DEPARTMENT OF BOTANY

Jahangirnagar University
Savar, Dhaka.

Syllabus for Master of Science (MS) in Botany for the academic sessions: 2013-14, 2014-15, 2015-16 and 2016-17

The Master of Science (MS) program in Botany shall be for one academic year and the examination will be held at the end of the course. The program consists of courses totaling of 750 marks equivalent to 30 credits. There shall be two groups, *viz.* General Group (**Group-A)** and Thesis Group **(Group-B)**. A student may take up either one of these two groups. Students obtaining at least **B grade** (3 grade point) according to CGPA system in the B.Sc. (Hons.) examination may be qualified for having choices for thesis work. The thesis work will be distributed to the qualified students determined by the academic committee of the Department.

The students of both General and Thesis Groups shall have to complete nine theory courses comprised of 500 marks equivalent to 20 credits. Among these courses eight courses of 400 marks or 16 credits will be the core courses and only one course of 100 marks or 4 credits will be a special course. The special course shall be allocated on a branch or discipline offered by the department and as per student's choice. For the theory courses, 70% marks shall be allotted for the year-end written examination, 20% marks for tutorial examination/assignment and 10% marks for class attendance.

The students of General Group shall have to undertake the practical courses of 200 marks or 8 (eight) credits for which 70% of the total marks shall be allotted for year-end written examination, 20% marks for tutorial/assignment and 10% marks for class attendance.

The students of Thesis Group shall have to complete a thesis work of 150 marks or 6 (six) credits. The thesis work for a student shall be allocated on a branch or discipline offered by the Department and as per his/her choice. Each of the students of this group shall have to present a seminar based on his/her research findings for which a total of 50 marks equivalent to 2 credits will be allotted. The distribution of marks for this seminar shall be as follows: 30 marks for the presentation of results and 20 marks for defense.

The students of both Groups shall have to participate in a *viva-voce* examination that will be held after the written and practical examination for which 50 marks equivalent to 2 credits will be allotted.

The distribution of marks and credits for both the Groups shall be as follows:

Courses, marks and credits distribution for the General Group

Courses	**Marks**	**Credits**
Theory courses 8 Core Courses (8 × 50 marks) = 400 marks (8 ×2 credits) = 16 credits 1 special course (1×100 marks) = 100 marks (1 ×4 credits) = 4 credits	400 100	16 4
Practical courses	200	8
Viva-voce	50	2
Total	**750**	**30**

Courses, marks and credits distribution for the Thesis Group

Courses	Marks	Credits
Theory courses 8 Core Courses (8 × 50 marks) = 400 marks (8 ×2 credits) = 16 credits 1 special course (1×100 marks) = 100 marks (1 ×4 credits) = 4 credits	400 100	16 4
Viva-voce	50	2
Thesis	150	6
Thesis presentation (Seminar and defense)	50	2
Total	**750**	**30**

Details of the courses offered by various disciplines of Botany are given below:

Core Theory Courses for both Group A and Group B

Course No.	Course Title	Marks	Credits
Bot.501	Microbiology	50	2
Bot.502	Seed Pathology and Seed Technology	50	2
Bot.503	Advanced Plant Systematics	50	2
Bot.504	Plant Ecology and Environment	50	2
Bot.505	Plant Physiology and Plant Biochemistry	50	2
Bot.506	Plant Breeding and Crop Improvement	50	2
Bot.507	Plant Biotechnology	50	2
Bot.508	Advanced Genetics	50	2
	Total =	**400**	**16**

Special Theory Courses for both Group A and Group B

Course No.	Course Title	Marks	Credits
Bot.511	Applied Microbiology	100	4
Bot.512	Advanced Plant Pathology	100	4
Bot.513	Contemporary Plant Systematics	100	4
Bot.514	Advanced Plant Ecology and Environment	100	4
Bot.515	Environmental and Crop Physiology	100	4
Bot.516	Plant Tissue Culture and Morphogenesis	100	4
Bot.517	Advanced Plant Breeding	100	4
Bot.518	Phytochemistry and Natural Products	100	4
Bot.519	Advanced Horticulture	100	4
Bot.520	Advanced Mycology and Mushroom Science	100	4
Bot.521	Molecular Biotechnology	100	4
Bot.522	Molecular Cytogenetics	100	4

Practical Courses for Group A

Course No.	Course Title	Marks	Credits
Bot.525	Microbiology, Seed Pathology and Seed Technology	50	2
Bot.526	Advanced Plant Systematics, Plant Ecology and Environment	50	2
Bot.527	Plant Physiology and Plant Biochemistry, Plant Breeding and Crop Improvement	50	2
Bot.528	Plant Biotechnology, Advanced Genetics	50	2

Details of the Core Theory Courses

Bot. 501 Microbiology **2 Credits, 50 (35+10+5) Marks**

1. **Microbial Systematics**: Microbial evolution, Microbial taxonomy, phylogenetic approaches to microbial classification, molecular based classification, fatty acid analysis for microbial taxonomy.
2. **Microbial Ecology**: Effect of abiotic factors on microorganisms- abiotic limitations to microbial growth, Leibig's Law of minimum, Shelford's Law of tolerance; effect of temperature, radiation, pressure, salinity, water activity, pH and redox potential.
3. **Microbial Metabolism**: Alternate pathways for glucose catabolism, Entner-Doudorf pathway, PPP, Anerobic respiration and Fermentation; analplerotic reactions, pathways of utilization of sugars other than glucose, biosynthesis of fatty acid and amino acid.
4. **Oncogenic Viruses**: Different types of oncogenic viruses, g-Feneral features and classification of retroviridae, genome structure and replication of retroviridae (HIV), viral oncogenes, molecular mechanisms of transformation by DNA and RNA viruses.
5. **Methanogenesis**: Importance of methane; Habitats of methanogens; Diversity and physiology of methanogens; Substrates of methanogenesis; Biochemistry of methanogenesis.
6. **Immunodeficiency and hypersensitivity**: Immunological tolerance, ontogeny and phylogeny, primary and secondary immunodeficiency, B cell deficiency, T cell deficiency.

References

1. Fields *et al*. 1996. Field's Virology (3/E). Bernard N. Lippincott Williams & Wilkins, Boston, USA.
2. Gottschalk G. 1986. Bacterial Metabolism. Springer-Verlag Berlin Heidelberg, New York.
3. Madigan M.T., Martinko J.M. and J. Parker. 2003. Brock's Biology of Microorganisms. Prentice-Hall International, New Jersey, USA.
4. Pelczar Jr.M.J., Chan E.C.S. and Krieg N.R. 1993. Microbiology: Concepts and Applications. McGraw-Hill Inc, USA.
5. Prescott L.M., John P.H. and Donald A.K. 1999. Microbiology. (4/E), 2002 (5/E), 2005 (6/E). McGraw-Hill Company, USA.

