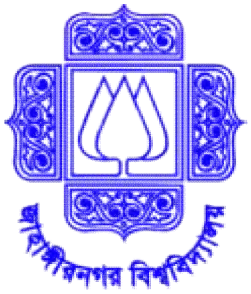
Curriculum

M. Phil and Ph. D in Biotechnology and Genetic Engineering



DEPARTMENT OF BIOTECHNOLOGY AND GENETIC ENGINEERING

JAHANGIRNAGAR UNIVERSITY

Vision, Mission and Program objectives of the Department of Biotechnology and Genetic Engineering

Vision:

To provide the state-of-art knowledge and skills in the field of Biotechnology and Genetic Engineering for sustainable development of society, industry and environment of Bangladesh

Mission:

- To provide quality education for producing competent graduates in Biotechnology and Genetic Engineering to contribute in different sectors including agriculture, healthcare, industry and environment.
- To facilitate the development of scientists, entrepreneurs and policymakers towards nation building program.
- To disseminate knowledge and skills for the betterment of the society and promote meaningful collaboration with academia, industry and research organization across the globe.

Program objectives:

To provide solution-based education with cutting edge knowledge in Biotechnology and Genetic Engineering in order to harness the latest techniques, technologies and methodologies for the graduates in the field of:

- Medical and Pharmaceutical Biotechnology
- Molecular Biotechnology
- Nutrition and Food Biotechnology
- Microbial and Industrial Biotechnology
- Environmental Biotechnology
- Plant and Animal Biotechnology

Department of Biotechnology and Genetic Engineering

Jahangirnagar University

Curriculum for M. Phil and Ph. D courses for the session 2020-2021, 2021-2022, 2022-2023

The Department of Biotechnology and Genetic Engineering offers full-time two (2) year Master of Philosophy (M. Phil) and three (3) years Doctor of Philosophy (Ph. D) program and the courses are intended to provide comprehensive understanding, basic knowledge and practical experience of the diverse areas of Biotechnology and Genetic Engineering focusing the needs of Bangladesh.

The admission to M. Phil / Ph. D courses in Biotechnology and Genetic Engineering will be in accordance with the ordinance for the degree of M. Phil / Ph. D of Jahangirnagar University. In the first year of study the students of M. Phil /Ph. D course will take two full-unit theory courses from the list as approved by the department. At the end of the first year the students will take written examination.

The degree of M. Phil will be conferred by the University on the basis of a) Written examination of 200 marks on approved courses and b) Submission of a thesis on an approved topic. If a candidate obtains less than 50% marks or GPA-3.0 in the written examination of any of the prescribed courses, he/she will be declared as failed in the examination and his/her admission to the M. Phil course will be cancelled. However, the candidate may take re-admission on the recommendation of the Chairman of the Department and the Chairman of the Committee for Higher Studies of the Department concern within two academic years of his/her admission in the MPhil program. Such re-admission will be allowed only once for that candidate.

Conversely, the Ph. D course may be awarded upon a person who has pursued a supervised course of study and research approved by the Academic Council for not less than three academic years as a full-time research student of this University. A candidate admitted into the PhD program must take two full-unit theory courses prescribed by the Supervisor concerned. He / She must complete the course work within one year from the date of his/her admission. The pass marks in each course will be 50% or GPA 3.25. If a candidate obtains less than 50% marks or GPA-3.25 in the written examination of any of the prescribed courses, he/she will be declared to have failed in the examination and his/her admission to the Ph. D course will be cancelled. However, the candidate may take re-admission on the recommendation of the Chairman of the Department and the Chairman of the Committee for Higher Studies of the Department concerned within two years of his/her admission in Ph. D program. The re-admission will be allowed only once for a Ph. D student.

The following courses will be offered for the degree of M. Phil / Ph. D in Biotechnology and Genetic Engineering to be effective from the academic session 2020-21, 2021-22 and 2022-23.

Course No	Course Title	Total Credits	Total Marks
BGE 601	Research methodology	4	100
BGE 602	Advanced Downstream Processing	4	100
BGE 603	Trends in Plant Biotechnology	4	100
BGE 604	Bio-Prospecting of Plants	4	100
BGE 605	Bioethics, Biosafety and IPR	4	100
BGE 606	Advanced Microbial Biotechnology	4	100
BGE 607	Computational Systems Biology	4	100
BGE 608	Clinical Biotechnology	4	100
BGE 609	Recombinant DNA Technology	4	100

Each 4-credit theory course will be of 100 marks comprising 56 lecture-hours, and 2-credit theory course will be of 50 marks comprising 28 lecture-hours.

Course: BGE-601	Course Title: Research Methodology		Offered year: 6th
Minimum course hour: 56h	**Credit hour:** 4	**Final exam duration:** 4h	**Total marks:** 100

Rationale: This course is aimed to understand students to grasp about the research, how it is conducted and its importance in academic endeavour. The focus will be on assisting students in developing practical research skills and strategies to enhance academic and professional success. Major emphasis will be on helping students to understand the basic concepts of research and research methodology as well as the different research paradigms and their implications for doing research. Another focus is to develop the ability to effectively prepare a research proposal and perform research effectively. It also helps the students to gain knowledge on writing of thesis and research report.

Course Objectives:

- Guide students towards achieving competence and proficiency in the theory and practice to research
- Develop the ability to effectively prepare a research proposal
- Facilitate students to gain knowledge on research designs and methodology.
- Develop skills required in writing research proposals, research article, research reports, and dissertation

Intended learning outcomes (ILOs): At the end of the course the students should be able to demonstrate knowledge and understanding of:

- Understand research concepts and process
- The capacity for scholarly analysis and synthesis
- The capacity to review and assess new and complex phenomena, issues and situations autonomously and critically
- Draw on the literature in the field, analyze and interpret research evidence published on a topic.
- Identification of a suitable research problem/issue or opportunity, design the research study using a suitable paradigm, methodologies and analysis.
- Skills development required in writing research proposals, research article, research reports, and dissertation.

