit specified for each course or thesis or thesis defense if he/she secures C or a higher grade in it.
- 5.10. 5.10.1.
If a student obtains an F grade (Fail) in a particular course, thesis and thesis defense, the

Co-ordinator, CASR may allow him/her to repeat the relevant course, thesis and thesis defense on recommendation of the Supervisor and Head of the Department provided the whole process is completed within study period as stipulated in articles 3.2 and 3.3. A student may be allowed to carry and repeat no more than two courses in a semester but a maximum of four courses during his/her entire study programme to clear F grade(s).

5.10.2. If a student gets F grade in three or more courses in a semester, the concerned semester shall be deemed “crashed” and the student shall have to re-enroll to fulfill the course-credit requirement in available semester(s) subject to clauses 3.2 and 3.3.

- 5.11. The semester results and overall final results for different courses and thesis shall be presented in letter grades (clause 5.8) with Grade Point Average (GPA) and Cumulative Grade Point Average (CGPA or Cumulative GPA) as applicable respectively. The maximum attainable GPA or CGPA shall be 4. GPA or CGPA shall be calculated upto three decimal places.
- 5.12. The calculation of GPA and CGPA (for semester results and final results) shall be done as follows:

$$GPA = \frac{\sum (G_i \times C_i)}{\sum C_i}$$

$$CGPA = \frac{\sum (GPA_i \times TC_i)}{\sum TC_i}$$

Where,

- Σ = Sum of,
 G_i = Grade Point obtained in individual courses,
 C_i = Credit of respective courses,
 GPA_i = Grade Point Average obtained in individual semesters,
 TC_i = Total credits of respective semester s.

5.13. Boycotting of an examination, adoption of unfair means and breach of discipline in an examination.

5.13.1 The followings shall be considered as examination offences:

- i) Copying from incriminating documents or from other's script,
- ii) Possession of incriminating documents,
- iii) Communicating with other(s),
- iv) Smuggling in/out of answer script(s),
- v) Using abusive language or holding out threat to Invigilator/Chief Invigilator,
- vi) Creating obstruction or disturbances inside examination hall,
- vii) Assault or attempt to assault an Invigilator/Chief Invigilator,
- viii) Possession of arms or other lethal weapons inside the examination hall,
- ix) Using cell-phone inside examination hall, and
- x) Any other offences not mentioned specifically above but considered by the Chief Invigilator as breach of discipline in the examination.

5.13.2 For any offence mentioned in 20.1, the concerned course-examination of the examinee who committed the offence shall be cancelled by the Chief Invigilator subject to report to the Examination Discipline Committee through the Controller of Examinations. The result of the said course shall be finalized with “F” grade.

5.13.3 Depending on the gravity of the offence, the Chief Invigilator may refer the case(s) to the Examination Discipline Committee for further disciplinary action.

Disciplinary action shall be taken by the Examination Discipline Committee and that shall be reported to the Syndicate. The decision of the Examination Discipline Committee shall stand final. The Committee shall comprise as follows:

i)	Vice-Chancellor	Chairman
ii–iii)	Two Deans to be nominated by the Vice-Chancellor	Member
iv)	One non-salaried member of the Syndicate to be nominated by the Vice-Chancellor	Member
v)	Student's Affairs Advisor	Member
vi)	Proctor	Member
vii)	Registrar	Member
viii)	Controller of Examinations	Secretary

Nominated members shall hold office for a term of two years. Four members shall form quorum in the meeting.

5.13.4 Students who either individually or jointly boycott the examination unlawfully shall be marked absent by the Chief Invigilator and the matter shall be referred to the Examination Discipline Committee for further disciplinary action.

5.13.5 The Chief Invigilator shall submit the report on the offence committed by the examinee(s) to the Controller of Examinations in the prescribed form under sealed cover packet. The Controller of Examinations shall place the cases of unfair means along with relevant documents before the Examination Discipline Committee.

5.13.6 Before taking any disciplinary action by the Examination Discipline Committee, a notice shall be served upon the examinee found guilty of examination offences to show-cause. The Examinee shall be given a time not less than 72 hours for replying the notice.

5.13.7 The examinee who is identified in copying from incriminating documents or from other's script or found creating disturbances inside the examination hall or found possessing incriminating documents may be debarred from appearing at examinations in the current semester.

5.13.8 The examinee who uses abusive languages or holds threat in the Examination Hall to the Chief Invigilator or Invigilator(s) or other persons engaged in the examination shall be debarred from appearing at examinations for not more than 3 (three) semesters.

