UNIVERSITY OF RAJSHAHI

RAJSHAHI-6205, BANGLADESH

Syllabus and Curriculum for M.S.
Session: 2012-2013
M.S. Examination: 2017

DEPARTMENT OF BOTANY

Faculty of Life and Earth Sciences

This is a very important document that should be preserved along with other credentials for future use

University of Rajshahi
Faculty of Life and Earth Sciences
Department of Botany

Session: 2012-2013

M.S. Examination: 2017

Course Combination for M.S. Degree in Botany

The M.S. in Botany was introduced more than 40 years ago with an aim to provide an advanced knowledge of plant science and role of plants in economic development.

Since 2005 session, the Department of Botany has been offering M.S. degree in three specialized Groups:

Groups: Advanced Botany, Plant Biotechnology and Environmental Botany.

Both taught course and research, each group includes five different topics covering the areas and expertise of the teachers involved. The modular formats of the three specialized groups allow the students who already have the basic technical knowledge needed to understand plants and their environment, to train up in three different areas of plant science. Our aim is to:

(a) Provide in-depth expertise on their field for future studies /research at higher levels or for working in educational institutions, research organizations, NGOs and industries.

(b) Enable the candidate to make his /her own contribution in the management of our environment, biodiversity, development activities and improve quality of life.

Every student has equal opportunity to opt for five paper of one group following his future career development. The number of students in any group, however, will not exceed, one third of the total students.

Content description: The following is a detailed description of the teaching, learning profile, lectures, laboratory, assignments, field work and examinations.

There shall be two regimes in M.S. course, GENERAL and THESIS. A degree of M.S. in Botany shall be given and specialization of the student will be mentioned in transcript/testimonial on the basis of his /her courses and thesis. A thesis may be offered on any course from intended specialized group that has been offered to him /her.

GENERAL REGIME

In GENERAL REGIME there shall be FIVE theoretical courses each carrying 100 marks with 4 hours examination at the end. Class assessment including tutorial and terminal of each theoretical course will carry 10 marks. There shall be FIVE practical courses each carrying 30 marks covering the subject matters of FIVE theoretical courses. Practical examination of each course will be of six hours duration. Records of practical works and laboratory assessment/ attendance are included in practical examination. Field work report/project/excursion report/collection of samples report of each course will carry 10 marks. Viva-voce examination covering all the theory courses shall be held on a separate day and will carry 50 marks. For detail distribution of mark please see the chart given bellow.

MARKS DISTRIBUTION OF GENERAL GROUP

		Marks	**Units**	**Total**	**CP**
Theory	:	5×100	5	500	20
Class assessment (including attendance)[1], tutorial and terminal	:	5×10	0.5	50	2
Viva Voce	:	50	0.5	50	2
Practical including records of practical works and laboratory assessment /attendance[2]	:	5×30	1.5	150	6
Field work report/ project/excursion report/collection of samples report		50	0.5	50	2
Grand Total	**:**		**8.0**	**800**	**32**

1. 20% marks shall be awarded for class attendance. 2 for attendance and 8 for class assessment for each course, respectively. Total 10 for each course.

2. 10% marks shall be awarded for laboratory attendance and 10% for records of practical works. Marks for attendance shall be awarded on the basis of proportionality of attendance. 3 for lab. attendance, 3 for lab, assessment and 24 for lab, exam. for each respectively, total 30 for each course.

THESIS REGIME

There shall be FIVE theoretical courses each carrying 100 marks same as the General Regime. There shall be no practical examination for thesis students. Students with 55% or more marks in the B.Sc. / equivalent may be allocated a project supervisor for carrying out research and submitting a thesis (150 for thesis paper and 50 for viva on thesis workout totaling 200) in lieu of practical courses. The students are encouraged to give input to the project topic, to exhibit interest in the problem which must be relevant to his course and within the scope of the group /department. The candidate, with the approval of the supervisor, will submit a title and plan of work to the

Department within 6 weeks of admission approved by the Research Committee. The candidate may change the plan /title within 8 weeks after beginning his /her research and inform in writing to the Chairman. They have to complete their research work and writing up of the thesis within three months of the written examination. There will be Viva Voce of 50 marks covering the 5 theory papers. For detail distribution of mark please see the chart given bellow.

MARKS DISTRIBUTION OF THESIS GROUP

		Marks	Units	Total	CP
Theory	:	5×100	5	500	20
Class assessment (including attendance)[1], tutorial and terminal	:	5×10	0.5	50	2
Viva Voce	:	50	0.5	50	2
Thesis/Dissertation		150	1.5	150	6
Thesis Defense/Seminar		50	0.5	50	2
Grand Total	**:**		**8.0**	**800**	**32**

1. 20% marks shall be awarded for class attendance. 2 for attendance and 8 for class assessment for each course, respectively. Total 10 for each course.

Detail Syllabus for M.S. Degree

COURSES UNDER EACH SPECIALIZATION

SPECIALIZATION 1 ADVANCED BOTANY

Course No.	Course Title
BOT 501	Advanced Mycology
BOT 502	Advanced Phycology
BOT 503	Advanced Plant Systematics
BOT 504	Advanced Plant Histology
BOT 505	Plant Pathology & Plant Protection
BOT 506	Advanced Plant Physiology
BOT 507	Cytotaxonomy & Chemotaxonomy
BOT 508	Molecular Phytopathology
BOT 509	Advanced Pteridology
BOT 510	Seed Pathology

SPECIALIZATION 2 PLANT BIOTECHNOLOGY

Course No.	Course Title
BOT 516	Plant Tissue Culture & Somatic Cell Technology
BOT 517	Agricultural Biotechnology
BOT 518	Molecular Biology
BOT 519	Developmental Genetics
BOT 520	Plant Breeding
BOT 521	Biometrical Genetics
BOT 522	Cytogenetics & Crop Improvement
BOT 523	Applied Microbiology
BOT 524	Wood Science
BOT 525	Proteomics & Bioinformatics

SPECIALIZATION 3 ENVIRONMENTAL BOTANY

Course No.	Course Title
BOT 531	Plant Ecology & Ecosystem Management
BOT 532	Phytogeography & Social Forestry
BOT 533	Physiological Ecology
BOT 534	Applied Ethnobotany
BOT 535	Biodiversity & Plant Resources Management
BOT 536	Limnology & Aquaculture
BOT 537	Crop Physiology
BOT 538	Agronomy & Crop Management
BOT 539	Environmental Microbiology
BOT 540	Molecular Stress Physiology

SPECIALIZATION 1: ADVANCED BOTANY

The courses offered under this group provide an advanced knowledge in Plant Science. Aim of this group is enabling the students to pursue higher education /research or jobs in the educational / research organizations and/or NGOs dealing with Plant Sciences at any level of their activities.

BOT 501: ADVANCED MYCOLOGY

Total credit hour: Minimum- 60
1 Credit hour = 45 minutes

Full Marks : 100

(**Instructions for Question Setters:** Each question carries 20 marks and there will be four sub-sections. The highest and the lowest marks of each sub-section will be 10 and 2, respectively. In the examination, there will be eight questions, out of which five questions should be answered.)

1. **Introduction to fungi:** General characteristic features; Habit, habitats and ecological adaptation; Origin and phylogeny of fungi.
2. **Vegetative and cellular structure of fungi**: Range of vegetative structures; General and ultra-structure of fungal cell and its organelles.
3. **Reproduction of fungi**: Vegetative, asexual and sexual reproduction systems; Mode of life cycles. Spore release, dispersal, dormancy and germination mechanism of fungi.
4. **Fungal growth and development:** Mechanisms of fungal growth; Measurement of kinetics of growth; Nutrient requirement and acquisition; Environmental requirement and role.
5. **Fungal physiology, metabolisms and metabolites:** Degradation and decomposition; Pathways of carbohydrates, nitrogen and lipid metabolism; Energy obtaining in different conditions; Metabolites: Vitamin, toxins, phytoalexins and hormones of fungi.
6. **Pathological relationship of fungi in agriculture and animals**: Saprophytic, parasitic and disease causing fungi; Parasites of plants, human, animals, nematodes and arthropods.
7. **Mushroom science**:
   i. **Introduction to mushrooms:** Definition; History; Classification; Strategies of collection, identification, isolation and various preservation techniques of edible non-edible mushrooms; Vegetative diversity of mushrooms; toxicity of mushrooms.
   ii. **Various cultivation techniques of mushrooms**: Suitable conditions; Preparation of solid and liquid cultures; Spawn preparation; Bag, bottle, shelf and log cultivations.
   iii. **Importance of mushrooms**: Nutritional and medicinal values; Antimicrobial activities and diseases healing properties; Poverty alleviation by cultivating mushrooms; Economic and environmental importance.
8. **Genetics and applied molecular study for fungi:** Structure and organization of fungal genome; Classical/ Mendelian genetics in fungi (*Neurospora, Schizophyllum* sp.); Genetic variation and speciation.

9. **Biotechnology and industrial use of fungi**: Industrial mycology; Food processing and spoilage; Alcoholic fermentations and fermented foods; Medicines originated from fungi.

Practical: 1.2 Credits, 3 hrs/wk

1. Preparation of different culture media
2. Methods of sterilization and autoclaving techniques
3. Isolation, identification and culture procedure of fungi and mushrooms
4. Procedure of mushroom cultivations
5. Use of PCR and gel electrophoresis
6. Sequencing and alignment
7. Preparation of dendrogram /phylogenetic tree

Books Recommended:

1. An Introduction to Fungi. H.C. Dube. Vikas Publishing House Pvt. Ltd., New Delhi-110014.
2. Fundamentals of the Fungi. Elizabeth Moore- Landecker. Fourth Edition Prince Hall International.
3. Hand Book of Mushroom. Nita Bahl.
4. Mushroom Pests and disease control. Fletcher.
5. **gvki“g ev‡qvjwR. Avn‡g` BgwZqvR**

BOT 502: ADVANCED PHYCOLOGY

Total credit hour: Minimum- 60
1 Credit hour = 45 minutes

Full Marks : 100

(**Instructions for Question Setters:** Each question carries 20 marks and there will be four sub-sections. The highest and the lowest marks of each sub-section will be 10 and 2, respectively. In the examination, there will be eight questions, out of which five questions should be answered.)

1. Modern classification and trends in Algal taxonomy. (3)
2. Developmental history of phycological research in India, Bangladesh, Burma and Pakistan. (2)
3. Status of Prynesiophyceae (Haptophyceae), Eustigmatophyceae, Chloromonadophyceae, Prochlorophyceac and Glaucophyceae. (3)
4. Range of thallus organization and modern concept of ultra-structure of chloroplast in different groups of algae. (2)
5. Algal biochemistry: (a) Cell wall chemistry (b) Extracellular metaboloities (c) Alginate and alginic acids (d) Carrageenin, agar agar and laminarin (e) Heterotrophy and auxotrophy (g) Vitamins and growth regulators. (8)
6. Biology of Blue green algae (a) Biochemical similarities between BGA and Eubacteria; (b) Synthesis of metabolic intermediates and interrupted TCA-cycle and synthesis of amino acids (c) Nitrogen metbolism and nitrogen fixation, (d)

Parasexuality, transformation and transduction in BGA (e)Mutageneis and genetic recombination (f) Photomorphogenesis (g) Algalization and mass cultivation of BGA for algal biofertilizer. (6)

7. Phycovirus. (1)
8. Algal Phylogeny. (2)
9. Algal ecology: Ecology of subaerial, terrestrial, fresh water and marine algae and factors operating in the habitats, ecological types and life forms.
10. Algal association and colourless algae.
11. Phytoplankton: Classification, distribution, succession, controlling factors and role of aquaculture.
12. Economic importance of algae.

Practical: 1.2 Credits, 3 hrs/wk

1. Use of cameralucida, micrometry, photomicrography, algal culture techniques, taxonomic study of all algal plants available in the locality.
2. Demonstration about collection of water for chemical and biological analysis using standard techniques.
3. Determination of pH, DO, BOD, COD, total nitrogen, PO_4, free CO_2, CO_3, alkalanities, total hardness, total organic content, total dissolved solid; estimation of primary productivity using a standard method in a local pond/lake.
4. Collecton and preservation of natural phytoplankton and zooplanktonpopulation and their quantitative and qualititive study using standard techniques.

Books Recommended:

1. The Ecology of algae (1981) By F.E. Round Publ. by: The Cambridge University Press. U.K.
2. Algae Form and Function (1974) By G.S. Venkataraman, S.K. Goyal, B.D. Kaushik, Paromita Roy Choudhury Pabl. By: Today & Tomorrow's Printers & Publisher. New Delhi, India.
3. Algae An introduction to Phycology (1997) By C. Van den Hock, D.G. Mann H.M. Jahns Publ By: The Cambridge University Press. U.K.
4. Phycology (1999) by Robert Edward Lee Publ. By: The Cambridge University Press. United Kingdom.
5. Manual of Phycology (1951) Edited by Gilbert M. Smith Publ. By: Chronica Botanica Co.
6. The Algae A Review (1969) G.W. Prescott Publ: By: The Cambridge University Press:

BOT 503: ADVANCED PLANT SYSTEMATICS

Total credit hour: Minimum- 60 **Full Marks : 100**

1 Credit hour = 45 minutes

(**Instructions for Question Setters:** Each question carries 20 marks and there will be four sub-sections. The highest and the lowest marks of each sub-section will be 10 and 2, respectively. In the examination, there will be eight questions, out of which five questions should be answered.)