Teaching methods: Lecture, Multimedia display, Animation, Handouts, field visit, Seminar etc.

Assessment methods:

Tutorials: Q/A, Quiz, Assignment, MCQ, Presentation, Viva
Final exams: Q/A

Course Contents

1.	**Overview of research process:** Research; Classification of Research; Steps in research; Identification; Selection and formulation of research problem; Research design; Formulation of Hypothesis. Literature survey: Review of literature, review process and bibliography, Research Objectives and hypothesis, Data collection and analysis plan, Research budget and resources.
2.	**Research Methodology in Biotechnology:** • **Survey techniques used in biotechnology:** Principal, general procedure and

	instrumentation in centrifugation, electrophoresis, chromatography, spectrophotometry, spectroscopy, crystallography autoradiography and microscopy, general techniques in microbiology. • **Bioinfomatics and computer applications**: Computer network, on-line control using computers, Use of database, EMBL. NBAF, protein structural data bank, sequence analysis of proteins and nucleic acids, structure prediction, molecular modeling, bibliographic and non bibliographic research.
3.	**Experimental design:** research purpose selection, hypothesis development, target population selection, research methodology development, assessment of the intervention conditions, variable selection, random assignment and manipulation, data recording and analysis tools selection.
4.	**Scientific writing and communications:** Scientific documentation, Organization and writing of a research paper, short communications, review articles, monographs, technical and survey reports, authored books and edited books, and dissertation. Research ethics: legal issues, copyright, plagiarism. Make a Chapter : Research Ethics
5.	**Research and development of projects in biotechnology:** • **Funding agencies:** National and international funding agencies for R & D projects, • **Preparation of R & D projects for funding:** Organization of a research project, identification of gap areas in the subject, aims and objectives of the projects, possible outcome of the project, funds requirements and justification(s), • **Patents and patents writing:** Parts of Patent applications characteristics of the disclosure for a biotechnology invention, marketing of biotechnological invention.
6.	**Research ethics:** Fundamentals of bioethics, ethical issues in conducting research, conflict of interest and publishing biases, ethical design of research, animals in research.

Text Books:

1. Information Resources and Technology Transfer Management in Developing Countries By Richard Onyango (2020). ISBN 9780815355052.
2. Technology Transfer in a Global Economy. Editors: Audretsch, D.B., Lehmann, E.E., Link, A.N., Starnecker, A. (Eds.). Springer
3. Research Methodology: A Guide for Researchers In Agricultural Science, Social Science and Other Related Fields. Authors: Sahu, Pradip Kumar. Springer.
4. M. M. Young. 2012. Comprehensive Biotechnology. Amsterdam. The Neitherlands. Elsevier Publishers.
5. Dawson, Catherine. 2002, Practical Research Methods, New Delhi, UBS Publishers' Distributors
6. Kothari, C.R. 1985, Research Methodology- Methods and Techniques, New Delhi, Wiley Eastern Limited.
7. Kumar, Ranjit. 2005, Research Methodology-A Step-by-Step Guide for Beginners (2nd.ed.) Singapore, Pearson Education.
8. Singh, A. K. (1993). Tests, Measurements and Research Methods in Behavioral Sciences. Tata McGraw-Hill Pub. Co. New Delhi, India.

Course: BGE-602	**Course Title:** Advanced Downstream Processing		**Offered year:** 6th
Minimum course hour: 56 h	**Credit hour:** 4	**Final exam duration:** 4h	**Total marks:** 100

Rationale: This course is designed for understanding the variety of fermentation and subsequent processing approaches in order to manufacture the biological products and the design, operation and selection of these fermentation systems. The course also provides a firm foundation in the fundamentals and applications of downstream processing for the production of bioproducts in the area of industrial biotechnology.

Course Objectives:

- To provide knowledge of bioproduct separation and purification techniques used in biotechnology focusing real industrial products.
- To explain the principles and theories of various bio separation processes and how to improve or customize the processes
- To offer knowledge to solve the real problems in industrial design and improve productivity.

Intended Learning Outcomes (ILOs): At the end of the course the students will be able to-

- Have an overview of bioproduct separation and purification techniques.
- Know various theories and principles of various bioseparation processes.
- Learn critical aspects in operating various downstream techniques.
- Improve their skills in problem solving with respect to designing separation and purification processes.
- Design unique separation process which will cost worthy than the existing one.
- Improve or customize separation process to improve productivity.
- Get some ideas on the troubleshooting in the fermentation industries.

Teaching Strategy: Lecture, Multimedia display, Animation, Handouts, Hands on training etc.

Assessment Strategy:

Tutorials: Q/A, Quiz, Assignment, MCQ, Presentation, Viva
Final exams: Q/A

	Course Content
1.	**Introduction to downstream processing:** Role and importance of downstream processing in Biotechnology. Economics of downstream processing, cost cutting strategies, characteristics of biological mixtures, process design criteria for various bioproducts.
2.	**Primary Separation and Recovery Process:** Cell disruption method for intracellular products: chemical, mechanical and enzymatic methods. Principles, operation, design and scale up of sedimentation, flocculation, centrifugal settling and filtration.
3.	**Enrichment Operations:** **Precipitation and Extraction:** Precipitation methods by isoelectric precipitation, salt fractionation, polymer and organic solvent. Extraction: Concepts, modeling and design aspects. Principles and applications of aqueous two-phase, super critical extraction and crystallization. **Membrane Based Separations:** Theory and applications of Ultrafiltration and microfiltration, design and configuration of membrane based separations, Structure and characteristics of membranes. Concepts, modeling and design aspects of reverse osmosis,

	dialysis, liquid membranes and Membrane reactors.
4.	**Purification Techniques:** Principle and practice of the Chromatography techniques: Gel permeation, Ion exchange, Reverse phase, Hydrophobic and Affinity chromatography. Recent advances in purification techniques of bioproducts. In-situ product removal and process integration. Case studies: Ethanol, Antibodies and mammalian proteins.
5.	**Ultrafiltration:** Definition, Osmosis and Osmotic Pressure, UF Theory, Membrane Characteristics, Preparation of Membrane, Development of semi-permeable membrane, methods of preparation, membrane characteristics and performances, membrane fouling and treatment, UF equipment and processes.