5.13.9 The examinee who assaults or attempts to assault the Chief Invigilator or Invigilator(s) or any other person(s) engaged in the examination shall be liable to a maximum punishment of debarment from subsequent examinations of the University and expulsion for good from the University.

5.13.10 Any examinee found guilty of disclosing his/her identity or deliberately

making symbolic marks in his/her answer script, the answer script shall be cancelled by script examiner and the matter be reported to the Controller of Examinations.

5.13.11 The script of the examinee who has committed an Examination offence other than that defined in 20.10 shall not be sent to the Examiner for evaluation.

5.13.12 A student expelled for adopting unfair means, shall not get additional semester beyond the time limit defined in the “Ordinance for Course Credit Semester System of Undergraduate Studies at BAU (Third Amendment)” and Ordinance for the Award of Master of Science (M.S.) Degree”.

5.13.13 Any other cases not covered by the above rules shall be dealt by the Examination Discipline Committee in such a manner as it deems fit.

6. Research requirements

6.1. A candidate for M.S. degree shall undertake a piece of research work under the supervision of a teacher of the university/affiliated colleges/affiliated institutes or under a scientist of any recognized research institute/organization. A teacher or a scientist must have prior approval from the Coordinator, CASR to act as a Supervisor.

6.2. Research work of an M.S. degree student shall be supervised by a Supervisor or Supervisory Committee consisting of a Supervisor and a Co supervisor.

6.3. The Co supervisor shall be chosen from among the Supervisors recognized by the Coordinator, CASR.

6.4. The Co supervisor shall be proposed by the Supervisor. The Heads of the Departments/Principals of Affiliated colleges or Head of Institutes shall submit the proposals for Supervisory Committee to the Coordinator, CASR for approval during the first semester of the student's enrolment.


6.5. A student may begin his research work from the first semester and shall complete the research work and thesis writing and submit the same at least 30 days before the end of the last semester of the student's approved study period (as defined in Clauses 3.1 and 3.2).

7. Thesis evaluation

7.1. Thesis shall be prepared by the student and submitted to the relevant Head of the department after having being signed by the supervisor/ supervisory committee.

7.2. Each Thesis shall be individually evaluated on 100 marks by two Examiners to be selected by the CASR from a four member panel suggested by the relevant Board of Studies. The Proposed Thesis Examiners will be form amongst recognized M.S. Supervisors. The Examiners shall send the marks to the Head of the Department with a copy to the Controller of Examinations. The average of the marks given by the two Thesis Examiners shall be considered as the marks obtained, and the letter grade and grade point (GP) will be awarded, accordingly.

7.3. Supervisor and Co-supervisor shall not be the Thesis Examiners of the student(s) under their guidance.

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- 7.4. If a thesis examiner is absent or unavailable for some unavoidable reasons, or declines to act as an examiner, the concerned Head of the Department may recommend for appointment of the next person in the proposed panel of examiners; or in case of non-availability of any person in the panel, the Board of Studies may propose a new panel of examiners.
 - 7.4.1. In case of more than 20% variations in marks given by two thesis examiners, a third examiner from the panel of examiners shall examine the thesis and the average of two nearest marks shall be taken as final.
 - 7.4.2. The defense of the thesis of all students in a department shall be conducted and graded by a four member defense committee of which the Head of the concerned Department shall be the Chairman. The CASR shall select three members from a five member panel proposed by the relevant Board of Studies. The Committee shall remain valid for consecutive three semesters. All members of the defense committee shall receive copies of the thesis at least 7 days before the date of the defense of thesis.
 - 7.4.3. The defense of the thesis shall be held at least two weeks before the end of the semester in presence of a minimum of three members of the defense committee. If one or more members of the defense committee express their inability to be present during the defense due to some unavoidable reasons replacement may be made by the Head of the Department from the panel under intimation to the Coordinator, CASR. The date and time of defense shall be announced by the concerned Head of the Department of Bangladesh Agricultural University /Principal of affiliated college in consultation with the concerned Supervisor and under intimation to the Coordinator, CASR.

8. Publication of results

- 8.1. The defense committee shall tabulate and finalize the results, and send those to the Controller of Examinations for publication with a certificate that a copy of the thesis has been sent to the Bangladesh Agricultural University Library.
- 8.2. The results of the candidates shall be published by the Controller of Examinations by order of the Vice-Chancellor subject to the approval of the Syndicate.



