University of Dhaka

Faculty of Biological Sciences

Curriculum for Master of Science (MS) Degree in Microbiology

Sessions: 2022-23 and onwards

Department of Microbiology
University of Dhaka
Dhaka 1000
Bangladesh

UNIVERSITY OF DHAKA
DEPARTMENT OF MICROBIOLOGY

Curriculum for Master of Science (MS) Degree in Microbiology, Sessions: 2022-23 and onwards

The Department of Microbiology was established in 1979 under the Faculty of Biological Sciences, University of Dhaka (DU) and started its journey offering Master of Science (MSc) degree programme in Microbiology to a few competent students having a BSc (Honours) degree in Biochemistry, Botany, Pharmacy, Soil Science, from Dhaka University and MBBS degree from recognized Medical colleges. Currently located in the Science Complex Building, the Department steadily gained reputation in teaching and research at home and abroad and able to establish the necessity of graduate microbiologist in both industry and academia. It prompted the opening of the Undergraduate (Honours) programme in the academic session of 1988-89. From the academic session of 1994-95, the traditional three-year BSc (Honours) programme has been upgraded to a four-year BS (Honours) as terminal degree. At present, in addition to the undergraduate BS (Honours) programme, the Department offers specialized courses with research facilities in Post-Graduate levels such as MS, MPhil and PhD.

The Department follows state of the art teaching pedagogy with special emphasis on research and practical works. Teaching in the classrooms is facilitated with digital multimedia and other necessary supports. The Department has a rich seminar library with a large collection of reference books and journals. It possesses several practical and research laboratories with modern equipment, facilities and service systems. The faculty and the researchers of this department have been regularly publishing their research finding in the high impact national and international journals. The Department of Microbiology has already earned a place as a centre of excellence in the field of Microbiology, Molecular Biology and Biotechnology research in Bangladesh. Various research groups are working in collaboration with the top research organizations at home and abroad.

Introduction to the Programme

Title of the Programme: Master of Science (MS)
Duration of the Programme: One-Year
Level: Postgraduate
Type: Degree
Medium of Instruction: English

Eligibility for Admission: A 4-year B.S. (Honours) degree in Microbiology or an equivalent degree is required. As per the existing rules of the Faculty of Biological Sciences, University of Dhaka, students will be admitted to the MS programme with a minimum CGPA of 2.50 in the scale of four in a 4-Year BS (Honours) examination. The Department may re-fix the minimum CGPA requirement from time to time to a higher level with approval from the authority. Students intending to be admitted in the MS programme must seek admission within two academic years of completion of BS (Honours) programme.

General Objectives of the Programme

The courses aim to give detailed knowledge and understanding of important aspects of Microbiology, as currently applied in industry, food, health and medical sciences, environment management, and biotechnology, as well as in advanced research.

Emphasis is given on developing knowledge and understanding such that the graduate students acquire the skills, qualities and attributes expected by employers or required for postgraduate studies and research in applied microbiology. The trained graduates will play a vital role in the sustainable economic development and would bring qualitative changes in the above-mentioned areas in the country. The practical training and fieldwork in the curriculum will provide hands-on experience in different fields of microbiological and biotechnological sciences. It will also create awareness about public health and safety and facilitate the establishment of liaison between Microbiologist with society and industry. The individual learning outcomes of Microbiology study are:

- Students will recognize highly developed, advanced and complex levels of knowledge which will enable the development of in-depth and original responses to complicated and unpredictable problems and situations;
- Students will be involved in the demonstration of high level specialists and professional knowledge appropriate for senior professionals and senior managers;
- Students will communicate scientific concepts, experimental results and analytical arguments clearly and concisely, both verbally and in writing; and
- Students will demonstrate engagement in the Microbiology discipline through involvement in academic, research and social activities, student and professional associations and outreach or mentoring activities.

Requirements for MS Degree

A student must fulfill all the requirements for a Master of Science degree within a maximum of two (2) academic years starting from the year of enrollment. He/she must earn the minimum required GPA 2.5 on a 4.00 scale and must earn 34 credits for successful completion of the MS programme. After successful completion of the requirements, the degree will be awarded and conferred by the University authority. The postgraduate MS Degree in Microbiology shall be conducted as per the 'Rules and Guidelines of the Faculty of Biological Sciences, University of Dhaka' (Approved 23 August 2015).

Duration of the Programme

The MS Programme will be of 1 (one) academic year duration the breakdown of witch in given bellow:

Classes	28 weeks
Preparation Time for Course Final Examination	4 weeks
Course Final Examination (Theory)	4 weeks
Submission of Thesis/ Projects/ Practical/ Seminar	12 weeks
Results (Tabulation and publishing)	4 weeks
Total	**52 weeks**

Results should be published within 4 weeks from the date of the last final examination.

Assignment of Credits

(a) The entire Master's programme is covered by a set of theoretical, thesis, practical (laboratory/ field), project, and seminar courses.
(b) Theoretical Courses: A minimum of 15 class-hours will constitute 1 (one) credit.
(c) Practical courses: Distribution of credits, and pattern of Practical (Laboratory/ Field) courses will be determined by the Academic Committee of the Department.

(d) Thesis: Mode of distribution of thesis will be determined by the Academic Committee of the Department; the minimum earned CGPA should be 3.50 in a scale of 4.00 in the BS (Honours) degree.
(e) Seminar: Mode of assignment to the seminar course will be determined by the Academic Committee of the Department.
(f) Distribution of credits will be as follows:

Group	Theoretical Course	Thesis	Practical	Short Project	Seminar	Viva-voce	Total Credits
A (Practical)	24	-----	4	2	2	2	34
B (Thesis)	24	6	-----	-----	2	2	34

Evaluation of Student's Performance

The total performance of a student in a given course will be evaluated on the basis of a scheme of continuous assessment, In-course examinations and Course Final examinations.

(a) Marks Distribution for Courses:

(i) Theoretical and Practical courses:	
Class attendance/participation	5%
In-course assessment	35%
Course Final Examination	60%
(ii) Thesis and project courses:	
Defence/ Presentation	40%
Evaluation by external examiners	60%

(b) Continuous Assessment: The continuous assessment for theory courses will be made through a set of in-course examinations and class attendance. In case of practical course (laboratory/ field works), this will be made through class attendance/ participation, assignments, evaluation of interactive skills and practical reports and other sessional activities set by the course teacher(s) as preferred by the Department. The scheme of continuous assessment will be announced by the course teacher(s) at the beginning of the course.

(c) Class Attendance/ Participation: A student must attend at least 75% of the total classes held in an academic year to be eligible for appearing at the Course Final examinations. A student attending at least 60% classes, but less than 70% classes will be allowed to appear at the examination after paying non-collegiate fees fixed by the University and a student attending less than 60% classes will not be allowed to appear at the Final examination for that year/session. The basis of awarding marks for class attendance will be as follows:

Attendance (% of the total class held)	Marks (%)
95 and above	5
90 to less than 95	4
85 to less than 90	3
80 to less than 85	2
75 to less than 80	1
Less than 75	0

(d) In-course Assessment: In-course tests of one-hour duration shall be conducted and evaluated by the course teacher(s). There will be at least 2 (two) written tests for 3-credit theoretical courses. Additional assessment may be made by the course teacher(s) with prior/approval by the Academic Committee of the Department. The question patterns for the tests should preferably be of objective type. The Course teacher will show the assessed in-course scripts to the students and shall announce the results within two weeks of the date of holding the test.