Text Books:

1) Bioprocess Technology: Fundamentals and Application, S.O. Enfors and L. Haggstrom, Royal Institute of Technology, Stockholm
2) Bioseparations: Downstream Processing for Biotechnology, Belter, P. A. et al. Latest edition. Wiley-Interscience Publication.
3) Biotechnology: A Text Book of Industrial Microbiology, T. D. Brock; W. Grueger and A Grueger: Sinnaur Publication, USA.
4) Biochemical Engineering, J.M. Lee, Prentice Hall International Ltd, U. K. London.
5) Principles of Fermentation Technology, P. F. Stanburry and A. Whitaker.
6) Handbook of Bioseparations. Academic Press, San Diego. Ahuja S. (2000)

Recommended References:

1. Manual of Industrial Microbiology and Biotechnology, A. L. Demain and N. A. Solomon, American Society for Microbiology, Washington.

Course: BGE-603	**Course title:** Trends in Plant Biotechnology		**Offered year:** 6th
Minimum course hour: 56 h	**Credit hour:** 4	**Final exam duration: 4**h	**Total marks:**100

Rationale: The course is designed to provide, the knowledge and understanding in learning a broad exposure to molecular techniques behind the improvement of plants/crops for yield and quality and also commercialization of plant products.

Course Objectives:

- To provide basic and advanced knowledge and understanding on the molecular techniques behind the improvement of plants
- To understand the genetic manipulation of plants and their applications, conservation.
- To understand the current status, improvement techniques and future prospect of plant biotechnology in Bangladesh.

Intended Learning Outcomes (ILOs): After completion of the course, students will be able to-

- Explain the basics of the plant biotechnology, history, applications and future aspects.
- Understand how biotechnology has been used to develop knowledge of complex processes that occur in the plant
- Use basic biotechnological techniques to explore molecular biology of plants
- Understand the processes involved in the planning, conduct and execution of plant biotechnology experiments
- Explain how biotechnology is used for plant improvement and discuss the ethical issues related to the GM plants.

Teaching Strategy: Lecture, Multimedia display, Animation, Handouts, Hands on training etc.

Assessment Strategy:

Tutorials: Q/A, Quiz, Assignment, MCQ, Presentation, Viva

Final exams: Q/A

	Course Content
1.	**Gene Concept:** DNA as genetic material. Organization of Pro- and Eukaryotic genomes. Gene expression, Regulation of gene expression and gene silencing. Plant Genomics.
2.	**Plant Tissue Culture:** Introduction, Basic techniques in plant tissue culture; composition & medium preparation, lab setup, culture conditions, effects of hormones in plant growth and development, Types of cultures; cell, callus, embryo and organ. germplasm storage and conservation *in-vitro*, somaclonal variation. Production of haploids through anther, microspore, ovule culture and their role in Plant breeding. Plant tissue culture industries in Bangladesh, Industrial micropropagation of ginseng, alovera, orchid and potato.
3.	**Somatic Embryogenesis:** General techniques, Induction and development, Maturation of Somatic Embryos, Somatic embryos and Zygotic embryos, large scale somatic embryos production in Bioreactor. Synthetic seeds development.
4.	**Gene transformation mechanism:** Gene transfer mechanism in plants (monocot & dicot), Biology of vectors, binary vectors, viral vectors, co-integrative vector; Cloning strategy and methods of gene transfer; Vector less gene transfer. Ti and Ri plasmids and their organization, Transfer of T-DNA in to host genome, uses of reporter gene.
5.	**Gene Transfer Techniques:** Direct gene transfer methods: Electroporation, microinjection, biolistics, liposome mediated, PEG mediated and plastid transformation. Indirect gene transfer methods: *Agrobacterium* mediated gene transfer. Advantages and disadvantages of direct and indirect gene transfer method.
6.	**Crop Improvement through genetic engineering:** Applications of Plant Transformation for productivity & performance. Production of; herbicide resistance, insect resistance, virus resistance, disease resistance, antibiotic resistance, abiotic stress resistance, long shelf life of fruits & flowers.
7.	**Transgene validation through molecular techniques in transgenic plants:** PCR, RT-PCR, Southern Blot, Northern Blot, Western Blot, Dot Blot. Bioassay.
8.	**Molecular Markers:** Marker assisted selection for crop improvement-PCR, RAPD, RFLP, AFLP, SSR, EST Genome mapping.
9.	**Biotechnology and Intellectual property rights:** IPR, Patent trade secrets, copyright, trademark, choice of intellectual property and plant genetic resources, GAA, TRIPS. Plant Breeders rights.

Text Books:

1. Introduction to Plant Biotechnology. Chawla, H.S. 2002. 2nd Ed. Oxford University Press and IBH.
2. Gupta, P.K. Elements of Biotechnology, Rastogi, Meerut.
3. Lindsey, K. 1997. Transgenic Plant Research, Harwood Acad. Pub.
4. Primrose, S.B. Molecular Biotechnology, Blackwell Sc. Publications.
5. Molecular Plant Biology: A practical approach, Gilmartin and Bowler, (Vol. I and II).
6. CRISPR-Cas Methods. Springer Protocol. M Tofazzal Islam, Pankaj K Bhowmic and Kutubuddin A. Mollah eds.