Ordinance for PhD

(Effective from 1 April 2021)

1. Degree to be offered

The degree of “Doctor of Philosophy”, hereinafter referred to as PhD, will be offered by the Bangladesh Agricultural University (BAU), Mymensingh from the departments of Anatomy and Histology; Microbiology & Hygiene; Physiology; Pharmacology; Parasitology; Pathology; Medicine; Surgery & Obstetrics; Agronomy; Soil Science; Entomology; Horticulture; Plant Pathology; Crop Botany; Genetics & Plant Breeding; Agricultural Extension Education; Agricultural Chemistry; Biochemistry & Molecular Biology; Agroforestry; Biotechnology; Environmental Science; Seed Science & Technology; Animal Breeding & Genetics; Animal Science; Animal Nutrition; Dairy Science; Poultry Science; Agricultural Economics; Agricultural Finance & Banking; Agricultural and Applied Statistics; Agribusiness and Marketing; Rural Sociology; Farm Structure & Environmental Engineering; Farm Power & Machinery; Irrigation & Water Management; Food Tech. & Rural Industries; Fisheries Biology & Genetics; Aquaculture; Fisheries Management; and Fisheries Technology. In addition, PhD degree will be offered from such departments as may be approved by the University.

2. Admission

2.1. Eligibility

An applicant for admission to a course of study for PhD degree must possess at least one 1st class/Grade B in either Bachelor degree or Master’s degree with Thesis from Bangladesh Agricultural University. Also those having an equivalent degree (to be judged by a committee) from any other public university with at least a 1st class/Grade B and having one publication in relevant field and at least one year experience in teaching / research / extension / development / industry after being employed at the entry officer level. However, the requirement of the 1st class may be relaxed to 2nd class if an applicant has a minimum of five years’ experience in the stated fields and at least three publications in recognized scientific journals. An applicant having a 1st class with distinction (A+/GPA = 4) in both or one of the Bachelor and Master’s Degrees is eligible for admission into PhD course without any experience and publication. The maximum age limit for PhD admission is 50 years on the date of admission.

2.2. Procedure of application

Application for PhD admission will have to be made in a prescribed form available in the office and website of the Coordinator of Committee for Advanced Studies and Research (CASR). The filled in application will have to be submitted to the office of the Coordinator. Those who are in any formal employment (in government, non-government or other organizations) must submit their application through proper channel.

2.3. Time schedule

The academic year shall be counted from the date of admission and the maximum period permissible for submission of PhD dissertation will ordinarily be four years. A candidate can get admission into PhD course normally in April or October. However, in special requirement by the Funding Authority, the time of admission may be changed.

2.4. Admission committee

The eligibility of the applicant for admission shall be examined by an Admission Committee on the basis of the applicant’s academic and professional background, research experience, merit of the research proposal for dissertation, proficiency in English language, and performance in the interview.

The Admission Committee shall consist of:



- i. Coordinator of the CASR - Chairman
- ii. Proposed Supervisor - Member
- iii. Chairman of Board of Studies - Member
- iv. One Expert (to be nominated as Member by the Vice-Chancellor)

After receiving a panel of not less than three experts from the Head of Department, the Coordinator shall initiate action towards obtaining Vice-Chancellor's nomination for formation of the Committee. The committee will provide opinion on the applicant's eligibility for admission into PhD course.

2.5. Foreign student

Any foreign student seeking admission into the PhD course will have to submit application through the respective government agencies to the CASR with a certificate of proficiency in English language and letter of recommendation from two referees. The application will be processed as per Section 2.4. However, the foreign and Bangladeshi applicants residing abroad are required to appear before the Admission Committee for an interview through virtual system.

2.6. Enrolment

An applicant for PhD course will be admitted upon recommendation of the Admission Committee and approval by the CASR, and subsequently on payment of prescribed fees. The applicant shall get admitted into the PhD course within the maximum period of three months from the date of approval by the CASR. An applicant in employment must submit official letter of leave/deputation granted for PhD study period by his/her employer during admission.

3. Programme of studies

3.1. Supervisory committee

A student admitted to the PhD course shall work under the guidance of a Supervisor recognized by the CASR. The CASR shall also approve the Supervisory Committee proposed by the Supervisor through the Head of Department within three months from the date of enrolment of the student. The Supervisory Committee shall consist of three members:

- i. Supervisor
- ii. Co-supervisor (2)

The Co-supervisor shall be chosen from amongst the supervisors recognized by the CASR. The Supervisory Committee shall review the progress of the course and research works of the student and send the progress report annually to the Coordinator of the CASR through the Head of Department.