Make-up test will be arranged for a student who fails to appear at In-course test(s) due to unavoidable circumstances like accident, medical surgery or such situations with prior/approval of the Academic Committee of the Department and the test must be held during the course period. Absence in any In-course test will be counted as zero towards calculating the average marks for that In-course test.

(e) Course Final Examination: The Course Final examination for theoretical course will be conducted centrally by the Controller of Examinations as per University Rules. The examination will be of 2.5 hours duration for a 3-credit course. The question patterns for Course Final tests should be defined by the Department.

For evaluation of the Course Final examination for theoretical courses there will be two examiners: one internal (course teacher or teachers) and the other external (will preferably be within the Department/ University provided that he/she is not a course teacher for the course paper to be examined). Under the double examiner system, if the difference between the marks internal and external is more than 20%, there will be a 3rd examination, and closest marks of the two examiners will be considered towards calculating the average as final mark.

(f) Assessment of Seminar: Seminar presentations will be evaluated by a committee involving three internal members of the Examination Committee and two members nominated by the Academic Committee of the Department.

(g) Assessment of Final Laboratory Works: The Final Examination on practical works will be conducted by the course teachers to be appointed as examiners along with the external examiner of the Examination Committee.

(h) Assessment of project: A committee comprising internal members of the Examination Committee, one nominated member of the Academic Committee and respective project supervisor will evaluate the presentation on 40% marks. Final report on the project will be evaluated on 60% marks by two examiners – one within the Department (other than the supervisor) and the other from outside the Department nominated by Examination Committee.

(i) Assessment of Thesis: Oral presentation/ thesis defense will be evaluated by a committee of 5 members of which 4 are from examination committee and the fifth one is the respective supervisor. Thesis will be evaluated by two external examiners from outside the Department. If difference of marks of two external examiners is more than 20%, there will be a third examination to examine the thesis. Closest marks of the two examiners will be considered for calculation of average as final mark.

(j) Viva-Voce: A regular student must appear at the Viva-voce/ Oral examination at the end of the Course Final examinations and it will be conducted by the respective Examination Committee.

Grading System

A basic four-point (4.00) grading scale will be followed and marks obtained for each course will be converted to grades. The following letter grades and corresponding grade-points will be used to determine the student's grade point average (GPA).

Marks Obtained	Corresponding Letter Grade	Grade point	Grade Description
80% or above	A+	4.00	***Grade A*** **:** Exceptional performance; all course objectives achieved; objectives met in a consistently outstanding manner.
75% to less than 80%	A	3.75	
70% to less than 75%	A-	3.50	
65% to less than 70%	B+	3.25	***Grade B*** **:** Very good performance, significantly more than the majority (at least two-thirds) of the course objectives achieved, objectives met in a consistently thorough manner.
60% to less than 65%	B	3.00	
55% to less than 60%	B-	2.75	
50% to less than 55%	C+	2.50	***Grade C*** : Satisfactory performance; at least majority of the course objectives achieved; objectives met satisfactorily.
45% to less than 50%	C	2.25	
40% to less than 45%	D	2.00	***Grade D*** **:** Minimally acceptable performance; less than majority but more than the minimum required course objectives achieved; objectives achieved at a minimally acceptable level.
Less than 40%	F	0.00	***Grade F*** **:** Failed in the course

A course in which a student has obtained "D" or higher grade will be counted as credits earned by him/ her and obtained "F" grade will not be counted towards his/ her earned credits.

Calculation of GPA

Grade Point Average (GPA) is the weighted average of the grade points obtained in all courses passed/ completed by a student in an academic year. The GPA is computed as per following equation:

GPA = ∑PE/ ∑Cr

Where, PE means Points Earned (i.e. grade Points x credits) and Cr means Credits attempted in the year.

The Grade point Average (GPA) is computed by dividing the total accumulated grade points earned during the MS programme by total credit points attempted. For successful completion of MS programme, a student must earn 34 credits or more (if approved) with no F grade in any course. However, this minimum requirement may be raised by the Department as per their programme and final GPA will be calculated using all the credits attempted.

Retake Examination

A student can appear in retake examination once only, one course to clear F grade within 6 weeks after announcement/ publishing of results and definitely before registration for convocation. His/her In-course assessment marks will be retained.

Readmission

(a) A student failing to earn the degree may seek readmission once with the next batch. For readmission, a student will have to apply within one month after publication of the result of the concerned year. Readmission will be allowed only after the approval of the departmental Academic Committee.

(b) On readmission, a student may be allowed by the departmental Academic Committee to retain his/ her In-course marks, earned earlier as chosen by him/ her. The Academic Committee of the respective department will determine whether the re-admitted student can undertake any thesis work.

(c) If a student succeeds after taking readmission his/ her transcript will bear "R" after GPA, with a foot note "R means readmission".

Other General Regulations:

(a) Respective statutory authorities of the university shall design syllabus, allocate courses for teaching, constitute examination committee and panel of examiners as per rules of the university.

(b) At the beginning of the session, a course teacher shall provide the students with a course outline including: statement of objectives, main topics, teaching approaches (e.g., labs, case studies, field work etc.), schedule of tests, text books and other required materials.

(c) The course teacher shall announce the results of the in-course tests within two weeks of the date of holding the tests and submit the marks to the Chairman of the Examination Committee for the respective batch and a copy to the Controller Examinations at least two weeks before start of the final examination. He/she should also submit a statement showing the total number of classes held and the number of classes attended by each student in his/her course to the Chairman of the Examination Committee for the respective batch.

(d) Tabulation work will be started only after all the marks of the course of the final examinations for the year are received by the Chairman of Examination Committee. Marks received by the Chairman of the Examination Committee shall remain in the sealed envelope as sent by the Examiners until tabulation work is started. In case of thesis group, tabulation work will be started only after the thesis presentation.

(e) The present system of conducting course final examination and publication of results by the office of the Controller of Examinations shall continue.

(f) For any matter not covered in these rules, the existing rule of the University of Dhaka will be applicable.

Structure of the Curriculum

There shall be two groups of students: Group A (Practical Group) and Group B (Thesis Group). Students of the both groups shall undertake and appear at written examinations in the eight 3-credit theoretical courses as of their choices, a 2-credit seminar presentation and a 2-credit viva-voce. For Group A students, a 2-credit short project and a 4-credit laboratory works in research laboratories and/ or in industry will be included. Group B students shall undertake a 6-credit thesis/ dissertation. The completion, submission and assessment of dissertation/ projects/ practical/ seminar and other matters will be followed as per guidelines approved by the University of Dhaka.

Course Information

Course Number	***Course Name***	***Credit***
MPG 501	Environmental Biotechnology	3.0
MPG 502	Advanced Molecular Genetics	3.0
MPG 503	Immunopathology and Vaccine Development	3.0
MPG 504	Bioprocess Engineering and Technology	3.0
MPG 505	Enzyme and Protein Biotechnology	3.0
MPG 506	Advanced Bioinformatics	3.0
MPG 507	Epidemiology of Infectious Diseases	3.0
MPG 508	Microbial Food Safety Management	3.0
MPG 509	Bioenergy and Biofuel Technology	3.0
MPG 510	Molecular Virology and Oncology	3.0
MPG 511	Extremophiles and Novel Biological Products	3.0
MPG 512	Pharmaceutical Biotechnology	3.0
MPG 513	Practical/Laboratory works (Group A)	4.0
MPG 514	Short Project (Group A)	2.0
MPG 515	Thesis/ Dissertation (Group B)	6.0
MPG 516	Seminar presentation	2.0
MPG 517	Viva-voce	2.0

MPG 501 Environmental Biotechnology Credits: 3 Class: 45 hours

This course focuses on different types of environmental hazards and current applications of biotechnology to environmental quality evaluation, monitoring and remediation of contaminated environments. It discusses the natural and man-made hazards in the environment; role of microbes in making environment cleaner; biodegradation of xenobiotic compounds, radioactive and heavy metals, hydrocarbons and oil-spills; different biosensors and their significance in environmental monitoring; various physical chemical and Biological methods of solid waste treatment; aerobic and anaerobic methods of the waste water treatment; global environmental problems like Green house effect, acid rain, Ozone depletion and their treatment by biotechnological methods. Application and generation of biopesticides is another topic as preventive environmental biotechnology.