1. Contemporary views on the origin of vascular plants: General evolutionary tends in flowering plants- leaf structure, vascular bundles, inflorescence, flowers and fruits. (8)
2. The roots of plant systematics: Needs for classification, taxonomic hierarchy, uses of categories, taxonomy and systematics. (4)
3. Conceptual developments of plant systematics: Development of Pre-Darwinian classification- essentialism, nominalism, empericism; development of Post-Darwinian plant systematics; presentation of phylogenetic relationships, a critical evaluation of modern plant systematics. (8)
4. International Code of Botanical Nomenclature (ICBN): Currently applicable codes of ICBN (i.e. Melbourne code until 2011). (8)
5. Contemporary methods of studying plants. (4)
6. Significance and material basis of plant systematics: (9)
   i. Concept of species, nominalistic species concept, typological species concept, biological species concept, phylogenetic species concept, alternative species concept, Multi-dimensional species concept, Non-dimensional species concept. The concept of genus, family and above the rank of family level.
   ii. Concept of characters, weighting of characters, comparative study of morphology, anatomy and palynology, phyto-chemistry and biosynthetic pathways in relation to taxonomy. Modern plant systematics- 'the synthesis of unachieved'.
7. Population and environment: The population concept, causes of variation, physical and genetic factors, interaction of factor. (2)
8. Biosystematics: Classical taxonomy and biosystematics, units of micro-evolutionary dynamics, bisosystematic categories, methods in biosystematic study, evolution and differentiation of species. (4)
9. Statistics in plant systematics. (4)
10. Hybridization and taxonomy: Introduction, stabilization of hybrids, hybrid complexes, taxonomic treatment of hybrids. (2)
11. Reproductive Biology and Systematics: Breeding system; outbreeding and inbreeding system; Reproductive biology study methods. (2)

12. Herbaria and botanical gardens and their roles, presentation of taxonomic information. (3)
13. Systematic position of the following plants: Rice, wheat, maize mango, jack-fruit, litchi, pineapple, banana, lemon, plum, wood apple, guava. (2)

Practical: 1.2 Credits, 3 hrs/wk

1. Study and identification of Angiospermic plants.
2. Study and identification of Museum specimens.
3. Preparation of dichotomous key.
4. Study of capitulum, spikelet, cyathia, orchids and asclepiadaceae flowers.
5. Students should have thorough idea about the floristic composition of his area and northern part of Bangladesh.
6. Students should make occasional field trips to be acquainted themselves with the flora of his area and submit, duly maintained and prepare field book/herbarium

Books Recommended:

1. Bhattacharya, B and B.M. Johri. 2000. Taxonomy and Phylogeny. Narosa Publishing House, New Delhi, India.
2. Cronuist, A. 1968. The Evolution and Clanification of Flowering Plants. Houghton Miftlin Co. USA.
3. Davis, P.H. and V.H. Heywood. 1963. Principles of Angiosperm Taxonomy, Oliver Boyd. Edinburgh and London.
4. International Code of Botanical Nomenclature. Vienna Code. 2007.
5. Naik, V.N. 1984. Taxonomy of Angiosperm, Tata Mc Graw-Hill Publishing Company Ltd. New Delhi, India.
6. Radford, A.E. 1974. Vascular Plant Systematics, Harper and Row Publisher. New York.
7. Sivaranjan, V.V. and N.K.P. Robson. 1991. Introduction to the Principles of Plant Taxonomy. Oxford and IBH Publishing Co. Pvt. Ltd. Calcutta. New Delhi, India.
8. Stace, C.A. 1980. Plant Taxonomy and Biosystematics. Edward Arnold, London.
9. Sharma, O.P. 2004. Plant Taxonomy. Tata McGraw-Hill Company Limited, New Delhi, India.
10. Subrahmanyam, N.S. 2004. Modern Plant Taxonomy, Vikas Publishing House Pvt. Ltd. New Delhi, India.
11. Sambamurty, A.V.S.S. 2005. Taxonomy of Angiosperm. I.K. International Pvt. Ltd. New Delhi, India.
12. nvmvb, Gg.G. Ges Gg.†K.Avjg. 1997. Dw™¢` †kªYxweb¨vm ZË¡ (3q ms¯‹iY), nvmvb eyK nvDm, XvKv|
13. LvZzb, Avi, 2004. Dw™¢` †kªYxweb¨vm, Kwei cvewj‡KkÝ, XvKv|

BOT 504: ADVANCED PLANT HISTOLOGY

Total credit hour: Minimum- 60 **Full Marks : 100**

1 Credit hour = 45 minutes

(**Instructions for Question Setters:** Each question carries 20 marks and there will be four sub-sections. The highest and the lowest marks of each sub-section will be 10 and 2, respectively. In the examination, there will be eight questions, out of which five questions should be answered.)

1. **Cell:** Cellular complexity of plants: Origin, types, arrangement, shape, size, development, function and adjustment during growth. (2)
2. **Cell wall:** Origin, development, function, gross structure, ultrastructure and chemical nature, sculpture and modification of cell wall. (5)
3. **Meristems:** Meristem and meristematic tissue: Classification, origin, development, structure, function and cytological and morphological characters. (4)
4. **Apical meristem:** Definition, delimitation, structure, different growth zones initials and their derivatives, vegetative and reproductive apical meristem, origin and development of leaves, buds, flowers and inflorescence from apical meristem. (5)
5. **Organization of root and shoot apices:** Theories of apical organization in plants. (4)
6. Primary and secondary structures of the plant body. Normal and anomalous growth and structures. (4)
7. Pattern of vascular differentiation in higher plant, origin, development, structure and function of procambium: Differentiation of vascular tissues from procamabial ring. (5)
8. **Vascular Cambium:** Origin, structure, types, location function and cytoplasmic characters of vascular cambium. (4)
9. **Periderm and Lenticels:** Origin, occurrence, development, structure and function. (4)
10. **Mechanical tissue in plants:** Their origin, structure, distribution and function. (4)
11. **Secretary structure**: Origin, development, classification, occurrence and function. (3)
12. **Laticifers:** Origin, development, types, structure, function and distribution in plants. (3)
13. A general knowledge of collection, preserving (killing and fixing), staining and mounting of plant materials. (2)
14. A detailed knowledge of microtomy. (4)
15. **Wood anatomy:** Soft and hard wood, properties of wood-moisture, density, strength, conductivity, heat and energy, growth ring, compression tension, grain texture, colour, odor and taste, identification of timber. (4)
16. **Internal structure of wood:** *Tectona grandis, Shorea robusta, Artocarpus heterophylea, Mangifera indica, Salmania, malabarica, Magnolia champaka*. (3)

Practical: 1.2 Credits, 3 hrs/wk

1. Study of different types of cells maceration technique (Schultz's Method)
2. Study of internal structures of different types of leaves (especially dorsiventral and isobilateral type)
3. Study of different types of stomata (Dicot and Monocot) from leaves.
4. Preparation of permanent slide (free hand section) by using double stain - Safranin and Fast green.
5. Study of shoot apex- Dissection of shoot with the help of fine blade by removing the young leaf primordia and exposing the apical meristem.
6. Microtomy**:**
   a) Types of Microtome machine.
   b) Collection, killing and fixing materials in a fixative.
   c) Preparation of paraffin blocks of the fixed materials.
   d) Section cutting (both T.S. & L.S.) of the paraffin blocks with the help of Microtome machine and mounting ribbons on slides.
   e) Staining the paraffin slides with suitable stain and preparation of permanent slide.
7. **Spotting:** Study of prepared slides for identification.

Books Recomended :

1. Esau, K. 1953. plant Anatomy: John Wiley, N.Y.
2. Esau, K. 1961. Anatomy of seed plants. John Wiley & Sons Ltd. N.Y.
3. Esau, K. 1965. Vascular differentiation in plant. Holt, Rinehart & Winston N.Y.
4. Fahn, A. Plant Anatomy. (Translated from the Hebrew pergamon press by Sybil Broido-Altman) Oxford, U.K.
5. Metcalfe, C.R. & Chalk, L. 1950. Anatomy of the dicotyledons, Clarend on Vol. I and II. Press, Oxford.
6. Metcalfe, C.R. 1960 Anatomy of the Monocotyledons. Press Oxford Vol 1: Gramineae. Press Oxford.
7. Wardlaw C.W. 1968. Morphogenesis in plants. Methuen, London.
8. cvj, Gb. †K. 2008- Dw™¢` kixi¯'vb I Dw™¢` ¯ŒYZË¡|
9. Johansen. D.A. 1940. P;ant Microtechnique. Mac Graw Hill, N.Y.

BOT 505: PLANT PATHOLOGY & PLANT PROTECTION

Total credit hour: Minimum- 60 **Full Marks : 100**

1 Credit hour = 45 minutes

(**Instructions for Question Setters:** Each question carries 20 marks and there will be four sub-sections. The highest and the lowest marks of each sub-section will be 10 and 2, respectively. In the examination, there will be eight questions, out of which five questions should be answered.)

1. Introduction to experimental Plant Pathology. (2)
2. Effects of Pathogens on Physiology of host. (5)
   i) Effect on Photosynthesis
   ii) Effect on Respiration
   iii) Effect on transcription and translation.
3. Effect of environmental factors on disease development (3)
   i) Temperature effects
   ii) Moisture effects.
4. Plant disease epidemiology. The elements of an epidemics: (10)
   i) Host factors that affect development of epidemics
   ii) Levels of genetic resistance or susceptibility of the host
   iii) Degree of genetic uniformity of host plants
   iv) Pathogen factors that affect development of epidemics
   v) Environmental factors that affect the development of epidemics
   vi) Effect of human cultural practices and control measures
   vii) Measurement of plant disease
   viii) The structure of epidemics
   ix) Patterns of epidemics
   x) Comparison of epidemics
   xi) Development of epidemics
   xii) Modeling of plant disease epidemics.
   xiii) Computer semulation of epidemics.
5. Genetics and variability of plant pathogens: (8)
   i) Genetics and variability of viruses
   ii) Genetics and variability of bacteria
   iii) Genetics and variability of fungi
   iv) Mechanisms of variability of fungi.

6. Genetics of plant diseases: (6)
   i) Genes and diseases
   ii) Evolution of parasitism
   iii) Types of resistance of pathogens
   iv) Genetics of virulence in pathogens and resistance of host plants
   v) Plant breeding for disease resistance.

7. Management of Disease through Host Resistance (8)
   i) Disease escape, tolerance or endurance, and true resistance
   ii) Monogenic, polygenic, vertical, horizontal, specific and general resistance
   iii) Development of resistant varieties
   iv) Testing of resistant varieties
   v) Causes of failure of resistance
   vi) Management of resistance
   vii) Management of resistant varieties
   viii) Some examples of development of disease resistance (8)

8. Management of Disease with Chemicals
   i) Aim of chemical control
   ii) Functions of antipathogen chemicals
   iii) Classification of fungicides
   iv) Desired characters of an anti-pathogen chemical
   v) Dosage-response relations

9. Plant Protection (5)
   (i) Use of transgenic plants;
   (ii) Cross protection;
   (iii) Fungal antagonists;
   (iv) Pathogen free seeds;
   (v) Fumigation and
   (vi) Control of insect vector.

10. Biological control of weeds.

11. Integrated control of plant diseases. (5)

12. Assessment of Disease incidence and Loss (8)
    Measuring disease intensity
    Examples of assessment keys
    Sampling for assessment
    Remote sensing
    Measurement of loss
    Models for appraisal of loss

13. Disease-warning systems: development and use. (5)

Practical: 1.2 Credits, 3 hrs/wk

1. Preparation of different kinds of media.
2. Autoclaving.
3. Single spore isolation technique.
4. Use of cameralucida and micrometry.
5. Counting of spore in haemocytometer and colorimeter.
6. Slide culturer method.
7. Estimation of fungicides for a particular diseased plot.
8. Study of locally available diseases of plants.

Books Recomended :

1. Plant Pathology - G.N. Agrios
2. Principles of Plant Pathology- R. S. Singh
3. Plant Pathology- J.C. Walker
4. Dw™¢` †ivMZË¡- Ge‡b †Mvjvg mvgv` |
6. Dw™¢` †ivMweÁvb - A‡kvK Kzgvi wmsn|
8. Dw™¢` †ivMweÁvb †gŠjbxwZ - nvmvb Avkivdz¾vgvb|

BOT 506: ADVANCED PLANT PHYSIOLOGY.

Total credit hour: Minimum- 60 **Full Marks : 100**

1 Credit hour = 45 minutes

(**Instructions for Question Setters:** Each question carries 20 marks and there will be four sub-sections. The highest and the lowest marks of each sub-section will be 10 and 2, respectively. In the examination, there will be eight questions, out of which five questions should be answered.)

1. Major chemical components of plant cell, water, inorganic ions and organic molecules, physical, chemical and biological function of water and inorganic ions in plants. (8)
2. Types of metabolism: primary and secondary metabolic processes, metabolic pathways in cell- catabolic, anabolic and amphibolic pathways, metabolic interrelationships among carbohydrate, protein and lipid. (6)
3. Terpenoids- classification, chemistry and distribution of terpenoids in plants, essential oils, sesquiterpene, diterpene and gibberellins, triterpenes and steroids and tetraterpenes. Phloem loading and unloading, mechanism of translocation through phloem. (6)
4. Physiology of juvenility, maturity and senescence in plants, (6)
5. Fruit development and ripening – chemical changes during fruit development, fruit ripening, artificial fruit ripening. (6)
6. Stress physiology – plant responses to drought, high and low temperature and salt. (6)

7. Bioenergetics – introduction, flow of energy and matter in biological world, application of laws of thermodynamics in biological processes, high energy compounds and their metabolic sources, phosphorylation – oxidative, photosynthetic and substrate linked phosphorylation, exergonic, endergonic and coupling reactions. Chemi osmotic theory of ATP synthesis on chloroplast and mitochondrial membrane. (6)
8. Photomorphogenesis – Phytochrome, cryptochrome, phenomenology, cellular aspects and regulatory aspects of photomorphogenesis. (6)
9. Biological clock – historical aspects, types of biological clocks, photoperiodic clock mechanism, circadean rhythms, biolocical clock in nature.
10. Metabolic regulation. (4)

Practical: 1.2 Credits, 3 hrs/wk

1. Determination of water potential of Rhoeo leaf by the plasmolytic method.
2. Determination of osmotic potential of potato by the gravimetic method.
3. Determination of rate of transpiration (per unit time and per unit leaf area) by potometer.
4. Separation of photosynthetic pigments.
5. Qualitative test for carbohydrate, lipid and protein.
6. Demonstration of catalase activity.
7. Demonstration of amylase activity.
8. Quantitative estimation of sugar.
9. Estimation of proline.

Books Recommended:

1. Devlin, R.M. Plant Physilogy.
2. Pandey, S.N. & Sinha, B.K. Plant Physiology.
3. Noggle, G.R. & Fritz, G.J. Introductory Plant Physilogy.
4. Salisbury, F.B. & Poss, C.R. Plant Physiology.
5. Fitter, A.H. & Hay, R.K.M. Environmental Physiology of Plants.
6. Hopkins, W.G. Introduction to Plant Physiology.
7. Ridge, I. Plant Physiology.
8. Dieter, H. Plant Physiology.
9. Mukherji, S & Ghosh, A.K. Plant Physiology.
10. cvj, Gb, †K. D”PZi Dw™¢` kvixi weÁvb (1g I 2q LÛ)|
11. cvj, Gb, †K. D”PZi km¨ kvixi weÁvb (1g I 2q LÛ)|
12. ¸n. Rx. Dw™¢` kvixiwe`¨v|
13. mvnv, †k. i. Dw™¢` kvixi weÁvb I Dw™¢` imvqb|
14. cvj, Gb.†K. Dw™¢` cÖvY imvqb|

BOT 507: CYTOTAXONOMY & CHEMOTAXONOMY

Total credit hour: Minimum- 60 **Full Marks : 100**

1 Credit hour = 45 minutes

(**Instructions for Question Setters:** Each question carries 20 marks and there will be four sub-sections. The highest and the lowest marks of each sub-section will be 10 and 2, respectively. In the examination, there will be eight questions, out of which five questions should be answered.)

1. **Cytotaxonomy:** Definition, history, aims and steps of studies; plant classification based on cytology; cytogeography. (6)

2 Cytology as taxonomic evidence.

   i) Cell: Cell theory,cells of cellular organisms, prokaryotic and eukaryotic cells, evolution of eukaryotic cells. (6)

   ii) Nucleus: Occurrence, position, number, ultra structure and function. (2)

   iii) Chromosomes: Historical, number, morphology, ultra structure, material (eu and heterochromatin) and evolution of chromosomes; chromosome banding; karyotype and idiognam; behaviour of chromosomes at meiosis; classes of chromosome number relationship within taxonomic groups. (6)

   iv) B-Chromosomes: Discovery, origin and nature; occurrence, effects and adaptive significance. (2)

   v) Changes in chromosome number: Anenuploids and amphidiploids. (10)

   vi) Polyploidy and taxonomy: Frequency, types, autopolyploidy, cryptic polyploidy; segmental allopolyploidy, Allopolyploidy, polyploid complexes. (4)

3. **Taxonomic value of cytological data:** Genera, family level and above; generic level; specific level and below. (3)

4. **Apomixis**: Types, meiosis in apomictic plants; evolution and species concept in apomictic complex, taxonomy of seed apomict; advantages of apomictic species. (4)

5. **Ampimixis:** Types, mechanisms favouring inbreeding and outbreeding, evolutionary significance of breeding system. (4)

6. **Cytotaxonomy of crop plants**: Rice, Maize, Wheat. (10)

7. **Chemotaxonomy:** Definition, history, chemistry as comparative data: (i) directly visible characters (ii) Plant products (iii) Serology and electrophoresis of proteins. (10)

Practical: 1.2 Credits, 3 hrs/wk

1. Study of chromosome complements in relation to plant taxonomy.
2. Study of meiosis in some cultivated and wild plants.
3. Pollen mitosis and construction of ideograms.
4. Preparation of parmanent slides.