Recommended References:

1. Principles and Procedures of Plant Breeding. Chahal,G.S. and Gosal, S.S. 2002. Narosa Publ Hos. New Delhi.

2. Genome editing Edited by KursadTurksen. Springer Publishing
3. Plant Genomics, Edited by Ibrokhim Y. Abdurakhmonov, Published by InTech, JanezaTrdine 9, 51000 Rijeka, Croatia

Course: BGE-604	**Course title:** Bio-Prospecting of Plants		**Offered year:** 6th
Minimum course hour: 56h	**Credit hour:** 4	**Final exam duration:** 4h	**Total marks:** 100

Rationale: The course provides knowledge about the exploration of medicinal and aromatic plants for small molecules, macromolecules and biochemical and genetic information for development of commercially valuable products.

Course Objectives:

- To identify new compounds with novel biological activities
- To improve pharmaceuticals and medical site by identifying new material with potent clinical significances.
- To resolve health problems by exploiting the medicinal plants biochemistry.
- To build several synthetic analogues on phytochemical compounds isolated from medicinal plants.

Intended Learning Outcomes (ILOs): After completion of the course, the students will be able to-

- Learn about bioprospecting of medicinal and aromatic plants.
- Use medicinal and aromatic plants for development of commercially valuable products
- Expand their knowledge to develop synthetic analogues on phytochemical compounds isolated from medicinal plants.

Teaching Strategy: Lecture, Multimedia display, Animation, Handouts, Hands on training etc.

Assessment Strategy:

Tutorials: Q/A, Quiz, Assignment, MCQ, Presentation, Viva
Final exams: Q/A

Course Content

1.	**Introduction:** Plant genetic resources and their conservation: Medicinal and Aromatic Plants-Scope and importance. Approaches and strategies for *ex-situ* conservation: botanical garden, arboreta, herbal garden and field gene bank.
2.	**Plant secondary metabolites** Plant secondary metabolites, control mechanisms & manipulation of Phenyl Propanol pathway, Shikimate pathway. Biosynthesis of terpenes, phenols and nitrogenous compounds and their roles. Production of secondary metabolites by plant suspension cultures; Hairy root cultures and their cultivation for secondary metabolites production. Production of industrially important secondary metabolites from plants.

3.	**Nutraceuticals** Antioxidants, flavanoids, carotenoids, cholesterol lowering chemicals, nutritional importance and their functions, deficiency diseases, nutritional status evaluation.
4.	**Extraction and quantification** General principles of chromatography. Principle, instrumentation and application of HPLC, GC, GC-MS. Extraction methods: distillation, steam and solvent.
5.	**Pharmacology** Routes of drug administration, absorption and distribution. Pharmacological activity of morphine, atropine, ephedrine and camphor. Chemotaxonomy of higher and lower plants and distribution of certain chemotaxonomical group of constituents in plant kingdom like alkaloids, glycosides and terpenoids.
6.	**Post-harvest technology in medicinal crops:** Scope and importance. Adulteration with reference to plant drugs, type of adulterants and method of adulteration. Importance of herbal marketing. Biodiversity act and Intellectual Property Right in the area of medicinal plants.

Text Books:

1. Wilson K and John Walker, 1999. Principles and techniques of practical biochemistry, Cambridge University Press.
2. Aktal C K and B M Kapur, 1982. Cultivation and utilization of medicinal plants. RRL, CSIR, Jammu-Tawi.
3. Harborne J.B. 1998. Phytochemical Methods - A guide to modern technique of plant analysis, 3rd edn, Champan& Hall, UK.
4. Wijeskera, R. O. B. 1991. The medicinal Plant Industry, CRC Press, Boston, London.
5. Finar, I. L. 1975. Organic Chemistry, Stereochemistry and the Chemistry of Natural Products, ELBS, Longman Singapore Publication (P) Ltd., Singapore, 5th edn.
6. Secondary Plant Products, 1980. Encyclopaedia of Plant Physiology – New Series Vol.8, Springer-Verlag Berlin, Heidelberg, New York.

Course: BGE-605	**Course title:** Bioethics, Biosafety and IPR		**Offered year:** 6th
Minimum course hour:56 h	**Credit hour:** 4	**Final exam duration:** 4h	**Total marks:**100

Rationale: This course is designed to provide an understanding on biosafety, risk assessment of products and ethical issues in biotechnological research. Students will able to understand the current trends in biosafety as well as national and international regulations in biotechnology.

Course Objectives: The objectives of this course are to-

- Conceptualize basic knowledge of biosafety, biosecurity, ethics and regulations in biotechnology
- Analyze ethical aspects related to biological, biomedical, health care and biotechnology research
- Adopt safe handling and safe working practices relevant to the bioindustries and field of research

Intended Learning Outcomes (ILOs): At the end of the course the students will be able to-

- Acquire adequate knowledge in the use of genetically modified organisms and its effect on human health
- Understand the current trends in biosafety and national and international regulations in biotechnology
- Distinguish knowledge of biosafety and risk assessment of products derived from recombinant DNA research and environment release of genetically modified organisms, national and international regulations.
- Perceive knowledge about different biosafety protocols, bioethics and various legal issues.
- Understand patents, trademarks, copyright and related rights, practical aspects of licensing.

Teaching Strategy: Lecture, Projector display, Animation, Hands on experiment, Visit, etc.

