DEPARTMENT OF BOTANY

Jahangirnagar University
Savar, Dhaka.

Syllabus for Bachelor of Science (Hons.) courses in Botany for the academic session: 2013-2014, 2014-2015, 2015-2016 and 2016-2017

The B. Sc. (Hons.) program in Botany shall be of four academic years, divided into four parts- Part I, Part II, Part III and Part IV. These four parts shall be comprised of 57 courses including theory, practical and viva-voce and the total marks for these courses will be 3500 equivalent to 140 credits. Examination on the courses of Part-I, Part-II, Part-III and Part-IV shall be held respectively at the end of first year, second year, third year and fourth year. Assessment of each student for all courses shall be based on the marks obtained in- i) examination held at the end of the course, ii) tutorial examination and iii) class attendance. In a theoretical or a practical course, 70% of the total marks shall be from the written/practical examination to be held at the end of the course, 20% from the written tutorial examination and 10% from the class attendance. The marks distribution for a particular course is shown in details for each part. The viva-voce examination shall be held after the completion of written and practical examination of each part.

A course of 100 (70+20+10) marks shall be equivalent to 4 credits and that of 50 (35+10+5) marks equivalent to 2 credits. Viva-voce examination of 50 marks shall be of equivalent to 2 credits. The duration of theoretical examinations of 70 marks shall be of 4 hours and that of 35 marks shall be 2.5 hours. The duration of practical examinations of 35 marks shall be of 6 hours.

Study tour for each Part I, Part III, and Part IV shall be conducted at convenient time to gather field knowledge on vegetation and phytodiversity of the country, relevant research institutions and industries. Marks for study tour is incorporated in the practical course suited best.

The courses, marks and credits distributions are given below:

Part-I
(1st Year; Examination of 2014, 2015, 2016 and 2017)

Theory Courses

Course No	Course Title	Marks	Credits
Bot. 101	Basic Microbiology	50	2
Bot. 102	Mycology	50	2
Bot. 103	Phycology	50	2
Bot. 104	Higher Cryptogams	50	2
Bot. 105	Gymnosperms and Palaeobotany	50	2
Bot. 106	Plant Systematics-I	50	2
Bot. 107	Zoology	100	4
Bot. 108	Chemistry	50	2

Practical courses and Viva-voce

Bot. 111	Basic Microbiology, Mycology, Phycology	50	2
Bot. 112	Higher Cryptogams, Gymnosperms, Plant Systematics-I, Study tour	50	2
Bot. 113	Zoology	50	2
Bot. 114	Chemistry	50	2
Bot. 115	Viva-voce	50	2
	Total =	**700**	**28**

Part-II
(2nd Year; Examination of 2015, 2016, 2017 and 2018)

Theory Courses

Course No	Course Title	Marks	Credits
Bot. 201	Limnology	50	2
Bot. 202	Basic Plant Ecology	100	4
Bot. 203	Plant Anatomy, Embryology and Palynology	100	4
Bot. 204	Economic Botany and Ethnobotany	50	2
Bot. 205	Plant Physiology	50	2
Bot. 206	Cytology	50	2
Bot. 207	Genetics-I	50	2
Bot. 208	Computer Basics	50	2
Bot. 209	Biostatistics	50	2
Bot. 210	Biochemistry	100	4

Practical Courses and Viva-voce

Bot. 211	Limnology, Basic Plant Ecology, Plant Anatomy, Embryology and Palynology	50	2
Bot. 212	Economic Botany, Plant Physiology, Cytology, Genetics-I	50	2
Bot. 213	Computer Basics, Biostatistics	50	2
Bot. 214	Biochemistry	50	2
Bot. 215	Viva-voce	50	2
	Total =	**900**	**36**

Part-III
(3rd Year; Examination of 2016, 2017, 2018 and 2019)

Theory Courses

Course No	Course Title	Marks	Credits
Bot. 301	General Microbiology	50	2
Bot. 302	Plant Pathology	100	4
Bot. 303	Phytochemistry and Herbal Medicine	50	2
Bot. 304	Environmental Plant Physiology	50	2
Bot. 305	Plant Systematics-II	50	2
Bot. 306	Cytogenetics	50	2
Bot. 307	Agronomy and Horticulture	100	4
Bot. 308	Plant Tissue Culture	100	4
Bot. 309	Molecular Biology and Bioinformatics	100	4

Practical Courses and Viva-voce

Bot. 311	General Microbiology, Plant Pathology, Phytochemistry and Herbal Medicine	50	2
Bot. 312	Environmental Plant Physiology, Plant Systematics-II, Study tour	50	2
Bot. 313	Cytogenetics, Agronomy and Horticulture	50	2
Bot. 314	Plant Tissue Culture, Molecular Biology and Bioinformatics	50	2
Bot. 315	Viva-voce	50	2
	Total =	**900**	**36**

Part-IV
(4th Year; Examination of 2017, 2018, 2019 and 2020)

Theory Courses

Course No	Course Title	Marks	Credits
Bot. 401	Advanced Microbiology	100	4
Bot. 402	Plant Pathology and Plant Protection	100	4
Bot. 403	Developmental Plant Physiology and Plant Biochemistry	100	4
Bot. 404	Advanced Plant Ecology	50	2
Bot. 405	Soil and Environment	50	2
Bot. 406	Plant Systematics-III	50	2
Bot. 407	Biodiversity and Conservation	50	2
Bot. 408	Plant Breeding	100	4
Bot. 409	Biotechnology and Genetic Engineering	100	4
Bot. 410	Genetics-II	50	2

Practical Courses and Viva-voce

Bot. 411	Advanced Microbiology, Plant Pathology and Plant Protection	50	2
Bot. 412	Developmental Plant Physiology, Advanced Plant Ecology, Soil and Environment	50	2
Bot. 413	Plant Systematics-III, Biodiversity and Conservation, Study tour	50	2
Bot. 414	Plant Breeding, Biotechnology and Genetic Engineering, Genetics-II	50	2
Bot. 415	Viva-voce	50	2
	Total =	**1000**	**40**

Summary of the Syllabus

Part-I:	8 Theory courses	450 Marks	(18 credits)
	4 Practical courses	200 Marks	(8 credits)
	Viva-voce	50 Marks	(2 credits)
		Total = 700 Marks	**Total = 28 credits**
Part-II:	10 Theory courses	650 Marks	(26 credits)
	4 Practical courses	200 Marks	(8 credits)
	Viva-voce	50 Marks	(2 credits)
		Total = 900 Marks	**Total = 36 credits**
Part-III:	9 Theory courses	650 Marks	(26 credits)
	4 Practical courses	200 Marks	(8 credits)
	Viva-voce	50 Marks	(2 credits)
		Total = 900 Marks	**Total = 36 credits**
Part-IV:	10 Theory courses	750 Marks	(30 credits)
	4 Practical courses	200 Marks	(8 credits)
	Viva-voce	50 Marks	(2 credits)
		Total = 1000 Marks	**Total = 40 credits**

Grand Total: 3500 Marks (140 Credits)

GPA System Ordinance

Summary of Ordinance Provisions

Examination Marks

Course-end final theory	---	70%
Written tutorial	---	20%
Class attendance	----	10%

Class Attendance

A student with class attendance of less than 60% in any course will not be qualified to appear at the course-end examination of that course. Credits in the form of Marks will be given to students attending classes over the minimum 60% mandatory requirement. Basis for awarding Marks for class attendance will be as follows:

Class attendance	**Marks allocated for 4 credit courses**	**Marks allocated for 2 credit courses**
90% or above	**10**	**5**
85% to less than 90%	**9**	**4.5**
80% to less than 85%	**8**	**4**
75% to less than 80%	**7**	**3.5**
70% to less than 75%	**6**	**3**
65% to less than 70%	**5**	**2.5**
60% to less than 65%	**4**	**2**
Less than 60%	**0**	**0**

Grading System

The total numerical marks obtained by a student in each theory and practical course (that is, course-end examination plus class work) and in the Part-final viva-voce examination shall be converted into letter grades and grade points. There shall be 10 letter grades with corresponding grade points to evaluate a student. In addition, there will be an 'I' (Incomplete) category for those students who will leave a course incomplete at the end of an academic year due to medical or other compelling reasons acceptable to the Department. The numerical marks, letter grades and grade points shall be as follows:

Marks (%)	Letter Grade	Grade Point
80% and above	**A^+**	**4.00**
75% to less than 80%	**A**	**3.75**
70% to less than 75%	**A^-**	**3.50**
65% to less than 70%	**B^+**	**3.25**
60% to less than 65%	**B**	**3.00**
55% to less than 60%	**B^-**	**2.75**
50% to less than 55%	**C^+**	**2.50**
45% to less than 50%	**C**	**2.25**
40% to less than 45%	**D**	**2.00**
Less than 40%	**F (Fail)**	**0**
Incomplete	**I**	**0**

Earned Credits

Only that course will be counted towards credits of a student in which the student has earned a grade of D or above.

Calculation of Grade Point Average

Grade Point Average (GPA) is the weighted average of the grade points obtained in all the courses passed by a student in a year. For example, if a student passes five courses in a Part having credits of C1, C2, C3, C4, C5 and C6 and his/her obtained grade points in these courses are G1, G2, G3, G4, G5 and G6 respectively then,

$$\text{GPA} = \frac{\sum C_i G_i}{\sum C_i} \qquad \text{where i = 1 to 6}$$

For example, if a student takes 6 courses in one academic year and obtains the following grades:

Course	Credits	Letter-grade	Grade Points
101	4	A^+	4.00
102	4	C^+	2.50
103	4	A^-	3.50
104	2	B^-	2.75
105	2	B	3.00
106	2	F or I	0

Then the GPA for the particular Part, calculated to two digits after decimal point, will be:

$$\text{GPA} = \frac{4(4.00)+4(2.50)+4(3.50)+2(2.75)+2(3.00)+2(0)}{4+4+4+2+2+2} = 2.86$$

Cumulative Grade Point Average

Cumulative Grade Point Average (CGPA) is the weighted average of the GPA's secured in two or more successive academic Parts of the 4-part program of study calculated to two digits after decimal point. Total credits in each of the Parts will be used as weights for the calculation as shown in the following examples.

Part	GPA	Credit
I	4.0	20
II	3.0	30
III	3.5	25
IV	3.0	20

The CGPA in this case will be:

$$\frac{(20 \times 4) + (30 \times 3) + (25 \times 3.5) + (20 \times 3)}{20+30+25+20} = 3.34$$

Improvement of grade

(i) If a student obtains a grade lying between D and A in one or more courses in a particular Part, but fails to obtain more than 2.25 GPA in that Part, the student shall not be allowed to repeat any course for purpose of grade improvement.

(ii) Courses with only F grades are eligible for improvement examination subject to the condition that if a student obtains a 'F' grade in one or more courses in Part I, Part II or Part III examination, and also obtains at least a GPA of 2.00 in the relevant Part, the student shall be allowed to appear for improvement examination only in one course of the Part along with the examinations of the next academic session. In the improvement examination, however, the student shall not be eligible for a grade higher than C, but in the transcript there shall not have any indication that the grade C was obtained through an improvement examination.

DETAILS OF THE SYLLABUS

Part-I
(1st Year; Examination of 2014, 2015, 2016 and 2017)

THEORY COURSES

Bot. 101 Basic Microbiology **2 Credits, 50 (35+10+5) Marks**

1. Introduction: The history and scope of Microbiology; the discovery of the microbial world, the debate over spontaneous generations, and biogenesis. Germ theory of disease. Major inventions and the contributors
2. The diversity of Microorganisms: The concept of protoctista, prokaryotes and eukaryotes and their phylogeny. Whittaker's five kingdom concept, two super kingdom system of Margulis and Swartz and three domain concept.
3. General characteristics, structure, reproduction and importance of Prion, Viroid, Mycoplasma, Archaebacteria.
4. Viruses: Definition, structure, types, multiplication and transmission, importance and examples of viruses as human and plant pathogens.
5. Eubacteria: Definition, types, nutritional categories, cellular structure, multiplication and reproduction. Importance of bacteria: examples of plant and human pathogenic bacteria, biofertilizer, medicine, food and industrial products.
6. Actinomycetes: General properties, structures and reproduction; importance of Actinomycetes as environmental, public health and medical concern.
7. Microbial Growth: Definition; Growth curve– lag phase, exponential phase, stationary phase and death phase; Measurement of microbial growth– cell number, cell mass; mathematical expression of microbial growth.

References

1. Madigan M.T., Martinko J.M. and Parker J. 2003. Brock Biology of Microorganisms. Prentice-Hall International, New Jersey, USA.
2. Prescott L.M., John P.H. and Donald A.K. 1999. Microbiology. (4/E), 2002 (5/E), 2005 (6/E). McGraw-Hill Company, USA.
3. Pelczar Jr.M.J, Chan E.C.S. and Krieg N.R. 1993. Microbiology: Concepts and Applications. McGraw-Hill Inc, USA.
4. Stainer R.Y., Ingraham J.L., Wheelis M.I. and Panter P.R. 1986. General Microbiology, Prentice-Hall, London.
5. Talaro K.P. and Talaro A. 1999. Foundations in Microbiology, McGraw Hill Company, New York, USA.

Bot. 102 Mycology **2 Credits, 50 (35+10+5) Marks**

1. Introduction to Mycology: Historical development; scope and importance to mankind.
2. Slime Mold Fungi: General characteristics, somatic phase, classification, fruiting bodies and reproduction of slime mold.
3. Fungi: Habit, habitat, nutrition, somatic structure, modification of mycelium and cell structure of fungi; Type of spore, spore liberation and dispersal mechanism of fungi.
4. Classification of fungi: Alexopoulos and Mims (1979); Ainsworth (1973).
5. Reproduction: Asexual and sexual reproduction in different classes of fungi; Asexual and sexual fruiting bodies in fungi.
6. Salient features, life-cycle and taxonomic position of the following genera: *Synchytrium*, *Saprolegnia*, *Phytophthora*, *Rhizopus*, *Saccharomyces*, *Aspergillus*, *Penicillium*, *Puccinia*, *Agaricus*, *Alternaria*, *Colletotrichum*, *Fusarium.*
7. Economic importance of fungi: Role of fungi in agriculture, medicine and industries; List of plant, animal and human diseases caused by fungi.
8. Mushroom: General characteristics, morphology, cultivation and economic importance.
9. Lichen: Developmental history of lichen; Habitat, occurrence and distribution of lichen with special reference to Bangladesh; Classification and mode of reproduction of lichen; Economic importance of lichen.