Books Recomended :

1. Principles of Angiosperm Taxonomy. P.H. Dayis and V.H. Heywood.
2. Concept of cell Biology. P.S. Verma and V.K. Agarwall.
3. Cytogenetics - C.P. Swanson.
4. Cytogenetics - C.P. Swanson and W.J. Young.
5. The Chromoseme – A-Sharma.
6. Kosh Banshagotibiddya – M. Akhtaruzzaman.
7. The Biology of cells - H. Stem and D.L. Nanney

BOT 508: MOLECULAR PHYTOPATHOLOGY

Total credit hour: Minimum- 60 **Full Marks : 100**

1 Credit hour = 45 minutes

(**Instructions for Question Setters:** Each question carries 20 marks and there will be four sub-sections. The highest and the lowest marks of each sub-section will be 10 and 2, respectively. In the examination, there will be eight questions, out of which five questions should be answered.)

1. Elementary aspect: History of phytopathology; Concept of plant disease; types of plant diseases; causal agents- fungi, bacteria, phytoplasmas and spiroplasmas, viruses and viroids, protozoa and nematodes of plant diseases. (7)

2. **Molecular basis:** Molecular phytopathology; use of model organisms- *Agrobacterium* and *Saccharomyces cerevisiae* (4)
3. **Resistance mechanisms:** Classical concept of resistance- true resistance and apparent resistance; performed defenses: structural defenses-wax, cuticle, epidermal cell, stomata and lenticels and thick walled cells; chemical defenses-fungitoxic, phytoanticipins; induced defenses; cytoplasmic defense, cell wall defense, histological defense-formation of cork layer, abscission layer and tylosis, deposition of gums; gene-for-gene resistance, R- gene and *avr* gene. (9)
4. **Molecular mechanisms of plant–pathogen interaction:** Hypersensitive response, *hrp* genes, pathogenecity genes in plant pathogens: fungi, bacteria, plant viruses (6)
5. **Plant diseases caused by:**

   i) Fungi: Characteristics-morphology, reproduction, ecology and dissemination; concept of race structure; mating type gene; fungicides resistance, control of fungal diseases of plants. (6)

   ii) Viruses: Structure and composition of virus protein and nucleic acid, virus infection on plants, translation and replication of DNA and RNA virus, economic importance and control of viral diseases of plants. (6)

   iii) Bacteria: Morphology, reproduction, ecology and spread, antibiotic resistance and control of bacterial diseases. (5)

   iv) Nematodes: Characteristics,pathogenicity genes and control. (4)

6. **Microbial interactions:** *Agrobacterium* and crown gall disease, root nodule bacteria and symbiosis with Legumes. (4)
7. **Control of plant diseases:** Use of molecular biology for disease resistant variety, use of cloned resistance gene, expression of vaccine in plants, agrochemical productions (6)
8. **Soil borne diseases:** Mycoses. (3)

Practical: 1.2 Credits, 3 hrs/wk

The practical courses will cover the subject matters mentioned in the theoretical course.

Books Recommended:

1. Molecular Plant Pathology by M. Dickinson (Kindle edition) Amazon;
2. Plant Pathology by G.N. Agrios (fifth edition);
3. Plant Pathology: Techniques and Protocols (Methods in Molecular Biology) by Robert Burns;
4. Biology of Microorganisms: Madigan and Martinko.

BOT 509: ADVANCED PTERIDOLOGY

Total credit hour: Minimum- 60 **Full Marks : 100**

1 Credit hour = 45 minutes

(**Instructions for Question Setters:** Each question carries 20 marks and there will be four sub-sections. The highest and the lowest marks of each sub-section will be 10 and 2, respectively. In the examination, there will be eight questions, out of which five questions should be answered.)

1. **Classification of Pteridophytes:** Smith classification (1955) and molecular basis modern classification (2006). (4)
2. **The life cycle of Pteridophytes:** Alternation of generation, Abnormalities in the life cycle: Apogamy and Apospory. (6)
3. **Development and morphogenesis**
   - **i) Gametophyte:** Spore; Different types of adult prothallus. (5)
   - **ii) Sporophyte:** Morphology of Sporophyte: Stem, Root, Leaf. Different type of Sporangium and Sporophyll; Structure and development of sporangium; Differences between Eusporangium and Leptosporangium; Different type of sorus in Ferns, Stelar organization in ferns. (6)
4. **Control of differentiation of sex organs on gametophytes:** Antheridium structure and development; Archegonium structure and development. (6)

5. **Sexuality and genetics of gametophytes:** Reproduction of fern: Asexual, Sexual and Vegetative. (6)
6. **Ecology of Pteridophytes:** Habitat of Pteridophytes: Terrestrial, Aquatic, Xerophytic and others. (6)
7. **Pteridophytes, Environment and People:** Pteridophytic plants are used as medicine, vegetable food, Nitrogen fixation, Nitrogen accumulation, Antimicrobial activity, Decoration, etc. (6)

Practical: 1.2 Credits, 3 hrs/wk

The Practical courses will cover the subject matters mentioned in the theoretical courses.

Books Recommended:

1. V. Raghavan. - Developmental Biology of Fern Gametophytes
2. Tom A. Ranker and Christopher H. Haufler-Biology and Evolution of Ferns and Lycophytes.
3. Rashid A. - An Introduction to Pteridophyta
4. David B Lellinger- Ferns and Ferns- Allies.
5. Robin C. Moran- A Natural History of Ferns.

BOT 510: SEED PATHOLOGY

Total credit hour: Minimum- 60 **Full Marks : 100**

1 Credit hour = 45 minutes

(**Instructions for Question Setters:** Each question carries 20 marks and there will be four sub-sections. The highest and the lowest marks of each sub-section will be 10 and 2, respectively. In the examination, there will be eight questions, out of which five questions should be answered.)

1. **Introduction:** Brief history of seed pathology. (2)
2. **Concept and Scope of Seed Technology:** Definition, difference between seed and grain; seed quality characteristics and relationship with other sciences. (2)
3. **Seed industries in Bangladesh:** past and present status. (2)
4. General principles of seed production, processing and storage; seed production for rice and important vegetables. (2)
5. **Economic significance of seed borne diseases:** Significance of seed transmission compared to other means of transmission. Significance of seed transmission in selection of virulent pathogens. (4)
6. Seed borne viruses, bacteria, fungi and nematodes. (4)
7. **Storage fungi:** Fungi involved; predisposing factors; conditions during storage in relation to development of damage; harmful effects and precautions. (4)

8. **Entry point of seed infection and location:** Infection directly from the mother plant and infection from outside. Infected or contaminated parts of the seed. (4)
9. Seed-plant transmission, establishment of infection and course of disease. (4)
10. Environmental physiochemical factors affecting establishment and course of disease. (4)
11. Biological functions of control measures. (3)
12. Seed crop management for agriculture and commerce. (4)
13. Management of seed storage. (2)
14. Seed treatment, procedures and equipments. (4)
15. Quarantine for seed. (3)
16. **Seed Health tests:** objectives, basic requirements, equipments. Incubation tests and procedures. (4)
17. **Inspection of plants beyond the seedling stage:** Growing on test procedures, field trials and inspection of seed crops. (4)
18. **Forecasting losses from seed-borne diseases:** Measuring seed-borne inoculum; extent of transmission from seed to crop-epidemiological rates and relative importance of other means of transmission. (4)

Practical: 1.2 Credits, 3 hrs/wk

1. Seed quality test.
2. Seed health test through blotter method.
3. Comment on the supplied dried seed (Sample A) whether the seeds are healthy or infecfed.
4. Count the number of spores from the supplied materials (Sample B) using Haemocytometer
5. Students should visit local market to acquaint with different types of seeds.
6. Seed treatment with fungicides.

References:

1. Paul Neergaard. Seed Pathology. 1979 (Rev. Ed.) (Abridged Edition, 1986). S. Chand & Company Ltd., New Delhi-110055.
2. R.L. Agarwal. Seed Technology. 2nd Edision.1995. Oxford and IBH Pub. Co. Pvt. Ltd., New Delhi.
3. ISTA, 1976. International Rules for seed testing - Seed science and Technology 4 : 51-177.
4. Richardson, M.J. 1979. An Annotated list of Seed borne diseases (3rd Ed.). CMI, Kew, Surrey, U.K.
5. C.J. Alexopoulos, C.W. Mims. and M. Blackwell. 1996. Introductory Mycology (4th Ed.) John Wiley & Sons. Inc. New York.
6. D.K. Jha. A textbook on seed pathology. 1993. Vikas publishing house Pvt. Ltd. New Delhi-110014.

SPECIALIZATION 2: PLANT BIOTECHNOLOGY

The aim of this group is to impart basic and advanced technical knowledge needed to understand the subject and carry out higher education and /or research on any level of Biotechnology. It also prepares students to undertake employment in plant biotechnology.

BOT 516: PLANT TISSUE CULTURE & SOMATIC CELL TECHNOLOGY

Total credit hour: Minimum- 60 **Full Marks : 100**

1 Credit hour = 45 minutes

(**Instructions for Question Setters:** Each question carries 20 marks and there will be four sub-sections. The highest and the lowest marks of each sub-section will be 10 and 2, respectively. In the examination, there will be eight questions, out of which five questions should be answered.)

1. **Concept and historical background:** Cell theory, cellular aphorism, cellular totipotency and plant tissue culture. Milestone observations and experimentations towards the development of tissue culture techniques. (4)
2. **Definition and dimension:** Plant tissue culture, cell culture, callus culture, organ culture, quiescent cell, permanent cell and dividing cell. (2)
3. **Tissue culture medium:** Components and different types; importance of inorganic, organic, and undefined components; roles of growth regulators and additives (2)
4. **In Vitro developmental processes:** Dedifferentiation vs redifferentiation processes; cytodifferentiation, cualogenesis, rhizogenesis and hormonal regulation of organogenesis in callus culture; difference between organogenic and embryogenic developments. Different pathways / routes of plantlet development in tissue culture (4)
5. **Somatic embryogenesis:** Types of embryogeny in higher plants**,** nomenclatures of somatic cells before initial embryogenesis, stages of somatic embryo development *in vitro,* factors affecting somatic embryogenesis, incapsulation of somatic embryos and importance of somatic embryos. (4)
6. **Somaclonal variation:** Nomenclature and terminology, origin / source and causes of variation; why SV is considered superior to the variations originated through induced mutation, and how somaclones can be used for the improvement of crop plants. Somaclonal variants of important crop plants (4)
7. **Anther / pollen culture:** Techniques of anther and pollen cultures, different pathways of *in vitro* pollen embryogenesis and plantlet development, factors affecting and rogenesis and production of haploids and utilization of haploids in plant breeding and genetics. (4)

8. **Meristem culture:** Shoot tip vs meristem tip cultures, reasons of considering meristem as a virus free organ, techniques of isolation and culture of meristem, and production of pathogen-free plants through meristem culture. (4)
9. **Micropropagation:** Terminologies and techniques; objectives and requirements of different operational steps. Gradient of juvenility and maturity along the plant body. Factors affecting success in different steps; effects of topophysis, plagiotropism and orthotropism on micropropagation. Commercial application with special reference to cloning of tropical fruit and ornamental plants. (4)
10. **Cell culture:** Techniques of establishment and culture of cells, growth pattern of cells in suspension culture and types of cell suspension culture systems. Applications of single cell and mass suspension cultures. (4)
11. **Production of secondary metabolites:** Terminology, types and distribution of secondary metabolites in plant body, mass production using suspension culture and commercial application of *in vitro* secondary metabolites production. (4)
12. **Somatic hybridization and cybridization:** Techniques of isolation, purification, fusion and culture of protoplasts. Somatic hybridization vs cybridization and their importance. Stages of plantlet development from the fused/hybridized protoplast. Applications and limitations of somatic hybridization for raising distant hybrids. (5)
13. **Zygotic embryo culture:** Reasons behind and technique of zygotic embryo culture. Application of the embryo rescue technique in eliminating the incompatibility barrier of conventional cross breeding. (3)
14. **Selection of stress tolerant genotypes:** Types of stress, biological vs environmental stresses, stress tolerance vs stress resistance; selection and regeneration of stress (drought and salt) tolerant genotypes through cell /callus culture. (4)
15. **Cryopreservation:** Definition, scope, different steps and factors affecting the cryopreservation process. Its merits, demerits and impact on germplasm conservation of endangered plants. (4)
16. **Utilization and scope:** Roles and impacts of plant cell and tissue culture techniques in other areas of plant sciences and biotechnology. (4)

Practical: 1.2 Credits, 3 hrs/wk

1. Preparation of media and stock solution for growth regulatorts.
2 Collection, surface sterilization, preparation and inoculation of explants.
3. Establishment of callus and induction of somatic embryogenesis and organogenesis.
4. Microscopic analysis of callus for cytodifferentiatioin, embryogenesis and organogenesis.
5. Determination of appropriate stages of anther and pollen for culture initiation and induction of haploid plants.

6. Determination of growth index by callus culture and bioassay system for auxin and cytokinin.
7. Estimation of different growth parameters for evaluation of suitable media composition using proliferating shoot cultures.
8. Embryo and organ culture.
9. Evaluation and interpretation of experimental data.

Books Recommended:

1. Bhojwani, SS and Razdan, MK. 1983. Plant Tissue Culture: Theory and Practice. Elsevier Sci. Publ., Amsterdam, The Netherlands
2. Bhojwani, SS. 1990. Plant Tissue Culture: Applications and limitations. Elsevier Sci. Publ. Amsterdam, The Netherlands
3. de Fossard, RA. 2000. Commercial (Tissue Culture) Propagation. Agritech Publications, New York, USA
4. Debergh, PC and Zimmerman, RH. 1990. Micropropagation : Technology and Application. Kluwer Academic Publ. Dordecht. The Netherlands
5. George, EF, Hall, MA and De Klerk, G. 2008. Plant Propagation by Tissue Culture, 3rd Ed, Vol 1, Agritech Publications, New York, USA
6. Jain, SM and Saxena, PK. 2009. Protocols for In Vitro Cultures and Secondary Metabolite Analysis of Aromatic and Medicinal Plants, Agritech Publications, New York, USA
7. Kirakosyan, Ara, Kaufman, Peter B. 2009. Recent Advances in Plant Biotechnology. Agritech Publications, New York, USA
8. Razdan, MK. 1993. An Introduction to Plant Tissue Culture. Oxford & IBH Publ. Co. Pvt. Ltd. New Delhi. India
9. Torres KC 1989 Tissue Culture Techniques for Horticultural Crops. Van Norstand Reinhold, New York. USA

BOT 517: AGRICULTURAL BIOTECHNOLOGY

Total credit hour: Minimum- 60 **Full Marks : 100**

1 Credit hour = 45 minutes

(**Instructions for Question Setters:** Each question carries 20 marks and there will be four sub-sections. The highest and the lowest marks of each sub-section will be 10 and 2, respectively. In the examination, there will be eight questions, out of which five questions should be answered.)