Assessment Strategy:

Tutorials: Q/A, Quiz, Assignment, MCQ, Presentation, Viva
Final exams: Q/A

	Course Content
1.	**Biosafety and Risk Assessment:** Introduction; Historical Background; Biosafety guidelines for Government of Bangladesh; Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication. GMP and GLP.
2.	**International protocols on biosafety:** The UNIDO, IPPC, CBD and the Cartagena protocol. Essential elements and modalities of an ideal protocol. International organizations on biosafety.
3.	**Bioethics and Legal Issues:** Ethical issues; Public perception related to Biotechnology from developed and developing countries. Legal and socio-economic impacts of biotechnology, public awareness on genetically modified life forms (case study). Ethical implication of biotechnological products and technique. Social and ethical implication of biological weapons.
4.	**Introduction to Intellectual Property:** Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of New GMOs; International framework for the protection of IP. IP as a factor in R&D; IPs of relevance to biotechnology with case studies; Introduction to GATT, WTO, WIPO and TRIPS.
5.	**Biotechnology and Intellectual Property Rights:** Biotechnology and the Law-Objective, Evolution, Basic Structure of Gene Techniques, Applications, Commercial Potential of Biotech Inventions, Rationale for Intellectual Property Protection. Patenting Biotechnology Inventions-Objective, Concept of Novelty, Concept of inventive step, Microorganisms, Moral Issues in Patenting Biotechnological inventions. Plant varieties Protection-Objectives, Justification, International Position, Plant Varieties Protection in India, Bio-Prospecting and Bio-Piracy, Alternative ways, Protect ability, need for a Sui-

	Generis regime.
6.	**Concept of 'Prior Art' and Basics of Patents:** Invention in context of "prior art"; Patent databases; Searching International Databases; Country-wise patent searches (USPTO, EPO, India etc.); Analysis and report formation. Types of patents; Role of a Country Patent Office; Procedure for filing a PCT application.
7.	**Patent Filing, Infringement and Enforcement of IPR:** Patent application, types of patent applications, international patenting-requirement, procedures; Patent rules in Bangladesh, status in Europe and US. Patenting by research students, lecturers and scientists-University/organizational rules in Bangladesh and abroad, Patent infringement. Enforcement of Intellectual Property Rights, Practical Aspects of Licensing.
8.	**Biosecurity and regulations:** Biosafety and biosecurity in lab, Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety levels; specific microorganisms; Recommended biosafety levels for Infectious agents and Infected Animals; Physical security, Personnel security, Transport security, Information security, biological terrorism. Cartagena Protocol, Biosafety regulations to protect nature, growers and consumers interest and national interest, International agreements and guidelines, trans boundary movements.

Recommended Text Books/ References:

1. Biosafety guidelines of Bangladesh. Ministry of Environment and Forest, Government of the People's Republic of Bangladesh.
2. Laboratory biosafety manual (Third edition, 2004) By World Health Organization.
3. Eigner WW 1994. Just Technology? CACL, York Univ. Ontario
4. Moe-Wan Ho 1997. Genetic Engineering – Dreams or Nighmares? RFSTE/TWN, New Delhi
5. Melchias G 2000. Biodiversity and Conservation. Science Publ. Inc. New Hampshire, USA.
6. Mulongoy KJ 1997. Transboundary Movement of Living Modified Organisms, Int. Acad. Envir. Geneva.
7. Pistorius R 1997. Scientist. Planta and Politics. IPGRI, Rome.
8. TWN 1996. Biosafety – Scientific Findings and Elements of a Protocol, Malaysia.
9. The Ecological Risks of Engineered Crops, Rissler, J. and Mellon, M., Cambridge, USA: The MIT Press, (1996).
10. Genetic Engineering in Agriculture and the Environment: Assessing risk and benefits, Maurizio G. Paoletti and David Pimentel.

Course: BGE-606	**Course Title:** Advanced Microbial Biotechnology		**Offered year: 6th**
Minimum course hour: 56h	**Credit hour:** 4	**Final exam duration:** h	**Total marks:** 100

Rationale: The course is designed to offer modern concepts and functional aspects of microorganisms for welfare of human and nature. Advanced Microbial Biotechnology intends to explain the application of microorganisms in different sectors of Biotechnology such as food, agriculture, fermentation, protein and enzyme Biotechnology etc.

Course Objectives:

- To provide knowledge of different agriculturally and industrially important microorganisms.
- To be familiar with the application of microorganisms in different sectors of Biotechnology such as food, agriculture, fermentation and protein Biotechnology.
- To explain different eco friendly techniques for biodegradation and bioremediation.

Intended Learning Outcomes (ILOs): At the end of the course the students will be able to-

- Learn the modern concepts on agriculturally and industrially important microorgnisms.
- Realize the diversities of biotechnology sectors.
- Produce different useful enzymes, proteins and renewable energy from various sources.
- Learn different eco friendly techniques for biodegradation and bioremediation
- Know various methods of production of beneficial enzymes and proteins

Teaching Strategy: Lecture, Projector display, Animation, Hands on experiment, Visit, etc.

Assessment Strategy:

Tutorials: Q/A, Quiz, Assignment, MCQ, Presentation, Viva
Final exams: Q/A

Course Content	
1.	**Microbes in Biotechnology:** Microorganisms of industrial importance, historical overview and features, scope of biotechnology in developing countries.
2.	**Food Biotechnology:** Physiology, genetics and application of yeast and bacteria used in food and beverage fermentation, ecology of microbes in foods, microbial agents of food poisoning & food-borne infection, biotechnology tools to detect microorganisms and toxins responsible for food poisoning, spoilage and contamination, development of technologies to inhibit microbes of public health concern, Genetically modified foods.
3..	**Agricultural and Environmental Biotechnology:** Biopesticides for crops, transgenic plant development, purposes and types of uses of pesticides, pesticides in microbial environment, pesticides in soil and aquatic environment, effect of pesticides, persistence of pesticides, metabolism of pesticides by microorganisms; biogas and biofertilizers.
4.	**Fermentation Biotechnology:** Fermentation, modeling of fermentation, bioreactor design and operation, aeration-agitation, temperature-pH control, product extraction, typical industrial fermentation, microbial production of alcohol, acids, enzymes and antibiotics, preparation of fermented foods such as bread and baked foods, buttermilk, sour cream, cheeses, vinegar, wine, yogurt and soy sauce; microbial toxins and insecticides.
5.	**Protein Biotechnology:** Protein expression and purification, protein classification, protein structures and functions, protein engineering and production of MABs.
6.	**Enzyme Biotechnology:** Enzyme kinetics, properties of enzymes, Immobilized enzymes, Methods of immobilization of enzymes and cells, Applications of immobilized enzymes, Biosensors and biochips.
7.	**Environmental Bioremediation:** Recycling of agroindustrial wastes, hydrocarbon and aromatic transformations, methanotrophic and methanogenic ways of life.