References

1. Alexopoulos C.J., Mims C.W. and Blackwell M. 1996. Introductory Mycology (4th edn.). John Wiley and Sons Inc. New York, USA.
2. Elizabeth M.L. 1996. Fundamentals of the Fungi (4th edn.). Prentice Hall Inc. USA.
3. Mehrotra R.S. and Aneja K.R. 1990. An Introduction to Mycology. Wiley Eastern Ltd. New Delhi, India.
4. Sharma O.P. 2004. Text Book of Fungi, Tata McGraw Hill Publishing Company Ltd. New Delhi, India.
5. Webster J. 1980. Introduction to Fungi. Cambridge University Press, London, England.

Bot. 103 Phycology **2 Credits, 50 (35+10+5) Marks**

1. Introduction: Definition, history and scope of Phycology.
2. Definition of algae, its origin, evolutionary trends and phylogenetic relationships.
3. Classification of Algae: Van den Hoek and Jahns (1978) and Lee (1999)
4. Algal Habitats: Aquatic (Fresh, Brackish and Marine water); Terrestrial; Subaerial and special habitats (Symbiotic, parasitic, snow algae, thermal algae and desert algae).
5. General features: Pigments, reserve food, flagella, plastids, range of vegetative and reproductive structures of Algae.
6. General characteristics, economic importance of the following classes.
   (i) Cyanophyceae (ii) Chlorophyceae (iii) Euglenophyceae (iv) Bacillariophyceae (v) Phaeophyceae (vi) Rhodophyceae.

7. Salient features, life history and taxonomic position of representative genus belonging to the following classes. (i) Cyanophyceae: *Nostoc* (ii) Chlorophyceae : *Chlamydomonas*, *Oedogonium*, *Chara* (iii) Euglenophyceae: *Euglena*; (iv) Bacillariophyceae: *Navicula* (v) Phaeophyceae: *Sargassum* (vi) Rhodophyceae : *Polysiphonia*.
8. Ecological importance of Algae.

References

1. Bold H.C. and Wynne M.J. 1978. Introduction to Algae. New Jersey. Prentice-Hall.
2. Chapman V.J. and Chapman D.J. 1983. The Algae (2nd edn.). The MacMillan Press Ltd.
3. Kumar H.D. 1989. Algal Cell Biology (2nd edn.). Affiliated East-West Press Pvt. Ltd., New Delhi.
4. Lee R.R. 2008. Phycology. Cambridge University Press Ltd.
5. Pandey B.P. 1986. Algae. S. Chand and Company Ltd. India
6. Prescott G.W. 1984. The Algae: A Review, Bishen Sing Mahendra Pal Singh, Dehra Dun, India
7. Smith G.M. 1971. Cryptogamic Botany (2nd edn.), Algae and Fungi, vol.1. Tata McGraw Hill Publsiher, New Delhi.

Bot. 104 Higher Cryptogams **2 Credits, 50 (35+10+5) Marks**

Bryology:

1. Introduction, habit and habitat, general characters, classification, phylogenetic relationship and evolutionary trends in bryophytes.
2. Common bryophytes of Bangladesh along with their distribution, ecology and importance.
3. Detailed study of *Riccia*, *Sphagnum* and *Anthoceros* (Systematic position, identifying character, anatomical features, development of antheridium & archegonium, development of gametophyte and sporophyte, life cycle, economic importance).
4. Economic, biological and ecological importance of bryophytes.

Pteridology:

1. Introduction, habit and habitat, general characters, classification, phylogenetic relationship and evolutionary trends in pteridophytes.
2. Common pteridophytes of Bangladesh along with their distribution, ecology and importance.
3. Detailed study of *Lycopodium*, *Selaginella*, *Equisetum*, *Marsilea* and *Pteris* (Systematic position, identifying character, anatomical features, development of antheridium and archegonium, development of gametophyte and sporophyte, life cycle, economic importance).
4. Evolution of steler system, heterospory and seed habit tendency in pteridophytes.
5. Economic, biological and ecological importance of pteridophytes.

References

1. Pandey S.N., Trivedi P.S. and Misra S.P. 2000. A Text Book of Pteriodphyta. Vikas Pub. House. New Delhi.
2. Parihar N.S. 1965. An Introduction to Embryophyta (5th edn.). vol. I. Pteridophyta. Allahabad, India.
3. Schofield W.B. 1985. Introduction to Bryology. Black Burn Press, London, UK.
4. Smith G.M. 1972. Cryptogamic Botany (2nd edn.). Vol. II. Bryophytes and Pteridophytes. Tata McGraw Hill Pub., New Delhi, India.
5. Vashista P.C., Sinha A. K. and Kumar A.2006. Bryophyta and Pteridophyta. S. Chand and Company Ltd., New Delhi. India.

Bot.105 Gymnosperms and Paleobotany **2 Credits, 50 (35+10+5) Marks**

Gymnosperms

1. Introduction, habit and habitat, general characters, classification, phylogenetic relationship and evolutionary trends in gymnosperm.
2. Common gymnosperms of Bangladesh along with their distribution, ecology and importance.
3. Detailed study of ecological and morphological characters of *Cycas*, *Pinus* and *Gnetum*.
4. Reproductive and life cycle of *Cycas*, *Pinus* and *Gnetum*.
5. Primitive, advanced and relative characters of different gymnosperm genera.

Paleobotany

1. Introduction and scope of paleobotany.
2. Fossils: formation of rocks, determination of the age of rocks, formation of fossil, nature of fossils, significance of fossils, conclusions drawn from fossil record, imperfection of fossil record.
3. Determining the age of fossil, Outline of different paleogeological era, period and epoch with mentioning characteristic flora and its events, Gondwana flora of India and application of paleobotany (oil and coal).
4. Study of some fossil genera: Lepidodendron, Calamites, Lygenopteris.

References

1. Biswas C. and Johri B.M. 1997. An Introduction to Paleobotany. Tata McGraw Hill Pub. House Co., New Delhi.
2. Pandey S.N., Misra S.P. and Trivedi P.S. 2006. A Text Book of Botany-Bryophyta, Pteridophyta, Gymnosperm and Paleobotany. Vikas Pub. House. New Delhi.
3. Shripad N.A. 1995. Paleobotany. Oxford IBH Publishing Company Pvt. Ltd. India.
4. Vashista P.C. 2003. Gymnosperm. S. Chand and Company Ltd., New Delhi. India.
5. Vashista P.C., Sinha A. K. and Kumar A. 2006. Gymnosperm. S. Chand and Company Ltd., New Delhi. India.

Bot. 106 Plant Systematics-I **2 Credits, 50 (35+10+5) Marks**

1. Taxonomy and systematics: Meaning, relevance and application.
2. Principles of classification: A brief history of modern classification systems; kinds of classification; outlines of the classification systems of Linnaeus, Benthum and Hooker, Cronquist, Thorn and Angiosperm Phylogeny Group (APG).

3. Plant nomenclature: Ranks of taxa, nomenclatural types, effective and valid publication, author citation, retention and rejection of names, changes in names, nomenclature of hybrids and cultivars; construction of species and genus names.
4. Angiosperms: General and key characters, brief life history of a typical Angiosperm.
5. Taxonomic characters: Concept, types, selection, correlation and weighting of characters, character variations, field characters of grasses, sedges, palms, legumes, cucurbits, orchids and water lilies.
6. Botanical gardens and herbaria: Importance and functions of botanical gardens and herbarium, field and herbarium techniques; introductory knowledge on Bangladesh National Herbarium (DACB) and selected large world herbaria.
7. Elementary knowledge on the flora of Bangladesh: Introduction to the flora of Bangladesh; knowledge on botanical names, phenology and families of sixty species of medicinal, cereal, vegetable, fruit, timber, weed plants commonly found in Bangladesh.

References

1. Jones B.S. and Luschinger A.E. 1979. Plant Systematics, McGraw Hill Book Co. New Delhi, India.
2. Radford A.E., Dickison W.C., Massey J.R. and Bell C.R. 1974. Vascular Plant Systematics. Harper and Raw, New York.
3. Sivarajan V.V. 1980. Introduction to the Principles of Plant Taxonomy, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, India.
4. Stace C.A. 1980. Plant Taxonomy and Biosystematics. Arnold, London.
5. Stuessy T.F. 1990. Plant Taxonomy, Columbia University Press, New York.

Bot. 107 Zoology **4 Credits, 100 (70+20+10) Marks**

1. Classification of animal phyla up to the order with characteristic features.
2. General characters, classification, identification and biological significance of zooplankton.
3. Outline of life history and economic importance of the followings: (a) protozoa: *Giardia*; (b) Coelenterata: *Obelia*; (c) Platyhelminthes: *Taenia*; (d) Arthropoda: *Anopheles* sp.; (e) Pisces: *Labeo*; (f) Aves: *Gallus*; (g) Mammals: Guineapig.
4. Habit, habitats and adaptive features of fishes, amphibians, reptiles and birds.
5. Physiology of circulation, digestion, respiration and excretion in humans.
6. Common phytopathogenic nematodes: nature of damage and their control measures.
7. Common insect pests of rice, jute, cereals and stored grains and their control measures.
8. Pisciculture (Culture of Carp, Prawn and Shrimps in Bangladesh), apicultre and sericulture: Concept, methods, problems and prospects.
9. Wildlife Biology, concept, importance and threat, status and conservation of wildlife fauna in Bangladesh.
10. Venomous and non-venomous Snakes and Snake bites.

References

1. Barrington E.J.W. 1982. Invertebrates: Structure and Function (3rd edn.). Van Nostrand Reinhold, U.K.
2. Goto H.E. 1982. Animal Taxonomy. Edwad Arnold, U.K.
3. Khan M.A.R. 1982. Wildlife of Bangladesh- A Checklist, Dhaka Univ.
4. Storer T.I., Stibbins R.C., Usinger P.L. and Nybakken J.W. 2001. General Zoology, Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
5. Young T.Z. 1981. The Life of Vertebrates (2nd edn.). Oxford University Press, U.K.

Bot. 108 Chemistry **2 Credits, 50 (35+10+5) Marks**

1. Chemical Bonding**:** (a) Lewis electron-dot formula-ionic, Covalent and Coordinate covalent bond; Polar covalent bond, Hydrogen bond, Water as an interesting liquid, (b) Valence-shell electron pair repulsion theory, (c) Valence bond theory, Hybridization and shapes of molecular, Bond length and Bond energy.
2. Thermodynamics: (a) First law of thermodynamics, Heat of reaction and internal energy, Enthalpy and Enthalpy change, (b) Second law of thermodynamics, Entropy and entropy change for a phase transition, (c) Free energy and spontaneity, standard free-energy of formation and as a criterion for spontaneity.
3. (a) The Liquids: Intermolecular forces, Vapour pressure, Surface tension and capillary rise,
   (b) Solutions: Types of solutions, Solubility and the solution process, Effects of temperature and pressure on solubility, Ways of expressing concentrations.
4. (a) Colligative properties**:** Vapour pressure of a solution, Boiling point elevation and freezing point depression, Osmosis, Colligative properties of ionic solutions,
   (b) Colloids: Tyndall effect, Types of colloids, Hydrophilic and Hydrophobic colloids, coagulation, Association colloids.
5. Rates of Reactions: Reaction rate, order and rate law, Concentration-time equations, Half-life of reactions, Graphing of kinetic data, Collision theory, transition-State theory, Potential-Energy diagram of reactions Arrhenius equation, (b) Catalysis**:** Homogeneous and Heterogeneous catalysis, Enzyme catalysis.
6. (a) Acids and Bases: Arrhenius, Bronsted-Lowry and Lewis concept, Acid and base strengths, Self ionization of water and pH, Acid-ionization equilibrium, Buffers, (b) Electrochemistry: Oxidation-reduction reactions; Voltaic cells; construction and notation, Electromotion force, Standard cell emf's and standard electrode potentials.
7. (a) Aromatic Aldehydes and Ketones: Benzaldehyde, Gattermann-Koch Synthesis, Cannizzaro reaction, Benzoin condensation, Perkin reaction; Acetophenone, Backmann rearrangement; Benzophene, (b) Aromatic Carboxylic Acids: Benzoic acids, Benzyl chloride, Toluic acids, Anthanilic acid, Salicylic acid, Aspirin.

References

1. Ouellette R. J. 1984. Introduction to General, Organic, and Biological Chemistry. Macmillan Publishing Company, New York, U.S.A
2. Zumdahl S. S. 1996. Basic Chemistry. D.C. Heath and Company. Toronto, Canada
3. Bahl B.S. and Bahl A. 1994. A Textbook of Organic Chemistry. S. Chand and Company Ltd., New Delhi.

4. Bahl B.S., Tuli C.D. and Bahl A. 2004. Essentials of Physical Chemistry. S. Chand & Company Ltd., New Delhi.
5. Ebbing D.D. 1996. General Chemistry. Houghton Mifflin Co., Boston.
6. Chang R. 1996. Essential Chemistry. The McGraw-Hill Companies, Inc. New Delhi, Singapore, Tokyo.

PRACTICAL COURSES

Bot. 111 Basic Microbiology, Mycology, Phycology **2 Credits, 50 (35+10+5) Marks**

Basic Microbiology:
1. Microscope: Types and uses.
2. Growing microbes using cheaply available substrates.
3. Wet mounts preparation of bacterial culture.
4. Preparation and examination of films/smear of microorganisms.
5. Staining technique: Simple staining; Gram staining; Flagella staining; Negative staining; Spore staining.
6. Motility test for microorganisms: Hanging drop and semisolid medium techniques.
7. Study of colony characteristics of microorganisms.