1. Introduction to Crop Biotechnology:

i) Primary idea on different crop species: Cereal crops, pulses, vegetables, tuber crops and fruits. Necessity of biotechnology for crop improvement: Limitations of conventional plant breeding for crop improvement. Use of biotechnological tools to overcome the limitation of conventional plant breeding. (8)

ii) Tissue culture tools and crop improvement: Embryo rescue, pathogene elimination and meristem culture, Germplasm conservation and transportation, anther culture and development of homozygous lines. Somaclonal variants and crop improvement. (8)

iii) Genetic Engineering outline: Restriction Enzymes, RNA and DNA polymerases, Ligases, Cloning Vehicles, Gene isolation and cloning, Gene library, cDNA construction. (7)

2. Gene transfer systems for plants :

i) Direct systems: Protoplast transformation, eleatroporation, microinjection, pollen tube pathway, Microprojectile Gene method, Liposome mediated DNA delivery. (5)

ii) Indirect System: *Agrobacterium* – mediated gene transformation.

3. Production of genetically modified crops (GM Crops):

i) Transgenes: Insect resistant, fungus resistant, herbicide resistant, virus resistant, fruit processing genes (antisense RNA), genes for nutritional aspects, genes for stress tolerance, nitrogen fixing genes, apomixis and transgenic plants and phytoremediation, biofuel. (8)

ii) Molecular farming / pharming: Carbohydrates and lipids – carbohydrate production, metabolic engineering of lipids, molecular farming of proteins – production systems, medically related proteins. Economic consideration for molecular farming. (8)

iii) Biomolecular techniques and their applications: Marter aided selection, analysis and expression of cloned genes-Southern blotting, Northern blotting, western blotting, PCR anlysis. (8)

iv) Biosafety resolutions and intellectual property rights and protection: Guidelines for research in genetically modified crops, patents, trade secrets, copyright, trademarks. (8)

Practical : 1.2 **Credits, 3 hrs/wk**

1. Techniques of preparation of plant tissue culture media.
2. Techniques of preparation of bacterial culture media for culture of bacteria.
3. Molecular techniques of analysing transgenic plants.
4. GUS assay.
5. Bioassay of transformed tissues and plants.

Books Recommended:

1. Breeding Asian Field Crops. John Milton Poehlman and Dhirendranath Borthakur.
2. An Introduction to plant Tissue Culture M.K. Razdan.
3. Methods in plant Tissue Culture. U. Kumar.
4. An Introduction to Genetic engineering, Desmond S.T. Nicholl.
5. Plant Biotechnology. The Genetic Manipulation of Plant. Adrian Slater, Nigel W. Scott and Mark R. Fowler.
6. A Textbook of Biotechnology. R.C. Dubey.
7. Biotechnology. Purohit and Mathur.
8. Elements of Biotechnology. P.N Gupta

BOT 518: MOLECULAR BIOLOGY

Total credit hour: Minimum- 60 **Full Marks : 100**

1 Credit hour = 45 minutes

(**Instructions for Question Setters:** Each question carries 20 marks and there will be four sub-sections. The highest and the lowest marks of each sub-section will be 10 and 2, respectively. In the examination, there will be eight questions, out of which five questions should be answered.)

1. **Basic Molecular Biology (Review):** History and scope of recombinant DNA Technology, nucleic acid, organization and structure of eukaryotic and prokaryotic genes flow of information, gene expression, regulation and signal transduction. (5)
2. Extraction and purification, separation, detection, quantification and separation of nucleic acids. (5)
3. **Cuttings and joining of DNA:** Restriction endonuclease, ligation, alkaline phosphate, double digest, modification of restriction fragment ends, other ways of joining DNA molecule. (5)
4. **Vectors:** Plasmid vectors, properties of plasmid vectors, transformation. Vectors based on lamda bacteriophage, lamda biology, in vitro packaging, insertion vectors and replacement vectors. Cosmid and M13 vectors. Expression vectors for cloning eukaryotic genes. (5)
5. **DNA cloning and sequencing:** Principles of gene cloning, methods and strategies. Principle of sequencing automated sequencing, and short gun sequencing. Genome sequencing methods and strategies. (5)
6. **Genomic and cDNA libraries:** Genomic DNA libraries, cDNA libraries, random, arrayed and ordered libraries. Screening libraries with gene probes, screening expression libraries with antibiotics and characterization of plasmid clones. (5)
7. **Analysis of Sequence Data:** Analysis and annotation: ORF (open reading frame), exon/intron boundaries, identification of genes and their products, expression signals, other feature to nucleic acid sequence, protein structure, protein motif and domains. Data bank, Sequence comparison: DNA sequence, protein sequence comparison. Sequence alignment: CLUSTAL. (5)
8. **Analysis of Genetic Variation:** Nature of genetic variation, single nucleotide polymorphism, large-scale variation, conserved and variable domain. Methods of studying genetic variations: RFLPs, PCR based methods and genome wide comparison. (5)
9. **Analysis of Gene Expression:** Analysis of transcription, comparing transcriptomes, methods for studying promoters and transnational analyses. (5)
10. **Analyses of Gene Expression:** Relating gene and function, relating genetic and physical map, linkage analysis, allelic replacement and gene knockout, studying signal function through protein interaction. (5)

11. **Manipulating Gene Expression:** Factors affecting expression of cloned gene, Expression of clone gene in Bacteria, Expression of cloned gene in eukaryotic host cell. Adding tags and signals, in vitro mutagenesis. (5)
12. **Genomics:** Organization and structure of viral, prokaryotic and eukaryotic genome. Organelle genome organization. Comparative genomics. Special genome: human, rice and *Arabidopsis.* (5)
13. **Special application, Present and Future:** Vaccines, detection and identification pathogen, Human genetic disease and gene therapy, animal transgenics, plant transgenics and their application. (5)

Practical: 1.2 Credits, 3 hrs/wk

1. Isolation of DNA from plant tissue/cells.
2. Isolation of RNA from plant tissue/cells.
3. Agarose gel electrophoresis.
4. Polymerase chain reaction.
5. Multiple sequence alignment.

Books Recommended:

1. From Gene to Genomics: Concept and Application of DNA Technology. JW Dale and MV Schanfz 2002. John Wily and Sons.UK
2. An Introduction to Genetic Analysis. AJF Griffiths, JH Miller, OT SuzukiRC Lewonfin and WM Gilbart. 1998. Freeman Company. USA
3. Principles of Gene Manipulation. SB Primrose, RM Twyman and RW old. BlackWell Science Ltd. 2001.UK
4. Molecular Biology. JU Ahmed. 2002, Hasan Book House, Dhaka.
5. Principle of Genome Analysis and Genomics. SB Primrose and RM Twyman. 2003. Black Well Publishing, UK.
6. Introduction to Bioinformatics. Arthur M. Lesk, 2002. Oxford University Press.
7. Benjamin Lewin. 2000. Genes VII. Oxford University press, New York, USA.
8. David Freifelder. 1996. Molecular Biology. Narosa Publishing House, New Delhi, India.
9. H.D. Kumar. 2002. Molecular Biology. Vikas Publishing House Pvt. LtD., New Delhi, India.
10. Watson, J.D. et al. 1987. Molecular Biology of the Gene 4th Edition. Benjamin Cummings, Melno Park, USA.

BOT 519: DEVELOPMENTAL GENETICS

Total credit hour: Minimum- 60 **Full Marks : 100**

1 Credit hour = 45 minutes

(**Instructions for Question Setters:** Each question carries 20 marks and there will be four sub-sections. The highest and the lowest marks of each sub-section will be 10 and 2, respectively. In the examination, there will be eight questions, out of which five questions should be answered.)

1. Introduction- An approach to Plant Development

Pattern formation in plant development, difference between plant and animal development, germ line development, post embryonic development, regeneration and totipotency, variety of plant organs, and cell types, intercellular communication, model plant system, cloning genes relevant to plant development. Gene families and their role in plant development, and virtual plants.

2. Cell lineage and Positional Formation

Founder cell and developmental compartments, positional information in plant development, cell layers and chimeras, transmission of information between layers, knotted gene and floricaula gene.

3. Embryogenesis

Genetics of embryogenesis, embryo lethal mutant in *Arabidopsis* and maize, cell fate map in embryo development, *in vitro* fertilization and embryo development.

4. Seed Development

Photomorphogenesis, different light sensitive photomorphogenic mutants in *Arabidopsis*, down stream in photomorphogenesis.

5. Shoot Development

Shoot apical meristem (SAM), organization layers and zones, SAM mutants, cell differentiation in SAM and SAM molecular biology

6. Leaf Development

Genetics of leaf development in monocot and dicot. Stomatal patterning and spacing.

7. Transition to flowering

Transition to vegetative to inflorescence, and inflorescence to floral development in *Arabidopsis*

8. Flower Development

Molecular genetics of flowering- ABC model. Identification of floral Homeotic genes and MADS box genes. Sex determination- monoecious and dioecious

9. Development of floral Reproductive Organ and Gametophytes

Genetics of anther development, pollen, pistle, ovule and embryo sac development.

10. Pollination and Apomixis

Pollen germination, tube growth and guidance, Self incompatibility, apomixes.

11. Seed and Fruit Development

Different stages in seed development, dormancy and the control of germination, Molecular mechanism of fruit growth and ripening.

12. Root Development

Root apical meristem and promeristem, origin of primary root during embryogenesis, molecular genetics of root development.

13. Vascular Development

Development of stem and leaf vascularae. Differentiation of xylem and phloem and programmed cell death. Gene expression during vascular development.

Practical: 1.2 Credits, 3 hrs/wk

The practical courses will cover the subject matters mentioned in the theoretical courses.

Books Recommended:

1. Developmental genetics and plant development. QCB Cronks, RA Bateman and JA Hakins. 2002. Tailor and Francis, USA.
2. Molecular genetics of plant development. SH Howell. 2002. Cambridge University Press, UK.
3. Developmental genetics of flower. Edited by DE Soltis, JH Leebanes-Mack and PS Soltis. Series Editor JA Callow. Volume 34. 2006. Elsevier Ltd. USA.
4. Molecular systematics of plant II DNA Sequensing. Edited by DE Soltis, PS Soltis and JJ Doyle. 1999. Kluwer Academic Publisher, USA.
5. Genetic analysis of gene and genome. DL Hartl and EW Jones. 2009. Jones and Barlet Publisher, USA.
6. Mechanism of plant development. O Leyser and Stephen Day. 2003. Blackwell Publishing, USA.
7. An introduction to plant structure and development. CB Beck. 2005. Cambridge University press. UK.
8. Plant architecture and its manipulation. CGN Tumbull. 2005. Blackwell Publishing. USA.

BOT 520: PLANT BREEDING

Total credit hour: Minimum- 60 **Full Marks : 100**

1 Credit hour = 45 minutes

(**Instructions for Question Setters:** Each question carries 20 marks and there will be four sub-sections. The highest and the lowest marks of each sub-section will be 10 and 2, respectively. In the examination, there will be eight questions, out of which five questions should be answered.)

1. Definition, history and principle; methods of plant breeding and breeding system of plants. (5)
2. Origin and evolution of crop plants: wheat and rice. (4)
3. Components of variation and its estimation. (4)
4. Experimental design, analysis of variance and test of significance. (4)
5. Male sterility and production of hybrid seeds in corn, rice and onion. (8)
6. Molecular basis of plant breeding and genetic engineering. (4)
7. Breeding for disease resistance. Basis of resistance, breeding strategies and methods. (5)

8. Breeding stress tolerance, salinity and draght tolerance breeding and selection. (7)
9. Genetic conservation and breeding property rights and patents new crops. (5)
10. Special methods of breeding, polyploidy, mutation, hapliody in vitro methods. (6)
11. National and international institutions in plant breeding, impacts of modern varieties. (4)
12. GMO and biosafety, relevant convention, protocols. Future of human race and plant breeding. (4)

Practical: 1.2 Credits, 3 hrs/wk

1 Computer aided data analysis.
2. Experimental design and layout of different experiments in the field.
3. Techniques and methods of plant breeding as covered by the above theoretical courses.

Books Recommended:

1. Principles of crop Improvement. N.W. Simmends. Long man
2. Allard R.W. Principles of Plant Breeding
3. Purseglove. J.W. Tropical Crops. Longman
4. Poehlman J.M. Breeding Field Crops. Holt, NY.
5. Hayes H.K, Immei F.R. Smith D.C. Methods of Plant Breeding. McGraw- Hill. Ny.

BOT 521: BIOMETRICAL GENETICS

Total credit hour: Minimum- 60 **Full Marks : 100**

1 Credit hour = 45 minutes

(**Instructions for Question Setters:** Each question carries 20 marks and there will be four sub-sections. The highest and the lowest marks of each sub-section will be 10 and 2, respectively. In the examination, there will be eight questions, out of which five questions should be answered.)

1. Hierachichal analysis of variance; Fixed and Random effects; biological basis of interaction and e.m.s. (4)
2. Matrix algebra. (4)
3. Weighted least squares. (2)
4. Linear and multiple regression. (4)
5. Discriminant function and selection index. (4)
6. Biometry and genetics: Pure lines and multiple factor hypothesis. (6)
7. Scales, scaling tests and transformation of the scales. (4)
8. Components of means and model fitting: Additive-dominance model and non-allelic interaction model. (6)

9. Genotype × environment interaction: Specification and detection. (4)
10. Genotypes × environment interaction: Segregating generations. (4)
11. Components of variation: Variation in F_2 and back-crosses. (4)
12. Components of variation: Generations derived from F_2 and black-crosses. (4)
13. Random breeding population: BIP's and triple test cross. (6)
14. Diallels: Analysis of Hayman's diallel table and combining ability. (6)
15. Dominance selection and Heterosis. (2)
16. Heritability and selection. (2)
17. Estimation of linkage. (2)
18. Effective factors and its estimation. (2)

Practical: 1.2 Credits, 3 hrs/wk

Revision of analysis of variance and regression; analysis of variance (hierarchical); matrices; regression; weighted least squares; scaling test; joint scaling test; non – allelic interaction; generation means: GXE (Parents and F_1). GXE (Multiple lines); deviation of expected mean squares; components of F_2 and lines derived from it; predicted response to selection (BIP); triple test cross; diallel; heterosis.

Books Recommended:

1. Sir Kenneth Mather FRS and John L. Jinks FRS, Biometrical Genetics. Third Edition- 1982, Publisher- Chapmamn And Hall.
2. D.S. Falconer, Introduction to Quantitative Genetics. Second Edition, 1981, Publisher-Longman.
3. N.W. Simmonds. Principles of Crop Improvement. First Edition Published, 1979. Publisher- Longman.
4. Dr. R.K. Singh and Dr. B.D. Chaudhary. Biometrical Methods In Quantitative Genetic Analysis. Revised Edition 1979. Kalyani Publishers.
5. M.W. Strickberger. Genetics. Second Edition, 1976.
6. George W. Snedecor and William G. Cochran. Statistical Methods. Seventh Edition, 1980. Publisher-The Iowa State University Press, Ames, Iowa, U.S.A.
7. Robert G.D. Steel and James H. Torrie. Principles And Procedures of Statistics: A Biometrical Approach. Second Edition, 1981. Publisher-Mcgraw-Hill International Book Company.

BOT 522: CYTOGENETICS & CROP IMPROVEMENT

Total credit hour: Minimum- 60 **Full Marks : 100**

1 Credit hour = 45 minutes

(**Instructions for Question Setters:** Each question carries 20 marks and there will be four sub-sections. The highest and the lowest marks of each sub-section will be 10 and 2, respectively. In the examination, there will be eight questions, out of which five questions should be answered.)