8.	**Biodegradation:** Microbial degradation of cellulose, hemi cellulose and lignin, applications in textile, jute and food industries.

Recommended Text Books/ References:

1. A text Book of Biotechnology, Dubey, R. C., S. Chand & Co. Ltd. New Delhi-110055, (2004).
2. Principles of Gene Manipulation, R.W Old & Primrose. Blackwell publishing company, UK (2001)
3. Molecular biology of the Gene, Watson, Hopkins Roberts, Steitz and Weiner. Benjamin/Cumming Publishing Co., (1987).
4. Biology of Microorganism, Brock, T.D., Madigan, M.T., Martinco, J.M. and Parker, J., Benjamin Cummings; 13 edition (2010).
5. Bacterial Plasmid, Hardy, K.M., Published by American Society of Microbiology, (1986).
6. Sensory Evaluation of Food: Statistical Methods and Procedures (Food Science and Technology Series, Vol 16). Michael O' Mahony. 2002.
7. Genetically Engineered Foods: Assessing Potential Allergenicity. Tong-Jen Fu and Steven M. Gendel. USA, 2005
8. Molecular Biotechnology-Principles and Applications of Recombinant DNA.B.R. Glick and J.J.Pasternak.London, 2003.
9. Advances in Environmental Sciences and Technology, Vol. 3. Environmental Biochemistry. N. Rajvaidya and O.K. Markandey. A.P.H Publishing Corporation, New Delhi, India.1998
10. Food Science (Repr of 5th Ed) Food Science Texts Series. Norman N. Potter, Joseph H. Hotchkiss. 2005.

Course: BGE-607	**Course Title:** Computational System Biotechnology		**Offered year: 6th**
Minimum course hour: 56h	**Credit hour:** 4	**Final exam duration:** 4h	**Total marks:** 100

Rationale:

Recent advances in biology, including the human genome project, have created new opportunities to understand biological problems from a systems perspective. Systems Biology intends to explain how higher-level properties of complex biological systems arise from the interactions among their parts. This course aims to introduce students to the new concepts and knowledge relevant to systems biology and to help them select important unsolved problems in biology and medicine that may now be possible to address using quantitative and theoretical approaches.

Course Objectives:

- Introduce the students to the background and advancements of computational and systems biology
- Emphasize a deeper insight into the fundamentals of molecular network biology
- Introduce tools and techniques in mathematical modeling of the biological processes
- Make the students aware of the applications of computational and systems biology in innovation and critical analysis to generate new ideas.

Intended Learning Outcomes (ILOs):

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

- Understand the goals and advancements through the Human genome project and beyond
- Discuss how biological systems information relating to genes, proteins and cellular structures can be used to model living cells, and even to create new synthetic cells.
- Acquainted with the quantitative nature of the systems approach
- Understand mathematical model building of biological systems that link mechanistic information on the molecular function to systems-wide networks and interactions.
- Develop ideas about the current and future trends and techniques of systems biology for discovery and innovation.

Teaching Strategy:

Lecture, Projector display, Animation, Hands-on problem-solving, group discussions etc.

Assessment Strategy:

Tutorials: Q/A, Quiz, Assignment, MCQ, Presentation, Viva
Final exams: Q/A

	Course Content
1.	**Introduction to Systems Biology:** Definition and Principle, Genomes to life , Human Genome Project (HGP) & Beyond, Review of Next-generation sequencing technologies , Cloud computing, Beyond HGP projects: the 1000 genomes; Human epigenome, microbiome, connectome project, Concepts of 'omics'and their networks and interactions.
2.	**Comparative and Functional Genomics:** Functional annotation; Gene ontology, Evolution of functional RNAs and their interactions, RNA interference (RNAi); Therapeutic possibilities of RNAi; CRISPR: gene editing technology, Genome analysis in identification of drug targets, Gene expression analysis by sequencing: RNA-seq basic principles, file format, bias detection and correction, quality control, read alignment, quantifications (count, FPKM), differential expression, functional enrichment analysis from count data. Single-cell RNA sequencing (scRNA-seq): principles, alignment, counting, clustering (PCA, ICA, tSNE)
3.	**Translatomics:** Polysomal profiling, ribosome footprinting, RIPseq, tagged proteins (libraries)
4.	**Cellular and Molecular systems biology:** Construction and modeling of genetic, control theory and genetic networks; local activation and global inhibition models, gradient sensing systems.
5.	**Computational Systems Biology:** Introduction, areas, and challenges , Databases: data representation and model exchange formats (XML and XML-based format, e.g., SBML, CellBL, BioPAX, PSI-MI; UML) database models and model storage
6.	**Biological Networks:** Basic principles of networks, network properties and biology, Understanding the cell's functional organization, reconstructing transcriptional regulatory modules and networks, Synthetic biology: Simple synthetic networks, Network construction from high throughput screen, Designer network, modeling of genetic networks and engineered gene circuits; Petri Nets (PN) for modeling biological networks, matrix notation of PN; Cell signaling networks • **Metabolomics:** Basic concept, structural properties, structural and functional analyses of Metabolic Networks (MN), Modeling MN - network reconstruction models from genome and proteome information; designer networks: Engineered Gene Circuits. Flux balance analysis, metabolic profiling, and transcription factors for metabolic engineering