Course Objectives

The students will be able to

1 Acquaint with current concept on emerging and re-emerging pathogens and their status in natural ecosystem and their risk.

2 Know the pollution problem due to metals and xenobiotic molecules and their remediation using microorganisms.

3 Know the effects and use of biosensors and biopesticide.

Learning Outcomes

After completion of the course, the students will be able to

1 Learn the concepts on environmental hazards including survival potentiality of VBNC in natural habitat and importance of microbiological risk and their assessment.

2 Learn the biotechnological tools for monitoring the inorganic and organic pollutants in the environments.

3 Learn about the use, importance and application of microbial cells and enzymes for controlling pollution in wastewater and industrial effluents.

4 Implement the biodegradation and bioremediation techniques for controlling organic pollutants in the environments.

5 Understand the metal pollution and their microbial bioremediation.

6 Acquaint with current knowledge on the bioremediation process for important special types of wastes from different services.

7 Learn about xenobiotic degrading catabolic genes and their detection in the environment.

8 Develop innovative processes for preventive and sustainable biopesticides.

Unit	Course contents	Class hours
1	**Environmental Hazards and Risk Assessment:** Classification and characterization of environmental hazards; Biological hazards- Viable but non-culturable cells as potential environmental hazards; Molecular methods of detection and identification of VBNC; Risk assessment- concept, process and microbiological risk assessment.	6
2	**Environmental Monitoring Systems:** Environmental biosensors- development, types and applications; Biomarkers- bio-monitoring and bio-effect monitoring; Genetic engineering approaches; Integrated bio-detection systems- principle and application, and technology and conceptual plans.	5

3	**Biotechnology of wastewater and industrial effluent:** Use of microorganisms, enzymes and immobilized cells in wastewater and industrial effluent treatment, potential application of recombinant DNA technology in waste treatment.	7
4	**Bioremediation of organic pollutants:** Biodegradation of organic pollutants- mechanisms and factors affecting biodegradation, and degradation of different organic pollutants; Bioremediation- In situ and ex situ bioremediation technologies; Bioremediation of oil spills, and phytoremediation; Use of GMO in bioremediation; Biological treatment of waste gas- biofilters, bioscrubbers, membrane bioreactors, biotrickling filters.	6
5	**Microorganisms and metal pollutants:** Properties and Effects of Metals; classification of Metals, Speciation of Metals, sources of metals; metal bioavailability in the environment, effects of metal toxicity on microbial cells, mechanisms of microbial metal resistance and detoxification, health hazards due to metal pollution and pesticide; bioremediation of arsenic and chromium in Bangladesh context.	6
6	**Microbial bioremediation of some specific pollutants**: radioactive/ radionuclear wastes, hospital wastes, pharmaceutical wastes, industrial and municipal solid wastes.	6
7	**Xenobiotic Degrading Bacteria and Their Catabolic Genes in Bioremediation:** In situ analysis of microbial community and activity in bioremediation, DNA- and RNA-based methods of microbial community analysis in bioremediation, genetic finger printing techniques.	5
8	**Preventive and Environmental Biotechnology:** Innovation of novel bioprocesses; Microbial insecticides- bacteria, fungal and viral pesticides in pest management; Microbial biopesticides- biology and applications of *Bacillus thuringiensis* (Bt) in pest control	4

Recommended Books

1 Wastewater Microbiology, Bitton G. 4th Edition, Wiley and Sons Inc.
2 Microbial Biotechnology, Fundamentals of Applied Microbiology. Glazer AN & Nikaido H, Cambridge University Press
3 Environmental Microbiology, Maier RM, Pepper II & Gerba CP. Academic Press
4 Biotreatment System, Vol 2, Wise DL. CRC Press
5 Nonculturable Microorganisms in the Environment, Colwell RR & Grimes DJ. ASM Press
6 Molecular Approaches to Environmental Microbiology, Pickup RW & Saunders JR, Prentice Hall
7 Microbial Ecology: Fundamentals and Application. Atlas RMA and Bartha R. 4th Edition. Benjamin/Cummings Science Publishing
8 Textbook of Environmental Biotechnology, Mohapatra PA, 2006; I.K. International Publishing House, New Delhi
9 Biodegradation and bioremediation by M. Alexander
10 Wastewater treatment for pollution control, 2nd edition. Arceivala

MPG 502 Advanced Molecular Genetics Credits: 3 Class: 45 hours

This course is designed to familiarize students with regulation of gene expression in eukaryotic system, cell signaling systems, various genetic disorders in human, and gene therapy. Techniques to study gene expression at different levels are also introduced in this course.

Course Objectives

The students will be able to

1 learn the regulation of gene expression in eukaryotic system at various levels.
2 know different cell signaling systems.
3 study various genetic disorders, their mechanisms, and prevention by gene therapy.
4 comprehend different techniques for studying gene expression and their function.

Learning Outcomes

After completion of the course, the students will be able to

1 describe features, types of regulation of gene expression at various levels.
2 use different cell signaling systems in microorganisms.
3 apply gene therapy as a treatment strategy.
4 detect and analyze transcription and translation products.

Unit	Course contents	Class hours
1	**Eukaryotic genome**: Introduction to the size, structure and organization of eukaryotic genes and genomes, functional significance of a genomes organization and chromatin-structure. Mitochondrial genome and Chloroplast genome. Transcription of eukaryotic genes. Multigene families and repetitive DNA, polymorphism and polymorphic markers, Models of studying gene structure and function: Yeast, *Caenorhabditis elegans*, Drosophila, Zebrafish, and Mammals.	8
2	**Regulation of gene expression in eukaryotes**: Spatial and temporal regulation of eukaryotic gene expression; controlled transcription of DNA, alternate splicing of RNA, cytoplasmic control of mRNA stability, induction of transcriptional activity by environmental and biological factors. Molecular control of transcription; Gene expression and chromosome organization- molecular organization of transcriptionally active DNA, DNA methylation and imprinting, gene amplification; Activation and inactivation of whole chromosome. Gene silencing and position effects. Gene regulation in developmental biology and the cell cycle. Mechanisms that regulate development from single cell to multicellular organisms. Tumor genetics: Principles of how dysregulation causes tumor growth.	8
3	**Studying gene expression and function**: Transcription analysis of cloned gene, Identifying and studying the translation product of a cloned gene: hybrid-release translation (HRT) and hybrid-arrest translation (HART). Studying protein-protein interaction by phage display, yeast two hybrid system.	6
4	**Human genetic disorders and gene therapy**: Monogenetic disorders, Multifactorial disorders, Chromosome disorders, and Mitochondrial inheritance disorder. Somatic cell gene therapy and germ-line therapy; Gene function interruption therapy: antisense RNA and ribozyme; Therapeutic use of anti-	8

	sense oligonucleotide: pre-transcriptional and post-transcriptional inactivation of RNA; Gene therapy and cancer, Strategies for gene therapy and production of medicines via genetically-modified organisms: expression vectors and viral vectors. Genetic screening of individuals. Ethical issues raised by gene therapy.	
5	**Signaling through ion-channel linked cell surface receptors:** Voltage-gated channels, Ligand-Gated channels, NMDA Receptors, GABA receptors, 5-HT receptors, IP_3 receptor, Nicotinic acetylcholine receptors, Neurotransmitters, and their Applications. Regulation of ion channels by G-proteins, desensitization of G-protein-linked receptors.	7
6	**Signaling through enzyme-linked cell surface receptors**: Receptor tyrosine kinases, Activation of Ras, signals from activated Ras to a cascade of protein kinases including MAP-kinases, PI 3-kinase/protein kinase B signaling pathway, Cytokine receptors, and the JAK-STAT pathway. Two-component signaling pathway of bacterial chemotaxis. TGF Signaling pathways. Smad signaling via negative feedback loop, TGFα signaling, and abnormal cell proliferation.	8