1. **Autopolyploid:** Occurrence and phenotypic effects. Meiotic behaviour, breeding behaviour and genetics. (4)
2. **Allopolypiolds and Genome Analysis:** Distinction between autopolyploids and allopolyploids, Genome analysis in allopolyploids. Synthesis of new genera and species using allopolyploids *(Primula Kewensis, Agrotrichum, Triticale).* (6)
3. **Hyperploids:** Transmission of extra chromosome and breeding behaviour of trisomics. Use of trisomics in chromosome mapping. Trisomics in human. Tetrasomics in plants. (6)
4. **Hypoploids:** Meiotic and breeding behaviour of monosomics. Locating genes on chromosome arms. Meiotic and breeding behaviour of nullisomics. Use of nullisomics in locating genes on chromosomes. (6)
5. **Intra- and Inter - Chromosomal Changes:** Detection of duplication. Duplication in plant breeding and evolution. Use of deficiency for chromosome mapping in plant. Effect of duplication and deficiency on crossing over. Behaviour of bridge and fragment in inversion heterozygote. Included and overlapping inversion. Role of inversion in evolution. Orientation of interchange quadrivalents. Breeding behaviour of interchange heterozygotes. Cytogenetic localization of genes using interchanges. (12)
6. **Molecular Cytogenetics:** Chromosomal DNA vs Chromosome length/area/volume. Chromosomal DNA and evolution. Detection of repetitive DNA. Repetitive DNA vs Satellite DNA. Detection and localization of gene on chromosome. (6)
7. **Evolution of Karyotype:** Prokaryotype to eukaryotype. Selective regulation of karyotype. Amount of DNA per genome, Evolution of individual chromosome, Karyotypic changes within taxa. (6)
8. **Alien Genetic Resources in Crop Improvement:** Alien additive and values. Transfer of genea from an alien chromosomes, possibilities and limitation. (4)
9. **Genetic Recombination in Crop Improvement:** Recombinant DNA, its application for conversation of cereal crops in to nitrogen fixing plants, for resistance to viruses and other pathogen, for improving nutritional quality of pulse and for construction of male sterile lines. (4)
10. **Haploid in Crop Improvements:** Classification, meiosis and production system, parthenogenesis and apogynus, chromosome elimination and somatic reduction, anther and microspore culture, ovule culture, breeding application. (6)

Practical: 1.2 Credits, 3 hrs/wk

Study of chromosome compliment from root meristem; pollen grain mitosis to study gross morphology of chromosomes and to determine the chromosome number. Interphase nuclear and interphase chromosome volume in different plant species. Observation and calculation of chiasma frequency from pollen mother cells and presentation of data. Genome analysis in crop plants, induction of polyploidy.

Books Recommended:

1. Cytogenetics- C.P. Swauson, T. Merz & W.J. Young.
2. Cytogenetics- P.K. Gupta.
3. Cytogenetics of Crop Plants- M.S. Swami Nathan, P.K. Gupta & U.Sinha.
4. Cytogenetics- E.D. Garber.

BOT 523: APPLIED MICROBIOLOGY

Total credit hour: Minimum- 60 **Full Marks : 100**

1 Credit hour = 45 minutes

(**Instructions for Question Setters:** Each question carries 20 marks and there will be four sub-sections. The highest and the lowest marks of each sub-section will be 10 and 2, respectively. In the examination, there will be eight questions, out of which five questions should be answered.)

1. **Introduction:** Modern development of microbiology; development of microbiology in medical, agriculture, industry, biochemistry, genetics, biotechnology and recombinant DNA technology. (4)
2. **Control of microorganisms:** Disinfectant, antiseptic, sterilant, germicide; Physical methods- heat, filtration, desiccation, high pressure and radiation. Chemical methods- major disinfectants and antiseptics, chemical sterilants and gaseous sterilants. (5)
3. **Microbiology of air:** Introduction, Estimation of microorganisms in the air, indoor aeromicrobiology, indoor air purification methods, aeroallergens, allergic disorders by air microflora, airborne diseases and prevention. (4)
4. **Microbiology of water:** Introduction, Sources of water, Fresh water and marine water microbiology, microbial pollution of natural water, purification of drinking water, microorganisms as indicator of water quality, microbiological analysis of water purity- Sanitary tests for coliforms, MPN test for coliforms, defined substrate test, IMViC test. (5)
5. **Microbiology of food:** Introduction, Microbial contamination of foods, principles of food spoilage, microbial examination of food, indices of food sanitary quality, food preservation methods, fermented foods, enforcement and control agencies. (5)

6. **Industrial microbiology:** Fermentation process, bioreactor, production of lactic acid by microbial fermentation, production of penicillin and strain improvement. Single cell protein, production of *Spirulina* and yeast biomass. (5)
7. **Vaccines:** Principles and effects of vaccination, problems in vaccine production, nature and types of vaccines, generation of recombinant vaccine. Hepatitis B vaccine, poliomyelitis vaccine, polypeptide vaccine and DNA vaccine. (3)
8. **Chemotherapeutic drugs:** Antibiotics, types of antibiotics based on chemical structure and mechanisms of action; Synthetic compounds; Development of antibiotic resistant bacteria; Microbial suseptibility to chemotherapeutic agents. (5)
9. **Diagnostic serology**: Antigen, antibody, serological tests - precipitation, agglutination, enzyme-linked immunosorbent (ELISA), immuno fluorescence, radio immmuno assay (RIA). (4)
10. **Bioremediation:** Basic concept, xenobiotics, microbial degradation of pesticides, biodegradation path way of xenobiotics, detoxification and accumulation of heavy metals, removal of spilled oil, designer biocatalyst. (5)
11. **Biosensors**: Concepts and principles of biocensor, types of biosensor, application of biosensor in medical, industry and environmental pollution control. (4)
12. **Biofertilizers**: Microbial inoculants, types of biofertilizers and their potential, mass cultivation and application of *Rhizobium* and mass cultivation of blue green algae as biofertilizers; benefits and marketing. (4)
13. **Biopesticides:** Bacterial insecticides- *Pseudomonas* as bacterial insecticides, *Bacilllus* species as insecticides; Fungal insecticides- Arthropod toxins from fungi; viral insecticides. (3)
14. **Biogas:** Introduction, feed stock materials, biogas production: anaerobic digestion- solubilization, acidogenesis, methanogenesis; factors affecting methane formation; Prospective of biogas in context of Bangladesh. (4)

Practical: 1.2 Credits, 3 hrs/wk

1. Differential staining of bacteria: Acid fast staining.
2. Biochemical test: Catalase, amylase, protease and indole.
3. Assessment of coliforms standard in water samples.
4. Measurements of bacterial growth.
5. Study of antibiosis through microbial sensitivity test.
6. Estimation of indoor and outdoor airborne fungi.

Books Recommended:

1. Dubey, R.C. 1998. A text book of biotechnology. S. Chand and Company LTD, India.

2. Dubey R.C. and Maheswari D.K. 2009. A text book of microbiology. S. Chand and Company LTD, India.
3. Jay J.M. 1987. Modern Food Microbiology. 3rd edition, CBS publishers & distributors, India.
4. Markendey D.K. and Markendey N.R. 2002. Microorganisms in bioremediation. Capital publishing company, India.
5. Pelzer M.J., Chan E.C.S and Krieg N.R. 1993. Microbiology: Concepts and Applications. McGraw-Hill, Inc.
6. Prescott S.O. and Dunn C.G. 1959. Industrial Microbiology (Third edition). McGraw-Hill, Inc.
7. Purohit S.S and Mathur S.K. 1996. Biotechnology: Fundamental and Applications. Agro Botanical Publishers, India.
8. Purohit S.S., Saluza A.K. and Kakrani H.N. 2008. Pharmaceutical microbiology. Agrobios publishing company, India.
9. Sahai, V.N. 1990. Fundamentals of soil. Kalyani Publishers, New Delhi.
10. Sen S.P. and Palit P. 1988. Biofertilizers: Potentialities and Problems. Naya Prokash, Calcutta.
11. Tortora G.J., Funke B.R. and Case C.L. 2004. Microbiology an Introduction (Eighth edition). Pearson Education. Ltd. India

BOT 524: WOOD SCIENCE

Total credit hour: Minimum- 60 **Full Marks : 100**

1 Credit hour = 45 minutes

(**Instructions for Question Setters:** Each question carries 20 marks and there will be four sub-sections. The highest and the lowest marks of each sub-section will be 10 and 2, respectively. In the examination, there will be eight questions, out of which five questions should be answered.)

1. Wood: definition, types and comparative study within different types of wood like as, hard, soft, heart and sap wood. Description of wood properties: common and less common properties. (5)
2. Description of wood quality and wood seasoning. Illustrate the wood producing trees in Bangladesh and their wood nature with uses. (2)
3. Importance of timber trees plantation. (1)
4. Physical characteristics of wood: color, luster, odor, taste, weight, hardness, grain, texture, figure, etc. (2)
5. A detail description on macroscopic structure of wood: Transverse, Radial and Tangential surfaces. (1)
6. A detail description on microscopic structure of wood: growth rings, vessel elements, imperforate tracheary elements, axial parenchyma, rays and cell contenting secretory structure in wood. (6)

7. The mechanism of wood formation: Primary growth, secondary growth and cell development. (3)
8. Describe branch wood and root wood. (1)
9. Describe in detail about various kinds of wood defects: Knots, checks and shakes, splits, cross grain, diagonal grain, warping, wane, decay and others. (2)
10. Degradation of wood: Bacterial wood degradation, Fungal wood degradation, wood degradation with insects and other reasons for wood degradation. (3)
11. Ultra-structure of fiber cell wall: cell wall layer, microfibril angle and orientation in cell wall layers of fiber. (5)
12. Chemical constituents of hard and soft wood. (5)
13. Chemical structure and biosynthesis of wood biomass: cellulose, hemi-cellulose and lignin. (2)
14. Reaction wood: definition, types, demerits and formation. (5)
15. Characteristics of compression and tension wood and comparative study between these two types wood. (3)
16. Wood preservation: preservatives, importance, methods and impact on some particular fields. (2)
17. Describe genes involved in the biosynthesis of lignin, cellulose and hemi-cellulose in wood. (2)

Practical: 1.2 Credits, 3 hrs/wk

1. Hand lens features of soft wood and hardwood, sapwood and heart wood specimens.
2. Wood specimen collection and preservation.
3. Section preparation by rotary and sliding microtome.
4. Preparation of permanent slide after double staining with safranin and fast green.
5. Microscopic features identification in transverse section (TS), longitudinal section (LS) and radial section (RS) in permanent slide by inspection of some soft wood and hardwood species.
6. Identify different types of cells after using maceration technique (Schultz,s method).
7. Measurement of dimensions of woody tissues in macerated cells and in stained section in the permanent slides (preparates).
8. Measurement of growth increment in reaction wood. Observation of compression and tension wood characteristics. Compare normal and reaction wood features.
9. Spotting: Identification of wood by hand lens. Identification of wood features in TS, LS and RS under light microscope from the permanent slide.

Books recommended:

1. Comparative wood anatomy systematic, ecological and evolutionary aspects of dicotyledon wood - Sherwin Carlquist.
2. Integrative plant anatomy - William C. Dickison.
3. Ecological strategies of xylem evolution - By Sherwin Carlquist.
4. Wood structure and environment - Fritz Hans Schweingruber.
5. New perspective in wood anatomy - Pieter Baas.
6. A Field guide to tropical plants of Asia - David H. Engel, Suchart Phummai.
7. Identification of the timbers of Southest Asia and the Western Pacific - Ken Ogata, Tomoyuki Fujii, Hisashi Abe and Pieter Baas.
8. Cellular ultrastructure of woody plants - W.A. Côté Jr. & A.C. Day.
9. Xylem structure and the ascent of sap - M. H. Zimmermann.
10. Transport process in wood - J.F. Siau.
11. Growth stresses and strains in trees - R.R. Archer.
12. Heartwood and tree exudates - W. F. Hillis.
13. Natural products of woody plants - J. W. Rowe (Ed.).
14. Wood production, wood technology, and biotechnological impacts-Ursula Kües.
15. Forest products biotechnology - Alan Bruce, John W. Palfreyman.
16. Biotechnology in pulp and paper manufacture - T. Kent Kirk, Hou-min Chang.
17. Lignin biodegradation: microbiology, chemistry, and potential applications - T. Kent Kirk, Takayoshi Higuchi, Hou-min Chang.
18. Association between lignin and carbohydrates in wood and other plant tissues - Tetsuo Koshijima, Takashi Watanabe.

BOT 525: PROTEOMICS & BIOINFORMATICS

Total credit hour: Minimum- 60 **Full Marks : 100**

1 Credit hour = 45 minutes

(**Instructions for Question Setters:** Each question carries 20 marks and there will be four sub-sections. The highest and the lowest marks of each sub-section will be 10 and 2, respectively. In the examination, there will be eight questions, out of which five questions should be answered.)

1. **Introduction**: Definition of proteome, protein structure, Nature of proteome, Overview of the tools to study proteome, Overview of the categories of current proteomic studies. (4)
2. **Proteomics and plant biotechnology:** Proteomics in plant breeding and genetics; Proteomics for the analysis of genetically modified plants; Proteomics and the analysis of secondary metabolites. (6)
3. **Basic Techniques in proteomic studies:** Protein separation by PAGE, Protein purification techniques - gel filtration chromatography, affinity chromatography, ion exchange chromatography, reverse phase high pressure liquid chromatography (RP-HPLC). (6)

4. **Methods of studying proteins:** Determining the existence of proteins in complex mixtures; Image analysis and Proteins Identification, Characterization of proteins, Determining the proteins which are post-translationally modified, protein sequencing. (7)
5. **From genomics to proteomics:** Challenges and approaches in proteomics; Mass spectrometry-based proteomics; Array-based proteomics; Structural proteomics; Functional proteomics. Future developments and challenges. Limitations to genomic study. (8)
6. **Quantitative Proteomics:** 2D-PAGE method, Mass spectrometry based method, Absolute quantification method. (4)
7. **Structural proteomics:** Basic concepts of determination of protein structure through X-ray crystallography and NMR. (4)
8. **Protein design and Engineering:** Basic concept, application of protein engineering, peptide synthesis, recombinant protein production, PCR based mutagenesis for engineering of recombinant protein. (4)
9. **Interaction Proteomics:** Principal Technology Platforms: Yeast 2-hybrid, Data analysis: Graph-based visualization, Identification of protein clusters and modules, Data analysis challenges: false positives; Protein-protein interaction networks: Topology, Network motifs. (8)
10. **Internet technologies for bioinformatics:** Concepts; Methods and standards; BLAST, Multiple sequence alignment, Phylogenetic analysis, conserved domain identification, 3D structure prediction through molecular molding. (5)
11. **Practical applications of proteomics:** Application in Plant Biotechnology, Medical, and Pharmaceutical industries. (4)

Practical: 1.2 Credits, 3 hrs/wk

The practical courses will cover the subject matters mentioned in the theoretical courses.