Mycology:
1. Vegetative and reproductive structures of major fungal groups: Mycelial-types, asexual spores, asexual and sexual fruiting bodies, sclerotia and rhizomorph.
2. Studies on *Synchytrium, Saprolegnia, Albugo, Rhizopus, Mucor, Saccharomyces, Ascobolus, Aspergillus, Penicillium, Puccinia, Alternaria, Helminthosporium, Colletotrichum, Fusarium*.
3. Demonstration of mushroom cultivation and identification of mushroom: Morphological and anatomical features of *Agaricus* spp. and *Pleurotus* spp.
4. Study of the lichen genera available in local habitats.
5. Collection and preservation of fungi and lichen.

Phycology:
1. Working out of representative algae belonging to various groups mentioned in the theoretical syllabus.
2. Study of various types of algal habitats.
3. Collection, preservation and identification of algae from various habitats.

Marks Distribution

Practical examination	- 27 Marks
Lab. Note Book	- 5 Marks
Sample Collection	- 3 Marks
Total = 35 Marks	

Bot. 112 Higher Cryptogams, Gymnosperms, Plant Systematics-I, Study tour **2 Credits, 50 (35+10+5) Marks**

Higher Cryptogams and Gymnosperms:
1. Working out of the representative specimens belonging to higher cryptogams and gymnosperms mentioned in the theoretical syllabus.
2. Collection and preservation of higher cryptogams and gymnosperms.

Plant Systematics-I
1. Observation of diagnostic characters of Angiosperm families relevant to theoretical syllabus.
2. The students are to collect and submit both fresh and preserved specimens from all groups at the time of their practical examination.

There will be at least one field trip at any national garden or forest area and/or Bangladesh National Herbarium.

Marks Distribution

Practical examination	-	23 Marks
Lab. Note Book	-	4 Marks
Study tour including submission of field note book and report	-	8 Marks
Total =		**35 Marks**

Bot. 113 Zoology **2 Credits, 50 (35+10+5) Marks**

1. Temporary and permanent slide preparation for fresh water organisms and mouth parts of insects.
2. Studying different stages in the life cycle of representative insects covering theoretical syllabus.
3. Studying digestive, circulatory and respiratory systems through dissecting type organism.
4. Total and differential count of human blood; Blood groupings, and measurement of blood pressure.
5. Identification of important insect pests of crops.
6. Isolation and identification of nematode from soil and root samples.
7. Study of museum specimens of representative animal groups.
8. Preparation of taxidermy.

Marks Distribution

Practical examination	-	25 Marks
Lab. Note Book	-	5 Marks
Sample Collection	-	5 Marks
Total =		**35 Marks**

Bot. 114 Chemistry **2 Credits, 50 (35+10+5) Marks**

1. Preparation of (a) Normal solutions, (b) Molar solutions and (c) Colloidal solutions.
2. Titration of acids and bases.
3. Determination of pH by using pH meter and color reaction.
4. Detection of functional group from organic and inorganic compounds.

Marks Distribution

Practical examination	-	30 Marks
Lab. Note Book	-	5 Marks
	Total =	**35 Marks**

Bot. 115 Viva-voce **2 Credits, 50 Marks**

Part-II
(2nd Year; Examination of 2015, 2016, 2017 and 2018)

THEORY COURSES

Bot. 201 Limnology **2 Credits, 50 (35+10+5) Marks**

1. Introduction: Definition, History, Scope of Limnology; and Global Water Budget.
2. Physical factors of inland aquatic environments: Density, viscosity, surface tension, incident radiation, colour, turbidity, TSS and TDS of water, water movement, pH, electric conductivity and effect of light and temperature on the growth of organisms, thermal stratification and circulation.
3. Chemical factors of inland aquatic environments: dissolved oxygen, carbon dioxide, nitrogen, phosphate, silicon, iron and vitamin.
4. Productivity of aquatic habitat: Concept of primary productivity and its measuring technique - light and dark bottle, oxygen and ^{14}C tracer technique.
5. Nature of inland water bodies of Bangladesh
6. Classification of lakes, and special type of world lakes.
7. Eutrophication: Definition, Causes, symptoms, types and control measures.
8. Plankton: Definition, Classification, floating mechanisms of plankton, water bloom and their biological significance.
9. Common macrophytes of inland water bodies of Bangladesh, their economic importance and biological roles.

References

1. Hutchinson E.G. 1976. Treatise on Limnology. John Wiley and Sons, New York.
2. Ruttner F. 1975. Fundamentals of Limnology (3rd edn.). University of Toronto Press, Toronto and Buffalo.
3. Welch P.S. 1952. Limnology (2nd edn.). McGraw Hill Book Company, USA.
4. Wetzel R.G. 1983. Limnology. Saunders College Publishing, USA.

Bot. 202 Basic Plant Ecology **4 Credits, 100 (70+20+10) Marks**

1. Concept of Plant Ecology: Introduction, history, principles, scope and applications of plant ecology.
2. Autecology: Definition, importance, ecological life history of species, different aspects of autecological study of a species.
3. Population ecology: Definition, population characteristics, population dispersal and interactions among individuals of population.
4. Plant community ecology: Definition, characteristics and composition of community, community classification, life form and life-form categories, physiognomy, community evolution and community dynamics.
5. Study of vegetation: Analytical characteristics of plant community, qualitative and quantitative structure, sampling methods, quantitative analysis, Index of similarity, importance value index, phytograph and synthetic characteristics of plant community.
6. Ecosystem and ecosystem dynamics: Definition and concept of ecosystem, structure, components and function of ecosystem; classification and description of ecosystem, ecosystem dynamics and energy flow in ecosystem.
7. Plant succession: Definition, processes, causes and types of succession; Trends in succession; Primary and secondary succession; detail description of Hydrosere and Xerosere; Climax concepts.
8. Ecological adaptation of plant: Introduction, classification of plants on the basis of adaptation, morphological and anatomical characters of hydrophytes, xerophytes, halophytes and mangrove species.
9. Phytogeography: Concept; Distribution pattern of global plant species; Principles of dynamic phytogeography; Classification of world floristic regions; Continuity and discontinuity of floral elements.

References

1. Bannister, P. 1976. Introduction to Physiological Plant Ecology. Blackwell Scientific Publications. New York.
2. Dash M.C. 2002. Fundamentals of Ecology. Tata McGraw-Hill Publishing Co. Ltd. New Delhi, India.
3. Krebs C.J. 1978. Ecology: The Experimental Analysis of Distribution and Abundance. Harper International.
4. Muller D.D. and Ellenberg H. 1974. Aims and Methods of Vegetation Ecology. John Wiley & Sons. New York.
5. Odum E. P. 1971. Fundamentals of Ecology. Toppan Co. Ltd. Japan.
6. Shimwell D. N. 1971. Description and Classification of Vegetation. Sidgwick and Jackson. London.
7. Shukla R.S. and Chandel P.S. 2000. Plant Ecology and Soil Science. S. Chands and Company Ltd. New Delhi, India.
8. Subrahmanyam N.S. and Sambamurty A.V.S.S. 2000. Ecology. Narosa Publishing House. Mumbai, London.

Bot. 203 Plant Anatomy, Embryology and Palynology **4 Credits, 100 (70+20+10) Marks**

Plant Anatomy:

1. Tissue, types of tissue, meristem and meristematic tissue, permanent tissue-simple, complex and special.
2. Tissue system, epidermal, ground and vascular tissue system.
3. Primary histological structure of plant body, root stem and leaf.
4. Normal and anomalous secondary growth of plant.
5. Root-stem transition of vascular bundles.
6. Wood, anatomical features, physical and mechanical properties.
7. Anatomy and properties of some important woods of Bangladesh - Teak, Mahagony, Sal, Sisoo, Koroi, Garjan and Toon.

Plant Embryology:

1. Microsporangium, structure and development; microsporogenesis, microgametogenesis and development of male gametes.
2. Megasporangium, structure and development; Megasporogensis, megagametogenesis, types of embryo sac and their development.
3. Fertilization, process of syngamy and triple fusion.
4. Emrbyo, types and their developemnt.
5. Endosperm, type and development; fate of endosperm.
6. Apomixix and polyembryony.
7. Embryological aspects of seed & fruit.

Palynology:

1. Scope and application of palynology.
2. Morphoforms of pollen and spores, wall stratification and sculpture, wall chemistry.
3. Evolution of pollen and spores through ages and their phylogeny.
4. Paleopalynology, pollen and spores in strata, their impoact in coal and oil exploration.
5. Melisopalynology, bee forage plants, nectar, and nectraines in plants, pollen analysis and diagnosis in honey, allergy and toxicity of pollen.
6. Biogenic Palynology.

References

1. Bhojwani S.S. and Bhatnagar S.P. 1978. The Embryology of Angiosperms (3rd edn.). Vikash Publishing House, New Delhi.
2. Desch H.E. 1982. Timber, its Structure, Properties and Utilization (6th edn.). Mac Millan and Co. Ltd.
3. Eames A.J. and MacDaniels L.H. 1978. In Introduction to Plant Anatomy (2nd edn.). Tata McGraw-Hill Publishing Co. Ltd. New Delhi.
4. Esau K. 1998. Anatomy of Seed Plants (2nd edn.). John Wiley and Sons. Singapore.
5. Maheswari P. 1950. An introduction to the Embryology of Angiosperms (TMH edn., 1971). TATA McGraw-Hill Pub. Co., New Delhi.
6. Nair P.K. 1985. Essentials of Palynology. Asia Publishing House, New Delhi.
7. Pandey B.P. 1993. Plant Anatomy, S. Chand & Co. Ltd., New Delhi.
8. Pasha M.K. 2008. Paragrenubiggan, Bangla Academy, Dhaka.
9. Pasha M.K. 2014. Adhunik Vrunbiggan and Paragrenubiggan, Bangladesh Book Bank, Dhaka.

Bot. 204 Economic Botany and Ethnobotany **2 Credits, 50 (35+10+5) Marks**

Economic Botany

1. Introduction, basic concept and scope of Economic Botany; Classification of economic plants.
2. Food values and uses of the followings: a) Cereals; b) Millets c) Legumes and Nuts.
3. Plant sources of: Vegetable oil, medicinal plants, incense, molasses, palm jaggery, fibre, timber, bamboo, rattan, pulp and paper, resins, tannins and gums (scientific names, family names and part or parts used should be given with special emphasis to Bangladesh).
4. Tea, Sugar and Paper yielding plants**:** Their cultivation, problems and industrial process.
5. Small scale plant based industry**:** Introduction, sources of raw materials, their cultivation and processing/extraction, economic prospects of the following small scale industries: a) Mushroom; b) Perfumes and c) Dyes.
6. Popularization of non-conventional plants as food sources**:** Introduction, sources, process and uses of the following non-conventional food sources: a) *Spirulina*, b) *Cassava* and (c) *Dioscorea.*

Ethnobotany

1. Introduction, basic concept and scope of Ethnobotany.
2. Methods in ethnobotanical studies. Ethnobotanical uses of indigenous plants.
3. Important plants used by different ethnic groups of Bangladesh: Medicinal plants, food plants, psychoactive plants
4. Conservation and ethnobotany: Ethnobotany and plant conservation, ethnobotany and germplasm diversity, economic value of conservation.

References

1 Hill A.F. 2000. Economic Botany. Tata McGraw-Hill Publishing Co. Ltd., India.
2. Simpson B. B. and Conner-Ogorzaly M. 1986. Economic Botany (Plants in Our World). McGraw-Hill Book Co. New Delhi, Singapore, Tokyo, London
3. Kochhar S.L.2003. Economic Botany in the Tropics. MacMillan India Ltd.
4. Ghani A. 1998. Medicinal Plants of Bangladesh. Asiatic Society of Bangladesh. Dhaka.
5. Cotton C.M. 1997. Ethnobotany, Principles and Applications. John Willey & Sons, New York
6. D'Rozario A., Bera S. and Mukherji D. 2004. A Hand Book of Ethnobotany. Kalyani Publishers, Kolkata, India.

Bot. 205 Plant Physiology **2 Credits, 50 (35+10+5) Marks**

1. Water relations and life related phenomena: Imbibition, diffusion, osmosis, osmotic pressure, role of osmosis, plasmolysis and its advantages, protoplasm as colloidal system, water potential, suction pressure or diffusion pressure deficit.
2. Absorption of water: Structure and property of water, mechanism of water absorption: external factors affecting water absorption, translocation of water.
3. Loss of water: Transpiration, kinds of transpiration, mechanism of stomatal transpiration, significance of transpiration, factors affecting transpiration, other means of losing water.
4. Photosynthesis**: I**. An introduction to photobiology. Physical nature of light, absorption of light, absorption and action spectra, photoreceptors, photosynthesis in leaves, ultrastructure and biochemical compartmentation of chloroplasts. **II**. The light dependent reactions of photosynthesis: Photosystems and reaction centers, red drop and Emerson enhancement effect, photophosphorylation, cytochrome complex and photosystem I, photosystem II and the oxidation of water, **III**. Carbon metabolism; C3 photosynthetic carbon reduction (PCR) cycle includes carboxylation, reduction and regeneration steps, C4 photosynthetic carbon assimilation (PCA) cycle, kranz anatomy, significance of the C4 cycle, Crassulacean acid metabolism (CAM), Variation between C4 and CAM cycle, significance of CAM, export and storage of photosynthetic product, synthesis of sucrose and starch in the chloroplast.
5. Respiration: Introduction, type, fermentation, respiratory quotient, glycolysis, oxidation of pyruvic acid, Kreb's cycle, some unique features of plant's TCA cycle, pentose phosphate pathway, electron transport chain of the mitochondrion and oxidative phosphorylation, ATP yield in Aerobic and anaerobic respiration, factors affecting respiration and significant of respiration, Biological efficiency of respiration.
6. Photorespiration: Introduction, site of photorespiration, mechanism of C_2 photorespiratory carbon oxidation (PCO) cycle, biological function of photorespiration.

References

1. Devlin R.M. and Witham F.H. 2000 Plant Physiology (4th edn.). CBS Publishers and Distributors, India.
2. Hopkins W.G. 1999. Introduction to plant physiology (2nd edn.). John Wiley and Sons. Inc. New York.
3. Kumar A. and Purohit S.S. 1998. Plant Physiology fundamentals and application. Agro Botanica. India.
4. Mukherji S. and Ghosh A.K. 2005. Plant Physiology (1st edn.). New Central Book Agency Ltd. India.
5. Salisburry F.B. and Ross C.W. 2005. Plant Physiology (4th edn.). Thomson Asia Ptv. Ltd. Singapore.
6. Taiz L. and Zieger E. 1991. Plant Physiology. The Benjamin/Cummings Publishing Co. Inc. California.