Bot. 502 Seed Pathology and Seed Technology **2 Credits, 50 (35+10+5) Marks**

1. **Concept and Scope of Seed Technology:** Definition, difference between seed and grain; seed quality characteristics, relationship with other sciences.
2. **Seed industries in Bangladesh:** Seed production, marketing, target, achievement and present status.
3. **General principles of seed production, processing and storage:** Seed production for rice, seed potato and true potato seed (TPS) with special reference to management of pests and diseases.
4. **Storage fungi:** Fungi involved; Predisposing factors; Conditions during storage in relation to development of damage; Harmful effects; Precautions.
5. **Entry point of seed infection and location:** Infection directly from the mother plant; Infection from outside. Infected or contaminated parts of the seed.
6. **Seed to plant transmission of pathogens:** Establishment of infection and course of disease.
7. **Seed health tests:** Objectives, Basic requirements, Equipments; Incubation tests; Procedures.
8. **Inspection of plants beyond the seedling stage:** Growing on test procedures, field trials, inspection of seed crops.

References

1. Agarwal R.L.1995. Seed Technology (2nd edn.). Oxford and IBH Pub. Co. Pvt. Ltd., New Delhi, India.
2. Dasgupta M.K. 1994. Principle of Plant Pathology. Allied Publishers Limited, New Delhi, India.
3. ISTA 1976. International Rules for Seed Testing- Seed Science and Technology 4: 51-177.
4. Neergaard, P. 1977. Seed Pathology. The Millan Press Ltd., London, U.K.
5. Richardson M. J. 1979. An Annotated List of Seed Borne Diseases (3rd edn.). CMI, Kew, Surrey, U.K.

Bot. 503 Advanced Plant Systematics **2 Credits, 50 (35+10+5) Marks**

1. **Center of origin, evolution and diversification of Angiosperms:** Hypotheses on the place of Angiosperms origin; mechanisms of evolution, diversification of Angiosperms.
2. **Taxonomic identification:** Prerequisites for the identification of an Angiosperm taxon; Identification through expert determination, comparison with the voucher specimens and published keys; DNA barcoding and its application in taxonomic identification.
3. **Phylogeny based classification:** Common steps and procedures followed in construction of phylogeny of a plant group; constructing a classification; comparing a phylogenetic classification with other classification systems.
4. **Taxonomic studies and publication:** Current trends in taxonomic studies and publication. New record; new species; checklist, Flora, monograph and revision; publication on phylogenetic reconstruction.
5. **Biogeography:** Definition, history and fundamentals of biogeography; historical, ecological and vicariance biogeography and their relevance to plant systematics.
6. **Introduction to Phytocoria:** Floristics provinces (Takhtajan) and Kingdoms (Good).
7. **Application of Plant Systematics:** Identification services, collection and databases of necessary specimens, knowledge on relationships, phylogeny, classification and biogeography of the interested plant groups; in conservation biology.

References

1. Cox B.C. and Moore P.D. 2005. Biogeography- An Ecological and Evolutionary Approach. (7th edn.). Blackwell Publishing, Malden, USA and Oxford, UK.
2. Graur D. and Li W.H. 2000. Fundamentals of Molecular Evolution (2^{nd} edn.). Sinauer Associates, Sunderland, Massachusetts.
3. Judd W.S., Campbell C.S., Kellogg E.A., Stevens P.F. and Michael J.D. 2002. Plant Systematics: A Phylogenetic Approach, (2nd edn.). Sinauer Associates, Sunderland, Massachusetts.
4. Nei M. and Kumar S. 2000. Molecular Evolution and Phylogenetics. Oxford University Press, Oxford, UK.
5. Whittaker R.J. 2007. Island Biogeography-Ecology, Evolution and Conservation. (2nd edn.). Oxford University Press.

Bot. 504 Plant Ecology and Environment **2 Credits, 50 (35+10+5) Marks**

1. **Modern approach in population and community ecology:** Ecotype and Ecospecies; Population density; Species richness; Niche concept; Density-stability relationship; Modern approach for measurement of species; Regulations of species diversity.
2. **Ecosystem dynamics and energy flow:** Introduction; Concept of energy; Process of energy flow; Laws of Thermodynamics; Energy transformation in nature; Lindeman's work and Golley's work; Model of energy flow in ecosystem; Ecological efficiencies.
3. **Ecosystem productivity and its measurement:** Definition; Types of productivity; Primary and Secondary Production; Factors effecting primary production; Methods of measuring primary production; Ecosystem types based on levels of productivity.
4. **Vegetation types and vegetation zones of Bangladesh:** Habitats; Topography; Soil types; Ecological distribution and floristic composition of vegetation types and vegetation zones of Bangladesh; Ecological case study in protected areas of Bangladesh.
5. **Soil formation; properties and soil-plant relationship:** Soil formation; Profile; Texture; Components; Soil properties; Soil factors effecting vegetation; Types of soil water; Soil-plant relationship.
6. **Application of ecology and human welfare:** Introduction; Role of ecology in Agriculture, Biological control; Land management; Natural resources conservation and restoration, Wild-life management; Protected area management; Need of ecological knowledge for public awareness.
7. **Major environmental problems in Bangladesh and their ecological consequences:** Major environmental problems; Forest and forest resources degradation; Shifing and Jhum cultivation; Use of insecticides, pesticides and chemical fertilizers; Arsenic problem in drinking water and its pollution in agro-ecosystem; Climate change

References

1. Bannister P. 1980. Introduction to Physiological Ecology. Blackwell Scientific Publication. New York.
2. Dash M.C. 2002. Fundamentals of Ecology. Tata McGraw-Hill Publishing Co. Ltd. New Delhi, India.
3. Greig-Smith P. 1982. Quantitative Plant Ecology, Blackwell Scientific Pub. New York
4. Karshaw A.K. 1977. Quantitative and Dynamic Plant Ecology. The English Language Book Society and Edward Arnold Publishers Ltd. London, U.K.
5. Kent M. and Paddy C. 1995. Vegetation Description and Analysis-A practical approach. John Wiley and Sons. New York.
6. Moore P.D. and Chapman S.B. 1986. Methods in Plant Ecology. Blackwell Scientific Publication. New York.

Bot. 505 Plant Physiology and Plant Biochemistry 2 Credits, 50 (35+10+5) Marks

1. **Hormones and Growth regulators:** Introduction, Biosynthesis of Auxin (Indole-3-acetic acid), Abscisic acid, Gibberellin and Cytokinin. Transport of growth regulators. Other phytohormones and growth inhibitors.
2. **Photomorphogenesis:** Physical and chemical properties of phytochrome, distribution and role of phytochrome; phytochrome and light in plant growth and flowering, chryptochrome-properties, distribution and role.
3. **Energy production in plants:** Energy production through oxidation of carbohydrate and lipids; Biological efficiency in oxidation of carbohydrate and lipid;
4. **Surface protection and secondary defense compounds:** Cutin, suberin and Waxes: their structure and function.
5. **Secondary Metabolism:** Introduction, Biosynthetic pathways for Terpenes (Mevalonic acid pathway) Nitrogen containing secondary products (Biosynthesis of nicotinic acid); Plant Phenolics- Shikimic acid pathway, Importance of secondary metabolites. Simple view of the major pathways of secondary product biosynthesis and their relationship with primary metabolism;
6. **Enzymes:** Distribution of enzymes in plants, models for explaining enzyme reactions, regulation of enzymatic action, enzyme secretion by plant cells, the mechanism of protein secretion, isozymes, the causes of enzyme multiplicity; Extraction, purification and assay methods of enzymes (α-Amylase, cellulase).
7. **Application of enzymes:** Application of enzymes in industries (protease, amylase, cellulase, xylanase and pectinase); Enzymes involved in biodegradation of lignocellulosics and toxic pollutants.