Books Recommended:

1. Christine, O., David J., Janet T. 2005. Bioinformatics: Genes, Proteins and Computers. BIOS Scientific Publishers Ltd. UK.
2. Daniel S.S. 2007. Spectral Techniques in Proteomics. Crc press, NW.
3. Herve T., Michel Z., Catherine D., Valerie M. 2007. Plant Proteomics: Methods and Protocols. Humana Press Inc. Totowa, New Jersey, USA.
4. Michael R.B., Ian C. G. 2003. Bioinformatics for Geneticists. John Wiley & Sons Ltd. UK.
5. Reiner W., Tom N. 2002. Proteomics in Practice: A Laboratory Manual of Proteome Analysis. Wiley-VCH Verlag GmbH, Germany.
6. Saito K., Dixon R.A., Willmitzer L. 2006. Biotechnology in Agriculture and Forestry 57: Plant Metabolomics. Springer-Verlag Berlin Heidelberg, Germany.

SPECIALIZATION 3: ENVIRONMENTAL BOTANY

Courses offered under this group aims to provide the students with indepth and most recent understanding of local and global ecosystems emphasizing plants and plant-environment interactions, management, conservation and sustainable utilization of biodiversity and plant resources. They will enrich their expertise to undertake higher research /education and specialized jobs.

BOT 531: PLANT ECOLOGY & ECOSYSTEM MANAGEMENT

Total credit hour: Minimum- 60 **Full Marks : 100**

1 Credit hour = 45 minutes

(**Instructions for Question Setters:** Each question carries 20 marks and there will be four sub-sections. The highest and the lowest marks of each sub-section will be 10 and 2, respectively. In the examination, there will be eight questions, out of which five questions should be answered.)

1. **Ecology:** Definition, branches and scope, Economic development and impacts. (3)
2. **Plants and environment:** Biosphere, composition of air; Temperature, rainfall, relative humidity and their fluctuations in Bangladesh. Green house effects: CO_2 and global warming. (7)
3. **The ecosystem:** Concept of ecosystem, Ecosystem structure and function. Ecosystem modeling, Study of major ecosystems of the world (Seas, estuaries, rivers, ponds, deserts, forests etc.) Ecosystem of Bangladesh. (8)
4. **Productivity in Ecosystem:** Primary and secondary productivity, Measurement of primary productivity, Productivity in different ecosystems, Factors affecting primary productivity. (5)
5. **Energy flow and ecosystem budgets:** Energy reaching the earth, light as an energy carrier, Energy transduction and laws of thermodynamics, The ecosystem as a thermodynamic unit. (5)
6. **Pollution ecology:** Types, causes, effects and control of pollution; surface water and ground water pollution; Air pollution; primary air pollution, Indoor air pollution; pollution of soil and water; Noise pollution; Biomagnification of non-biodegradable insecticides. (5)
7. **Communities:** Biotic community concept; Aims and methods of surveying plant communities, Structural characters (Both analytic and synthetic). (5)
8. Sampling, tests of comparision and application of quadrate measures. (2)
9. **Biodiversity:** Types of diversity, Habitat diversities; Conservation of phytodiversity- Principles and methods; Global diversity. Threatened species; Red data book, Measurement of diversity indices. (8)
10. **Population ecology:** Population attributes; Population growth form; Interactions among populations. (6)

11. Bioremediation of contaminated soil and water.

    Biological control of insects, pests;

    Natural resources bionomics and ecosystem management.

11. **Environmental ethics**: Sustainable earth ethics; Shallow and deep ecology; Environmental awareness Human impact on the earth; Ecocidal activities with restraints. (4)

12. Sustainable development and Bangladesh; future (2)

Practical: 1.2 Credits, 3 hrs/wk

1. Ecological study of two heliophytes (leaf area and anatomy).
2. Ecological study of two sciophytes (leaf area and anatomy).
3. Estimation of soil moisture (both weight and volume bases.).
4. Calculation of F.C. and S.W.C.
5 Determination of R.W.C. for the sunny and shady plants of some species.
6. Study of plant communities by a) list counts and point quadrats, b) line and belt transects.
7. Calculation of plant communities from the collected data.
8. Preparation of frequency histograms.
9. Construction of valence histograms, phytographs, and ecological comments.

Books Recommended:

1. Ambasht. R.S.- A Text Book of Plant Ecology.
2. Ashby, M.- Introduction to Plant Ecology.
3. Billings, W.D. –Plants, Man and the Ecosystem.
4. Arora, S.- Fundamentals of Environmental Biology.
5. Miller, G.T. – Living in the Environment.
6. Daubenmire, R.F. – Plants and Environment.
7. Kormondy, E.J. – Concepts of Ecology.
8. Shukla and Chandel – Plant Ecology.
9. Mehra, V.B and S.K. Khanna - Plant Ecology.
10. Weaver and Clements – Plant Ecology.
11. cvj, Gb.†K. 2006 D”PZi cwi‡ek weÁvb| Kwei cvewj‡KkÝ, XvKv|

BOT 532: PHYTOGEOGRAPHY & SOCIAL FORESTRY

Total credit hour: Minimum- 60 **Full Marks : 100**

1 Credit hour = 45 minutes

(**Instructions for Question Setters:** Each question carries 20 marks and there will be four sub-sections. The highest and the lowest marks of each sub-section will be 10 and 2, respectively. In the examination, there will be eight questions, out of which five questions should be answered.)

1. Principles of Phytogeography; factors affecting distribution of plants; world vegetation.
2. Phytogeographical regions of the world:
   a. Vegetation of the tropical region.
   b. Vegetation of the temperate region.
   c. Vegetation of the polar region.
3. Vegetation of the Ganges Plain; agroecological zones of Bangladesh; characteristic features textures of the zones; their vegetation and forests.
4. Phytodiversity and Environment: Measurement of diversity indices; diversity and development; erosion of phytodiversity; future impacts, persistent pollutants and plants.
5. Impact of Pollution on Vegetation:
   Germination and growth
   Physiological changes
   Effects of pollutants
   Control of pollution through vegetation.
6. Deforestation and its impacts; importance of trees; Concept and components of social forestry. Social forestry in Bangladesh: Past, present and future.
7. Agroforestry: Some traditional agroforests (Homestead agroforest, Tree farming)
8. Economic and environmental aspects of social afforestation.
9. Social afforestation in different countries (India, Indonesia and Nepal)

Practical: 1.2 Credits, 3 hrs/wk

The practical courses will cover the subject matters mentioned in the theoretical course.

Books Recommended:

1. Cain and Castro – Manual of Vegetation Analysis.
2. Daubenmire, R.F.– Plant Communities: A test Book of Plant Synecology.
3. Braun Bangguet, J- Plant synecology: The study of Plant Communities.
4. Kershaw, K.- Quantitative and Dynamic Ecology.
5. Oositing, H.J. – The study of Plant Communities.
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BOT 533: PHYSIOLOGICAL ECOLOGY

Total credit hour: Minimum- 60 **Full Marks : 100**

1 Credit hour = 45 minutes

(**Instructions for Question Setters:** Each question carries 20 marks and there will be four sub-sections. The highest and the lowest marks of each sub-section will be 10 and 2, respectively. In the examination, there will be eight questions, out of which five questions should be answered.)

1. Introduction: Concept, approach and dynamics; importance in natural resource management. (3)
2. The environment of plants: The hydrosphere, the atmosphere, the lithosphere; the biosphere; ecosystem: Interplay of biological and environmental factors. (4)
3. Microclimate; Radiation and plants, Radiation laws, Spectral distribution and radiation units, Radiation in natural environments, Radiation distribution within plant canopies, the modification of light climate by vegetation, temperatures profiles within vegetation, Air movement above the ground and within vegetation, the distribution of dust and gasses near the ground. (8)
4. Energy budget of different climatic zones, calculation of energy of forest canopies; Bangladesh: Climate, vegetation and agriculture. (4)
5. Energy balance and gaseous exchanges in plants: The radiation balance and diffusive resistances of leaves, stomatal movement and its ecotogical significance. (4)
6. Photosynthetic mechanisms of C_3, C_4 and CAM plants, their adaptive features, distribution and ecological significance. (4)
7. Soil environment: Physical and chemical aspects and the distribution of plants; Soils of Bangladesh agroecological zones. (4)
8. Physico – chemical characteristics of wet soils, Adaptations of plants to wetland environments, metabotic aspects of flood tolerant and flood intolerant plants; Mn and Fe toxicily to plants and their effect on chloroplast ultrastructure. (6)
9. Nutrient excess and mineral toxicity: Ecological aspects of calcicoles, calcifuges, halophytes, and excess of metal tolerated plants. (4)
10. Interactions: Interactions with plants, microorganisms and animals. (4)
11. Greenhouse effect: Major greenhouse gasses and their anthropogenic sources, their roles in creating greenhouse effects, ozone depletion and CFC; green house gases in Bangladesh. (4)
12. Climate change: Evidence and causes, impacts of global climate change on future sea level, food production and population; impact of Global climate charge on Bangladesh. (4)
13. Arsenic: An element and pollutant, Arsenic in ground water, source and effects on ecosystem (plants and animals), mitigation of the problem. (4)

14. Causes, effect and remedeis of the following ecological problems in relation to Bangladesh : a) Desertification, b) Waterlogging, c) Salinity and d) drought. (4)

Practical: 1.2 Credits, 3 hrs/wk

The practical courses will cover the subject matters mentioned in the theoretical course.

Books Recommended:

1. Bannister, P. Introduction to Physiological Plant Ecology.
2. Larcher, W. Physiological Plant Ecology.
3. Jones, H.G. Plants and microclimate.
4. Etherington, J.R. Environment and plant Ecology.
5. Fitter, A.H. And Hay, R.K.M. Environmental Physiology of Plants.
6. Verma and Agarwal. Environmental Biology Physiology of Plants.
7. Gain P, Moral, S and Raj. P. Bangladesh Environment: Facing the 21st cintury, SHED, 44/D, West Panthapath, Dhanmondi, Dhaka- 1205, Bangladesh.
8. kvixiZvwË¡K Dw™¢` cwi‡ekwe`¨v- Gb. †K. cvj|

BOT 534: APPLIED ETHNOBOTANY

Total credit hour: Minimum- 55 **Full Marks : 100**

1 Credit hour = 45 minutes

(**Instructions for Question Setters:** Each question carries 20 marks and there will be four sub-sections. The highest and the lowest marks of each sub-section will be 10 and 2, respectively. In the examination, there will be eight questions, out of which five questions should be answered.)

1. Ethnobotany as a discipline: Introduction, ethnobotany in the new world, current scope and potential application. (6)
2. Traditional Botanical Knowledge (TBK): The knowledge system and its nature, documentation of and interpretation of TBK. (5)
3. Ethno-taxonomy and Perceived Environment: Understanding the perceived environment, Ethno-plant taxonomy – its principles and categories, ethno-plant taxonomy and scientific taxonomy, significance of ethno-plant taxonomical information in economic development. (5)
4. i) Medicinal Plants: Historical background, rationality and scientific basis of herbal medicine, contribution of medicinal plants to modern medicine.(4)

   ii) Medicinal Plant cultivation, Conservation and Economic potential: Marketing of medicinal plants/plant products at national and international levels, cultivation and conservation of medicinal plants, economic importance and potentiality of medicinal plants in Bangladesh. (5)

5. Ethnobotanical Knowledge and Subsistence:

   i.) Ethnoecology and traditional agriculture, biodiversity of traditional agro-ecosystem, underutilized crop plants, their importance in crop diversification and livelihood management in fragile environment. (2)

   ii.) Traditional home garden, plant diversity of traditional home garden, dynamic nature of home garden in rural Bangladesh and its importance. (2)

   iii.) Paleo-ethnobotany and domesticated crop plants, process of domestication, places of domestication of crop plants in ancient times, levels of domestication, domestication of important crop plants (e.g. wheat, rice, etc.) (3)

   iv.) Wild resources – uses of wild plants, importance of wild plants on rural life, prospect of wild food plants to the improvement of rural livelihood. (5)

6. Ethnobotanical Knowledge and Environmental change: Dynamic nature of ecosystems, climate change and occurrence of disasters in Bangladesh. *Plants and disaster management*–Ethnobotanical knowledge and mitigation of those disasters. (5)

7. Bio-prospecting: Ethnobotanical knowledge and its scope in searching new bio products, agreements to collect biodiversity for modern biotechnological and pharmaceutical research and development. (3)

8. Plants, People and Rights: CBD, IPRs, TRIPS (Trade Related Aspects of Intellectual Property Rights), Bio-piracy and patentability of traditional products and knowledge system, agro-biodiversity and farmers' rights, global policies and its impact on national policies. (6)

9. Local ecosystem and its economic, ecological and cultural dimensions: External intervention and changing pattern of local resources utilization and impact, local resources users and their rights, integration of TBK and western scientific knowledge for achieving sustainable development. (4)

Practical: 1.2 Credits, 3 hrs/wk

1. Student should make field trips to understand plant-based knowledge of the visited areas should examine the extent of uses of plants by the local people, collect those plants / plant products for identification.
2. They should collect information of an ecosystem and evaluate the changes of that ecosystem. They will have to make comment on the reasons for the on-going changes of that ecosystem and the role of local people and other factors in order to conserve / destruct the natural resources there.
3. Students will have to collect folk formularies of some common diseases from the people of assigned areas.

Books Recommended:

1. Altieri, M.A. 1987. Agroecology: The Scientific Basis of Alternative Agriculture. Westview Press Inc. USA.
2. Brush, S.B. and D. Stabinsky (eds.) 1996. Valuing Local Knowledge: Indigenous People and Intellectual Property Rights. Island Press, Washington

DC.
3. Chowdhury, A.M. 2009. Protecting Bangladesh From Natural Disasters. Academic Press and Publishers Library, Dhaka, Bangladesh.
4. Cotton, C.M. 1996. Ethnobotany: Principles and Applications. John Willey and Sons; Chichester, UK.
5. Cunninigham, A.B. 2001. Applied Ethnobotany: People, Wild Plant Uses and Conservation. Earthscan Publication Ltd., USA.
6. Ghani, A. 2003, Medicinal Plants of Bangladesh with Chemical Constituents and Uses (2nd ed.) Asiatic Society of Bangladesh.
7. Martin, G.J. 1995. Ethnobotany: A Conservation Manual. Chapman and Hall, London.
8. Reid, W.V., S.A. Laird, C.A. Meyer, R. Gomej, A. Sittenfeld, D.H. Janzen, M.A. Gollin and C. Juma (Eds.). 1993. Biodiversity Prospecting: Using Genetic Resources for Sustainable Development. World Resources Institute (WRI), USA.

BOT 535: BIODIVERSITY & PLANT RESOURCES MANAGEMENT

Total credit hour: Minimum- 60 **Full Marks : 100**

1 Credit hour = 45 minutes

(**Instructions for Question Setters:** Each question carries 20 marks and there will be four sub-sections. The highest and the lowest marks of each sub-section will be 10 and 2, respectively. In the examination, there will be eight questions, out of which five questions should be answered.)

1. Plant biodiversity: Definitions; Components of biodiversity; pattern and process of biodiversity; Importance of biodiversity; Measurement of plant biodiversity; State of plant diversity in Bangladesh; Plant biodiversity rich areas in Bangladesh; Present status of protected areas and ecologically critical areas (ECA) in Bangladesh; Trends of change in plant diversity in Bangladesh; Biodiversity and sustainable development; State of genetic diversity of some major, minor and underutilized crops of Bangladesh ; Short description of bio-ecological zones of Bangladesh.

2. Threats to plant biodiversity: Major threats to biodiversity and their interaction; Habitat degradation and loss; Habitat fragmentation; Overexploitation, Species invasions impact on Bangladesh; Climate change of Bangladesh; Current pattern of biodiversity endangerment in Bangladesh.