Bot. 206 Cytology **2 Credits, 50 (35+10+5) Marks**

1. Introduction to cell and the development of cell theory.
2. A brief history of cytology.
3. Prokaryotic cell: Introduction to prokaryotic cells, discovery, structure, Importance.
4. Eukaryotic cell: Structure of a generalized plant and animal cells. Differences between: Eukaryotic and prokaryotic cells, Plant and animal cells.
5. Cell Organelles: Cell wall, Cell membrane, Mitochondria, Plastids, Ribosome, Endoplasmic reticulum, Golgi complex, Lysosome, Cytotubules, Nucleus.
6. Ultrastructure, chemical nature and functions of chromosome.
7. Special types of chromosomes: Discovery, occurrence, structure and functions of Polytene chromosomes, Lampbrush chromosomes and β-chromosomes.
8. Cell division: Preparation of cell division, cell-cycle, amitosis, mitosis, meiosis and their biological significance.

References

1. Bhamrah H.S. and Juneja K. 1993. Cytogenetics and evolution, Anmol Publications Pvt. Ltd. New Delhi, India.
2. Dnyansugar V.R. 1986. Cytology and Genetics, Tata Mc GrawHill Book Co., New Delhi, India.
3. Stebbins G.L. 1971. Chromosome Evolution in Higher Plants. Addison-Wesley Publishing Company Ltd., London.
4. Swanson C.P. 1965. Cytology and Cytogenetics. MacMillan and Co. Ltd., London.
5. Verma P.S. and Agarwal V.K.1997. Cytology. S. Chand and Company Ltd., New Delhi, India.

Bot. 207 Genetics-I **2 Credits, 50 (35+10+5) Marks**

1. Basic principles of heredity: Mendel's principles, historical background, monohybrid & dihybrid crosses, predicting the outcome of genetic crosses, back cross and test cross.
2. Gene interaction & modification of Mendelism: Allelic variation and gene function – multiple allele, genetic interaction, epistatic interactions, non-epistatic inter-allelic genetic interactions, atavism/reversion, penetrance (complete & incomplete), expressivity, pleiotropism.
3. Sex determination: Sex chromosome, mechanism of sex determination, sex linked characteristics, determination of heterogametic sex in plants
4. Linkage: Linkage, Morgan's view on linkage, Bateson and Punnett's coupling and repulsion hypothesis, kinds of linkage, linkage groups; sex linked genes, sex linked inheritance.
5. Crossing over and recombination: Definition, types of crossing over, mechanism of meiotic crossing over, cytological detection of crossing over, significance of crossing over., genetic recombination, types of recombination, achiasmy and heterochiasmy
6. Chromosome Mapping: Two & three point test cross, determination of linkage groups, map distance and gene order, genetic interference & coincidence, Analysis of single meiosis (Tetrad acnalysis), LOD scores. Mapping with molecular markers.
7. Non-Mendelian inheritance: Cytoplasmic inheritance, extranuclear inheritance (mitochondrial, chloroplast), non-chromosomal inheritance, maternal effect on inheritance, uniparental inheritance.

References
1. Gardner E.J., Simmons M.J. and Snustad D.P. 1998. Principles of Genetics. John Wiley & Sons, Inc.
2. Griffiths A.J.F., Miller J.H., Suzuki D.T., Lewontin R.C. and Gelbart W.M. 2002. An Introduction to Genetic Analysis (7th edn.). W.H. Freeman &Co. New York.
3. Jain H.K. 2000. Genetics. Oxford & IBH Publishing Co. Ptv. Ltd, New Delhi, India.
4. Price B.A. 2012. Genetics: A conceptual approach. WH Freeman & Company, New York.
5. Simmons M.J. 2010. Principles of Genetics (8th edn.). Wiley India Pvt. Ltd.
6. Tamarin R.H. 1999. Priciples of Genetics. WCB/McGraw-Hill, New York.
7. Watson J.D., Baker T.A., Bell S.P., Gann A., Levine M. and Losik R. 2008. Molecular Biology of the Gene (6th edn.). Pearson International Edition, Cold Spring Harbor, New York.

Bot. 208 Computer Basics **2 Credits, 50 (35+10+5) Marks**

1. Definition of computer and its generations.
2. Basic computer organization: Central processing unit (CPU), Microprocessor, computer memories and their
3. Characteristics/Storage unit, ALU, Control unit, Input unit, Output unit/devices with characteristics and use.
4. Primary storage: RAM, ROM. DROM, EPROM, Cache and Registers,
5. Secondary storage: Magnetic tape, Magnetic disk, Floppy disk, Optical disk.
6. Computer software: System software, Application software with examples of applications, office automations, programming languages, their types and levels, steps for software development.
7. Information technology: Data and information, information collecting, processing and distribution, system analysis and information systems. Basics of multimedia systems with examples, hardware and software, concept of data composition, multimedia system, development life cycle.
8. Operating system: Types of operating system, Application of Microsoft office word, Office Excel, Adobe Acrobat, Office PowerPoint, Email, Internet and Webpage development.
9. Introduction to common trouble shooting and computer virus.

References
1. Norton P. 2011. Introduction to Computer. Tata McGraw-Hill, New Delhi
2. Norton P. 2006. Computing Fundamentals. 6th Edition, McGraw-Hill Education
4. Fouri W. M. 1991. Basic for Computers and Information Processing. Amazon.com Willium, M. Fouri
5. Fouri W. M. 2009. Computer and Information Processing, 2nd Edition. Amazon.com Willium, M. Fouri
6. Mandell, S.L.1986. Computers and Data Processing Today: 2nd edition, West Publishing Co. St. Paul, MN, USA

Bot. 209 Biostatistics **2 Credits, 50 (35+10+5) Marks**

1. Definition of biostatistics and its uses, incidence, measurements, measures of relatives and attributable risk, screening related to plants, retrospective and prospective studies, odds ration and its application.
2. Measurement of central tendency : Mean, mode and media
3. Dispersion: Range, variance, standard deviation, standard error of mean, co-efficient of variance.
4. Probability and distribution: Theory of probability, binomial distribution, poison distribution and normal distribution. Relation of mean, mode and media with normal distribution.
5. Sampling: Random sampling, stratified sampling, cluster sampling and area sampling.
6. Correlation and regression: Fitting of simple regression line, multiple regressions, partial regression, simple correlation, partial correlation and multiple correlations.
7. Experimental Design: Completely randomized, randomized block and Latin square design, factorial experiment, confounded factorial experiment, split-plot design, designs for diallel crosses, replicated progeny row, compact family blocks, efficient utilization of seed, long term experiments.
8. Test of hypothesis: Null and alternative hypothesis, tests of means, proportions for small and large samples, test of variance, test of correlation and regression, test randomness, sign test, run test, Krushkal-Walli's test, Friedman's test, 'F' test, 'T' test and 'W' test. Duncan's multiple range tests.

References
1. Blackith R.E. and Reyment R.A. 1971. Multivariate Morphometrics. Academic Press, London, New York.
2. Cochran W.G. and Cox G.M. 1957. Experimental Designs. Wiely, New York.
3. Cohran W.G. 1963. Sampling Techniques (2nd edn.). Wiley, New York.
4. Gomeg K.A. and Gomeg A.A. 1984. Statistical Procedures for Agricultural Research (2nd edn.). John Wiley and Sonds. New York
5. Green R.H. 1979. Sampling Design and Statistical Methods for Environmental Biologists. Chichester, Brishane; Wiley, Toronto.
6. Morrison D.F. 1967. Multivariate Statistical methods. McGraw-Hill Book Co., New York.
7. Sokal R.R. and Rohlf F.J. 1969. Biometry (2nd edn.). The Principles and Practice of Statistics in Biological Research. Freeman, San Francisco.
8. Sokal R.R. and Rohlf F.J. 1981. Biometry (2nd edn.). The Principles and Practice of Statistics in Biological Research. Freeman, San Francisco.
9. Steel R.G. and Torrie J.H. 1980. Principles and procedures of statistics. A Biometrical Approach (2nd edn.). McGraw Hill Book Co. Inc., New York.

Bot. 210 Biochemistry **4 Credits, 100 (70+20+10) Marks**

1. Introduction; Biochemical substances in living organisms, Macromolecules and its origin.
2. Carbohydrates: Definition, Classification-Monosaccharides, Oligosaccharides and Polysaccharides, Common carbohydrates found in plants, Structure and biological importance of carbohydrates.
3. Lipids: Classification, Distribution, Structure and Biological importance of lipids.

4. Amino acids and Proteins: Classification of amino acids, Essential and Non-essential amino acids, Characteristic features of protein, Classification, Structure of protein-primary, secondary, tertiary and quaternary structure, Denaturation and renaturation of protein.
5. Nucleic acids: Definition, Classification Chemical nature, Structure and Function.
6. Enzymes: Nomenclature and classification of enzymes-old system and new system, Structure of enzymes; coenzymes, cofactor and activator; Mode of action of enzymes-Lock and Key theory, Koshland Induced fit theory; Mechanism of action of enzymes; Properties of enzymes; Factors affecting enzyme activity; temperature, pH, enzyme concentration and substrate concentrations; Enzyme inhibition.
7. Secondary metabolites: Introduction; Alkaloids; Terpenoids; Flavonoids and Phenolic compounds; Classification/types, Distribution in plants and functions, Structure of sterol, gosypol, rubber, quinine, Caffeine, Menthol, Gossypol and flavonoids, Sterol, digitoxigeria.
8. Vitamin: Introduction, Classification-Water soluble vitamins and fat soluble vitamins, Function, Source and deficiency symptom.
9. Metabolic concepts: Definition and terminology; Metabolic pathways; catabolism and anabolism; Central pathways; Secondary pathways; Regulation of metabolic pathways.
10. Methods of biochemical analysis: Centrifugation; Spectrophotometry; Electrophoresis; Basic concepts of chromatography.

References

1. Conn. E.E., Stump P.K. and Doic R.II. 1995. Outlines of Biochemistry. John Wiley and Sons. Inc.
2. Goodwin T.W. and Mercer E.I. 1998. Introduction to Plant Biochemistry. CBS Publishers and Distributors, New Delhi.
3. Hopkins W.G. 1999. Introduction to Plant Physiology (2nd edn.). John Wiley and Sons. Inc. New York.
4. Lehninger A.L. 2000. Biochemistry (2nd edn.). Kalyani Publishers, New Delhi.
5. Lehninger A.L., Nelson D.L. and Cox M.M. 1993. Principles of Biochemistry (2nd edn.). CBS Publishers and Distributors, India.

PRACTICAL COURSES

Bot. 211 Limnology, Basic Plant Ecology, Plant Anatomy, Embryology and Palynology **2 Credits, 50 (35+10+5) Marks**

Limnology:

1. Analysis of (a) dissolved oxygen (b) free CO_2 (c) salinity and (d) pH of pond/lake waters.
2. Method of collection, preservation and processing of phytoplankton.
3. Local excursion to a pond/lake bed for collection, preservation of macrophytes.
4. Study of some common genera of phytoplankton and macrophytes.

Basic Plant Ecology:

1. Autecological studies of important plant species of JU campus.
2. Study of vegetation by quadrat method.
3. Study of ecosystem composition in JU campus and surrounding areas.
4. Study of adaptation characters of Hydrophytes, Xerophytes and Halophytes.

Plant Anatomy, Embryology and Palynology,

1. Study of microsporangium and microspore tetrad and microspore of different plants.
2. Study of megasporangium and types of ovules.
3. Preparation of stains-safranin and fast green, dehydrating agents-alcohol grades, clearing agents - xylol, clove oil.
4. Sectioning of stems, roots and leaves of monocotyledons and dicotyledons-transverse, longitudinal and radial.
5. Identification of stem, root and leaf through microscopic observation.
6. Tissue maceration.
7. Preparation of permanent slides following hand sections and microtomy.
8. Preparation of pollen slides and study of pollen morphology of at least 5 species.
9. Pollen study in honey samples, find the types and similarities of the sample, identification of major and minor contributors.
10. Study of pollen physiology-sterile and fertile pollen.

Marks Distribution

Practical examination	-	27 Marks
Lab. Note Book	-	5 Marks
Sample Collection	-	3 Marks
Total	**=**	**35 Marks**

Bot. 212 Economic Botany, Plant Physiology, Cytology, Genetics-I **2 Credits, 50 (35+10+5) Marks**

Economic Botany:

1. Identification, collection and preservation of plant products having economic value.
2. Preparation of herbarium sheets/submission of economically important plants/ plant parts from various parts of Bangladesh.
3. Visit for study of plant based industry or production centers.

Plant Physiology:

1. Osmosis: Demonstrate of osmosis by egg osmosis.
2. Plasmolysis: To examine the phenomenon of plasmolysis.
3. Determination of water uptake, water relation and water deficit in plants.
4. Transpiration: The rate of transpiration in different environmental conditions.

5. Photosynthesis: (a) To demonstrate oxygen liberated in the process of photosynthesis (b) The effects of light intensity and temperature on the rate of photosynthesis.
6. Respiration: To demonstrate the production of heat during respiration.
7. Fermentation: (a) to demonstrate the effects of different substrate on evolution of CO_2 during alcoholic-fermentation by yeast cells. (b) To demonstrate the effects of temperature on alcoholic-fermentation by yeast cells.
8. Extraction of photosynthetic pigments and their separation by paper chromatography and separating funnel.
9. Kranz anatomy and C_3 anatomy of selected plant leaves.

Cytology:

1. Study and handling of microscope.
2. Preparation of stains.
3. Preparation of different prefixatives on plant chromosome.
4. Preparation of different fixatives.
5. Study of mitosis cell division in onion root tip cell.