References

1. Bergmeyer H.U. 1974. Methods of Enzymatic Analysis, vol.4. (2nd edn.). Academic Press, New York.
2. Dey P.M. and Harborne J.B. 2000. Plant Biochemistry, (1st edn.). Academic Press, USA.
3. Hopkins W.G. 1999. Introduction to Plant Physiology. John Wiley and Sons. Inc. New York.
4. Kumar A. and Purohit S.S. 1998. Plant Physiology: Fundamentals and Applications. Agro Botanica, India.
5. Malik C.P. and Singh M.B. 1980. Plant Enzymology and Histo-Enzymology. Kalyani Publishers, New Delhi.
6. Salisbury F.B. and Ross C.W. 2007. Plant Physiology (4th edn.). Wadsworth Publishing Company, California.

Bot. 506 Plant Breeding and Crop Improvement 2 Credits, 50 (35+10+5) Marks

1. **Plant breeding:** Objectives of plant breeding research in Bangladesh. Problem and prospects of plant breeding research in Bangladesh.
2. **Different methods of crop improvement:** Selection, hybridization, mutation.
3. **Center of origin of crop:** Vavilov's, concept, origin and evolution of rice, wheat and jute.
4. **Plant introduction and acclimatization:** Types of introduction, history, procedure, importance and achievements.
5. **Breeding for resistance to abiotic (drought) and biotic (insect) stresses:** Effect, sources, genetics, breeding and importance.

6. **Synthetic and Composite varieties:** Definition, operations in producing a synthetic and composite varieties, merits and demerits, factors determining the performance of synthetic and composite varieties, maintenance of synthetic varieties.
7. **Biotechnology in crop improvement:** Scope and importance, application of tissue and cell culture, application of genetic engineering, achievements and future prospects, integration with plant breeding.
8. **International organization for crop improvement:** IRRI, CIMMYT, ICRISAT, IPGRI.

References

1. Fasoulas A. 1978. Principles and Methods of Plant Breeding. New York. USA.
2. Sharma J.R. 1994. Principles and Practices of Plant Breeding. Tata MacGraw Hill Publishing Co. Ltd.
3. Simnond N.W. 1979. Principles of Crop improvement, Longman, London.
4. Sing B.D. 1983. Plant Breeding. Kalayan Publishers, New Delhi, India.
5. Singh P.2006. Essentials of Plant Breeding. Kalyani Publishers. New Delhi, India.

Bot. 507 Plant Biotechnology **2 Credits, 50 (35+10+5) Marks**

1. **Plant regeneration through in vitro culture:** Environmental control in micropropagation, *in vitro* photo-autotrophic micropropagation, acclimatization of *in vitro* raised plantlets. Application of *in vitro* culture method in mass production of commercially important crops with special reference to orchids, banana, potato, pineapple, papaya and tree crops. Zygotic embryo rescue and culture for wide cross hybrid.
2. **Somaclonal variation:** Scheme for obtaining somaclonal variation, factors influencing somaclonal variation, causes of somaclonal variation, application of somaclonal variation in crop improvement.
3. **Secondary products in cell and tissue culture:** Production of secondary metabolites used as medicaments and food adjuncts through cell and tissue culture.
4. **In vitro germplasm conservation:** Cryopreservation, determination of survival of cryopreserved germplasm, regeneration of plantlets from cryopreserved germplasm.
5. **Gene transfer in plants:** Transient and stable gene expression, marker genes; gene transfer methods, vector mediated gene transfer; *Agrobacterium* mediated DNA transformation; Vectorless or direct DNA transfer, physical and chemical gene transfer methods.
6. **Transgenics in crop improvement:** Resistance to biotic stresses- insect resistance, virus resistance, disease resistance; resistance to abiotic stresses- herbicide resistance; transgenics for quality improvement, storage, flower color and shape, male sterility, terminator seed.

References

1. Bhojwani S.S. and Razdan M.K. 1983. Plant Tissue Culture: Theory and Practice. Elsevier Science Publishers, Amsterdam, Oxford, New York, Tokyo.
2. Chawla H.S. 2002. Introduction to Plant Biotechnology. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
3. Gamborg O.L. and Phillips G.C. 1995. Plant Cell, Tissue and Organ Culture-Fundamental Methods. Springer-Verlag, Berlin, Heidelberg. Indian Edition, 1996, Narosa Publishing House, New Delhi, Madras, Bombay.
4. Pierik R.L.M. 1987. In Vitro Culture of Higher Plants. Martinus Nijhoff Publishers, Dordrecht, Boston, Lancaster.
5. Reinert J. and Bajaj Y.P.S. 1977. Applied and Fundamental Aspects of Plant Cell, Tissue, and Organ Culture. Springer-Verlag, Berlin, Heidelberg. Indian Edition, 1988, Narosa Publishing House, New Delhi, Madras, Bombay.
6. Slater A., Scott N. and Fowler M. 2003. Plant Biotechnology. Oxford University Press.

Bot. 508 Advanced Genetics **2 Credits 50 (35+10+5) Marks**

1. **Organization and structure of genome:** Genome and genomics; unity and diversity of life; genome sequencing projects; genome sizes; genome structure in viruses and prokaryotes; organization of organelle genomes, organization of nuclear DNA in eukaryotes; overview of the genomes of *Escherichia coli* K-12, *Arabidopsis thaliana* and *Oryza sativa*.
2. **Genome maps and sequencing**: Molecular markers; genetic map; physical map and restriction map; construction of molecular maps in plants. chain termination DNA sequencing; pyrosequencing; shotgun approach; clone-contig approach; using a map to aid sequence assembly. Traditional ways to gene identification; detecting open-reading frames;

using homology to find genes; principles of similarity searching; determining the function of new gene and gene ontology.

3. **Microarrays and expression analysis**: DNA microarrays, application of DNA microarrays, microarray design, microarray fabrication, comparing global patterns of gene expression with microarrays; detection technology; northern blotting; PCR primer design, Different types of PCR.
4. **Proteomics**: Proteome and proteomics, polyacrylamide gel electrophoresis of protein; isoelectric focusing; two-dimensional gel electrophoresis, tryptic digestion of protein; protein sequencing.
5. **Recombination of genes**: Holiday Model, Meselson-Radding model, Double-strand break-repair model; enzymatic mechanism of recombination. Transposable genetic elements: McClintock's experiment; prokaryotic transposons (mu phage); mechanism of transposition in prokaryotes; retroviruses and retrotrnasposons (LINES and SINES); function and uses of transposable elements.
6. **Exploitation of plant genes**: Basic principles of plant gene regulation, epigenetic inheritance, strategies for insect pest, fungal and viral disease resistance; regulation of stress tolerance; Molecular farming for carbohydrates, protein and lipids.
7. **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), balanced polymorphism, artificial selection, random effect.