Recommended Books

1. Genetics: From Genes to Genomes. Hartwell L, Hood L, Goldberg M, Reynolds A and Silver L, 4th edition, McGraw-Hill Education
2. Gene Cloning and DNA Analysis: An Introduction - Brown TA, 7th Edition. 2016. John Wiley & Sons Ltd., West Sussex.
3. Principles of Genetics – Gardner EJ, Simmons MJ and Snustad DP, John Wiley & Sons
4. Gene VII. - B. Lewin, 7th edition, Oxford University Press
5. From genes to clones, Ernst. L Winnacker, 2nd edition, 2003. Panima publishing corporation, New Delhi

MPG 503 Immunopathology and Vaccine Development Credits: 3 Class: 45 hours

The course reinforces important concepts in immunology involving activation and inactivation of biologically active molecules, cytotoxic and cytolytic reactions, granulomatous reactions and inflammation, and vaccination procedures.

Course Objectives

The students will be able to

1. Learn and understand antibody-mediated activation and inactivation of biologically active molecules, immunohematologic diseases progress and autoimmune hemolytic disorders.
2. Understand the concepts of protective and pathologic effects in infectious diseases, granulomatous reaction.
3. Understand vaccine immunology.
4. Learn different strategies for designing vaccine.

Learning Outcomes

After completion of the course, the students will be able to

1. Understand how antibody acts for inactivation and activation of biologically active molecules
2. Learn how the immune system can be benefited or harmed by the cytotoxic & cytolytic reactions
3. Interpret granulomatous reaction

4 Conceptualize overall immune system & immunity
5 Apply their immunological knowledge in the designing and development of vaccines.
6 Acquaint with the strategies of experimental vaccines.

Unit	Course contents	Class hours
1	**Inactivation and activation of biologically active molecules**: Ligands, receptors and idiotypes, Biologically Active Molecules; Mechanism and types of antibody mediated inactivation and activation. Cases of antibody mediated inactivation and activation, Hormones, Insulin, Thyroid hormone, Chorionic gonadotropin, estrogen, progesterone, prolactin, Erythropoietin. Receptors: Insulin receptor, TSH receptor, Acetylcholine receptor, β-adrenergic receptor, Other biologically active molecules: Intrinsic factor; Blood clotting factors, Drugs; Other antibodies: Neutralizing antibodies.	6
2	**Cytotoxic and cytolytic reactions:** Mechanism of Cytolytic Reactions, Immunohematology Diseases: Anemia, Agranulocytosis, Platelets; Acquired autoimmune haemolytic disorders; Haemolytic reaction to drugs, Cytolytic skin diseases, Other Cytotoxic Reactions; Detection of Circulating Cytotoxic Antibodies; Protective and pathologic effects in infectious diseases.	6
3	**Granulomatous reactions and Inflammation:** Nature of Various Granulomas; T-cell factors for modulation of granulomas, Granulomatous hypersensitivity reactions and its protective function. Progression of granulomas. Case study: Tuberculosis, Leprosy, Parasitic infections, Disease of unknown etiology, Sarcoidosis, Wegener's disease, Regional enteritis, Autoimmune gastritis, Intestinal villous atrophy, Immune deficiency diseases.	9
4	**Vaccine design:** Antibody gene cloning, Recombinant antibody gene expression, Applications of engineered antibodies, designing vaccines using genomics, bacterial protein toxins used in vaccines, and glyco-conjugate vaccines.	6
5	**Vaccine Immunology:** Vaccine immunology, Mucosal vaccines, Designing, development and mode of actions of vaccines, Killed vaccines, Attenuated vaccines, Subunit vaccines, Conjugate vaccines, Edible vaccines, DNA vaccines and other vaccines, Vaccination programme, and adjuvants.	10
6	**Vaccine strategies:** Reverse vaccinology, Experimental vaccines for Botulism; Anthrax, Pneumonia, Cholera, Typhoid, Hepatitis, Malaria, Cancer, vaccines against newly emerging diseases.	8

Recommended Books

1 Immunology: Immunopathology and Immunity. S Sell and EE Max. 2nd edition. Medical Dept. Harper & Row
2 Bacterial Pathogenesis: A molecular Approach. BA Wilson, AA Salyers, DD Whitt and ME Winkler Third edition, 2011. ASM Press, Washing, DC, USA
3 Molecular Immunology. Edited by B. D. Hames and D. M. Glover, 1999, Oxford University Press
4 The Microbial Challenge: Human Microbe Interaction. RI Krasner. 2002. ASM Press, Washing, DC, USA.
5 Kuby Immunology. Edited by Judith A. Owen, Jenni Punt, Sharon A. Stranford and Patricia P. Jones. 7th Edition, 2013. W. H. Freeman and Company.
6 Vaccine Design: Innovative Approaches and Novel Strategies. Edited by Rino Rappuoli and Fabio Bagnoli. 2011. Caister Academic Press.

7 Advanced Vaccine Research Methods for the Decade of Vaccines. Edited by Fabio Bagnoli and Rino Rappuoli. 2015. Caister Academic Press.
8 Vaccines. Edited by Stanley A. Plotkin, Walter A. Orenstein and Paul A. Offit. 2013. Elsevier Inc.

MPG 504 Bioprocess Engineering and Technology Credits: 3 Class: 45 hours

The course deals with the design and analysis of biochemical systems with applications in bioprocess engineering and metabolic processes including upstream and downstream processing technology. It also deals with studying various biotechnological processes used in industries for large-scale production of biological products for optimization of yield in the product and its quality. Bioprocess engineering may include the work of mechanical, electrical, and industrial engineers to apply principles of their disciplines to processes based on using living cells or sub cellular components.

Course Objectives

The students will be able to

1 To convey the principles of integrated nature of modern bioprocess development.
2 To understand the mainstream bioprocess design heuristics with engineering tools for engaging productively in multidisciplinary process devilment teams.
3 To know the advancement of bioreactor engineering.
4 To develop skills to produce biochemical products using integrated biochemical processes.

Learning Outcomes

After completion of the course, the students will be able to

1 Understand key process design concepts, developments and applications of bioprocess technology.
2 Learn the principles involved in optimization and scale-up to industrial operation in bioprocessing.
3 Demonstrate the economic methods of recovery and purification of commercial biological products.
4 Understand the bioreactors with their types, design and selection, operation, and control systems for bioprocessing industry.
5 Specify required technologies to effectively utilize genetically engineered microorganisms for bioprocessing.
6 Understand the biocatalysis in biotransformation along with their optimization and kinetic under different bioprocess systems.
7 Demonstrate knowledge of the recent advancement, challenges and innovation of bioengineering and bioprocess technology.