Genetics-I:

1. Identification of wilds and mutants of *Neurospora*.
2. Construction of genetic map: study of gene order and map distance using three point tests cross.
3. Verification of various monohybrid and dihybrid F_2 ratios by using Chi-square & goodness of fit.
4. Pedigree analysis of genetic diseases.

Marks Distribution

Practical examination	-	27 Marks
Lab. Note Book	-	5 Marks
Sample Collection	-	3 Marks
Total	**=**	**35 Marks**

Bot. 213 Computer Basics, Biostatistics **2 Credits, 50 (35+10+5) Marks**

Computer Basics:

1. Basic computation: Formatting cell and text, formatting a page and printing a document. Use of formula for calculation, use of some mathematical and statistical functions. Creating graph, statistical data analysis using excel.
2. Photoshop and PowerPoint management.
3. SPSS for windows: Creating a data file, creating a syntax file, creating and editing graphs. Statistical data analysis using SPSS for windows: Correlation, Regression, ANOVA. Test of Hypothesis.

Biostatistics:

1. Calculation of descriptive statistics
2. Drawing of histogram, frequency curve and give, pie-diagram
3. Fitting of regression line, calculation of correlation co-efficient
4. Test of independence in contingency table, tests based Krushkal-Walli's test, Friedman's test,'t', 'F', 'W' and X^2-distribution.
5. Analysis of CRBD, RBD, LSD, split-plot design, factorial experiment.
6. Grouping of means by different methods, test of the difference between a treatment and a control treatment.

Marks Distribution

Practical examination	-	30 Marks
Lab. Note Book	-	5 Marks
Total	**=**	**35 Marks**

Bot. 214 Biochemistry **2 Credits, 50 (35+10+5) Marks**

1. Study about Equipments commonly employed in qualitative and quantitative determination of bio-chemicals.
2. Common procedures of chemical analysis
   (a) Preparation of standard solution.
   (b) Preparation and standardization of solution.
   (c) Study of common indicators.
   (d) Determination of equivalent weight of acid, alkali, compound and oxidizing and reducing agents.
   (e) Preparation of Stock solution and preparation of different dilutions from the stock solution.
   (f) Prepare the solution at ppm and ppb level.
3. Adjustment the appropriate pH of a solution.
4. Preparation of different Buffer solution.
5. Qualitative test for Carbohydrate: i. glucose, ii. sucrose, iii. reducing and non reducing sugar, and iv. polysaccharide, starch, gum.
6. Qualitative test for protein and lipid.
7. Quantitative estimation of carbohydrate and protein
8. Qualitative estimation of Vitamin C from known and unknown sample.
9. Study of basic techniques of biochemical analysis by using, micropipettes, centrifuge, spectrophotometer and chromatography.

Marks Distribution

Practical examination	-	30 Marks
Lab. Note Book	-	5 Marks
Total	**=**	**35 Marks**

Bot. 215 Viva-voce **2 Credits, 50 Marks**

Part-III
(3rd Year; Examination of 2016, 2017, 2018 and 2019)

THEORY COURSES

Bot. 301 General Microbiology **2 Credits, 50 (35+10+5) Marks**

1. Fine structure and chemical composition of viruses; Replication cycle of viruses, Common viruses-overview of bacterial viruses T_2; temperate bacteriophage: Lambda; A transposable phage: Bacteriophage µ, Retroviruses,
2. Fine structure, function and chemical composition of bacterial cell: Flagella, pili, glycocalyx, cell wall, cytoplasmic membrane, and internal cell structure.
3. Metabolic diversity among the prokaryotic microorganisms: Introduction to energy production; Anoxygenic photosynthesis – anoxygenic photosynthetic microorganisms, generation of energy and reducing power.
4. Chemolithotrophy–Chemolithotrophic microorganisms, energy from the oxidation of inorganic electron donors, generation of reducing power by Chemolithotrophs.
5. Microbial genetics: Mechanism of gene transfer-transformation, transduction and conjugation; Genetic recombination and recombination mapping; Transposons and insertion sequences.
6. Domestic water and wastewater microbiology: Microbial pollution of drinking water; Water quality indicator microorganisms-Coliform bacteria; Bacteriological examination of water for sanitary quality; Wastewater-Characteristics and treatment.
7. Soil microbiology: Carbon cycle-decomposition of cellulose and hemicelluloses in soil; microorganisms involved, environmental factors, decomposing enzyme and their action; Microorganisms in biological Nitrogen fixation-biochemistry of nitrogen fixation and role in soil.

References

1. Alexander M. 1977. Soil Microbiology (2nd edn.). Wiley Eastern Limited, Calcutta.
2. Brock T.D., Smith D.W. and Madigan M.T. 1984. Biology of Microorganisms (7th edn.). Prentice Hall Int. USA.
3. Pelczar M.J., Chan E.C.S. and Krieg N.R. 1993. Microbiology: Concepts and Applications McGraw-Hill Inc. New York.
4. Prescott L.M., John P.H. and Donald A.K.1999. Microbiology. (4/E), 2002(5/E) 2005(6/E) McGraw-Hill Company, New York.
5. Stainer R.Y., Ingraham J.L., Wheelis M.L. and Painter P.R. 1986. General Microbiology (5th edn.). McMillan, London.

Bot. 302 Plant Pathology **4 Credits, 100 (70+20+10) Marks**

1. Brief history of plant pathology: Renowned scientists in the field of plant pathology; Germ theory of disease; the beginning of modern plant pathology.
2. Introduction to plant pathology: Concept and causes of plant disease; Symptoms of plant diseases; Classification of plant diseases; Importance of plant diseases; Diagnosis of plant diseases.
3. Parasitism and disease development: Parasitism and pathogenecity; Stages in the development of plant disease-inoculation, penetration, dissemination, over wintering and over-summering of the pathogen.
4. Plant disease epidemiology: Epidemics; Types of epidemics; Disease development in relation to host, Pathogen and environment; Factors responsible for the decline of epidemics.
5. Toxins in relation to plant fungal disease: Type of toxins - Pathotoxins, Vivotoxins, Phytotoxins, host specific and nonspecific toxins; Effect of toxins on plant tissue.
6. Selected fungal diseases of crop plants: Symptoms, causal agent, etiology and control measures of the following diseases- (i) Rice: Blast, brown spot, foot rot, sheath rot, sheath blight; (ii) Wheat: Stem rust, leaf rust, loose smut, (iii) Pulses and bean: Rust of bean and pulses; (iv) Jute: Stem rot, black band; (iv) Sugar cane: Red rot; (vi) Ground nut: Leaf spots; (vii) Betel vine: Foot rot; (viii) Banana: Panama, sigatoka; (ix) Chili: Anthracnose; (x) Potato: Late blight, early blight.
7. Viral Plant Pathology: (i) Developmental history of plant virology; Composition and structure of plant virus. (ii) Viruses as pathogens: Infection and Symptoms - external and Internal symptoms; factors affecting symptoms expression; Importance of symptoms in plant virology. (iii) Transmission of plant viruses: Mechanical transmission; Vector transmission; Graft transmission; Pollen and seed transmission. (iv) Host-vector relationship of plant viruses. (v) Physiology of virus infected plants. (vi) Studies on selected plant viral diseases - Tungro of rice, Leaf roll of potato, Yellow leaf curl of tomato, Purple vein of tomato, Mosaic of tobacco, Ring spot of papaya, Bunchy top of banana.
8. Bacterial Plant Pathology: (i) Classification of plant pathogenic bacteria. (ii) Mode of entry of bacteria into host and action of bacteria on plant tissues. (iii) Studies on selected bacterial diseases - Leaf blight of rice, Soft rot of potato, Wilt of tomato, Citrus canker, Angular leaf spot of cotton, Gummosis of sugarcane. (iv) Control of bacterial diseases of plants.
9. Nematode Plant Pathology: General characteristics of plant parasitic nematodes; Host pathogen relationship; Mechanism of nematode injury plants; Studies on selected nematode diseases-Ufra disease of rice, Ear-cockle disease of wheat, Molya disease of barley and Root-knot disease of vegetables.

References

1. Agrios G. N. 2000. Plant Pathology (4th edn.). Academic Press Inc. New York, U.S.A.
2. Bos L. 1983. Introduction to Plant Virology. Centre for Agricultural Publishing and Documentation. Netherlands.
3. Fahy P.C. and Persley, G.J. 1983. Plant Bacterial Disease- a diagnostic guide. Academic Press, London, U.K.
4. Mehrotra R.S. 1987. Plant Pathology. Tata McGraw Hill Company, New Delhi, India.
5. Noordam D. 1973. Identification of Plant Viruses Methods and Experiments. Centre for Agricultural Publishing and Documentation. Netherlands.
6. Rangaswami G. 1988. Diseases of Crop Plants in India. Prentice-Hall of India, New Delhi, India.
7. Singh R.P. 2005. Plant Pathology. Kalyani Publishers, Kolkata, India.

8. Walker J.C. 1969. Plant Pathology (3rd edn.) Tata McGraw-Hill Company, New Delhi, India.

Bot. 303 Phytochemistry and Herbal Medicine **2 Credits, 50 (35+10+5) Marks**

Phytochemistry:

1. Definition and scope of Phytochemistry; present status, classification of important bioactive agents from plant sources.
2. Primary and secondary metabolites, factors affecting secondary metabolites in medicinal plants, natural products as lead compounds.
3. General methods of extraction, isolation and purification of bioactive compounds from plants. Cardiovascular, Anticancer, Antimicrobial, Antiinflammatory and Antibiotic drugs from plants.
4. Plant source and uses of the following secondary metabolites
   a) Alkaloids- Nicotine, Atropine, Morphine, Caffeine.
   b) Glycosides- Amygdalin, Strophanthidin
   c) Steroids- Cholesterol,
   d) Carotenoids- Vitamin A, Lycopine and Beta-carotene
   e) Terpenoids-Camphor, Eugenol, Taxol, Pyrithrine.
   f) Flavonoids-Rutin, Quercetin

Herbal Medicine:

5. Scope and importance of herbal medicine, its relationship with pharmacology; group of drugs, methods of classification of drugs.
6. External and internal characters of plant drug; epidermal characters of the plant parts; various cell content and their importance in the identification and quality determination of plant drugs.
7. Medicinal plants- occurrence, distribution, chemical constituents and uses of some selected medicinal plants of Bangladesh.
8. Various indigenous systems of medicine (Unani and Ayurvedic systems, herbalism, folk medicine etc.), their methods of diagnosis and treatment; types and composition of medicinal preparation advantages and disadvantages.

References

1. Ali M. 1994. A Text Book of Pharmacognosy, CBS Publisher, New Delhi.
2. Cotton C.M. 1998. Ethnobotany: Principles and Applications. John Wiley and Sons, New York, Toronto, Singapore.
3. Ghani A. 1998. Medicinal Plants of Bangladesh. Asiatic Society, Dhaka.
4. Ghani A. 1999. Veshaja Rasayan. Bangla Academy, Dhaka.
5. Harborne J.E. and Swain, T. 1969. Perspectives in Phytochemistry. Academic Press, London.
6. Kreig M.B. 1996. Green Medicine, Rand Mcnally & Company, Chicago.
7. Trease G.E. and Evans W.C. 1978. Pharmacognosy. Bailliere Tindall, London.
8. Wallis T.E. 1960. Pharmacognosy. J & A. Churchil Ltd., London.

Bot. 304 Environmental Plant Physiology **2 Credits, 50 (35+10+5) Marks**

1. Concept and scope of studying Environmental Plant Physiology.
2. Plant cell walls, membrane and diffusion.
3. Solute transport: solute transport across a membrane barrier, across biological membrane and transcellular transport.
4. Environmental regulation of photosynthesis and its impact on plant responses to leaf expansion, partitioning of dry mass, water status and transpiration.
5. Mineral nutrients: Definition of essential, non-essential and beneficial nutrient elements. Sources, general roles and deficiency symptoms of important nutrient elements in plant growth and development. Methods to overcome mineral deficiency in plants. Silicon and plant growth.
6. Mineral ion absorption: Introduction, availability of mineral salts, mechanisms of mineral salt absorption, active and passive absorption, factors affecting salt absorption.
7. Definition and growth responses of plants to drought, salinity and temperature stress. Mechanisms of drought resistance, salt and heat tolerance.
8. Pollution stress: Definition, source and effect of air pollutants on the physiology and growth of plants. Metal toxicity and acid rain, and their effects on plant growth

References

1. Hopkins W.G. 1999. Introduction to Plant Physiology (2nd edn.). John Wiley and Sons. Inc. New York.
2. Mukherji S. and Ghosh A.K. 2005. Plant physiology. 1st edition. New Central Book Agency Ltd. India.
3. Noggle G. R and Fritge G. J. 2002. Introductory Plant Physiology. 2nd edition. Prentice-Hall of India Private Limited, New Delhi-110001.
4. Salisburry F.B. and Ross, C.W. 2005. Plant Physiology (4th edn.). Thomson Asia Pvt. Ltd. Singapore.
5. Tiez L. and Zieger E. 1991. Plant Physiology, The Benjamin/Cummings publishing Co. Inc. California.
6. Verma S. K. 2003. A Text Book of Plant Physiology and Biochemistry. S. Chand & Company Ltd. New Delhi-110055.

Bot. 305 Plant Systematics-II **2 Credits, 50 (35+10+5) Marks**

1. Concepts and problems of taxonomic categories: Concept of higher taxonomic categories, species concept; infra-specific categories; biosystematic categories; genecological experiments.
2. Formation of new species: Variation in plant populations; natural hybridization and its impacts; definition and mechanisms of isolation and speciation.
3. Herbarium techniques: Collection, drying, preservation and management of plant specimens.
4. Sources of non-molecular data useful in systematics: morphology, anatomy, cytology, genetics, embryology, reproductive biology, palynology, biogeography and ecology.

5. Sources of molecular data useful in systematics: Biochemical data; plant genomes and genes; generating, formatting and alignment of DNA data from green plants for phylogeny estimation.
6. Taxonomic keys: Definition and types; merits and demerits of conventional and interactive keys; procedure of key making.
7. Phenetics and phylogenetics: Concept and principles; requirements; general procedures.