References

1. Brown T.A. 2000. Genomes (2nd edn.). Bios Scientific Publications. UK.
2. Brown T.A. 2010. Gene Cloning and DNA Analysis (6th edn.). Wiley-Blackwell, UK.
3. Griffiths A.J.F.; J.H. Miller, D.T. Suzuki, R.C. Lewontin and W.M. Gelbart 2000. An Introduction to Genetic Analysis. W.H. Freeman & Company, New York.
4. Lesk A. M. 2007. Introduction to Genomics. Oxford University Press. UK.
5. Primrose S.B. and R.M. Twyman, 2003. Principles of Genome Analysis and Genomics (3rd Ed.). Blackwell Publishing Co. UK.
6. Sehena M.2003. Microarray Analysis (1st edn.). J. Wiley & Sons., NJ.

Details of the Special Theory Courses

Bot. 511 Applied Microbiology **4 Credits, 100 (70+20+10) Marks**

1. **Microbiological Quality Control of Food and Drinks**: Importance, principle and fundamentals of microbiological quality control; Quality assurance - hazard analysis and critical control point (HACCAP) systems; identification of potential hazards, monitoring system for critical control point (CCP).
2. **Fermentation Technology**: Introduction. Development of inoculums for various fermentation processes. Media for industrial fermentation – formulation, sterilization. Fermentation types and cultures. Down stream processing – recovery and purification of industrial products.
3. **Microbiology of air:** Composition – number and kinds of organisms in air – air borne micro organisms – droplet and droplet nuclei – air samplers and sampling techniques –Air sanitation.
4. **Immobilization**: Principles and benefit, methods of immobilization of enzymes and cells.
5. **Bioremediation**: Definition, types and application. Environmental modification for bioremediation; microbial seeding and bioengineering approaches to the bioremediation of pollutants. Biodegradation of xenobiotics- xenobiotic chemicals in the environment; Pesticides- reductive dechlorination; Microbial evolution for biodegradation; Biodegradation of synthetic polymers and the landfill crisis.
6. **Improvement of useful microorganisms**: Mutation and selection of strains; Protoplast fusion technology; Use of recombinant DNA technology.
7. **Microbial leaching of ores**: Importance of microbial leaching; microorganisms involved; leaching processes, metal recovery.
8. **Vaccines**: Production of the components of bacterial vaccines; Production of the components of viral vaccines; Blending, filling and drying.

References

1. Atlas R.M. and Richard B. 1997. Microbial Ecology: Fundamentals and Applications (4th edn.). Benjamin Cummings, USA
2. Gottschalk G. 1986. Bacterial Metabolism. Springer-Verlag Berlin Heidelberg, New York, USA.
3. Hugo W.B. and Russel A.D. 1998. Pharmaceutical Microbiology (6th edn.). Wiley-Blackwell, UK.
4. Lynch J.M. and Hobbie J.E. 1988. Microorganisms in Action, Concepts and Application. ***In:*** Microbial Ecology. Black Well Scientific Co. Boston, USA.
5. Madigan M.T., Martinko J.M. and Parker J. 2003. Brock Biology of Microorganisms. Prentice-Hall International, New Jersey, USA.
6. Maier R.M., Pepper I.L. and Gerba C.P. 2000. Environmental Microbiology. Academic Press, USA.
7. Pelczar, Jr.M.J., Chan E.C.S. and Krieg N.R. 1993. Microbiology: Concepts and Applications. McGraw Hill Inc., USA.
8. Prescott L.M., John P.H. and Donald A.K. 1999. Microbiology. (4/E), 2002 (5/E), 2005 (6/E). McGraw-Hill Company, USA.

Bot. 512 Plant Pathology and Disease Management 4 Credits, 100 (70+20+10) Marks

1. **Introduction**: Nature and modern concept of plant disease; cause of disease; Levels of parasitism; Plant diseases on human affairs; Trends in research in plant pathology worldwide.
2. **Role of Toxins:** Enzymes and Hormones in relation to pathogenesis.
3. **Plant pathogens in the interaction in plant physiological functions**: Permeability changes in diseased plants; Effect on translocation of water; on nutrients in the host plant; on photosynthesis; on respiration; on nitrogen metabolism and protein metabolisms.
4. Biochemical defense mechanism in infected plants.
5. **Genetics of plant pathogen interaction:** Genetics of host parasite interaction; genetic basis of resistance and susceptibility; Gene for gene theory.
6. **Effect of environmental factors and nutrition on disease development**: Effect of temperature, humidity, soil pH, soil texture, height, oxygen and carbon dioxide concentration, nutrients, biotic environment on disease development. Role of environmental factors in epiphytotics.
7. **Plant disease epidemiology and plant disease forecasting**: Important epiphytotics of the past and present; Epiphytotic growth and analysis; computer simulation of epidemics; systems approach in epidemiology; Methods used in plant disease forecasting.
8. **Innovative approaches to plant disease control**: Physical methods; Biological methods; Cultural methods.

References

1. Agrios G.N. 2000. Plant Pathology (4th edn.). Academic Press Inc. New York, U.S.A.
2. Atlas B. 1998. Microbial Ecology: Fundamentals and Applications (4th edn.). Benjamin/Cummings Publishing Company, Inc.
3. Dasgupta M.K. 1994. Principle of Plant Pathology. Allied Publishers Limited, New Delhi, India.
4. Ilan C. 1987. Innovative Approaches to Plant Disease Control. John Wiley & Sons. Inc. USA.
5. Mehrotra R.S. and Aggarwal A. 2003. Plant Pathology (2nd edn.). Tata McGraw-Hill Company, New Delhi, India.
6. 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.
7. Richardson M.J. 1979. An Annotated List of Seed borne diseases (3rd edn.). CMI Kew, Surrey, U.K.
8. Vander P.J.E. 1963. Plant Disease-Epidemics and Control. Academic Press, New York.

Bot. 513 Contemporary Plant Systematics 4 Credits, 100 (70+20+10) Marks

1. **Plant morphology:** Overview of plant morphology; morphological character classification; in-depth understanding on habit, root, stem, bud, leaf, flower and fruit morphology to collect the useful taxonomic characters; recording, formatting and using morphological characters.
2. **Specimen collection and management:** Essential know-how in collecting, processing, preserving and management of plant specimens; maintenance of plant specimen data bases.

3. **Taxonomic key, description and nomenclature**: Concept on making taxonomic keys, taxonomic checklist and typical taxonomic description for flora, monograph and revision; taxonomic information in World Wide Web; knowledge on the sources of nomenclatural information.
4. **Molecular data:** Collection, processing, formatting and application of molecular data in phylogenetic systematics.
5. **Phylogenetics**: Analysis of phylogenetic data, generating the phylogenetic trees and choosing the best phylogenetic tree using conventional phylogenetic methods and softwares; interpretation of a well resolved phylogenetic tree; making a classification from a phylogenetic tree.
6. **Interpreting the Past:** Principles and practice; phylogeography; molecular and isotope biogeography; few case studies based on molecular data; ancient DNA and uses.
7. **Island Biogeography:** Introduction; global significance; island theory and conservation.
8. **Concepts on some common families of flowering plants of Bangladesh**: Key characters of Nymphaeaceae, Magnoliaceae, Acantheceae, Malvaceae, Leguminosae, Moraceae, Dipterocarpaceae, Euphorbiaceae, Zingiberaceae, Apocynaceae, Rosaceae, Rubiaceae, Scrophulareaceae, Solanaceae, Orchidaceae, Cyperaceae, Palmae, Poaceae, Verbenaceae, Asteraceae.