Unit	Course contents	Class hours
1	**Concept and General Features**: Concepts, importance and steps in development of bioprocess; Applications- biopharmaceuticals, specialty products and industrial chemicals and environmental-management aids; Bioprocess unit operations- upstream and downstream processing; Development of microbial processes; Bioprocess regulatory constraints.	6
2	**Upstream Processing**: Inoculum development- growth, aseptic inoculation and sampling; Media formulation and preparation; Growth and product formation - batch, semi-batch, fed-batch and continuous cultures, substrate utilization, yield of biomass, productivity; Scaling up of fermentation process.	7

3	**Downstream Processing**: Strategies to recover and purify products; Separation of insoluble products- filtration, centrifugation, and other recent developments; Separation of soluble products- two-phase/multiphase and liquid-liquid extraction methods; Cell disruption- physical, chemical and enzymatic methods; Purification- precipitation, microfiltration/ultra-filtration, dialysis, reverse osmosis, adsorption and chromatography; Drying and crystallization.	6
4	**Bioreactor Engineering and operation**: Dynamic modeling for bioprocesses; Applications of tube, packed bed, fluidized bed, cyclone and trickle flow bioreactors; Process operation, monitoring and control; Scale-up and scale-down procedures- laboratory, pilot and large scale bioreactors; Aseptic conditions- sterilization of bioreactor, media and air; Mass transfer in bioreactor- gas-liquid exchange; oxygen transfer, heat transfer and aeration/agitation.	6
5	**Applications of Organisms in Bioprocess:** Isolation and screening organisms, enrichment and specific screening for the desired product; Improvement of selected organism- strategies of improvement for primary and secondary metabolites, mutation, protoplast fusion, and recombinant DNA technology; Problems associated with strain improvement organisms and biosafety; Preservation and maintenance of cultures.	7
6	**Biocatalysis and Biotransformation**: Concepts and principles- biocatalytic processes, metabolic engineering and applications; Factors influencing commercial biocatalytic process; Substrates- selection, types, composition, and development of media; Balancing of bioprocesses; Biotransformation kinetics- kinetics of growth, substrate utilization and product formation in batch, fed batch and continuous systems.	6
7	**Advances and challenges in Bioprocess Technology:** Sustainable waste management; Bio-treatment of industrial effluent and underground water; Biorefinery; Biobanking of microbes; Bioleaching of metals, Biocatalysts; Value added food, feed, fertilizer, fuel and fiber from renewable resources; nanobiosynthsis. Market perspectives- cell to sell.	7

Recommended Books

1 Bioprocess Engineering: an introductory engineering and life science approach – K.G. Clarke, Woodhead Publishing

2 Bioprocess Technology: Fundamentals and Applications. Stockholm KTH

3 Advances in Bioprocess Technology – P Ravindra, Springer

4 Biochemical Reactors – B Atkinson, Pion, Ltd. London.

5 Biochemical Engineering Fundamentals - Bailey and Ollis, Tata McGraw Hill, N.Y.

6 Advances in Biochemical Engineering - TK Bhosh, A Fiechter and N Blakebrough, Springer Verlag Publications, N.Y.

7 Bioprocess Engineering Kinetics, Mass Transport, Reactors, and Gene expressions – W.F. Veith, John Wiley and Sons.

8 Bioseparation: Down-stream processing for Biotechnology - PA Belter, EL Cussler and WS Hu, John Wiley and Sons, N.Y.

9 Separation process in Biotechnology – JA Asenjo, Marcel Dekkar, N.Y.

10 Bioprocess Engineering Principles - Doran, Acad. Press, London.

11 Bioreaction Engineering Principles- Nielsen, J. and Villadsen, Plenum press, N.Y.

MPG 505 Enzyme and Protein Biotechnology Credits: 3 Class: 45 hours

This course is designed to introduce students with the scopes, applications and production of different proteins and enzymes for industrial biotechnology using modern tools and technologies.

Course Objectives

The students will be able to

1. Learn the applications of different proteins and enzymes used in industries.
2. Acquaint students with the approaches, tools and advanced techniques for the production and purification of proteins and enzymes

Learning Outcomes

After completion of the course, the students will be able to

1. Describe the scopes of different proteins and enzymes used in industries.
2. Learn about the analytical methods of protein structure and function.
3. Know about the stability of proteins both *in vitro* and *in vivo.*
4. Learn about the methods of overproduction of protein using heterologous system.
5. Learn the applications of proteins and enzymes (both wild type and recombinant) in healthcare and other biotechnology industries.
6. Apply the approaches and molecular techniques for protein and enzyme engineering

Unit	Course contents	Class hours
1	**Industrial and Technical application of enzymes:** Enzymes in food and feed industry, Enzymes in detergents, Enzymes in leather industry, Enzyme in textile industry, Enzymes in pulps and paper industry. Enzymes in starch processing, Enzymes in fuel production, Enzymes as diagnostic reagents.	7
2	**Protein structure and function analysis**: Protein/ Enzyme structure and folding. Screening for new and improved enzymes, Structure determination by X-ray crystallography and NMR spectroscopy. Structure modelling and analysis using molecular graphics. Protein-ligand, protein-DNA and protein-protein interactions. Kinetic and thermodynamic characterization of interactions. Structure-function relationships.	10
3	**Conformational Stability of Protein:** Enzyme stabilization, *In vitro* and *In vivo* stability, stability of proteins in solution, denaturation mechanism and renaturation.	6
4	**Protein Sources:** The range of industrially significant proteins and their applications; Recombinant versus non-recombinant proteins; Microorganisms, plants and animal tissue as sources of protein.	5
5	**Enzymes overproduction:** Large-scale industrial enzyme/protein production, Expression in *E. coli*, bacteria, yeast, and baculovirus.	9
6	**Recombinant protein technology and Protein Engineering:** Basic concepts of recombinant protein technology, Techniques in enzyme/protein engineering (gene cloning, finding genes, DNA libraries, site directed mutagenesis, knockout mouse, tissue culture). Metabolic engineering. Post-translational and chemical modifications, Protein degradation. Combinatorial genetics.	8

Recommended Books

1. Protein Engineering and Design. 1st Edition, Edited by Sheldon J Park and Jennifer R. Cochran
2. Proteins: Biotechnology and Biochemistry, 1st Edition. Edited by Gary Walsh. Wiley Publishers
3. Fundamentals of Protein Biotechnology, CRC Press. 1990
4. Protein Engineering Handbook. Edited by Stefan Lutz and Uwe Theo Bornscheuer. 2012
5. Protein biotechnology. Edited by G Walsh & D Headon. 3rd Edition. John Wiley & Sons, Chichester
6. Protein biotechnology: Isolation, characterization and stabilization. Edited by Felix Franks. 1995. Humana Press, Totowa, New Jersey
7. Protein Engineering: Principles and Practice. Edited by Jeffrey L. Cleland and Charles S. Craik. 1st Edition, Wiley-Liss.
8. Protein Expression, A Practical Approach. Edited by S. J. Higgins and B. D. Hames. 1st edition. Oxford University Press. New York
9. Biotechnology of Microbial Enzymes: Production, Biocatalysis and Industrial Applications. Goutam Brahmachari. 1st Edition. Academic Press, 2016
10. Enzymes in Industry: Production and Applications, Edited by Wolfgang Aehle, 3rd Edition, 2007. WILEY-VCH
11. Industrial Enzymes: Structure, Function and Applications. Edited by Polaina, Julio, MacCabe, Andrew P. 2007. Springer

MPG 506 Advanced Bioinformatics Credits: 3 Class: 45 hours

With the advent of cutting-edge techniques in omics sciences (genomics, metabolomics, & proteomics), many biological data are emerging everyday which tends to amplify with time. To handle this data aiming to extract necessary biological information, highly skilled professionals in interdisciplinary fields (life sciences, computation and mathematical sciences) is utmost important. This course will provide an overview of genomics, proteomics and bioinformatics, covering a broad selection of the most important techniques used to analyze biological sequence and expression data.