3.2. Residential requirement

A PhD student shall undertake a programme of study for a minimum period of two years as a resident student at this University. The student who is in employment must take at least two years of leave/deputation from his/her employer to work as a resident student. The maximum period of residential requirement will be recommended by the Supervisory Committee and approved by the CASR within three months from the date of admission. Part of the residential requirement may be met in an Educational/Research Institute recognized by BAU for the purpose of research on recommendation of the Supervisory Committee and approved by the CASR.

3.3. PhD dissertation proposal

A PhD student will submit a dissertation proposal in prescribed format to the Coordinator of CASR through the Supervisory Committee and Head of the Department for approval within one year from the date of admission. The CASR will accord approval ordinarily

within three months from the date of receipt of the dissertation proposal. Submission of dissertation proposal should be preceded following a seminar presented by the student and organized by the Head of Department.

4. Course-credit requirements

- 4.1. Sixteen lectures/ contact hours, each of one-hour duration, for a theory course in a semester shall be considered as one credit-hour.
- 4.2. A minimum total number of credits, required for obtaining a PhD degree, shall be 76, out of which at least 24 credits shall be for course work.
- 4.2.1. A student shall be required to complete a minimum of 11 credits of courses in one of the two "course" semesters to earn total 24 credits in two semesters.
- 4.2.2. The details of credits for a PhD student under different heads are as follows:

Sl. No.	Item	Credit	Means of evaluation
i.	Compulsory courses (6 courses, each of 3 credits)	18	Grading
ii.	Elective courses (2 to 3 courses, each of 2 to 3 credits)	6	Grading
iii.	Seminars (2)	2 + 2 = 4	Satisfactory
iv.	Research reports (end of first and third year)	2 + 2 = 4	Satisfactory
v.	Research	23	Satisfactory
vii.	Dissertation evaluation	15	Satisfactory
viii.	Dissertation defense	6	Satisfactory
Total=		76	

A PhD student shall have to take 3 compulsory courses and 1 to 2 elective courses in each of the first two semesters of his/her PhD study. If any student becomes unsuccessful in any course(s) (not more than 2) in a semester, he/she must pass that course(s) within the sixth semester. If a student gets F grade in three or more courses in a semester, the concerned semester shall be deemed "crashed" and the student shall have to re-enroll to fulfill the course-credit requirement in available semester(s). However, if a student fails to appear at the semester final examination marks obtained by him/her in the class room examination and the assignments will be forfeited. However, a PhD student may be required to take one or more audit courses if desired by his/her supervisor under intimation to the Coordinator, CASR.

- 4.3. Each course will be taught and evaluated by one or two teachers that will be decided by the Board of Studies.
- 4.4. There shall be at least two classroom examinations and one final examination for each course in a semester. The classroom examinations shall carry 40 (20 + 20) percent marks and the final examination covering the entire course shall carry 40 percent of the total marks carried by a particular course. The remaining 20 percent of the marks shall be assigned to report writing, homework or any other assignments given by the course teacher(s). Assignments must be presented before the course teacher(s) using standard presentable form. The duration of final examination will be 3 hours for a 3 credit course and 2 hours for a 2 credit course. Regardless of differences in credit and duration of examination, all courses will be evaluated conveniently on 100 marks in total (covering class tests, assignments and final examination).

In order to qualify for final examination, a student must attend at least 75 percent of the classes for each course. A student must submit the examination entry form to the Controller of Examination through Head of the Department and Coordinator of the CASR.

- 4.5. Numerical marks given on all components of examinations/evaluations (for courses, dissertation evaluation, dissertation defense, etc.) shall be finally pooled and converted to letter grade and grade point (4-point scale) as follows:

Marks obtained	Latter Grade	Grade Point
80% and above	A ⁺	4.00
75% to 79%	A	3.75
70% to 74%	A ⁻	3.50
65% to 69%	B ⁺	3.25
60% to 64%	B	3.00
55% to 59%	B ⁻	2.75
50% to 54%	C	2.50
<50%	F	0.00

Percentage of numerical marks shall be calculated in round figure. A fraction of 0.5 or above shall be considered as the next higher integer.