References

1. Bold H.C. 1980. Morphology of Plants. New York.
2. Cox B.C. and Moore P.D. 2005. Biogeography-An Ecological and Evolutionary Approach (7th edn.). Blackwell Publishing, Malden, USA and Oxford, UK.
3. Davis P.H. and Hewood, V.H. 1963. Principles of Angiosperm Taxonomy. Oliver and Boyed, Edinburgh, U.K.
4. Felsenstein J. 2003. Inferring Phylogenics. Sinauer Associates.
5. Hall B.G. 2004. Phylogenetic Trees Made Easy (2nd edn.). Sinauer Associates, Sunderland, Massachusetts, USA.
6. Jones B.S. and Luschinger A.E. 1979. Plant Systematics, McGraw Hill Book Co. New Delhi, India.
7. Judd W.S., Campbell C.S., Kellogg E.A., Stevens P.F. and Michael J.D. 2002. Plant Systematics: A Phylogenetic Approach (2nd edn.). Blackwell Pubs.
8. Kitching I.J, Forey P.K., Humphries C.J. and Williams D. 1998. Cladistics. The Theory of Parsimony Analysis. Oxford University Press.

Bot. 514 Advanced Plant Ecology and Environment 4 Credits, 100 (70+20+10) Marks

1. **Phyto-geography and major vegetational zones of the world:** Definition; Principles of Phytogeography; Factors affecting distribution of species; Detail classification and description of the major phytogeographical zones (Biomes) of the world with particular reference to their habitat distribution and floristic composition.
2. **Endemism and endemic plants of Bangladesh:** Definition; Types of endemics; Factors affecting distribution of species in different ecological habitats; Endemism and endemic species of Bangladesh; Some endemic species of the world.
3. **Forest and forest ecosystem management with reference to Bangladesh:** Importance and ecological significance of forest; Processes in forest ecosystem; Factors; Forest management; Classification and habitat distribution of forests of Bangladesh; Detail study on Deciduous and Mangrove forest ecosystems of Bangladesh; Social forestry.
4. **Natural resources, their degradation and conservation:** Definition and classification of natural resources; Types of natural resources; Causes of natural resources degradation; Ecological consequences of natural resources degradation; Case study on forest resources degradation in Bangladesh; Ways and means of natural resources restoration and conservation.
5. **Global environmental issues, catastrophes and their ecological impacts:** Sources of Green house gases; Green house effects; Global warming; Sea level rise; Ozone layer depletion; Acid rain, Biodiversity degradation.
6. **Soil erosion and conservation:** Definition; Types of soil erosion; Agencies causing soil erosion; Effects of soil erosion; Soil conservation aims; Methods of soil conservation
7. **Protection of land and Protected areas of Bangladesh and their case study:** Definition; Need of protection; Criteria of protection; Classification of protected area; Detail classification of protected areas of Bangladesh; Description of important protected areas;

Ecological aspects of protected areas of Bangladesh; Assigned field based case study on protected areas.

8. **Environmental and ecological institutions, International cooperation and laws:** International institutions; Objectives, activities and functions of International Union for the Conservation of Nature and Natural Resources (IUCN), World Conservation Monitoring Centre (WCMC), Convention on Biological Diversity (CBD); Global Environmental Agreements; Man and Biosphere Programme (MAP); National Forest Policy of Bangladesh; National Environmental Policy of Bangladesh

References

1. Ahmed Z.U. 2008. Encyclopedia of Flora and Fauna of Bangladesh. Vol.1. Bangladesh Profile. Asiatic Society of Bangladesh.
2. Green M.J.B. 1990. IUCN Directory of South Asian Protected Areas. IUCN, Gland Switzerland, and Cambridge, U.K.
3. Karshaw A.K. 1977. Quantitative and Dynamic Plant Ecology. The English Language Book Society and Edward Arnold (Publishers) Limited. London, U.K.
4. Moore P.D. and Chapman S.B. 1986. Methods in Plant Ecology. Blackwell Scientific Publication. New York.
5. Mukherjee B. 1996. Environmental Biology. Tata McGraw Hill Publishing Co. Ltd. New Delhi, India.
6. Odum E.P. 1975. Ecology. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi, India.
7. Pasha M.K. and Uddin S.K. 2013. Dictionary of Plant Name of Bangladesh. Janakallyan Pubs. Ctg., Dhaka.
8. Shimwell D.W. 1968. The Description and Classification of Vegetation. Sidwick and Jackson.

Bot. 515 Environmental and Crop Physiology 4 Credits, 100 (70+20+10) Marks

1. Definition and scope of Environmental Plant Physiology.
2. **Salt tolerance:** Screening and variability, selection of tolerant types, physiological methods of improving salt tolerance, salt shock proteins.
3. **Crop tolerance to air pollutants:** Introduction, selection of tolerant crops, physiological bases of tolerance, growth and developmental responses of crops to air pollutants.
4. **Metal toxicity:** Effects of toxic metal ions (Cd. Pb, Hg, Cu, Mn, Fe and Al) on plant growth and development.
5. **Irradiation stress:** Effects of light and ionizing radiation stress on plant growth.
6. Crops and world food supply with special emphasis to Bangladesh.
7. **Physiological aspects of crop production and crop yield:** Physiological basis of crop production and yield; Nitrogen metabolism and crop productivity; production-related assimilate transport and partitioning; carbohydrate synthesis and crop metabolism; Effect of plant population, weeds and stress on crop yield; Yield of mixed crop and crop harvest index (HI), Crop Ideotype and its physiological basis.
8. **Crop growth measurement:** Fresh and dry weight and leaf area measurement; leaf area ratio (LAR); Relative growth rate (RGR) and net assimilation rate (NAR).
9. **Physiological responses of crop plants to environmental factors and climate changes:** Role of temperature light, carbon dioxide, water supply on assimilation rate and in the physiology of crop plants. Crop plant responses to rising CO_2 and climate change.
10. Application of growth regulating chemicals for increasing crop yield.

References

1. Donald R. 1967. Crop Ideotype. Cambridge University Press.
2. Fitter A. H. and Hay R.K.M. 2002. Environmental Physiology of Plants (3rd edn.). Academic Press in London
3. Gupta U.S. 1997. Crop Improvement, vol. 2, Stress Tolerance. Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi.
4. Hopkins W.G. 1999. Introduction to Plant Physiology. John Wiley and Sons. Inc. New York.
5. Hunts R. 1982. Plant Growth Curve: Fundamental Approach to Plant Analysis. Edward Arnold.
6. Nobel P.S. 2005. Physiochemical and Environmental Plant Physiology (3rd Edition). Elsevier Science Publisher
7. Salisbury F.B. and Ross C.W. 2007.Plant Physiology. (4th edn.). Wadsworth Publishing Company, California.