	• **Regulatory network:** reconstruction, analysis, and simulation; Gene Network: estimation, modeling, and simulation • **Protein-Protein Interaction (PPI) networks:**Biologicalexperiments, computational techniques and analyses databases.
7.	**Developmental systems biology:** General pattern formation models, Cell fate and cellular programming, Future of developmental and stem cell biology.
8.	**Image informatics:** Basics of image informatics, Imaging in the quantitative studies of systems biology, Biomedical image informatics.
	Recommended Books/References: 1. National Human Genome Research Institute. NIH, Educational Resources. 2. Anatomical structural network analysis of human brain using partial correlations of gray matter volumes. Joshi, A.A., Joshi, S.H., Dinov, I.D., Shattuck, D.W. Leahy, R.M., & Toga, A.W. IEEE International Symposium on Biomedical Imaging: From Nano to Macro. 2010. 3. Next-generation DNA sequencing Informatics. Brown, S.M. Cold Spring Harbor Press., 2013. 4. CRISPR: gene editing is just the beginning. Ledford, H. Nature News, 531(7593), 156. 5. An introduction to systems biology: design principles of biological circuits. Alon, U. CRC press., 2006. 6. Systems Biology. A Textbook. Klipp, E., Liebermeister, W., Wierling, C., Kowald, A., Lehrach, H., Herwing, R. ISBN 978-3-527-31874-2, 2009. 7. Cloud computing: a new business paradigm for biomedical information sharing. Journal of biomedical informatics. Rosenthal, A., Mork, P., Li, M. H., Stanford, J., Koester, D., & Reynolds, P. 43(2), 342-353, 2010. 8. Sequencing technologies—the next generation. Metzker, M. L. Nature reviews genetics, 11(1), 31-46, 2010. 9. Next-generation DNA sequencing methods. Mardis, E. R. Annu. Rev. Genomics Hum. Genet.9, 387-402, 2008. 10. Networks: An Introduction. Newman, M.E.J. Oxford University Press, 2010.

Course: BGE-608	**Course title:** Clinical Biotechnology		**Offered year:** 6th
Minimum course hour: 56h	**Credit hour:** 4	**Final exam duration:** 4h	**Total marks:** 100
Rationale: This advanced course is designed to introduce Clinical Biotechnology and to cover the recent advancements in this area. This course will help the graduates to find employment in a range of areas including biomedical industries, biotechnology companies, different research institutes, hospitals and universities.			
Course Objectives: • To familiarize with fundamental process of clinical study and design of clinical studies. • To get updated knowledge of drug design and synthesis. • To equip students with the knowledge of biopharmaceutical products, blood and blood products, therapeutic proteins, cancer biology and therapy, clinical toxicology, clinical research governance, and legal and ethical issues on biotechnology, biomedical research and its scientific basis, and developed skills.			

Intended Learning Outcomes (ILOs): At the end of the course the students will be able to-

- Learn about general procedure and practices needed for biomedical research setup.
- Know the recent advances related to drug design and synthesis, clinical study, blood and blood products, therapeutic proteins and cancer biology.
- Understand the clinical toxicology, legal and ethical issues of Clinical Biotechnology research and innovations.
- Describe the modern improvements in Clinical Biotechnology.

Teaching Strategy: Lecture, Projector display, Animation, Hands on experiment, Visit, etc.

Assessment Strategy:

Tutorials: Q/A, Quiz, Assignment, MCQ, Presentation, Viva
Final exams: Q/A

	Course Content
1.	**Introduction:** Introduction to Clinical study and design of clinical studies. Epidemiological research and treatment studies: Double-blind and Single-blind Randomized controlled trial, Non-blind trial, Nonrandomized trial-quasi-experiment. Observational studies: Cohort study-Prospective cohort and Retrospective cohort. Time series study, Case-control study and Nested case-control study. Community survey and Ecological study. Seasonal studies: Conduction of studies in seasonal indications such as Allergies and Influenza.
2.	**Statistical Analysis and Interpretation:** Background and purpose, trial design consideration, Parallel group design, cross over design, factorial design. Introduction to Statistical Application Software (SAS), procedures and clinical data management.
3.	**Drug Design and Synthesis:** Synthesis of compounds in accordance with the molecular structure and biological activity concept: Analgesics, neuromuscular blocking agents, anti-fertility drugs and bactericidal & bacteriostatic agents (sulphonamides, mercury compounds and antiseptics).
4.	**Study of Therapeutic Proteins and Related Case Studies:** Blood and Blood products: Clotting factors, anticoagulants, Thrombolytic Agents, Tissue plasminogen activator and streptokinase. Safety guidelines in Blood Transfusion. Therapeutic Proteins: Antibodies, Enzymes, Hormones, Growth factors (Erythropoietin), Vaccines (HIV and Cancer), Interferon and Interleukins.
5.	**Cancer Biology and Therapy:** Introduction to cancer biology and modes of treatment: radiotherapy, chemotherapy, surgery, Biological therapy, immunotherapy and gene therapy.
6.	**Clinical Toxicology:** Basic concept in toxicology. Types and mechanism of toxin action-Epoxidation & drug toxicity, N-oxidation & drug toxicity and sulphur xenobiotics. Hepatotoxicity and Nephrotoxicity. Biotransformation of toxins, inactivation and removal from the body.
7.	**Clinical Research Governance and Ethics:** Overview on regulatory affairs for pharmaceuticals, neutraceuticals and medical devices. Good Clinical Practices (GCP) and International quality standard and related guidelines (ICH-E6). Risk assessment and trial monitoring. Legal and ethical issues on biotechnology, medical research and related clinical

	practice.