- 4.6. A student shall have to enroll himself/herself in each semester on payment of necessary fees as per University rules. The fees are:
- (a) Course fee per credit hour Tk.50/
 (b) Examination Entry Fee Tk.200/
- 4.7. All examinations shall be conducted and evaluated by the course teacher(s). The final Examinations shall commence at least 30 days before the end of the semester and shall be completed within 10 working days. The course teacher(s) shall also evaluate the home assignments, report writing etc. and shall submit the marks to the Head of the Department and with a copy to the Controller of Examinations soon after evaluation under intimation to the Coordinator, CASR for further necessary action. The Heads of the relevant Departments shall preserve all such records for a period of three years.
- 4.8. The relevant Head of the Department shall prepare and circulate the schedule of final examinations of the courses offered by the course teachers in a particular semester at least 4 weeks before the commencement of the examinations.
- 4.9. The Head of the Department along with course teacher(s) shall tabulate the results of the semester final examinations and send it to the Controller of Examinations for publication. The results of the examination shall be published at least a week before the end of the semester.
- 4.10.1. If a student has not sat for the classroom examination(s) for reasons satisfactory enough to the course teacher(s), the course teacher(s) may give him/her another chance for that examination(s) within the semester but it must be held before the semester final examination.
- 4.10.2. If a student fails to appear at the semester final examination marks obtained by the student in the class room examination and the assignments will be forfeited.

5. PhD examination

5.1. Examination entry form

A PhD student shall submit a duly filled in Examination Entry Form to the Controller of Examination through Head of the Department and Coordinator of the CASR and shall pay the prescribed fee for two semester final examinations and before submission of the disser-

tation for evaluation.

5.2. Submission of dissertation

A student will be eligible to submit his/her dissertation to be evaluated for the award of the degree of Doctor of Philosophy, PhD, after a minimum period of 3 (three) years but normally not later than 4 (four) years from the date of admission. Before submission of dissertation the candidate must publish at least one research paper (review paper will not be considered for this requirement) from his/her PhD research work during research period in peer reviewed journal or any national/international journal governed by active editorial board and published by recognized professional publisher society/ organization/ institution but not in any predator journal. The student shall prepare dissertation and submit one hard copy in simple bound form and one pdf copy in a good quality CD to Head of the Department for onward transmission to the Chairman of the Examination Committee for further necessary actions. If a student fails to submit the dissertation within the total period of 4 (four) years from the date of enrolment, the enrollment shall automatically stand cancelled. If, however any student fails to submit the dissertation for reasons beyond his/her control and for reasons satisfactory to the Supervisory Committee and the Coordinator of the CASR, he/she may apply for a re-admission with recommendation of the Supervisory Committee to the CASR for consideration. In such case, the student must have to submit an up-to-date report of PhD dissertation through Supervisory Committee along with an application. Depending on the merit of the application, CASR may approve his/her for re-admission.

The student shall have to submit the dissertation within one year from the date of cancellation of admission with the privilege of carrying over the past research work, provided that other academic requirements for the PhD degree have been satisfied. If the student fails to submit the dissertation within that period (five years from the date of his/her admission) his/her admission shall stand cancelled automatically and no further re-admission will be allowed.

5.3. Examination committee

There will be an examination committee for evaluating reports of the dissertation examiners and for conducting the dissertation defense. The Board of Studies will nominate the chairman of the examination committee ordinarily from amongst the professors of the student's own department or, in case of unavailability, of other departments. The chairman of the examination committee must be recognized by the CASR to act as supervisor for PhD students. The committee shall comprise:

- i. Chairman- (to be nominated by the Board of Studies)
- ii. Supervisor of the student - Member
- iii. Chairman of the Board of Studies - Member
- iv. One of the dissertation examiners - Member
(to be nominated by the examination committee from among the in-country examiners)
- v. One member to be nominated by the Co-ordinator of the CASR from any department of BAU who is well acquainted with the PhD evaluation process-Member

The Controller of Examination will issue appointment letters to all members of the examination committee after obtaining approval of the Vice-Chancellor through the Coordinator of the CASR.

5.4.1. Criteria for dissertation examiners

- i. At least one of the examiners must be from foreign Universities or Research Institutes outside Bangladesh;
- ii. All examiners must have research experiences and expertise in the general area of

the dissertation (a copy of short CV in a prescribed form to be submitted with proposal of examination committee);

- iii. All examiners must be free from any real or apparent conflict of interest in the examination of the dissertation.