References

1. Davis P.H. and Haewood V.H. 1963. Principles of Angiosperm taxonomy. Oliver and Boyed, Edinburgh.
2. Freeman S. and Herron J.C. 2001. Evolutionary Analysis, 2nd edition. Prentice Hall, Upper Saddle River, New Jersey.
3. Heywood V.H. and Moore D.M. 1984. Current Concepts in Plant Taxonomy, London.
4. Judd W.S., Campbell C.S., Kellogg E.A., Stevens P.F. and Donoghue M.J. 2008. Plant Systematics: A Phylogenetic Approach, 3rd edition. Sinauer Associates Inc., Sunderland, Massachusetts.
5. Simpson M.G. 2002. Plant Systematics, Elsevier, Academic Press, New York.

Bot. 306 Cytogenetics **2 Credits, 50 (35+10+5) Marks**

1. Introduction: definition, scope and brief history of Cytogenetics.
2. Karyotype and Idiogram-Symmetric; asymmetric, monomodal and bimodal karyotype and significance.
3. Genome Analysis- Genome in respect of Cytogenetics, Karyotype analysis, Chromosome association in meiosis, Chromosome banding- CMA, DAPI and C-banding, Fluorescent *in situ* Hybridization (FISH) and Genomic *in situ* Hybridization (GISH).
4. Abnormalities in cell division- non-disjunction, endopolyploidy or endoreduplication, polytene, cytomixis, crossed-spindle, elimination of single or set of chromosomes in insects.
5. Chromosomal aberration: general account and classification.
6. Structural aberration: Deletion: definition, kinds, genetic effect and meiotic behavior. Duplication: definition, kinds, genetic effect, meiotic behavior, breakage-fusion-bridge cycle. Inversion: definition, kinds, synopsis, result of crossing-over in intra and extra loop, consequence of Chromatid Bridge. Translocation: definition, kinds, meiosis in translocation heterozygote, consequence of crossing-over.
7. Numerical aberration: Aneuploidy: different types of aneuploidy- definition, kinds, origin, meiotic behaviors, segregation and genetic ratios. Euploidy: different types of euploidy-definition, kinds, meiotic behavior, segregation, application.

References

1. Bhamrah H.S. and Juneja K. 1993. Cytogenetics and Evolution, Anmol Publications Pvt. Ltd. New Delhi, India.
2. Dnyansugar V.R. 1986. Cytology and Genetics, Tata Mc GrawHill Book Co., New Delhi, India.
3. Stebbins G.L. 1971. Chromosome Evolution in Higher Plants. Addison-Wesley Publishing Company, London.
4. Swanson C.P. 1965. Cytology and Cytogenetics. MacMillan and Co. Ltd. London.
5. Verma P.S. and Agarwal V.K.1997. Cytology. S. Chand and Company Ltd. Delhi, India.

Bot. 307 Agronomy and Horticulture **4 Credits, 100 (70+20+10) Marks**

Agronomy:

1. Agronomy and Horticulture: Scope of Agronomy, Basic Principales of Agronomy, Role of Agriculture in the economy of Bangladesh.
2. Tillage: Objectives, types and uses, merits and demerits of different types of tillage.
3. Sowing and Planting: Methods of sowing and planting, importance of handling, sowing and planting.
4. Fertilizers: Need for using fertilizers, classification and methord of fertilizer application.
5. Irrigation: Methods, sources of water, timing and frequency of irrigation.
6. Drainage: Need for drainage, methods of drainage and their suitability for different crops.
7. Crops and Cropping: Agricultural classification of crops, cropping season, cropping pattern and crop rotation.
8. Cultivation: Modern methods of cultivation of high yielding varieties, associated problems and remedies of the following- rice, wheat, jute and lentil.
9. Seed: seed quality, harvesting, storage, testing.

Horticulture:

1. Introduction, scope and importance of horticulture.
2. Propagation of horticulture plants: Plant propagules asexual propagation-layering, cuttings, weeding & grafting.
3. Organic farming: Purpose, principles, composting.
4. Nursery: Types of nursery production, nursery structure, importance.
5. Pruning and Training: Objectives, types and importance.
6. Biological enemies of horticultural plants.
7. Cultivation of important vegetables and flowers: Tomato, Brinjal, Okra, Rose, Tuberose, Gladiolus.

References

1. Acquaah G., 2002. Principles and Practices of Horticulture. Prautice- Hall of India Pvt. Ltd. New Delhi.
2. Bhuiya S., Islam M., Uddin R., Salam A., and Rahman M. 2005, Introductory Agronomy, Oracle Publication.
3. Halfacre R.G. and Borden J.A. 1979. Horticulture McGraw Hill Inc. New York.
4. Hartman H.T., Kester D.E. and Davies F.T. 1993. Plant propagation. Principles and Practics, Prentice-Hall of India, New Delhi.
5. Hossain M. 1991. Agriculture in Bangladesh. University Press, Dhaka.
6. Wobster C.C. 1980. Agriculture in Bangladesh, University Press, Dhaka.

Bot. 308 Plant Tissue Culture **4 Credits, 100 (70+20+10) Marks**

1. Plant tissue culture- history, scope and application.
2. Laboratory requirements and general techniques.

3. Tissue culture media -types, constituents, selection and preparation of tissue culture media.
4. Explants selection, aseptic culture technique, callus culture, cell culture, Application of callus and cell culture.
5. Cellular totipotency, cytodifferentiation, organogenic differentiation.
6. Somatic embryogenesis, anatomy and cytology of somatic embryo development, maturation and germination of somatic embryo.
7. Haploid production, anther and microspore culture, ontogeny of androgenic haploid, haploid production through distant hybridization.
8. Triploid production from endosperm culture, callusing, organogenesis, application.
9. Meristem culture and production of pathogen free plants, virus elimination by meristem-tip culture and callus culture.
10. In vitro pollination and fertilization, ovule and ovary culture, application.
11. Protoplast isolation and culture, mechanical and enzymatic, plant development from protoplast.
12. Somatic hybridization, protoplast fusion methods, selection of hybrid cells, potential of somatic hybridization, cybrids, application of somatic hybrids and cybrids.
13. Zygotic embryo culture, technique, culture requirements, application.

References

1. Ammirato P.V., Evans D.A., Sharp W. R. and Bajaj Y.P.S. 1990. Hand Book of Plant Cell Culture, V.5. Ornamental Species. McGraw-Hill Publishing Co. New York, Tokyo, Toronto, Singapore.
2. Bhadra S.K. 2002. Udvid Tissue Abad: Projukti O Proyog. Bangla Academy, Dhaka.
3. Bhojwani S.S. and Razdan M.K. 1983. Plant Tissue Culture: Theory and Practice. Elsevier Science Publishers, Amsterdam, Oxford, New York, Tokyo.
4. Chawla H.S. 2002. Intrdocution to Plant Biotechnology. Oxford & IBH Publsihing Co. Pvt. Ltd., New Delhi.
5. Gamborg O.L. and Phillips G.C. 1996. Plant Cell Tissue and Organ Culture - Fundamental Methods. Springer-Verlag, Berlin, Heidelberg. Narosa Publsihing Hosue, New Delhi.
6. Geneve R.L., Preece J.E. and Merkle, S.A. 1997. Biotechnology of Ornamental Plants. CAB International, London, New York.
7. Pierik R.L.M. 1987. In Vitro Culture of Higher Plants. Martinus Nijhoff Publishers, Dordrecht, Boston, Lancaster.
8. Reinert J. and Bajaj Y.P.S. 1988. Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture. Springer -Verlag, Berlin, Heidelberg. Narosa Publishing House, New Delhi.

Bot. 309 Molecular Biology and Bioinformatics **4 Credits, 100 (70+20+10) Marks**

1. Structure and functions of nucleic acids: Monomeric components; discovery and structure of DNA double helix; conformational flexibility of DNA molecules; tandem repeat, inverted repeat, palindrome, hairpin and cruciform. Structure and function of RNA species.
2. Information organization in DNA molecule: Organization of DNA, the genetic code; types of codon; codon assignment- base composition and base sequence of codon; characteristics of the genetic code.
3. DNA replication: semi-conservative replication; Enzymes and accessory proteins involved in replication; generalized model for DNA replication; fidelity.
4. Plasmids: Types; copy number; compatibility group; segregation and maintenance; plasmids and drug resistance.
5. Transcription in prokaryotes and eukaryotes: (a) transcription in prokaryotes: promoter, RNA polymerase; transcription mechanism; (b) transcription in eukaryotes: eukaryotic promoters; eukaryotic RNA polymerases, transcription mechanism, post-transcriptional modification of RNA.
6. Translation: Ribosome, tRNA and aminoacylation, protein synthesis in prokaryote and eukaryote; post-translational modification of protein.
7. Molecular mechanisms of gene regulation: Positive and negative regulation of transcription, the operon model, regulation of transcription in a prokaryote (*lac* operon) and in a eukaryote (GAL genes); enhancers and silencers; RNA interference.
8. Techniques in molecular biology: (a) isolation of chromosomal, plasmid and plastid DNA; (b) Agarose gel electrophoresis; (c) SDS-PAGE (d) polymerase chain reaction; and (e) DNA sequencing.
9. Bioinformatics: Introduction to bioinformatics; databases, sequences and nomenclature; types of sequences used in bioinformatics, data retrieval tools (ENTREZ, PubMed); database similarity search tool (BLAST), sequence alignment (Global alignment, local alignment and multiple sequence alignment), significance of sequence alignment.

References

1. Tropp B. E. 2008. Molecular Biology (3rd edn.). Jones and Bartlett Publishers, Massachusetts, USA.
2. Karp G. 2002. Cell and Molecular Biology (3rd edn.). John Wiley & Sons, New York. USA.
3. Watson J.D. et.al. 2004. Molecular Biology of the Gene. (5th edn.). Pearson Education, Inc. USA.
4. Krebs J. E. *et al*. 2010. Lewin's Essential Genes (2nd edn.). Jones and Bartlett Publishers, Massachusetts, USA.
5. Twyman R.M. 1998. Advanced Molecular Biology. Bios Scientific Publishers, Oxford. UK.
6. Lesk A.M. 2003. Introduction to Bioinformatics. Oxford University Press. UK.
7. Lewin B. 2004.Genes VIII Pearson Prentice-Hall. USA.
8. Nelson D.L and M.M. Cox. 205 Lehninger Principles of Biochemistry (4th edn.). W.H. Freeman and Co. New York, USA.
9. Pasha M.K. 2000. Anobik Zibobiggan. Vol. I, II and III. Bangla academy. Dhaka, Bangladesh.

PRACTICAL COURSES

Bot. 311 General Microbiology, Plant Pathology, Phytochemistry and Herbal Medicine **2 Credits, 50 (35+10+5) Marks**

General Microbiology:

1. Serial dilution technique.
2. Isolation, enumeration of bacteria from different samples - soil, waste water, clinical specimen.
3. Pure culture of bacteria
4. Study of coliform bacteria- enumeration and characteristics.

Plant Pathology:

1. Study of general symptoms, causal organism of common plant diseases included in the theory course as well as interesting diseases occurring in the campus.
2. Preparation of slides through free hand section or by other methods.
3. Preparation of culture media for fungal pathogen, isolation and purification techniques.
4. Studies on the field symptoms of plant virus, bacteria and nematode.
5. Collection and preservation disease specimens.

Phytochemistry and Herbal Medicine:

1. Preparation of herbarium sheets of 50 important medicinal plant species.
2. Preparation of different reagents and qualitative test for alkaloids, terpenoids and flavonoids.
3. Qualitative test for alkaloids, spot test by Mayers's, Dragendorff's, Wagner's, and Hager's reagents and Tannic acid.
4. Extraction of volatile oil and alkaloids.
5. Pharmacognostic study of powdered herbal drugs.

Marks Distribution

Practical examination	-	28 Marks
Lab. Note Book	-	4 Marks
Sample Collection	-	3 Marks
Total	**=**	**35 Marks**

Bot. 312 Environmental Plant Physiology, Plant Systematics-II, Study Tour **2 Credits, 50 (35+10+5) Marks**

Environmental Plant Physiology:

1. Experiment on the effect of salt stress on germination and growth of plants.
2. Effect of silicon on germination and growth of crop plants.
3. Experiment on the effect of heavy metals on germination and growth of plants.

Plant Systematics-II

1. Identification of unknown families, genera and species following taxonomic keys.
2. Preparation of taxonomic keys for the identification of representative plant taxa.
3. Collection, drying, preservation and management experience on plant specimens following field trips.
4. Studies on primitive, and advanced, symplesiomorphic and synapomorphic characters in selected groups of Angiosperms.

Marks Distribution

Practical examination	-	24 Marks
Lab. Note Book	-	4 Marks
Study tour including submission of collection and report	-	7 Marks
Total	**=**	**35 Marks**

Bot. 313 Cytogenetics, Agronomy and Horticulture **2 Credits, 50 (35+10+5) Marks**

Cytogenetics:

1. Determination of centromeric type, centromeric index, relative length and chromosomal formula.
2. Preparation of karyotype from the supplied plates.
3. Preparation of idiogram from the supplied plates.
4. Study of meiosis in *Rhoeo discolor*, *Setcreasea purpurea*.
5. Study of C, CMA and DAPI banding.

Agronomy and Horticulture:

1. Study of the identification of different types of seeds, fertilizers, seedlings and seed preservation technique.
2. Study of Seedbed preparation.
3. Study of propagation of woody plants.
4. Study of weeding, mulching and pruning.
5. Study of compost preparation.

Marks Distribution

Practical examination	-	25 Marks
Lab. Note Book (including field report)	-	5 Marks
Sample Collection	-	5 Marks
Total	**=**	**35 Marks**

Bot. 314 Plant Tissue Culture, Molecular Biology and Bioinformatics **2 Credits, 50 (35+10+5) Marks**

Plant Tissue Culture:

1. Preparation of various media for different culture media.
2. Meristem culture, embryo culture and bud culture of suitable crop and forest plants.

3. Demonstration of somatic embryogeneis in carrot tissue culture.
4. Anatomical studies of morphogenesis.
5. Acclimatization of *in vitro* raised plants.
6. Mass cloning technique of forest trees through cuttings.