Bot. 516 Plant Tissue Culture and Morphogenesis 4 Credits, 100 (70+20+10) Marks

1. **Plant tissue culture:** Types of culture- seed culture, embryo culture, nucellus culture, endosperm culture, organ culture and their application.
2. **Cell and suspension culture:** Batch culture, continuous culture- open and closed, growth measurement, synchronization of cell suspension culture; technique for single cell culture and its application.
3. **Protoplast culture:** Protoplast isolation and purification, viability test of isolated protoplast, development of whole plant from single protoplast; protoplast fusion for development of somatic hybrids and cybrids and their application.
4. **Anther and microspore culture:** Technique of culture for production of haploid plant from anther and microspore, factors affecting androgenesis; ontogeny of andtrogenic haploids; importance of haploidy in higher plants.
5. **Impact of tissue culture techniques on the development of agribusiness:** Some case studies- orchids, potato, banana, jackfruit and bamboo.
6. **Somatic embryogenesis:** Zygotic embryos versus somatic embryos; factors affecting somatic embryogenesis; anatomy and cytology of somatic embryo development; loss of morphogenic potential in long-term culture- genetic and physiological hypothesis.
7. **Cytodifferentiation:** *In vitro* differentiation of vascular elements, factors affecting vascular tissue differentiation.
8. **Morphodiffertiation:** Organogenic and embryogenic differention, factors affecting shoot-bud and embryo differentiation- physiological and biochemical aspects

References

1. Bhadra S.K. 2002. Udvid Tissue Abad: Projukti O Proyog. Bangla Academy, Dhaka.
2. Bhojwani S.S. and Razdan M.K. 1983. Plant Tissue Culture: Theory and Practice. Elsevier Science Publishers, Amsterdam, Oxford, New York, Tokyo.
3. Chawla H.S. 2002. Introduction to Plant Biotechnology. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
4. Gamborg O.L. and Phillips G.C. 1995. Plant Cell, Tissue and Organ Culture- Fundamental Methods. Springer-Verlag, Berlin, Heidelberg. Indian Edition, Narosa Publishing House, New Delhi.
5. Pierik R.L.M. 1987. In Vitro Culture of Higher Plants. Martinus Nijhoff Publishers, Dordrecht, Boston, Lancaster.
6. Reinert J. and Bajaj Y.P.S. 1977. Applied and Fundamental Aspects of Plant Cell, Tissue, and Organ Culture. Springer-Verlag, Berlin, Heidelberg. Indian Edition, 1988, Narosa Publishing House, New Delhi, Madras, Bombay.
7. Slater A., Scott N. and Fowler M. 2003. Plant Biotechnology. Oxford University Press.
8. Woong Y.S, Sant S.B. and Soh W.Y.S. 1999. Morphogenesis in Plant Tissue Culture. Springer, Dordrecht, Boston, Lancaster.

Bot. 517 Advanced Plant Breeding 4 Credits, 100 (70+20+10) Marks

1. **Introduction to plant breeding:** Past, present and future breeding programs of Bangladesh Plant breeding for food security of Bangladesh.
2. **Reproductive biology:** Mode of reproduction and pollination.
3. **Crop genetic resources:** Different genetic resources, gene pool concept, genetic resources erosion and conservation.
4. **Clonal selection:** Characteristics of clone, comparison among clone and inbreeds, clonal degeneration methods of improvement.
5. **Hybrid breeding:** History, need and mechanisms.
6. **Mutation breeding:** Types, effect, molecular basis, breeding for oligogenic and polygenic trait, importance.
7. **Polyploid breeding:** Types, origin and applications in crop improvement, methods for polyploid breeding.
8. **Breeding for disease resistance:** Source, mechanisms, genetics and method of breeding for disease resistance.
9. **Ideotype in crop improvement:** Types, characteristics of a crop ideotype, ideotype breeding, limitations.
10. **Somatic hybridization:** Introduction to somatic hybridization, technique of somatic hybridization and application.

11. **Maintenance of crop varieties:** Self pollinated crops, hybrid lines, inbred lines and asexually propagated crops.
12. **Plant variety protection:** Plant patent act, Plant variety protection act, Plant breeder's right.

References

1. Fasoulas A. 1978. Principles and Methods of Plant Breeding. New York. USA.
2. Jcasea F.N. 1988. Plant Breeding Methodology. Wiley Intemcieace Publishers.
3. Purseglove J.W. 1972. Tropical Crops (Vol. I&II) Longman Group Ltd. London, UK.
4. Sharma J.R. 1994. Principles and Practices of Plant Breeding. Tata McGraw Hill Publishing Co. Ltd.
5. Sing B.D. 1983. Plant Breeding. Kalyani Publishers. New Delhi, India.
6. Singh P. 2006. Essentials of Plant Breeding. Kalyani Publishers. New Delhi, India.

Bot. 518 Phytochemistry and Natural Products 4 Credits, 100 (70+20+10) Marks

1. Introduction to Phytochemistry and secondary Plant product; Phytochemical methods of plant analysis- Methods of extraction and isolation, Methods of separation, Methods of identification.
2. **Phenolics**: Introduction, Phenols and Phenolic acids, Flavonoid Pigments, Anthocyanins,
3. Flavonols and flavones, Quinone Pigments, Shikimic acid pathway.
4. **Alkaloids:** Definition, Chemistry and distribution; Classification; General methods of isolation, Alkaloid reagents; Natural sources, Chemistry and uses of (a) nicotine (b) atropine (c) codeine (d) ephedrine and (e) morphine.
5. **Glycosides :** Definition; General characters and classification; methods of isolation; Natural sources, chemical constituents and uses of (a) Salicin b) Digitoxin c) Apterin d) Panaquilon and e) Liquorice.
6. **Lipids and Essential oils**: Steroids, Terpenoids: introduction, classification biosynthesis of Terpens, Fat-soluble vitamins, Triglycerides, Waxes, The acetate pathways, fatty acid and polyketide biosynthesis. Definition and general properties of essential oils; Classification, methods of isolation; source, chemical constituents and uses of (a) Clove oil (b) Cinnamon oil (c) Cardamon oil (d) Lemon grass oil (e) Eucalyptus oil.
7. **Tannins and Resins**. Introduction; definition; chemical nature and properties; test for identification and their uses.
8. **Natural products**: Definition, occurrences and importance of some natural products.
9. Molecular shapes and polar/non-polar properties, stereochemistry of natural products in nature.
10. **Supplement product**: Introduction to supplement product, antioxidant, ROS species and oxidative damages, free radial scavenger, Dietary and energy food or drink.
11. **Phytochemical analytical tools:**
    a. **Spectrophotometry**: Working principle of spectrophotometery and its application in phytochemistry. UV-VIS spectroscopy: EMR, chromophore and auxochrome, effect of UV on conjugated bond. Beer-Lamberts law and its application.
    b. **Chromatography**: Fundamental of Chromatography, Thin layer and paper chromatography Column chromatography (CC), Ion-exchange chromatography, High performance liquid chromatography (HPLC), Gas chromatography.
    c. **Spectroscopic techniques**: IR: IR absorption process, methods of vibration and bending, bond properties an absorption trends, IR spectrophotometer. NMR: Nuclear spin state, nuclear magnetic moments, NMR spectrometer, 1D and 2D NMR, ^{1}H and ^{13}C spectra. MS: Mass spectrophotometer, molecular weight determination, fragmentation pattern of alkanes, alkenes, alkynes, aromatic hydrocarbons, alcohol and phenols, ketones.