5.4.2. Appointment of dissertation examiners

The Board of Studies shall send a panel of 6 (six) examiners (with telephone, fax, e-mail and postal address) with at least two from foreign Universities/Institutes to the Coordinator of the CASR who will forward the panel to the Vice-Chancellor for nomination of any three examiners including one foreign examiner. The panel must not include any member of the Supervisory Committee of the student.

5.5.1. Examination of dissertation

The Head of Department will forward the dissertation (both hard and soft copies) to the Chairman of the Examination Committee, who will send a soft copy of dissertation along with examination form and other necessary documents to each examiners. The examiners will send the examination report in pdf form to the Chairman of Examination Committee and Coordinator, CASR.

5.5.2. Student–examiner relation

- i. The examiners may consult one another, but must formally inform Coordinator of the CASR of any such consultation. Each examiner is required to submit an independent evaluation report.
- ii. A candidate must not discuss any aspect of the dissertation examination with his/her examiners during the period from submission of the dissertation until an evaluation report is obtained by the CASR.
- iii. The supervisor or/and the Head of Department must not discuss any aspect of the examination with the examiners until an evaluation report is obtained by the CASR except when a prior approval is obtained from the CASR if necessity arises.
- iv. Deception by a student (including, but not limited to, plagiarism and falsification of research results) is a disciplinary offence. Any such falsification will be dealt strictly by the CASR primarily not offering the PhD degree to the student.

5.5.3. Delay in providing report by examiner

If an examiner does not provide an evaluation report of the dissertation within three months after receiving the dissertation for examination, the Coordinator of the CASR, on request from the Chairman of the Examination Committee, may appoint a new examiner in that examiner's place from the panel with approval from the Vice-Chancellor.

5.6. Dissertation defense

The Examination Committee shall examine the reports of the Dissertation Examiners. If any correction and/or modification of any part of the dissertation based on the examiners' reports are necessary, the committee will instruct the student to make the necessary corrections/modifications. The committee shall ensure incorporation of necessary corrections and modifications, and submission of the final dissertation to the Chairman of the Examination Committee (one hard copy and one pdf copy) within the period specified by the Examination Committee before holding the Dissertation defense.

If the reports of at least two examiners are found satisfactory, the Chairman of the Examination Committee will fix a date for Dissertation defense of the student under intimation to the Coordinator of the CASR and the Controller of Examination. On satisfactory completion of the Dissertation defense, the Examination Committee, with consent from majority of the members, shall recommend the student to the

CASR for award of the PhD degree with all the relevant papers and a final bound copy of the dissertation. The Chairman of the Examination Committee will forward one bound copy of the dissertation to the library and another bound copy of the same to Head of the Department for preservation in the library/storage of the department.

5.7. Re-submission of dissertation

If the report of at least one dissertation examiner is satisfactory, the student shall be given a chance to re-submit the dissertation within six months from the date of notification by the Examination Committee. Thereafter, the procedure as stated under Section 5.5 and Section 5.6.

5.8. Second defense

If the performance of the student in the first viva-voce examination is unsatisfactory, he/she may be allowed to appear at a second viva-voce examination within a period of 6 (six) months from the date of first viva-voce examination.

5.9. Award of the degree

After considering the report of the Examination Committee, the CASR shall forward its recommendations to the Academic Council and, on the recommendation of the Academic Council, the PhD degree shall finally be awarded to the student by the Syndicate of the University.

6. Anything not covered by this Ordinance may be referred to the Academic Council through the CASR for a decision.



Standing from Left : Dr. Shamsul Huda Choudhury; Dr. Md. Sirajuddin (External Examiner);
Prof. Dr. Ashraful Haque; Dr. A.A.A. Muhsi; Dr. Md. Sanauallah.

Sitting from Left : Md. Amirul Islam; Md. Azhar Hossain; A. K. M. Ali Imam; Md. Ali Newaj;
Syed Khurshid Anwer; Md. Fariduddin Mia; Mohammad Abu Isa;
Md. Moynul Hoque.

Study Tour and Social Activities



Family Get Together of the Department



Karamjal Wildlife Sanctuary, Sundarban



Bangabandhu Sheikh Mujib Safari Park, Gazipur



Plant Ecology Lab & its major instruments



Plant Physiology Lab & its major instruments

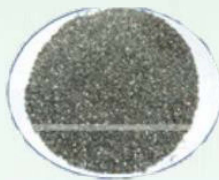


Field Lab





**Crop varieties
released from
Dept. of Crop
Botany**



BAU Chia-1



BAU Chia-2