Text Books:

1. Biopharmaceuticals Biochemistry and biotechnology (2nd Edition) by Gary Walsh, Pub: Wiley
2. Drug Delivery and Targeting by A.M. Hillery, A.W. Lloyd and J. Swarbrick, Harwood Academic Publisher
3. Pharmaceutical Biotechnology by S. P. Vyas, V. Dixit, CBS Publishers
4. Pharmaceutical Biotechnology by Sambhamurthy & Kar , NewAge Publishers
5. Monoclonal antibodies: applications in clinical oncology by Epenetos A.A.(ed), Chapman and Hall Medical, London
6. Biopharmaceutics and Pharmacokinetics by V.Venkatesharalu , Pharma Books Syndicate

References:

1. Preservatives in pharmaceutical, food and environment industries. Edited by R.G. Board M.C. Allowodd and .J. G. Bank Blackwell Scientific Publication, (1987).
2.

Course: BGE-609	**Course title:** Recombinant DNA Technology		**Offered year: 6th**
Minimum course hour: 56h	**Credit hour:** 4	**Final exam duration:** 4h	**Total marks:** 100

Rationale: The course is designed to offer basic and modern concepts of rDNA technology. Advancement of recombinant DNA technology allows genetic manipulation of organisms by incorporating DNA from different sources into a single recombinant molecule. This technology has immense applications in the field of plant, environmental and clinical genomics.

Course Objectives:

- To introduce the concepts of recombinant DNA technology and its development.
- To understand the tools and techniques in implementing and transferring genetic material at molecular and cellular levels.
- To provide in-depth knowledge on tissue and protein engineering.
- To understand the potential applications of recombinant DNA technology.

Intended Learning Outcomes (ILOs): At the end of the course the students will be able to-

- Understand the basic principles of recombinant DNA technology.
- Learn the tools required for the transmission of genetic material from one source to another.
- Know the applications of this technology and can apply their knowledge in the practical field.
- Get in-depth knowledge on tissue and protein engineering.
- Learn significance of cell and tissue engineering, challenges of tissue engineering.

Teaching Strategy: Lecture, Projector display, Animation, Hands on experiment, Visit, etc.

Assessment Strategy:

Tutorials: Q/A, Quiz, Assignment, MCQ, Presentation, Viva
Final exams: Q/A

Course Content

1.	**Fundamentals of rDNA technology:** Introduction to gene cloning and rDNA technology; DNA manipulative enzymes; Linkers and adaptors; Cloning and expression vectors; Transformation and transfection; Selectable markers; other selection methods.

2.	**Manipulation of gene expression in prokaryotes:** Prokaryotic gene expression system; Gene expression from constitutive and inducible promoters; Fusion proteins; Increasing protein stability; DNA integration into the host chromosome; Increasing extra-cellular secretion; Metabolic load; General problems with the production of recombinant eukaryotic proteins in prokaryotes.
3.	**Manipulation of gene expression in eukaryotic systems:** Eukaryotic expression systems; Fungus-based expression systems; Baculovirus-insect cells expression systems; Mammalian cell expression systems; Biopharming; Methods to make transgenic animals; Application of transgenic model organisms; Cloning by nuclear transfer; Transgenic livestock, poultry and fish; Targeted gene modification; Gene Knock-out, Cre-LoxP and CRISPR in genome editing, knock-in technologies; Antisense RNA technology to control gene expression.
4.	**Mutation and protein engineering:** Site directed mutagenesis procedures; Error prone PCR; Random mutagenesis with nucleotide analogues; DNA shuffling; Adding disulfide bond; Increasing enzyme activity, specificity and protein stability; Modifying metal cofactor requirements; Decreasing protease sensitivity, etc.
5.	**Industrial-scale Protein production:** Maximizing the efficiency of the fermentation process; Increasing plasmid stability; Increased protein secretion; Typical large-scale fermentation systems; Harvest of microbial cells; Disruption of cells and downstream processing; Protein solubilization.
6.	**Tissue engineering**: 3-D cell culture; Organ culture; Significance of cell and tissue engineering; Challenges of tissue engineering, Embryonic and adult stem cells, Induced pluripotent stem cells, Transdifferentiation capabilities of cells.
7.	**Applications of rDNA technology:** Synthesis of commercial products using rDNA technologyAntibiotics, Biopolymers, human insulin, growth hormones, Factor VIII, Amino acids, Enzymes, Recombinant vaccines, Small biological molecules; Gene therapy; Insect and pest resistant plants; Herbicide tolerance in plants; Plants with enhanced nutritional quality; Bioremediation and Biomass Utilization; Genetic engineering of biodegradable pathways.
8.	**Ethical issues in biotechnology**: Concerns about the safety of consuming genetically modified foods; Concerns about the impact of genetically modified organisms on the environment; Economic issues; Regulating recombinant DNA technology; Deliberate release of genetically modified microorganisms; Regulating GE food and food ingredients; Patenting rDNA technology derived products.

Recommended Text Books/ References:

3. Molecular biotechnology: Principles and applications of recombinant DNA. (4th ed.). Glick, B.R., & Pasternak, J.J. 1752 N St. NW, Washington, DC: ASM press. 2010.
4. An introduction to genetic engineering. (3rd ed.). Nicholl, D.S.T. The Edinburgh Building, Cambridge CB2 8RU, UK: Cambridge University Press. 2008.
5. Biotechnology in medical sciences. Khan, F.A. 6000 Broken Sound Parkway NW, Suite 300: CRC Press. 2014.
6. Gene cloning and DNA analysis: An introduction. (6th ed.). Brown, T.A. The Atrium, Southern Gate, Chichester, West Sussex, PO19 8SQ, UK.: John Wiley & Sons Ltd., 2010.