References

1. Bell E.A. and Charlwood B.V. 1980. Secondary Plant Products (Encyclopedia of Plant Physiology, New Series (Vol 8). Springer-Verlag Berlin Heidelberg, New York.
2. Ghani A. 1998. Medicinal Plants of Bangladesh, Chemical Constituents and Uses, Asiatic Society of Bangladesh, Dhaka.
3. Ghani A. 1999. Veshaja Rasayan. Bangla Academy, Dhaka.
4. Harbone J.E. and Swain, T. 1996.Perspective in Phytochemistry, Academic press, London.
5. Harborne J.B. 1973. Phytochemical Methods, a Guide to Modern Techniques of Plant Analysis, Chapman and Hall.
6. Kalsi P.S. 2001. Chemistry of Natural Products, Kalyani Publishers, New Delhi.

7. Sharma U.R. 2005. Elementary Organic Spectroscopy. 3rd Edition, S. Chand and Company Ltd. New Delhi
8. Torssel K.B.G. 1983. Natural Products Chemistry, J. Wiley and Sons New York.

Bot. 519 Advanced Horticulture **4 Credits, 100 (70+20+10) Marks**

1. **Classification of horticultural plants**: Classification of vegetables and fruits; Scope and objectives of horticulture.
2. **Nursery planning and management**: Types of nursery, site selection, nursery soil management, preparation of seedbeds, sowing and potting, care and maintenance of seedlings, watering, shading, mulching, hardening and transplanting of seedlings, pruning and aftercare.
3. **Floriculture and its practice**: Scope and objectives of commercial floriculture in Bangladesh, production of cut flowers, production of potted plants, growing and forcing flowering, bulbs and corms, production of bedding plants, home floriculture. Use of plant growth regulators on horticultural plants.
4. **Seed technology**: Sources of seeds, seed collection, drying, cleaning and storing procedures, pre-treatment of seeds, seed testing and seed certification, use of seeds from seed orchards; orchard development through site planning and plantation.
5. **Pest, disease and pest management**: Types of plant pests and diseases, common pests and diseases of garden plants and their management.
6. **Plant propagation**: General methods of propagation, types of vegetative propagation-propagation by cutting, layering, grafting and budding, advantages and disadvantages of vegetative propagation, propagation of horticultural aspects and management of the following selected fruits: Mango, Jujube, Guava, Pineapple and Lemon; selected flowers: Tuberose, Gladiolus lily, Marigold, Rose, Dahlia and Chrysanthemum.
7. **Organic farming**: Soil organic matter, completely oxidized compounds, factors affecting the rate of decomposition, nature and value of humus, Carbon-Nitrogen ratio of organic matter, production of organic matter, organic fertilizers versus commercial fertilizers.
8. **Production and preservation technology**: Technologies for production of nursery and horticultural plants, Technologies for preservation of nursery and horticultural products, Packaging and Marketing.
9. **Landscape designing**: Scope of landscape designing, basic principles of landscape design, components of landscape design, residential landscaping.

References

1. Bose T.K., Mitra S.K. and Sadhu M.K. 1991. Propagation of Tropical and Sub-tropical Horticultural Crops. Naya Prakash, Calcutta, India.
2. Collins G.H. 1955. Commercial Fertilizers. 5th Ed. McGraw Hill Publishing Co. Ltd, New York.
3. Edmond J.B., Senn T.H., Andrews F.S. and Halfcare R.G. 1990. Fundamentals of Horticulture. Tata McGraw-Hill Publishing Co. Ltd., New Delhi, India.
4. Faulkner R. 1995. Seed Orchards. Forestry Comm. Bull. No.54. London. U.K. Her Mijestry, Stationary Office.
5. Lauric A., Kiplinger D.C. and Nelson K.S. 1968. Commercial Flower Forcing. McGraw-Hill Publishing Co. Ltd., New York, U.S.A.
6. Nelson K.S. 1966. Flower and Plant Production in the Green House. Danville, III. Interstate Printers and Publishers.
7. Simonds J.O. 1961. Landscape Architecture. McGraw-Hill Publishing Co. Ltd. New York.
8. Teuscher H. and Adler R. 1960. The Soil and its Fertility. Reinhold. New York.

Bot. 520 Advanced Mycology and Mushroom Science **4 Credits, 100 (70+20+10) Marks**

1. **Introduction to Fungi**: Vegetative structure of fungi, Chemical composition of fungal cell wall, Nutritional and physical requirements for fungal growth and metabolism.
2. **Sexuality and Genetics of Higher Fungi**: Discovery and findings in Sexuality, Genetics of the mating type loci and sexual morphogenesis of higher fungi, Genetics of fungi.
3. **Fungal Fermentation Systems and Products**: Fungal fermentation systems, Ethanol production, Commercial fungal products.
4. **Antibiotics, Enzymes and Chemical Commodities from Fungi**: Antibiotic production, pharmacologically active products, Enzymes, Chemical commodities.

Mushroom Science

5. Historical development of mushroom science, Taxonomy and Classification.
6. Facilities for setting up mushroom farm for seasonal and environmentally control cultivation, Requirement and maintenance of temperature, Relative humidity, CO_2, ventilation in cropping rooms, Cultivation technology of *Agaricus bisporus, Pleurotus ostreatus, Calocybe indica* and *Ganoderma lucidum*.
7. Nutritional attributes and medicinal value of mushroom.
8. Insect pests, Diseases and abnormalities of cultivated mushroom and their management, Post-harvest technology and value addition of mushroom cultivation.

References

1. Alexopoulos C.J., Mims C.W. and Blackwell M. 2000. Introductory Mycology (4th edn.). John Wiley & Sons, New York.
2. Chadha K.L. and Sharma S.R. 2001. Advances in Horticulture (Mushroom). Vol. XIII. Malhotra. New Delhi.
3. Chang S.T. and Miles P.G. 2002. Edible Mushrooms and Their Cultivation. CRC Press, Florida. USA.
4. Dhar B.L and Tewari R.P. 2005. Cultivation Technology of High Temperature Tolerant White Button Mushroom, *Agaricus bitorquis*. DIPA, ICAR, New Delhi.
5. Kevin K. 2005. Fungi Biology and Applications. John Wiley & Sons Ltd., The Atrium, Southern Gate, Chichester, West Sussex PO19 8SQ, England.

Bot. 521 Molecular Biotechnology 4 Credits, 100 (70+20+10) Marks

1. **Introduction to molecular biotechnology**: Emergence of molecular biotechnology, commercialization of molecular biotechnology, concerns and consequences.
2. **Fundamentals of gene cloning:** Steps of gene cloning, tools for gene cloning, cDNA library, construction of genomic library, identification of desired clones, properties of a good vector, cloning vectors, cosmid, phagemid, BAC vector, shuttle vectors, vectors for plants. Integration of DNA insert into vector, properties of a good host, introduction of recombinant DNA into a suitable host, selection of the clones containing recombinant DNA.
3. **PCR-amplified oligonucleotide-directed mutagenesis**: Procedure of PCR; PCR efficiency; applications, advantages and limitations of PCR; oligonucleotide-directed mutagenesis by PCR.
4. **Production of protein from cloned genes:** Expression of foreign genes in *E. coli*; general problems with the production of recombinant protein in *E. coli*; production of recombinant protein in *S. cerevisiae*; recombinant proteins from plants.
5. **Protein engineering:** Adding disulfide bonds; increasing enzyme activity and specificity; modifying metal cofactor requirements of subtilisins.
6. **Synthesis of commercial products by recombinant microorganisms:** Cloning antibiotic biosynthetic genes of *Streptomyces*; improving antibiotic production; Engineering *Xanthomonas campestris* for xanthan gum production.
7. **Plant growth-promoting bacteria**: Nitrogen fixation, nitrogenase; isolation and genetic engineering of nodulation genes; phytoremediation.
8. **Microbial insecticides**: Insecticidal toxins of *Bacillus thuringiensis*, mode of action and use; toxin gene isolation; engineering of *B. thuringiensis* toxin genes.
9. **Transgenic plants**: Development of pathogen-resistant plants, production of BT-Begun (Bt-brinjal); modification of plant nutritional content *(e.g*., lysine, β carotene).