Course Objectives

The students will be able to

1. Be equipped with the cutting-edge data evolving techniques in omics science.
2. Have knowledge in interdisciplinary fields (life sciences, computation and mathematical sciences).
3. Know the effective learning from *theory to practice* to deal with biological data.

Learning Outcomes

After completion of the course, the students will be able to

1. Gain critical insight of the cell at the molecular level.
2. Use the techniques of mapping genome prior to sequencing.
3. Use the sequencing techniques of the gene and genome.
4. Extract biological information from sequences by post genomics.
5. Handle different bioinformatics tools to analyze biological data.

Unit	Course contents	Class hours
1	**Genome Biology**: Genomes to life; Mapping Genomes: Genetic and Physical Maps; Importance of genome project; Microbial genome: whole genome sequencing of microbes: virus and bacteria; Human Genome Project (HGP); Human epigenome, microbiome, connectome project.	6

2	**Next Generation Sequencing (NGS)**: NGS Methods; NGS technologies/ platforms; experiment types and applications; Workflows for various NGS experiments; Basics of NGS data analysis; Various file formats such as FASTQ, SAM, VCF, BED	10
3	**Metagenomics**: Introduction; metagenome concept; shotgun metagenomics (pyrosequencing); whole genome metagenomics; Tool's in metagenomics; MEGAN, MG- RAST; Applications: Gene survey, Environmental genomes, Microbial diversity e.g.; Human gut microbiota.	7
4	**Comparative and Functional Genomics**: Functional annotation; Gene ontology; Microarray: Basic principle; Gene chips; Handling processed microarray data; Clustering of genes based on their expression level; Pathway analysis and building gene/protein regulatory network; Gene expression analysis by sequencing: RNA-seq, ChIP-seq; 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. Single-cell RNA sequencing (scRNA-seq).	8
5	**Computational proteomics**: Overview on LC-MS/MS; Peptide mass fingerprinting; Proteomics databases, Application of stable isotope labeling of amino acid in cell culture (SILAC) technology for quantitative proteomics.	5
6	**Immunoinformatics**: Basic mechanism of antigen presentation; Familiarization with immunoinformatics websites and tools; Identification of immunogenic epitopes by computational methods for designing vaccines.	5
7	**Emerging techniques in Bioinformatics**: The cutting-edge techniques evolving in the field of bioinformatics available from the current literature	4

Recommended Books

1. Genetics: From Genes to Genomes. Hartwell L, Hood L, Goldberg M, Reynolds A and Silver L, 4th edition, McGraw-Hill Education
2. Introduction to Genomics, Arthur M. Lesk, 2nd edition, Oxford University press
3. Next-Generation DNA Sequencing Informatics, Stuart M. Brown, CSH Laboratory Press
4. Biotechnology: Genomics and Bioinformatics, Rehm H-J & Reed G, 2nd edition, vol. 5b.
5. Genomes 3. Brown TA, 3rd edition, Garland Science
6. Metagenomics for Microbiology, Izard & Rivera, Elsevier

MPG 507 Epidemiology of Infectious Diseases Credits: 3 Class: 45 hours

This course is designed to understand the mechanisms used by common bacterial pathogens to cause disease in human and survive within the host. The course discusses investigation and response to infectious disease and typing of causal agents. It brings in the concept of one health. Statistical analysis of disease dynamics is also described.

Course Objectives

The students will be able to

1. Be familiarized with selected microbial pathogens and basic typing tools used in epidemiology.
2. Explain the ways by which disease outbreaks are investigated and disease dynamics are analyzed using statistical tools.
3. Know the concept of one health.

Learning Outcomes

After completion of the course, the students will be able to

1. Describe the molecular basis of pathogenesis by which different diseases develop.
2. Elucidate the application of various physical and molecular systems in microbial typing.
3. Explain how disease outbreaks are analyzed and what responses can be taken as a result.
4. Explain the concept of one health and its significance in Bangladesh.

Unit	Course contents	Class hours
1	**Infectious bacterial Diseases:** Pathogenesis of Bacterial ulcer, Anthrax, Listeriosis, Meningitis, Chlamydiasis and Plague.	8
2	**Infectious parasitic Diseases:** Pathogenesis of Malaria, Leishmaniasis, Filariasis	6
3	**Emerging microbial infections:** Diseases of current local and global concern	3
4	**Disease Outbreak Investigation and Response:** Identification and investigation of outbreaks.	5
5	**Molecular epidemiologic typing systems of bacterial pathogens:** Importance of Epidemiologic Typing, Criteria for evaluating typing system; Phenotypic and genotyping techniques for typing of bacterial pathogens.	10
6	**One Health concept in disease control:** Understanding One Health concept. Deterministic and multicausal model of disease. One health concept in controlling infectious diseases	8
7	**Dynamics of Infectious Diseases:** Analysis of variance (One-way, two-way), Modelling of stratified data, risk and outcome severity.	5

Recommended Books

1. Applied Epidemiology: Theory to practice: Ross C. Brownson, Diana B Petitti, 1998. Oxford University Press
2. Disease Management: A Systems Approach to Improving Patient Outcome. 2001. Warren E. Todd, David B. Nash, MD. Wiley Publications
3. Disease Control Priorities in Developing Countries. 2006. Dean T. Jamison, Joel G. Breman, Anthony R. Measham, Oxford University Press
4. Communicable Disease Control Handbook. 2008. Jeremy Hawker, Norman Begg, Iain Blair. 2nd edition. Blackwell Publishing
5. Epidemiology. Leon Gordis, 2014. 5th edition. Saunders, Elseveir
6. Epidemiological research methods. Don McNeil. 1996. John Willey and sons

MPG 508 Microbial Food Safety Management Credits: 3 Class: 45 hours

The course is designed to provide an overview on necessary information on the principles underlying the production of microbiologically safe and stable foods. It covers the different food safety issues involving microbiological risks and hazards in food supply chains, the challenges to prevent the hazards in aspects of quality assurance, including HACCP, hygienic design of food factory and premise, methods of hazards and risk assessment, legislation frameworks, and the design of food safety microbiology laboratories. The course is valuable to all academic, research, industrial and laboratory supporting food programmes, and institutions involved in food safety, food microbiology, quality assurance and assessment, food legislation, food science and technology.

Course Objectives

The students will be able to

1. To address the advancement of microbiological food safety management systems for the safety and protection of human health.
2. To describe the challenges faced in national and global food-supply chains, food safety emergencies, prevention and control of microbial contamination and food toxins.
3. To explain the legal framework developed by the national and international regulatory agencies for effective food safety management system

Learning Outcomes

By the end of the course, the learner should be able to

1. Understand the importance of food safety, food safety culture and the need for food safety management systems.
2. Identify the hazards and risks in the different food supply chains including domestic, import and export chains.
3. Implement the recommended scientific guidelines for Standard Operating Procedures (SOP) within primary and secondary food processing industries to ensure safe food for consumers.
4. Undertake risk analysis for identifying hazards associated with food processing and management of food safety incidence.
5. Understand and exercise national and international food safety regulations.
6. Organize the training and research programmes in food safety management systems.
7. Demonstrate the national and international food safety inspection and management systems.