Molecular Biology and Bioinformatics:
1. Laboratory safety and material safety data sheets
2. Use of micropipette and microcentrifuge.
3. Preparation of TAE or TBE buffers
4. Isolation of nuclear and plastid DNA from DNA from plant.
5. Isolation of genomic and plasmid DNA.
6. Agarose gel electrophoresis of DNA.
7. Retrieving DNA sequences from databases.

Marks Distribution

Practical examination	-	30 Marks
Lab. Note Book	-	5 Marks
	Total =	**35 Marks**

Bot. 315 Viva-voce **2 Credits, 50 Marks**

Part-IV
(4th Year; Examination of 2017, 2018, 2019 and 2020)

THEORY COURSES

Bot. 401 Advanced Microbiology **4 Credits, 100 (70+20+10) Marks**

1. Antibiotics: Types, chemistry, mode of action and use of important antibiotics; Antibiotic resistance.
2. Immunology: Specific immunity-Complement system; Antigens-haptens, super antigens cluster of Differentiation (CD); B cells and T cells; Antibodies- structure, function, classes and mode of action.
3. Hypersensitivity–type-I, type-II, type-III and type-IV reactions; Autoimmunity and important autoimmune diseases.
4. Clinical and Medical Microbiology: Microorganisms as human pathogens- Virulence factors of pathogenic bacteria; Characteristics, pathogenicity and control of *Shigella, Salmonella, Vibrio, Pseudomonas, Staphyllococcus* and *Streptococcus*.
5. Diagnostic microbiology: general principles of the isolation of pathogens from clinical specimens; Growth Dependent identification; Antibiotic sensitivity; Fluorescent antibodies; ELISA tests.
6. Biofertilizers: Types; Principles of development and application of the inoculants of *Rhizobium, Azospirillum* and diazotrophic cyanobacteria.
7. Food and Industrial microbiology: Industrial production of alcohol, citric acid, lactic acid and Vinegar using microorganisms.
8. Pharmaceutical Microbiology: Spoilage and preservation of pharmaceutical products– mixture, suspension, syrups; Production of immunological products-vaccines, immunosera and human immunoglobulins.

References

1. Atlas, M.R. 1984. Microbiology: Fundamentals and Applications. Macmillan Publishing Co., New York.
2. Casida L.E. 1968. Industrial Microbiology, Wiley, New York.
3. Hugo W.B. and Russel A.D. 1983. Pharmaceutical Microbiology, Blackwell Scientific Publications, NY.
4. Khaleque K.A. and Maman Z. 1999. Medical Microbiology. Dhaka.
5. Madigan M.T., Martinko J.M. and Parker J.2008. Brock Biology of Microorganisms (11th edn.). Prentice Hall International, New Jersey, USA
6. Rao S.N.S. 1988. Biofertilizers in Agriculture. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
7. Riott I.M. 2001. Riott's Essential Immunology (10th edn.). Wiley-Blackwell, UK.
8. Trevan M.D., Boffey S., Goulding K.H. and Stanbury P. 1987. Biotechnology: the biological principles. Open University Press, Milton Keynes.

Bot. 402 Plant Pathology and Plant Protection **4 Credits, 100 (70+20+10) Marks**

1. Pathogen attack of host plants: Mechanical forces exerted by pathogens; Role of toxins, role of enzymes and role of growth regulators in plant disease development.
2. Principle of disease forecasting and methods: Important, requirements and basis of forecasting; Weather and disease forecasting; Methods and general procedure for developing a forecasting system; Devices used for forecasting.
3. Diseases of trees: *Artocarpus heterophyllus*, *Dalbergia sisso*, *Heritiera fomes*, *Hevea brasiliensis*, *Mangifera indica*, *Shorea robusta*, *Tectona grandis* with special references to Bangladesh.
4. Wood decay: Types of wood decay, fungi involved, mechanism of wood decay, preventive and control measures.
5. Seed Pathology: Scope of seed pathology; Different mode of seed-plant-seed transmission of pathogens; Methods of seed health testing and identification of seed-borne diseases; Microbial spoilage of seed in storage; Management of seed storage.
6. Host defense against pathogens: Structural defense- pre-existing structural defense, induced structural defense mechanisms; Biochemical defense- pre-existing chemical defense, induced biochemical defense mechanisms.
7. General principle of plant disease control: Physical control- physical methods of controlling plant diseases; Chemical control- types of chemical used, specification of perfect fungicides, methods of application, factor affecting fungicidal efficacy protectant versus systemic fungicides; Biological control- recent development of an application of biopesticides.

8. Integrated Disease Management: Concept, ecological basis of the approach, methods, phases and achievement through IDM approaches for rice and vegetables.
9. Methods in plant pathology: Methods of inoculation; Collection of field data on plant disease; Estimation of yield loss; Disease survey and monitoring.

References

1. Agrios G.N. 2000. Plant Pathology (4th edn.). Academic Press Inc. New York, U.S.A.
2. Bakshi B.K. 2000. Forest Pathology- Principle and Practice in Forestry. Published by the Controller of publication, New Delhi, India.
3. Chakraverty A. 1988. Post Harvest Technology of Cereals, Pulses and Oilseeds. Oxford and IBH Pub. Co. Pvt. Ltd., New Delhi, India.
4. Dasgupta M.K. 1994. Principle of Plant Pathology. Allied Publishers Limited, New Delhi, India.
5. Mehrotra R.S. and Aggarwal A. 2003. Plant Pathology (2nd edn.). Tata McGraw-Hill Company, New Delhi, India.
6. Neergaard P. 1977. Seed Pathology. The MacMillan Press Ltd., London, U.K.
7. Nene, Y.L. and Thaphlyal P.N. 1979. Fungicides in Plant Disease Control (2nd edn.) Oxford and IBH Pub. Co. Pvt. Ltd., New Delhi, India.
8. Singh R.P. 2005. Plant Pathology. Kalyani Publishers, Kolkata, India.

Bot. 403 Developmental Plant Physiology and Plant Biochemistry 4 Credits, 100 (70+20+10) Marks

1. Plant growth and development: Definition of growth, growth regions, growth pattern, growth curve, factors affecting growth.
2. Plant growth regulators: Definition, hormone concept, classification, chemical nature, physiological role of growth regulating chemicals and mechanism of action of growth regulators, flowering hormone.
3. Growth inhibitors: Chemical nature of inhibitors, absicisic acid, phenolic inhibitors, other types of inhibitors.
4. Vernalization: Perception of the cold stimulus, mechanism of vernalization, importance of vernalization.
5. Aging: Juvenility, maturity and senescence in plant, patterns of senescence, physiological changes during senescence, control of plant senescence.
6. Physiology of flowering: Initiation of flower primordia, Light effect- Photoperiodism, classification of photoperiodic responses, site of perception of photoperiodic stimulus, critical day length, importance of light and darkness in photoperiodic cycle, photoperiodic induction, nature of phytochrome pigment, role of phytochrome in flowering, chemicals having effect on flowering, light quality and photoperiodism, temperature effect.
7. Fruiting: a) fruit set: definition, flower fading, receptivity, limitations of fruit set, parthenocarpy. b) Fruit growth - fruit growth rate, fruit size and role of seeds, c) Fruit drop and causes; d) Role of growth hormones in fruit growth and development e) Fruit ripening: definition, changes with ripening, ripening mechanism, hormonal controls of ripening.
8. Physiology of seed: Seed germination, morphological and biochemical changes during seed germination, hormonal regulation of germination, factors affecting germination. Seed dormancy- types of seed dormancy, causes of dormancy, breaking of dormancy, the role of light in seed dormancy, Seed quality.
9. Tuber and bulb formation: Tuber and bulb growth, nature of the stimulus, tuber ripening, environmental effects.
10. Nitrogen metabolism: Sources of nitrogen for plants, mechanism of nitrogen fixation, conversion of ammonium into organic compounds, nitrogen cycle.
11. Fat metabolism: Introduction, breakdown of fatty acids and energy formation through β-oxidation, Glyoxalate cycle.

References

1. Hopkins W.G. 1999. Introduction to Plant Physiology (2nd edn.). John Wiley and Sons. Inc. New York.
2. Kumar A. and Purohit S.S. 1998. Plant Physiology Fundamentals and Application. Agro Botanica. India.
3. Leopold A.C. and Kriedemann P.E.1985. Plant Growth and Development, second edition. Tata McGraw Hill Publishing Company Ltd.
4. Mukherji S. and Ghosh A.K. 2005. Plant Physiology (1st edn.). New Central Book Agency Ltd., India.
5. Noggle R.G and Fritz G.J. 2002. Introductory Plant Physiology (2nd edn.). Prentice-Hall of India Private Ltd., New Delhi.
6. Salisburry F.B. and Ross C.W. 2005. Plant Physiology (4th edn.). Thomson Asia Pvt. Ltd., Singapore.
7. Street H.E. and Opik H. 1984. The Physiology of Flowering Plants: Their Growth and Development (3rd edn.). Edward Arnold (London).
8. Tiez L. and Zieger E. 1991. Plant Physiology. The Benjamin/Cummings Publishing Co. Inc. California.

Bot. 404 Advanced Plant Ecology 2 Credits, 50 (35+10+5) Marks

1. Structural and functional concept of ecology, the earth's life-support systems: components and functions of Atmosphere, Lithosphere, Hydrosphere and Biosphere.
2. Ecological factors: Definition; Ecological factors and their relationship with plants:
   a) Climatic factors: Light, Temperature, Precipitation, Humidity. Wind-speed and their effects on vegetation.
   b) Edaphic factors: Soil components and their effects on vegetation
   c) Physiographic factors: Topographic conditions and their effects on vegetation.
   d) Biotic factors: Types, interactions between plants, animals and man, interactions between plants and plants, and interactions between plants and micro-organisms.
3. Ecological data analysis and data presentation: Introduction; need of statistics and biometry in ecology; Methods of quantitative data analysis (diversity and species richness); Ecological data processing presentation.
4. Pollution ecology: Introduction, classification of pollution and pollutants, causes, effects and management of air, water, agricultural, noise and radiation pollution; different pollution in Bangladesh and their consequences.
5. Ecological degradation: Introduction, types, causes and effects of ecological degradation; Greenhouse effects, global warming, sea level rise, acid rain, ozone layer depletion and, salinity and drought problems in Bangladesh.

6. Remote sensing in ecological research: Introduction, physical basis for remote sensing, process of information extraction, role of remote sensing in ecological research.

References

1. Bannister P. 1976. Introduction to Physiological Plant Ecology. Blackwell Scientific Publications. New York.
2. Chapman J.L. and Reiss M.J. 1992. Ecology: Principles and application. Cambridge University Press. London, UK.
3. Edwards P.J. and May R.M. 1994. Large Scale Ecology and Conservation Biology. Blackwell Scientific Publications. New York.
4. Etherington J.R. 1971. Environment and Plant Ecology. John Wiley & Sons. New York.
5. Larcher W.L. 1975. Physiological Plant Ecology. Springer. Oxford, United Kingdom.
6. Rana S.V.S. 2005. Essentials of Ecology and Environmental Science. Prentice-Hall Pvt. Ltd. India.
7. Verma P.S and Agarwal V.K. 1986. Principles of Ecology. S. Chand and Co. Pvt. Ltd. New Delhi, India.
8. Waisel J. 1972. Biology of Halophytes. Academic Press. London, UK.

Bot. 405 Soil and Environment **2 Credits, 50 (35+10+5) Marks**

1. Introduction: Definition; History; Classification and importance of soil.
2. Origin and formation of soil: Introduction; Process of soil formation: Weathering processes- Physical, Chemical and Biological weathering; Pedogenesis; Factors affecting soil formation.
3. Components of soils: Mineral components; Organic matter and humus; Soil atmosphere; Soil water; Soil micro-organisms.
4. Soil physical properties: Soil texture, Structure, Weight and Density, Porosity, Permeability, Colour, Temperature, Plasticity, Cohesion and Adhesion.
5. Soil chemical properties: Soil Inorganic matter, Organic matter, Colloidal properties, Soil reaction and Buffer action, Soil acidity and alkalinity.
6. Soils of Bangladesh: Classification, types, characteristics and habitat distribution of different soils of Bangladesh.
7. Soil and environment relation: Soil-water relation, Soil-temperature relation, Soil- nutrient relation, Soil- plants relation, Soil-animals and micro-organisms relation.
8. Soil erosion and conservation: Types of erosion; Factors causing soil erosion; Aims and methods of soil conservation.

References

1. Arora M.P. 2004. Ecology, Himalaya Publishing House. Bombay, India.
2. Bannister P. 1976. Introduction to Physiological Plant Ecology. Blackwell Scientific Publications. New York.
3. Etherington J.R. 1971. Environment and Plant Ecology. John Wiley & Sons. New York.
4. Kapur P. and Govil S.R. 2004. Experimental Plant Ecology. CBS Publishers and Distributors. New Delhi, India.
5. Rana S.V.S. 2005. Essentials of Ecology and Environmental Science. Prentice-Hall Pvt. Ltd. India.
6. Shukla R.S. and Chandel P.S. 2000. Plant Ecology and Soil Science. S. Chand and Co. Pvt. Ltd. New Delhi, India.
7. Singh S. 2004. Environmental Geography, Prayag Pustak Bhuban. India.
8. Verma P.S and Agarwal, V.K. Principles of Ecology. 1986. S. Chand and Co. Pvt. Ltd. New Delhi, India.

Bot. 406 Plant Systematics-III **2 Credits, 50 (35+10+5) Marks**

1. Introductory Molecular Systematics: Theoretical background; characteristics and assumptions; applications and advantages.
2. Concepts on molecular evolution: Principles and causes of molecular evolution; theories on the driving forces of molecular evolution; information needed to study plant evolution.
3. Phylogeny: Basic concept; monophyly, paraphyly, and polyphyly; parallelism-convergence; homoplasy; apomorphy; symplesiomorphy; synapomorphy; outgroup-sistergroup; phylogeny based classification and relationships.
4. Methods for inferring phylogenies: Introduction to bioinformatics; parsimony, maximum likelihood, Bayesian inference and distance matrix methods; commonly used software programs for the construction of phylogeny-PAUP and MrBayes; molecular clock.
5. Origin of Angiosperms: Time of origin and early diversification; ancestors of Angiosperms.
6. Relationships of Angiosperms: Guiding principles of Angiosperm's relationships; relationships of Angiosperms with other groups and relationships within Angiosperms; molecular phylogeny of Angiosperms.