References

1. Brown T.A. 2010. Gene Cloning and DNA Analysis: An Introduction (6th edn.). Wiely-Blackwell. UK.
2. Glick B.R. and Pasternak J.J. 2003. Molecular Biotechnology Principles and Applications of Recombinant DNA (3rd edition). ASM Press. USA
3. Griffiths A.J.F., Miller J.H., Suzuki D.T., Lewontin R.C. and Gelbart W.M. 2000. An Introduction to Genetic Analysis. WH Freeman & Company, New York.
4. Lewin B. 2004. Genes VIII. Pearson Prentice Hall. USA
5. Pahsa M.K. 2000. Anobic Zibbiggan. Vol. III. Bangla Academy, Dhaka.
6. Price B.A. 2012. Genetics: A conceptual approach. WH Freeman & Company, New York.
7. Primrose S.B. and Twyman R.M. 2006. Principles of Gene Manipulation and Genomics (7th ed.), Balckwell.UK.

8. Slater A., Scott N. and Fowler M. 2003. Plant Biotechnology. Oxford University Press.
9. 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.

Bot. 522 Molecular Cytogenetics **4 Credits, 100 (70+20+10) Marks**

1. Classification of Interphase nucleus and Prophase chromosomes.
2. **Karyotype analysis**: The Evolution of Karyotypes; Karyotype morphology as an aid to taxonomic classification.
3. The effect of Pre-treatment and fixation on chromosomes morphology for karyotype study.
4. **Polyploidy**: Secondary modification of polyploidy; The Polyploid complex as an evolutionary unit and origin of higher categories.
5. Definition, Origin and Evolution of chromosome banding methods: Classification and nomenclature of chromosome bands; Banding and chromosome evolution; Speciation with no apparent change in banding pattern; Difference in heterochromatin between species; Rules governing the evolution of heterochromatins; Rearrangement of euchromatic parts of chromosome.
6. **C-banding**: Methods, nature, mechanism and application of C-banding, G-banding, Q-banding, R-banding, N-banding and NOR-banding.
7. **Fluorescent banding**: Ethidium fluorochrome; CMA-specificity for GC-rich, DNA; DAPI-Specificity for AT-rich DNA; Application of CMA and DAPI- banding.
8. **In-Situ hybridization**: Definition; Methods; Chromosome mapping by using known DNA-probes by fluorescent in situ hybridization (FISH); Comparative genomic hybridization (CGH), Spectral karyotyping (SKY); Multiplex-FISH (M-FISH); Determination of genomic homology by Genomic in situ-hybridization (GISH).

References

1. Jenkins G.J.M. and Schweizer D. 2001. Advanced Molecular Cytogenetics. Wydaynictwo; University Tetu Slaskiego, Katowice.
2. Leitch A.R., Schwarzacher T., Jakson D. and Leitch I.J. 1994. In-Situ Hybridization. BIOS Scientific Publishers Ltd. NY.
3. Schwaszacher T. and Harrison P.H. 2000. Practical In-Situ Hybridization. Springer-Verlag, New York.
4. Singh R.J. 2003. Plant Cytogenetics (2nd edn.) CRC press. New York.
5. Stebbins G.L. 1971. Chromosome Evolution. ***In***: Higher Plants. Addition-Wesley Publishing Co., London.
6. Sumner A.T. 1990. Chromosome Banding. Unwin Hyman, London.

Practical courses

Bot. 525 Microbiology, Seed Pathology and Seed Technology **2 Credits, 50 (35+10+5) Marks**

Microbiology:

1. Pure culture techniques – streak plate, pour plate, spread plate methods.
2. Preservation of bacterial culture by periodic transfer by keeping under liquid paraffin, and by keeping at -20^{o}C.
3. Growth Curve – Visual and Non-Visual methods.
4. Biochemical tests for identification of bacteria – starch hydrolysis, sugar fermentation, H_2S gas production, nitrate reduction, dehydrogenase activity.
5. Determination of effect of temperature, pH and salt on microbial growth.

Seed Pathology and Seed Technology

1. Seed health testing methods: (a) Standard blotter method; (b) Deep freeze method; (c) Special method for the detection of pathogen;
2. Dry seed inspection and comparison with other methods.
3. Growing on test of seedlings in suitable sterile media.
4. Determination of vigour index of the supplied seed samples.
5. Seed treatment, processing and preservation techniques.

Bot. 526 Advanced Plant Systematics, Plant Ecology and Environment **2 Credits, 50 (35+10+5) Marks**

Advanced Plant Systematics

1. Practice with taxonomic studies on local flora using DELTA program.
2. Flora spectral analysis on locally available taxa.
3. Exercise on reproductive biological characters of locally available plant species.
4. Practice on interpretation of phylogenetic relationships and phylogeography of different taxa in published phylogenetic trees.

Plant Ecology and Environment

1. Determination of Species Area curve and application of different quadrat techniques.
2. Vegetation sampling, recording and quantitative analysis.
3. Determination of IVI and phytograph of dominant species.
4. Determination of Similarity Index
5. Case study of forest vegetation in Sal forest ecosystem adjacent to J.U. campus.
6. Determination of important physical properties of soils.

Bot. 527 Plant Physiology and Plant Biochemistry, Plant Breeding and Crop Improvement **2 Credits, 50 (35+10+5) Marks**

Plant Physiology and Plant Biochemistry

1. Effect of growth regulators on growth, development and yield of wheat, mungbean and rapeseed.
2. Isolation and production of enzymes (Cellulase, xylanase, laccase, pectinase, amylase and peroxidase).
3. Assay of enzymes (Cellulase, amylase and peroxidase)
4. Protein estimation: Dye binding/sectrophotometry

Plant Breeding and Crop Improvement

1. Estimation of genetic variance.
2. Estimation of heritability.
3. Study of induced mutation.
4. Study of distant cross
5. Study of pollen viability and fertility.

Bot. 528 Plant Biotechnology and Advanced Genetics **2 Credits, 50 (35+10+5) Marks**

Plant Biotechnology

1. *In vitro* regeneration method of banana, pineapple and potato
2. Technique of clonal propagation of forest trees through *in vitro* culture.
3. Zygotic embryo rescue and culture.
4. Technique of synthetic seed production

Advanced Genetics

1. Generation of restriction enzyme map.
2. BLAST search for homologous sequences.
3. Olignucleotide design.
4. Amplification of specific DNA sequence by PCR.