Unit	Course contents	Class hours
1	**Food Safety Management Systems (FSMS)**: Concept, elements and challenges of FSMS; Food hazards- biological, chemical and physical hazards; Food and personal hygiene; Hygienic design in food premises and food equipment; Food safety standards; Ethics in food safety management.	6
2	**Microbiological Hazards in Food Supply Chains**: Microbiological hazards and safety management in domestic, import and export food supply chains - fruits and vegetables, crops, poultry and eggs, livestock and meat, milk and dairy products, fish and shellfish and other food products; Supply chain verification; Food defense from farm to fork.	7
3	**Preventive Management of Food Production**: Primary production – natural and GM crops, Good Agricultural Practice (GAP), Sanitary and Phytosanitary (SPS); Secondary production- Good Hygiene Practice (GHP), Good Manufacturing Practice (GMP), HACCP plan, Code of practice, Standard operating procedures, ISO 22000 and other guidelines for food safety and quality.	7
4	**Microbiological Food Safety Analysis and Surveillance Systems**: Food safety laboratory supports; Food safety analysis- safety assessment, management and communication; Investigation of microbiological food borne disease outbreaks and surveillance systems; Management of food safety incidence and emergency.	7
5	**Food Safety Regulations and Enforcement**: National legislation and enforcing agency; Safety of domestic, import and export foods; Roles of national, regional and international organizations/agencies; National and International policies on Food Safety and Quality; Global food safety initiatives (GFSI).	6

6	**Development of Food Safety System**: Prevention of microbiological food-borne Illness; Food risk management in retailing; Food safety management systems for food business operators; Survey on microbiological and chemical status of foods; Recent trends in food safety management systems.	6
7	**Food Safety Inspection**: Traditional inspection systems; Categorization of risk foods; Risk based food safety inspection systems; Food labeling and claims; Food safety alert; Traceability system; Assessment of food safety management systems.	6

Recommended Books

1. The Microbiological Safety and Quality of Foods (vol 1) – BM Lund, TC Baird-Parker and GW Gould; Aspen Publications
2. Advances in Microbial Food Safety (vol 1 & 2) – J Sofos, Woodhead Publishing
3. Food Safety and Protection – VR Rai and JA Bai; CRC Press
4. Food Safety Management Programs: Applications, best practices and compliances – D Newslow; CRC Press
5. Food Safety Management- Y Mutarjemi and H Lelieveld; Elsevier
6. Principles of Food Sanitation, Safety and Hygiene – B Malicse, Technology Business
7. Food Safety Risk management– FAO of the UN, Food Safety & Quality Series No. 4. 2017
8. ISO 22000: 2018 Food Safety Management System – International Organization for Standardization

MPG 509 Bioenergy and Biofuel Technology Credits: 3 Class: 45 hours

The course is designed to focus on the academic achievement with recent developments in bioenergy and biofuel technology covering current issues from an interdisciplinary approach. It includes energy and fuels, biotechnology, economics, optimization, biochemical engineering, and algae science. It will also feature coverage of anticipated future trends related to each of biofuels. It aims at disseminating major concepts, principles and novel insights concerning major bioenergy and biofuels applied to biomass conversion to energy processes and systems.

Course Objectives

The students will be able to

1. Acquit knowledge regarding renewable feedstocks for bioenergy and biofuel technologies and their sustainable applications.
2. Practice knowledge-based critical thinking and solution offering about emerging innovative bioenergy technologies.
3. Feature to incorporate public policy along with a summation of anticipated future trends in fuel generation and applications.

Learning Outcomes

After completion of the course, the students will be able to

1. Explain the basic concepts, fundamental principles and development of technologies for generation of biofuels as renewable energy sources.
2. Identify existing and emerging biomass feed-stocks for bioenergy and biofuel technologies.
3. Explore the efficient and economic production of bioethanol as alternative source of energy.
4. Apply the microbiological technologies for efficient production of methane and biohydrogen from biomass.

5 Develop a critical thinking about sustainability and resilience on the generation of biodiesel as future fuel for transport system; and

6 Determine potential solutions for energy needs and problems by incorporating the bioenergy technologies being explored.

Unit	Course contents	Class hours
1	**Perspectives of Bioenergy and Biofuels**: Concept, principles and development of technologies; Bioenergy resources and interconversions; Opportunity and constrains; Environmental, economic and social concerns; Conversion of biomass to biofuels; Generations and types of biofuels; Biomass power plants and biofuel cells; Interdisciplinary approach to develop technologies and their sustainable applications.	6
2	**Feedstocks for Bioenergy and Biofuels**: Types, availability and pretreatment of feedstocks- sugar, starch, lignocellulosic, plant oils and animal fats, and bio-waste materials; Production and utilization- desirable feedstocks, advantages and problems for fuel generation; Sustainable feedstocks for advanced bioenergy and biofuel for developing countries; Value-added biofuel residues and co-products.	7
3	**Fuel Ethanol from Biomass**: Biomass and recent development in manufacturing technology; Process design, trends and integration of opportunities; Technological, economic and energy issues for bio-ethanol production from biomass wastes- lignocellulosics, molasses, wet-milling and dry-milling grains, and other agro-industrial wastes; Future prospects and applications.	6
4	**Bioconversion of Biomass to Methane**: Synthesis of methane under natural conditions; Biomass composition and methane production; Potential microbes involved in methane generation; Man-made processes- methane from sanitary landfills, sewage, farm, industrial wastes and energy crops; Reactor design for methane generation; Utilization of the methane as fuel.	7
5	**Generation of Biohydrogen**: Biosynthesis of hydrogen under natural habitats; Renewable hydrogen from biomass; Metabolic process and engineering; Potential substrates and biological systems- dark fermentation, photobiological and combined systems; Hydrogen generation plants- design, process operation and recovery.	6
6	**Biodiesel from Crops and Microbes**: Biodiesel production by using- potential crops, microorganisms, algae and trans-esterification process; Strategies to engineer microbes and crops for biofuel generation; Algae as a potential oil generator for biodiesel; Major types, applications and problems associated with the production of biodiesel crops and microbes.	6
7	**Biofuel Cells**: Bioluminescence and its applications; Fuel cells- conversion of organic matter to secondary fuels; Biofuel cells for electricity- enzyme-based, direct glucose-based, microbial-based and mammalian biofuel cells; Application of biofuel cells- transport, energy generation, implantable power, and robots; Future prospects and innovation of biofuel cells.	7

Recommended Books

1. Biofuels and Bioenergy – J Love and JA Bryant, Wiley and sons Inc.
2. Bioenergy and Biofuels – O Konur, CRC Press
3. Biomass for Biofuels – K Bulkowska, ZM Gusiatin, E Klimiuk, A Pawlowski, T Pokoj, CRC Press
4. Algal Biofuels – L Pereira, CRC Press
5. Biotechnology: Principles and Applications. Higgins IJ, Best DJ & Jones J.
6. Biotechnologies and Renewable Energy – Murray Moo-Young, Sadiq Hossain, Jonathan Lamptey
7. Biofuels – W Soetaert and EJ Vandamme, Wiley
8. Biofuel Engineering Process Technology- GM Drapcho and TH Walker, McGrew Hill

MPG 510 Molecular Virology and Oncology Credits: 3 Class: 45 hours

MPG 510 covers the molecular mechanisms of viral persistence and its infections in the hosts, which have attracted worldwide attention for their pandemic occurrences and outbreaks. This course also describes the basic and molecular concepts on oncology.