References

1. Freeman S. and Herron J.C. 2001. Evolutionary Analysis, 2nd edition. Prentice Hall, Upper Saddle River, NJ.
2. Graur D. and Li W.H. 2000. Fundamentals of Molecular Evolution. University of Chicago.
3. Hillis D.M., Moritz C. and Mable B.K. 1996. Molecular Systematics (2nd edn.). Sinauer Associates, Sunderland Massachusetts.
4. Lee W.H. 1997. Molecular Evolution. Sinauer Associates, Sunderland, Massachusetts.
5. Page R.D.M. and Holmes E.C. 1998. Molecular Evolution, a Phylogenetic Approach. Blackwell Science, Oxford.

Bot. 407 Biodiversity and Conservation **2 Credits, 50 (35+10+5) Marks**

1. Status of World biodiversity; worldwide loss of biodiversity, causes of loss of biodiversity; importance of world biodiversity and their conservation strategies; options and poverties of biodiversity conservation.
2. Genetic resource of Bangladesh: Importance and need for genetic diversity. Status of plant genetic resources, dispersal and diversification of domestication, dynamics of genetic diversity.
3. Conservation in practice: Techniques and methods of biodiversity conservation; management categories for conservations protected areas of Bangladesh.

4. Role of Botanic gardens, arboreta national parks, eco-parks, resource forests, sacred forests, sanctuary, agricultural orchards and wetlands of Bangladesh in conservation.
5. Concept, characteristic features and type of plant indicators; bio-ecological zones of Bangladesh; plant indicators of various landscapes of Bangladesh; versatile, endangered threatened, rare and endemic species of aquatic, terrestrial and epiphytic natural plant resources of Bangladesh.
6. National conservation strategies of Bangladesh.
7. Wildlife resources of Bangladesh and their conservation strategies.

References

1. Flint M. 1991. Biological Diversity and Developing Countries: Issues and Options. ODA, London, U.K.
2. Frankel O.H., Brown A.H.D. and Burdan J.J. 1995. Conservation of Plant Diversity, Cambridge University, Cambridge.
3. Heywood V.H. 2005. Global Biodiversity Assessment. IUCN
4. Kapoor V.P. and White J. 1992. Conservation Biology: A Training Manual for Biological Diversity and Genetic Resources. The Commonwealth Science Council, London, U.K.
5. Khan M.S. 1991. Towards Sustainable Development: Conservation of Genetic Resources of Bangladesh. NCS Series, published by IUCN, Ministry of Environment and Forest and NCS Secretariat, BARC, Farmgate, Dhaka.
6. Lal J.B. 1987. Environnemental Conservation. International Book Distributors, India.

Bot. 408 Plant Breeding **4 Credits, 100 (70+20+10) Marks**

1. History, objectives, scope and achievements of plant breeding.
2. Plant introduction: history/types, merit-demerits, achievements, purpose and procedure of introduction.
3. Selection in plant breeding: Objectives, field technique, merits and demerits, achievements of mass, pure line, pedigree and clonal selection.
4. Hybridization: Objectives, types, techniques and importance, hybridization techniques in Rice, Maize, Brinjal and Okra
5. Heterosis breeding: Scope, genetic, physiological and biochemical basis and importance.
6. Backcross breeding: Objectives, techniques, importance, merits-demerits, and achievements.
7. Mutation breeding: Objectives, types, techniques and importance, limitations, mutagens.
8. Germplasms in plant breeding: Importance, collection, cataloguing and conservation techniques.
9. *In vitro* techniques in plant breeding: Types, techniques and importance.
10. Male sterility: Types, causes, importance/limitations.
11. Self in compatibility: Types, mechanisms, overcoming techniques, importance.
12. Research activities of different research institutes: BRRI, BARI, BJRI, BTRI, BFRI
13. Procedure followed to release an improved variety from laboratory to the farmers.

References

1. Allard R.W. 1960. Principles of Plant Breeding, John Wiley and Sons Inc, New York.
2. Chopra V.L. 2000. Plant Breeding Theory and Practices. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
3. Fasoulas A. 1978. Principles and Methods of Plant Breeding. New York. USA.
4. Purseglove J.W. 1972. Tropical Crops (Vol. I&II) Longman Group Ltd. London, UK.
5. Sharma J.R. 1994. Principles and Practices of Plant Breeding. Tata McGraw Hill Publishing Co. Ltd. New Delhi.
6. Simmonds N.W. 1994. Principles and Crop Improvement. Longman, London and New York.
7. Singh B.D. 1983. Plant Breeding, Kalayni Publishers, New Delhi, India.
8. Singh, P. 2006. Essentials OF Plant Breeding. Kalyani Publishers. New Delhi, India.

Bot. 409 Biotechnology and Genetic Engineering **4 Credits, 100 (70+20+10) Marks**

1. Biotechnology: Basic concepts, history and development.
2. Recombinant DNA Technology and applications: Restriction endonucleases and restriction maps; cloning vectors; production of recombinant DNA molecules and its incorporation into vector; vector transformation; cDNA cloning; genomic cloning; identification and selection of clones; analysis and manipulation of cloned DNA; site-directed mutagenesis.
3. Bioprocess Technology: (a) exploitation of microorganisms: Design and operation of conventional fermentor; solid substrate fermentation; fermentation media and culture systems; productivity maximization and downstream processing. (b) exploitation of animal cells: basics of mammalian cell culture; bioreactor and mass cultivation of cells; product formation and purification.
4. Enzyme Technology: traditional uses of enzymes; enzyme immobilisation; bioreactor for immobilised enzymes; enzymatic electrocatalysis and biosensor.
5. Biotechnology in Health: Immunotechnology-Immune dysfunctions, cytokines, monoclonal antibody and vaccines. Application of hybridoma and recombinant-DNA technology in health science.
6. Plant and Animal Biotechnology: Introduction; Methods of Genetic engineering in plants and animals. Transgenic plants and animals with their significance.
7. Environmental Biotechnology: Renewable and Non-renewable resources; Conventional fuels and environmental impact; Non-conventional fuels and environmental impact; Biofuel, bioenergy, energy plantation, petroplants, alcohol (liquid fuel) and gaseous fuel (biogas and hydrogen). Waste treatment, composting, bioremediation and biomining. Biopesticide and BT.
8. Economic, ethical and social implications of Biotechnology.

References

1. Brown T.A. 2010. Gene Cloning and DNA Analysis: An Introduction (6th edn.) Wiely-Blackwell. UK.
2. Chawla H.S. 2002. Introduction to Plant Biotechnology. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi
3. Glick B.R. and Pasternak J.J. 2003. Molecular Biotechnology Principles and Applications of Recombinant DNA (3rd edn.). ASM Press. USA
4. Griffits A.J.M., Miller J.H., Suzuki D.T., Lewontin R.C. and Gelbart W.M. 2000. An Introduction to Genetic Analysis. WH Freeman & Company, New York. USA.

5. Lewin B. 2004. Genes VIII. Pearson Prentice Hall. USA
6. Primrose S.B. and Twyman R.M. 2006. Principles of Gene Manipulation and Genomics (7th edn.). Balckwell. UK.
7. Slater A., Scott N. and Fowler M. 2003. Plant Biotechnology. Oxford University Press.UK.
8. Watson J.D., Hopkins N.H., Roberts J.W., Steitz J.A. and Weiner A.M. 1987. Molecular Biology of the Gene (4th edn.). Benjamin Cummings. USA.

Bot. 410 Genetics-II **2 Credits, 50 (35+10+5) Marks**

1. Genotype and Allele frequencies : Introduction to quantitative genetics, deriving allelic frequencies from molecular data, changes in allele frequencies.
2. Quantitative genetics: Quantitative vs quantitative traits, norm of reaction and phenotypic distrbution, polygenic inheritance, Nilsson-Ehle's cross, statistical methods used in quantitative genetics.
3. Heritability: Definition, classification, methods of estimation, factors influencing heritability, limitations, additive and dominance variance, penetrance and expressivity.
4. Gene and Environment: Effect of environmental factors on the genotype and phenotype of organisms, developmental noise.
5. Population genetics: Variation and its modulation; effect of sexual reproduction on variation (Hardy-Weinberg Equilibrium), Sources of variation (mutation, recombination, migration, inbreeding and assortative mating), Selection, rate of change in gene frequency, balanced polymorphism, artificial selection, genetic drift, gene flow.
6. Mutations: a) Definition, occurrence, types of mutation, mutagens and chemically induced mutations, molecular basis of mutation, mutation and cancer. b) Mechanism of mutagenesis, suppressor mutations, detecting mutations with the Ames test, biological repair mechanisms.
7. Developmental genetics: Molecular genetic basis of plant reproduction, Genes controlling flower development in plant, genes for floral organ identity, MADS-Box genes. Programmed cell death and apoptosis.
8. Pedigree analysis: Symbols of pedigree, pedigrees of sex-linked and autosomal (dominant & recessive) diseases, Chi-square test, t-test.

References

1. Falconer D.S. 1989. Introduction to Quantitative Genetics. Longman Group Ltd. London.
2. Gardner E.J., Simmons, and D.P. Snustad, 1998. Principles of Genetics. John Wiley & Sons, Inc.
3. Griffiths A.J.F., Miller J.H., Suzuki D.T., Lewontin R.C. and Gelbart W.M. 2002. An Introduction to Genetic Analysis (7th edn.). W.H. Freeman & Co. New York.
4. Power C.B. 1992. Cell Biology. Himalaya Publishing House. Bombay, India.
5. Price B.A. 2012. Genetics: A conceptual approach. WH Freeman & Company, New York.
6. Watson J.D., Baker T.A., Bell S.P., Gann A., Levine M. and Losik R. 2008. Molecular Biology of Gene. Pearson International Edition, Cold Spring Harbor, New York.

PRACTICAL COURSES

Bot. 411 Advanced Microbiology, Plant Pathology and Plant Protection **2 Credits, 50 (35+10+5) Marks**

Advanced Microbiology:

1. Study of Antibiosis – antibiotic sensitivity test.
2. Biochemical tests: Catalase, fermentation of sugars, oxidase, methyl red, indole, Voges-Proskauer.
3. Enumeration and isolation of *Azotobacter* from soil.
4. Study of root nodules in legume plants.
5. Bread production using beaker's yeast.
6. Methylene blue reduction test for raw milk quality assessment.

Plant Pathology and Plant Protection:

1. Field survey of diseases and diagnosis of plant pathogens, identification.
2. Studies on seed-borne pathogenic fungi.
3. Preparation and application of contact and systematic fungicides.
4. Study of fungitoxicity using commercial fungicides and botanicals.
5. Collection and preservation of diseased specimens.

Marks Distribution

Practical examination	-	27 Marks
Lab. Note Book	-	5 Marks
Collection	-	3 Marks
Total	=	**35 Marks**

Bot. 412 Developmental Plant Physiology, Advanced Plant Ecology, Soil and Environment **2 Credits, 50 (35+10+5) Marks**

Developmental Plant Physiology:

1. Measurement of growth and growth curve.
2. To demonstrate phototropism.
3. To demonstrate the effect of light on flowering of crop.
4. Application of growth regulators on selected crops (*Oryza sativa* L., *Triticum aestivum* L., and *Zea mays* L.) to be grown in the pots and fields
5. Measurement of seed germination, Speed of germination, seed viability test using tetrazollium salts and observation of dormancy period of various seeds. To examine the effect of temperature, light, moisture, phytohormones and mineral nutrients on seed germination.
6. Measurement of enzymes, carbohydrates and protein in ripening fruits.

Advanced Plant Ecology:

1. Study of biotic and abiotic components of typical ecosystem.
2. Study the floristic composition and measurement of species diversity of different ecological zone/ecosystem
3. Study of environmental pollution (Determination of BOD, COD).
4. Study of common parameters used in GIS.
5. Preparation of field and laboratory note books.

Soil and Environment:

1. Measurement of soil temperature.
2. Evaluation of soil colour property.
3. Determination of soil moisture content.
4. Determination of maximum water holding capacity
5. Determination of soil pH.
6. Preparation of field and laboratory note books.

Marks Distribution

Practical examination	-	30 Marks
Lab. Note Book	-	5 Marks
Total	**=**	**35 Marks**

Bot. 413 Plant Systematics-III, Biodiversity and Conservation, Study tour **2 Credits, 50 (35+10+5) Marks**

Plant Systematics-III:

1. Preparation of taxonomic description through DELTA program.
2. A phylogenetic (Parsimony or Bayesian) analysis with supplied morphological and/or molecular data and interpretation of the strict consensus tree.

Biodiversity and Conservation:

1. Assessment of plant species diversity in selected sites.
2. Introduction to ecosystem diversity of any selected area.
3. Identification, characterization and collection of land races of the crops.
4. Characterization of the varieties of economically important plants.

Marks Distribution

Practical examination	-	20 Marks
Lab. Note Book	-	5 Marks
Study tour including submission of plant samples, field note book and report	-	10 Marks
Total	=	**35 Marks**

Bot. 414 Plant Breeding, Biotechnology and Genetic Engineering, Genetics-II **2 Credits, 50 (35+10+5) Marks**

Plant Breeding:

1. Study of hybridization techniques of different plants.
2. Study of hybrid seed production.
3. Test of pollen fertility.
4. Germplasm collection, evaluation and conservation

Biotechnology and Genetic Engineering:

1. Preparation of competent cell for transformation.
2. Assay for cellulase activity.
3. Use of microbes, microbial and plant products as biopesticide.
4. Mutant isolation by gradient plate method.

Genetics-II:

1. Genetic variation analysis following ANOVA
2. Determination of heritability
3. Prediction for a population in Hardy-Weinberg equilibrium.

Marks Distribution

Practical examination	-	27 Marks
Lab. Note Book	-	5 Marks
Sample Collection	-	3 Marks
Total	=	**35 Marks**

Bot. 415 Viva-voce **2 Credits, 50 Marks**