3. Biodiversity conservation: Concept; Different approaches to biodiversity conservation; Understanding ecosystem dynamics and resilience; Functional landscapes and the biodiversity conservation; Biodiversity conservation in Bangladesh.

4. Plant biodiversity management: Concept; Methods and importance of biodiversity management; Different approaches and their effectiveness to biodiversity management; adaptive ecosystem management, Biodiversity and genetic resource

management in Bangladesh: needs, opportunity and present attempts; what can be done.

5. Plant Resources : i) Concept of plant resources; ii) Plant Resources: a)Forest resources : Introduction and scope ; Major forest produce and their uses - Timber, fuel, paper (two examples of each); Minor forest produce and their uses – Gum, resin, tannin, dyes and pigments (two examples of each) ; b) Sea-weed resources – Food, fodder and fertilizer Applications; c) Renewable and non-renewable plant resources: concept, differences and their uses and balance.

6. Plant resources management (PRM): Concepts and basic features of PRM; Management practices - need and methods; Community Participation for sustainable development in PRM; Importance and forms of community participation in PRM; Community participation for environmental governance.

7. CBD and IUCN**:** Convention on biological diversity (CBD); Bio-safety; National biodiversity strategy action plan of Bangladesh; IUCN's Red list categories and Red Data Book (RDB) of Bangladesh; Indigenous knowledge; Intellectual property rights.

Practical: 1.2 Credits, 3 hrs/wk

1. Visits, survey, collection, description and materials; Field assignments: Submit herbariums of a specified number of species of flora.
2. Description of species within the flora; include diagrams; photographs, maps, distribution, lists, relative abundance; time of flowering, pollution details; fruit and seed production;
3. Preparation of Keys to identify the collected species.
4. Methods of conservation of seeds, seed banks. Study of *ex situ*, *in situ* and cryopreservation.

Recommended Books:

1. Principles of Conservation Biology- Martha. J. Groom, Gary K. Meffe, C. Ronald Carrall.
2. Biodiversity Conservation- M.P/ Dahiya.
3. ev‡qvWvBfviwmwU- W. wbkx_ Kzgvi cvj I W. †gvt Avãyj gvbœvb miKvi|
4. Biodiversity and Environment- SK Agarwal and PS Dubey
5. Environmental Biodiversity and Conservation – MA Khan
6. Bangladesh State of Biodiversity- Q I Chowdhury
7. Environmental Management of Developing Countries- G. Tharun, NG Thanh and R Bidwell
8. Environmental Impact Assessment – P. Wathern
9. Natural Disasaters – Alexander Davit.

BOT 536: LIMNOLOGY & AQUACULTURE

Total credit hour: Minimum- 60 **Full Marks : 100**

1 Credit hour = 45 minutes

(**Instructions for Question Setters:** Each question carries 20 marks and there will be four sub-sections. The highest and the lowest marks of each sub-section will be 10 and 2, respectively. In the examination, there will be eight questions, out of which five questions should be answered.)

1. Wetland definition; Importance of wetlands; Flood plain wetlands and water bodies; Bangladesh: Chalan beel, a case study; (6)
2. Lake energetics: Source, type, utilization, under water light climate; water movement; photosynthetic behavior of natural photosynthesis (Neoblackman model), periodicity and vertical distribution of productivity. (6)
3. Carbon dynamics in eutrophic lakes, location of DOC in aquatic ecosystem; pelagic carbon cycling (phytoplankton EOCn release). (2)
4. Zooplankton, phytoplankton, fish and benthic community interactions. (3)
5. Applied limnology: a) Pollution; sources and types of pollution, b) Sewage & its treatment, origin & composition, mechanical, biological treatment c) Contaminated waters: self purification process; indicator organism, rehabilitation of water; biomanipulation; bioaccumilation and effects of persistent pollutants. (6)
6. Trace elements of water; role of agrochemicals and heavy metal in water pollution; impact on ecosystem health. (6)
7. Arsenic pollution in Bangladesh; accumulation in water bodies and food chain; impacts. (5)
8. Aquaculture: Definition and history; trends of Aquaculture in Bangladesh. (6)
9. Culture types: Monoculture, Polyculture; definition, pattern and techniques of composite culture, mixed and integrated fish farming in Bangladesh. (5)
10. Pond fertilization: Definition of fertilizer, manure, organic and inorganic fertilizers in fish ponds, drying of ponds, liming of ponds, water quality and fertilizers; impact on aquatic ecosystem; sustainability. (8)
11. Aquatic vegetation: Types of aquatic plants, role of aquatic plants in fish culture; conservation of aquatic biodiversity. (6)

Practical: 1.2 Credits, 3 hrs/wk

1. Study of Lake Morphometry.
2. Collection and preservation of natural phytoplankton and zooplankton population and their quantitative and qualitative study using standard technique.
3. Determination of alkalinities and total hardness of water.
4. Determination of relation between pH and water temperature.

5. Determination of net productivity, gross primary productivity and rate of respiration of a fresh water habitat,
6. Practical notebook to contain description, labeled diagrams and identifying characters of the studied plankton genera.

Books Recommended:

1. Wetzel, R.G. 1983. Limnology 2nd ed, W.B. Saunders Co., Philadelphia USApp767.
2. Welch, S.Paul. 1948. Limnological methods. McGraw Hill Book Company, New Tork, pp.377.
3. S.C. AGRAWAL 1999. Limnology. AP.H Publishing Corporation New Delhi. India.
4. Islam, Anowarul. Mocher Pukurer Pani (evsjv GKv‡Wgx)
5. Khondker, Moniruzzaman 1995. Limnology (cÖKvkK, XvKv wek¦we`¨vjq, XvKv|)
6. Das, Bishnu Motsho Babosstapona (Vol. I-IV) (cÖKvkK, dRjyi iwng, cwiPvjK, cwiKíbv I cÖwk¶b wefvM, evsjv GKv‡Wwg, XvKv|
7. IUCN, Wetlands of Bangladesh

BOT 537: CROP PHYSIOLOGY

Total credit hour: Minimum- 60 **Full Marks : 100**
1 Credit hour = 45 minutes

(**Instructions for Question Setters:** Each question carries 20 marks and there will be four sub-sections. The highest and the lowest marks of each sub-section will be 10 and 2, respectively. In the examination, there will be eight questions, out of which five questions should be answered.)

1. **Introduction:**
   Crops and world food supply: Origin and classification of crop plants. Physiological aspects of crop evolution. History and scope of crop physiological studies. Distribution of different crops: Global and Bangladesh perspectives.
2. **The Environments:**
   a. Soil: Classification and weathering of rocks and soil formation. Physical properties of soil: soil structure and texture, soil water, soil air, soil temperature, soil erosion. Concepts on soil degradation and pollution.
   b. Atmosphere: Solar radiation: Temperature: Diurnal and annual cycles and ranges their importance for crop growth and development. Humidity: Concepts on evaporation, sublimation and melting. Amount and source of atmospheric moisture. Specific humidity, mixing ratio and relative humidity. Effects of rainfall, dew, snow and fog on crop growth. Gaseous substances in the air, aerial pollution and its impacts on crop growth.
   c. Abiotic stresses: Physiological mechanisms of drought, water logging, adverse temperature and salinity tolerance.
3. **Supply and use of water:**

a. Physical and chemical properties of water, water relations in plant cells, supply of water by the soil, absorption of water by the root system, Conduction of water in plants:
b. Crop water loss: Role of stomatal and boundary layer resistances, evaporation from a crop.
c. Conception on water balance in crops.

4. Mineral nutrition of crops:

a. Mineral elements of the soil and their absorption and transportation by the crops. Plant nutrient responses.
b. Required elements for crop growth and development.
c. Types and use of fertilizers and effects of their unjustified uses.

5. Photosynthesis and respiration in crop plants:

a. Absorption of light by plant canopies.
b. Photochemical aspects of photosynthesis: solar radiation, interception of solar radiation by crop, reduction of carbon dioxide, diffusion pathways of carbon dioxide. Boundary layer, stomatal and mesophyll resistances.
c. Environmental factors influencing photosynthesis: light, carbon dioxide, temperature, water, minerals and salinity.
d. Carbon balance of crop plants.
e. Photorespiration in relation to crop yield.

6. Growth and development of crop plants:

a. Growth pattern, classical and functional growth analysis techniques.
b. Vegetative and reproductive growth: leaf production, growth of stem, flowering, fruit and seed growth.
c. Chemical control of growth and development, functions of natural growth regulators and their practical application.

7. Physiological basis of crop yield:

a. Basis of yield assessment, limiting processes – source or sink
b. Capacity of assimilate translocation, partition of assimilates, storage capacity as limitation on yield.
c. Development of yield capacity.
d. Plant characters in relation to yielding ability.
e. Factors limiting grain yield, yield maximization. Bangladeshi farmer's position.

8. Physiological case histories of the following crops: Rice, Wheat, Sugarcane, Potato, Jute, Cotton, Pea and Rapeseed.

Practical: 1.2 Credits, 3 hrs/wk

Experiments on Crop water relations, transpiration, mineral nutrition, photosynthesis, respiration, germination, growth and development. Classical and functional growth analyses approaches.

Books recommended:

1. Charles Edwards, P.A. Physiological Determinants of Crop Growth.
2. Evans, L.T. Crop Physiology: Some Case Histories.
3. Landsberg, J.J, and Cutting, C.V. Environmental Effects on Crop Physiology.
4. Milthorpe, F.L. and Moorby, J. An Introduction to Crop Physiology.
5. Paul, N.K. Shashya Sharirbijnan (in Bengali).

6. Sahai, V.N. Fundamentals of Soil.

BOT 538: AGRONOMY & CROP MANAGEMENT

Total credit hour: Minimum- 60 **Full Marks : 100**

1 Credit hour = 45 minutes

(**Instructions for Question Setters:** Each question carries 20 marks and there will be four sub-sections. The highest and the lowest marks of each sub-section will be 10 and 2, respectively. In the examination, there will be eight questions, out of which five questions should be answered.)

1. **Introduction:** Origin, history and importance of agronomy; basic principles of Agronomy. (6)
2. **Tillage:** Definition, objectives and types of tillage, modern implements for tillage. (6)
3. **Plant nutrients:** Source in soil, classification, loss from soil, fertilizers and its relation to plant nutrients, calculation of amount of fertilizer, economics of plant nutrients use. (6)
4. **Soil fertility & Productivity:** Concept, characteristics of productive soil, soil amendments, factors affecting soil fertility, organic matter & soil fertility. (4)
5. **Weeds:** Crop-weed association, principles and methods of weed managements, herbicides. (4)
6. **Dryland farming:** Concept, importance, problems of crop production in dry land, drought and its classification, rain water management, watershed management. (4)
7. **Cropping systems:** Cropping systems & its use, mixed cropping, intercropping, multiple cropping & relay cropping. (6)
8. **Cropping pattern:** Determinants, factors influencing cropping patterns, major cropping patterns in different agro ecological zones of Bangladesh. (6)
9. **Crop forecasting:** Objectives & methods of crop report preparation, crop cutting experiment. (4)
10. **Seed science:** Seed quality, seed rate & grading, seed storage & seed testing. (6)
11. **Production technology of the following crops:** Rice, wheat, sugarcane, potato, jute, rapeseed, sunflower. (14)

Practical: 1.2 Credits, 3 hrs/wk

1. Identification of seeds of field crops
2. Identification of sand, silt, and clay by finger method.
3. Identification of manures & fertilizers.
4. Preparation & preservation of farmyard manure & compost.
5. Testing seed for moisture, purity, germination, viability & vigour.

6. Study of life cycle & morphology of major weed with emphasis on the identification of propagating organs.
7. Raising of green manuring crops & techniques of greed maruring.
8. Preparation of crop calendar & cropping schedule of different conditions under different systems of croppings.
9. Preparation of crop rotation schedules.

Books Recommended:

1. Cropping system: Theory and practice. B.N. Chatterjee.
2. Fundamentals of Agronomy. G.C.De.
3. Principles and Practice of Agronomy. B. Aniyan and S.P. Palaniappan
4. Modern Techniques of Raising Field Crops. C. Singh
5. Principles and Practices of Agronomy. S.S. Singh
6. Principles of Agronomy. T. Yellamada Reddy & G. H. Sanka Reddy.
7. Fundamentals of Cereal Crop Production. R.K. Rai.
8. K…wlZ‡Z¡i †gŠjbxwZ. Gg. G. KzÏym I Gg. Gb. Bmjvg

BOT 539: ENVIRONMENTAL MICROBIOLOGY

Total credit hour: Minimum- 60 **Full Marks : 100**

1 Credit hour = 45 minutes

(**Instructions for Question Setters:** Each question carries 20 marks and there will be four sub-sections. The highest and the lowest marks of each sub-section will be 10 and 2, respectively. In the examination, there will be eight questions, out of which five questions should be answered.)

1. Microbes and environment: Populations and community, microbial growth on surfaces and biofilm; terrestrial and freshwater environments; marine habitat and microbial distribution, deep sea microbiology.

2. Microbial growth: Environmental effects on microbial growth- temperature; pH; osmolarity and oxygen.

3. Microbial growth control: Physical control-Heat, radiation and filter sterilization; Chemical control- chemical growth control (MIC); antimicrobial agents- sterilants, disinfectants, sanitizer and antiseptics; synthetic drugs and natural occurring drugs (penicillins), antiviral and antifungal drugs; Antimicrobial drug resistance.

4. Significance of microbial activities in the environment: Carbon, nitrogen, sulfur and iron cycles; Microbial bioremediation: pesticides, plastic and petroleum biodegradation.

5. Microorganisms and pollution: Microbial aspects of air and water pollution; microbial toxins in the environment; Microorganisms as indicators of environmental pollution

6. Microbial interactions: with plants-Lichens and michorrhizae, *Agrobacterium* and crown gall disease, root nodule bacteria and symbiosis with legumes; **with human**- normal microbial flora of the skin, oral cavity and gastrointestinal tract; **with insect**- multiple microbial symbionts of fungus-cultivating ants.

7. Airborne transmission of microbial diseases: Airborne pathogens and respiratory infection and disinfection.

8. Soil borne microbial diseases: Tetanus and Mycoses.

9. Wastewater treatment, water purification and waterborne microbial disease: wastewater microbiology, public health and water quality- coliforms, drinking water purification-physical and chemical, disinfectant; wastewater and sewage, wastewater treatment- primary, secondary (anoxic and aerobic) and tertiary; sources of waterborne infection, cholera and typhoid fever.

10. Methods in microbial ecology: culture-dependent analysis of microbial communities-enrichment and isolation, isolation in pure culture; molecular (culture-independent) analysis of microbial communities- DAPI, FISH; PCR, DGGE; Environmental genomics (metagenomics); measuring microbial activities in nature-radioisotopes and microelectrodes.

Practical: 1.2 Credits, 3 hrs/wk

1. Safety rules in Microbiology lab.
2. Uses and maintenance of instruments for microbiological research.
3. Isolation of microorganisms from various environments.
4. Methods for the determination of microbial numbers,
5. Preparation of pure cultural and preservation.
6. Preparation of physiological saline, buffers and antibiotics
7. Determination of minimum inhibitory concentration (MIC) by Agar dilution and disc diffusion methods.
8. Important biochemical tests: carbohydrate fermentation, catalase, coagulase and indole test.

Books Recommended:

1. Biology of Microorganisms: Madigan, MT and Martinko, JM, 11th Ed. 2006 Pearson Prentice Hall.
2. Microbiology: Pelzer, M; Chan, ECS and Krieg, NR, 5th Ed, Tata Mcgraw-Hill edition 1993.
3. Micro-organisms function, form and environment: Hawker, LE and Linton, AH, Edward Arnold Ltd. 1971.

BOT 540: MOLECULAR STRESS PHYSIOLOGY

Total credit hour: Minimum- 60 **Full Marks : 100**

1 Credit hour = 45 minutes

(**Instructions for Question Setters:** Each question carries 20 marks and there will be four sub-sections. The highest and the lowest marks of each sub-section will be 10 and 2, respectively. In the examination, there will be eight questions, out of which five questions should be answered.)

1. **Introduction:**

   Definition, landmark, plant cells, tissues and organs, vacuole, cytosol, types of biotic and abiotic stresses, chelators, phytochelatins.
2. **Mineral uptake in plants:**

   Uptake and transport of Fe and Zn in plants, transporters genes (*IRT1, ZIP1, ZIP4, FRO1, HAI1*), molecular aspects of uptake and long-distance transport of iron and zinc under deficiency.
3. **Heavy metal tolerance in plants:**

   Biochemical responses, natural variations in metal tolerance, chelating and metal binding mechanisms, metabolites and genes involved in metal transport and vacuolar sequestration (*NAS2, PCS1, MT1*), hyperaccumulator.
4. **Phytoremediation**

   Definition, strategies, alleviation of heavy metal toxicity though exogenous compounds (silicon, salicylic acid, glutathione).
5. **Salinity stress:**

   Na and K balance under salinity, toxicity, tolerance strategies: (shoot ion independent stress, ion exclusion and Na^+ tissue tolerance), compatible solute accumulation and osmotic protection, salinity-induced genes and molecular basis of salt-tolerant, salinity problem in Bangladesh and its effect on crop yield.
6. **Drought and osmotic stress in plants:**

   Effect on plants, biochemical responses, physiological and molecular mechanisms associated with drought tolerance in plants.
7. **Role of hormones in abiotic stress tolerance:**

   Type of hormones and their functions in stress responses, involvement in gene regulation and long-distance transport of stress-induced signal, roles in alleviating heavy metal stresses.
8. **Antioxidant system and its role on stress tolerance:**

   Antioxidant activities, reactive oxygen species (ROS), sulfur and nitrogen containing amino acids, types of antioxidant enzymes, role antioxidant activities in detoxifying reactive oxygen species.
9. **Biotechnological applications for stress-tolerant crops:**

   Molecular methods for crop improvement, marker-assisted breeding for stress resistance in crop plants, genetic transformation of stress tolerant genes, over-expression of stress tolerant genes, RNAi.

10. Metabolic engineering for stress tolerance:

Metabolome and metabolomics, importance of metabolic engineering, wild species to understand specific stress adaptations, targets selection for metabolic engineering, identification of Pathways and genes, analytical techniques for metabolomics analysis, advantage and disadvantages, database for metabolomic pathways.

Practical: 1.2 Credits, 3 hrs/wk

1) Methodological overview and demonstration of high-performance liquid chromatography (HPLC) for analyzing plant metabolites.
2) Isolation of plant RNA and checking RNA integrity through gel electrophoresis method.
3) Primer designing, calculating annealing temperature and demonstration of PCR program for RT-PCR analysis.
4) Collection of xylem sap through root pressure method.
5) Calculation and preparation of stock and working solution.
6) Preparation of stock and working solution as well as the establishment of hydroponic culture.
7) Spotting
8) Laboratory notebook.

Books recommended:

1. Plant Physiology by L. Taiz and E. Zeiger.
2. Physiology and Molecular Stress Tolerance in Plants. Madhava Rao, Raghavendra and Janardhan Reddy.
3. Plant Physiology, Biochemistry and Molecular Biology by David T. Dennis and David H. Turpin
4. Introduction to Plant Physiology by William G. Hopkins
5. Bioinformatics for Dummes by Jean-Michel Claverie and Cedric Notredame

ORDINANCE FOR THE DEGREE OF MASTER OF SCIENCE (M.S.)

1. The Faculty of Life and Earth Sciences shall consist of the following Departments:

i) Geography and Environmental Studies
ii) Psychology
iii) Botany
iv) Zoology
v) Geology and Mining

and such other department(s) that may be established by the University from time to time and as assigned to the Faculty by the Academic Council.

2. The Faculty of Life and Earth Sciences shall be constituted according to the Statutes, Ordinances and Regulations of the University governing the constitution of the Faculties.

3. There shall be a course of study of Master of Science (M.S.) Degree.

4. Duration of the Course:

The M.S. course, consisting of General and Thesis Groups, shall extend over a period of 1 (one) academic year. The degree has to be completed within a minimum of 1 (one) academic year and not more than 2 (two) academic years from the date of first admission.

5. Admission Requirements:

For admission to the M.S. course in any subject of the faculty a student must have the following qualifications:

(a) The Bachelor of Science (B.Sc.) with Honours Degree of four years duration of this University or of a recognized University in the subject or similar subject to be decided by the relevant Department.

(b) To be eligible for admission to M.S. programme, a student must have to obtain at least 2.50 and 3.25 CGPA in the B. Sc. (Honours) Examination for the General and Thesis Groups respectively.

(c) Admissible duration of break of study after passing B.Sc. (Honours) Examination to be decided by the relevant Department.

(d) Candidate appearing at the B. Sc. (Honours) Final Examination from this University may be admitted provisionally to the M.S. classes pending publication of their examination results, the confirmation of their admission being subject to their passing the examination as and when the results of examination are published.

(e) If a student obtain or fails to obtain or improve the M.S. Degree within a maximum of 2 (two) academic years from the date of first admission shall not be allowed for admission or readmission.

(f) The number of seats in each Department will be determined by the relevant Department.

6. Course, Distribution of Marks, Units and Credits:

The total marks of M.S. Examination (General and Thesis Groups) shall be 800 (8 Units and 32 Credits) for all the subjects. The marks shall be distributed among the Theory courses, Class assessment, Tutorial, Terminal, Practical/ Thesis/ Dissertation, Field work report/ Project/ Thesis defense/ Seminar etc. as follows:

Course		Marks	Units	Credits (Credit Points)
a)	Theory (not exceeding 6 courses)	500	5	20
	Class assessment (including attendance)[1], Tutorial and Terminal	50	0.50	2
	Viva-voce	50	0.50	2
b)	Practical including records of practical works and laboratory assessment / attendance[2]	150	1.50	6
	Field work report / Project/ Excursion report / Collection of samples report	50	0.50	2
	or			
	Thesis / Dissertation	150	1.50	6
	Thesis Defense / Seminar	50	0.50	2
Total		800	8.00	32

*1. 20% marks shall be awarded for class attendance.
*2. 10% mark shall be awarded for laboratory attendance and 10% for records of practical works. Marks for attendance shall be awarded on the basis of proportionality of attendance.

There shall be at least 30, 45 and 60 lecture hours in an academic year for each theory course of 0.50, 0.75 and 1.0 unit respectively and at least 30, 60 and 90 laboratory periods in an academic year for each practical course of 0.5, 1.0 and 1.5 unit respectively.

Class assessment, Tutorial and Terminal marks (average) are to be submitted by the teachers concerned to the Chairman of the relevant Examination Committee before the commencement of the final Practical Examination. Consolidated average marks of class assessments, tutorials/, terminals/, viva-voce, practical courses and defense/ seminar are to be submitted to the Controller of Examinations by the Chairman of the relevant,2 Examination Committee before finalizing the result.

7. Eligibility for Examination: In order to be eligible for taking up the M.S. Examinations, a student must have pursued a regular course of study by attending not less than 75% of the total number of classes held (theoretical, practical, class assessment etc.) provided that the Academic Committee of the Department on special grounds and on such documentary evidence, as may necessary may condone the cases of shortage of attendance ordinarily not below 60%. A student, appearing at the examination under the benefit of this provision shall have to pay in addition to the examination fees, the requisite fee prescribed by the Syndicate for the purpose.

8. Admission to Examinations: Every student for admission to the M.S. Examination shall submit his/ her application in the prescribed form together with certificates of attendance and fulfill all other conditions prescribed by the University. The

application shall be submitted through the Chairman of the Department and Provost of the Hall concerned so as to reach the Controller of Examinations at least 4 (four) weeks before the date fixed for the commencement of the Examination.

9. **Examination Committees:** There shall be an Examination Committee of the M.S. examination provided that where there are more than one group in any subject there may be more than one but not more than three examination committees. The Examination Committee(s) shall be proposed by the Departmental Academic Committee. The Examination Committee shall consist of 5 (five) members, 1 (one) of whom should be an External Member from outside of the Department/ University, 1 (one) Chairman and 3 (three) other Members from among the teachers of the Department.

The Examination Committee shall (i) propose the names of the question setters and script/ field work report/ project report/ excursion report/ sample collection report/ thesis/ dissertation etc. examiners from the previously approved panel of examiners, (ii) moderate questions of the examination, (iii) propose the examination date and schedule (for approval of the Department), (iv) recommend the names of 3 (three) tabulators (for approval of the Vice Chancellor) and (v) finalize the results.

The Examination Committee shall make necessary arrangement for holding Theory, Practical, Viva-voce, Seminar/ Defense examination (s).

10. **Medium of Answers:** The medium of answers in the examination of all courses of each subject will be either in English or Bangla, unless otherwise directed by the concerned Department.

11. **Examination, Question setters, Examiners and Marks:** The M.S. Examination shall be held annually. There shall be 2(two) question setters in each of the Theory course and 2 (two) script examiners (first and second examiners) in each Theory course/ Field work report/ Project report/ Excursion report/ Sample collection report, 2 (two) examiners [1(one) of whom should be an External Examiner from outside the Department / University and 1(one) examiners from among the teachers of the Department (usually Supervisor/ Principal Supervisor)] for Thesis/ Dissertation and 5 (five) examiners (including an external) for the Practical Examination of 10 (ten) students per day. However, if the number of students in the Practical Examination is less than 10 (ten) per day, there shall be 3 (three) examiners including the external examiner.

Viva-voce and Seminar/ Defense examinations will be conducted by the relevant Examination Committee.

The arithmetic mean of the marks awarded by the 2 (two) examiners in each course shall be taken. In case the marks awarded by the 2 (two) examiners differ by 20% or more the Examination Committee shall recommend a third examiner and the arithmetic mean of 2 (two) nearest marks will be counted. If the 3 (three) marks are equally apart, mean of the higher 2 (two) marks (advantage to the student) be taken.

If the number of script to be third examined is 50% or more of the total scripts of a course then the all scripts of that course shall have to be third examined.

12. Thesis /Dissertation Submission:

Five (5) copies of Thesis/ Dissertation report (type-written/printed and bound) duly signed by the concerned supervisor(s) shall have to be submitted to the Chairman of the relevant. Examination Committee within the schedule date [ordinarily 3 (three) months after the completion of theoretical examination] of submission. One copy approved for M.S. Degree shall be sent by the Chairman of respective Examination Committee to the Departmental Seminar / University Library for future reference.

13. The Grading Systems:

(a) **Credit Point (CP):** The credit points achieved by an examinee for 0.50 and 1.0 unit courses shall be 2 and 4 respectively. For further fractions of a unit, proportionality should be applied.

(b) Letter Grade (LG) and Grade Point (GP): Letter Grade and corresponding Grade points shall be awarded in accordance with provisions shown below:

Percentage range of marks	LG	GP per CP
80% or its above	A^+ (A plus)	4.00
75% to less than 80%	A (A regular)	3.75
70% to less than 75%	A^-(A minus)	3.50
65% to less than 70%	B^+ (B plus)	3.25
60% to less than 65%	B (B regular)	3.00
55% to less than 60%	B^- (B minus)	2.75
50% to less than 55%	C^+ (C plus)	2.50
45% to less than 50%	C (C regular)	2.25
40% to less than 45%	D	2.00
Less than 40%	F	0.00
Incomplete / Absence	I	--

(c) Grade Point Average (GPA) and Total Credit Point (TCP):

The weighted average of the grade points obtained in all the courses by a student shall be calculated from the following equations:

$$GPA = \text{Sum of } [(CP)i \times (GP)i] \div \text{Sum of } (CP)i$$

where (GP)i = Grade point obtained in individual course

(CP)i = Credit point for respective course

14. Award of Degree, Improvement of Results and Readmission:

(a) **Award of Degree:** The M.S. Degree in any subject shall be awarded on the basis of GPA and TCP obtained by a student. GPA shall taken upto 4 (four) places after decimal. In order to qualify for M.S. Degree a student must have to obtain within 2 (two) academic year from the date of admission:

(i) A minimum GPA of 2.50

(ii) A minimum GP of 2.00 in the practical courses and Thesis/ Dissertation

(iii) A minimum TCP of 28, (Maximum 4 CP shortage in Theoretical course(s) only will be allowed)

The result shall be given in GPA with the corresponding LG in bracket.

(b) **Publications of Results:** The Controller of Examinations shall publish the result and provide the transcript in English showing course number, course title, credit point, letter grade and grade point of individual courses, GPA and corresponding LG for the overall result.

(c) **Improvement of Result:** A student earning less than 2.75 and F/I grade in individual theory courses in the first academic year shall be allowed to improve the grades of courses (not more than two theory courses) and thereby overall result through the regular examination of immediate following academic years. If a student fails to improve the result the previous results shall remain valid.

(d) **Readmission:** A student, who failed to appear at the examination or fails to pass the examination in the first academic year, may on approval of the relevant Department be readmitted to the immediate following session. A readmitted candidate shall have to reappear at the examination of all courses. A student failing to earn requisite TCP and GPA after taking readmission shall be dropped out of the programme.

15. Academic Calendar:

The date of beginning and completion of course, date of examination etc. shall have to be declared by the Department concerned through an academic calendar at the beginning of the session.

Examination results shall ordinarily be published within 6 (six) weeks from the date of completion of examination.

16. Duration of Examination:

(a) The duration of examination of theory course shall be 3 (three) hours for 0.50 and 4 (four) hours for 0.75 to 1.00 unit courses.

(b) The duration of practical examination shall be 24 (twenty four) hours [6 (six) hours per day].

17. Examination Ethics:

(a) Every one involved in the process of examination has to ensure the security of examination and follow the examination rules of the University.

(b) An examinee never be asked any question that hurt his/her religious or ethnic background.

(c) If someone (teacher or employee) is involved in examination process has the following relatives as examinee(s) he/she should inform the Chairman of concerned Examination Committee or the Controller of Examinations immediately:

(i) husband/ wife, (ii) son/ daughter, (iii) brother/ sister (iv) brother-in-law/ sister -in- law, (v) son in-law/daughter-in-law, (vi) nephew/ niece, (vii) first cousins, (viii) father/ mother (ix) Uncle/ aunt and (x) father-in-law/ mother-in-law.

18. Administration:

Respective statutory authorities of the University shall design syllabus, allocate courses for teaching, constitute Examination Committee and the panel of examiners as per rules of the University.

19. Enforcement of the Ordinance:

This ordinance, shall come in force from the academic session 2010-2011 (examination-2011) onwards and the previous one shall stand cancelled. Students under previous ordinance shall have to complete their programme in special consideration if such students remain in the programme after the due date.

20. Amendment:

Any proposal to amend this ordinance shall be processed through the Faculty of Life and Earth Sciences and shall have to be passed by the Academic Council of the Rajshahi University

END