Course Objectives

The students will be able to

1. Know persistent viruses and their mechanisms of persistence in the host cells.
2. Be updated with the latest outbreaks of viral infections.
3. Understand the processes underlying the transformation of a normal cell to its malignant counterparts, mutational basis of oncology, oncogenic viruses and mechanisms of oncogenic transformation by viruses.
4. Know the molecular mechanisms of cancer metastasis and tumor suppressor genes.
5. Understand the physico-chemical and cellular factors associated with cancer development.

Learning Outcomes

After completion of the course, the students will be able to

1. Know the molecular mechanisms of viral persistence and its control and management strategy
2. Know the latest information about the viral outbreaks globally as well as in Bangladesh
3. Have a knowledge on the basics of cellular transformation and mutations, associated with specific cancer genes and tumor suppressor genes.
4. Know the physical and chemical agents responsible for cancer development.
5. Develop the necessary skills to undertake independent research.

Unit	Course contents	Class hours
1	**Persistence of Viruses**: Mechanisms of viral persistence; Persistence of HSV and EBV	5
2	**Viruses of Special Interest and recent outbreaks:** Dengue and chikungunya virus; Ebola and Nipah virus infection; Other important viruses of recent epidemics	5
3	**Virus Evolution and Emerging Viruses:** Emerging viruses; Emergence of dengue virus infection in Bangladesh; prevention and control of its epidemic.	4
4	**Molecular oncology Tumor biology**: Causes of cancer. Cancer related genes, including oncogenes with their normal cellular function, mutagenesis and consequences of their mutant state in cancer.	7

5	**Spread of cancer**: Tumor progression and metastasis, The interaction between malignant and normal cells.	6
6	**Tumor Suppressor genes**: Definitions and functions of tumor suppressor genes, their normal cellular function; mutations and pathways of Rb and p53 and cancer.	5
7	**Oncogenic viruses**: Different types of oncogenic viruses. Viral oncogenes, molecular mechanisms of transformation by DNA and RNA viruses	6
8	**Major treatment principles of cancer**; surgery, radiotherapy, hormonal treatment, and biological therapy. Novel and developing treatment strategies. Ethics. Palliative treatment.	3
9	Physical and chemical factors contribute to cancer development. Role of epigenetic changes in cancer development. Telomerase activities and cancer. Vaccine approaches against cancer progression	4

Recommended Books:

1. Fields Virology. David M. Knipe and Peter M. Howley. Philadelphia, PA, USA. Lippincott Williams & Wilkins, 2013.
2. Principles of Virology: molecular biology, pathogenesis and control – Flint, Enquist, Krug et al. ASM press, Washington DC. 3
3. Molecular Oncology – Ian Tannock, Richard Hill, Robert Bristow, Lea Harrington- McGraw-Hill International Editions
4. Molecular Biology of Cancer- Mechanisms, Target and Therapeutics, Lauren Picorino, Oxford University Press.
5. The Biology of Cancer- Weinberg, Robert A, Taylor & Francis, London

MPG 511 Extremophiles and Novel Biological Products Credits: 3 Class: 45 hours

The course explores biology of extremophiles that flourish under conditions that are unfavorable to normal microbial life. It also deals with how ordinary microorganisms deal with periodically unfavorable circumstances. Emphasis is placed on understanding of the relevant adaptations and processes involved and the biotechnological application of extreme microorganisms (extremophiles) and their metabolic products. This course is especially important, as there are countless extreme environments on earth that needs to be explored and the potential to discover novel extremophiles and extremozymes and other extremophilic products that can play enormous roles in human life.

Course Objectives

The students will be able to

1. Be familiarized with the physico-chemical properties of extreme environments and their habitats.
2. Acquaint with the special techniques to isolate and culture extremophilic microorganisms.
3. Know the importance and biotechnological applications of metabolites of extremophilic origin.

Learning Outcomes

After completion of the course, the students will be able to

1. Learn the nature of extreme environments, microbial adaptation and molecular evolution along with their novel extremolytes and biotechnological applications.
2. Learn the adaptation of hallophiles and their biotechnological applications.
3. Learn hyperthermophiles and psycrophiles, their physiological capability and biogeochemical roles.
4. Understand the novel acidophiles and alkalophiles, their proteins and gene transfer systems.

5 Acquaint knowledge in adaptation and biotechnological exploitation of methanogens.
6 Learn the sources and screening strategy for novel extremozymes from extremophiles.
7 Learn the relevance of extremophiles under changing climate conditions, and the biotechnological application of extremophiles and/ or their metabolic products.

Unit	Course contents	Class hours
1	**Extremophiles and Extremolytes:** Extreme environments, natural adaptations, molecular evolution and engineering exploitation of extremophiles; Types and diversity of extremophiles; extreme environments as resources for microbial extremolytes as novel biological products; Applications of extremophiles in biotechnological processes.	6
2	**Potentials of Deep-sea Habitats and Microbial Halophiles:** Deep-sea habitats and their adaptations; Hypersaline environments; halophilic properties of microbes and their manipulation for applications; General features and applications of halophilic archaea; Biotechnological potential of piezophiles and halophiles; Strategy for isolation and cultivation of halophilic and piezophilic microbes.	7
3	**Hyperthermophiles and Psychrophiles:** Biotopes, isolation, and classification of hyperthermophiles; Heat stability and adaptation; Ecology and biotechnology of anaerobic thermophiles; Habitats, isolation, and characteristics of psychrophiles; Biotechnological applications of cold-adapted bacteria- molecular mechanisms of adaptation, cold-adapted enzymes, biodegradation and bioremediation.	7
4	**Acidophiles and Alakaliphiles:** Characteristics of eukaryotic, mesophilic and thermophilic acidophiles; their interactions in acidic environments; novel acidophiles, acid stable proteins and gene transfer systems. Isolation and classification of alkaliphilic microorganisms; cell wall, and genetic analyses.	6
5	**Biotechnological applications of Anaerobic Extremophiles:** Characteristics, adaptation and biotechnological exploitation of methanogens; Anaerobic and metal resistant microbes- characteristics and potentials for the control and bioremediation of toxic metal pollution; Anaerobic non-methanogenic extremophiles- characteristics, and potential biotechnological applications.	7
6	**Extremozymes as Novel Extremolytes:** Sources of natural extremozymes; Screening strategy for novel extremozymes- starch processing enzymes, cellulose hydrolysing enzymes, xylan degrading enzymes, proteolytic enzymes; chitin hydrolysing enzymes, DNA processing enzymes, and other thermoactive enzymes of biotechnological interests.	6
7	**Extremophiles and Their Innovative Applications**: Search for extra-terrestrial life; Applications in food processing, biofuel research, second generation of ethanol production; textile processing, recovery of metals, biosynthesis exopolysaccharides, implications of radiation resistant extremolytes; Smart therapeutics.	6

Recommended Books

1 Extremophiles - Microbial life in Extreme Environments. Horikoshi K and Grant WD. Wiley-Liss, New York
2 Microbial Growth and Survival in the Extreme Environments. Brock TD.
3 Biotechnology: Multi-volume comprehensive treaties, vol. 10 (Special processes). Rehm HJ & Reed G. Vch Verlagsgesellschaft Mbh, Germany

4 Microbiology of Extreme Environments – Edward C. McGraw Hill, New York
5 Extremophiles: Sustainable Resources and Biotechnological Implications. Singh OV. John Wiley & Sons, New York
6 Extremophiles; Where It All Began. Horikoshi K. Springer, Berlin
7 Extremophiles Hand book. Horikoshi K. Springer, Berlin

MPG 512 Pharmaceutical Biotechnology Credits: 3 Class: 45 hours

Biotechnology and Biopharmaceuticals is intended to provide the student with a working knowledge of the preparation and development of different recombinant therapeutic proteins and peptide drugs, such as enzymes, hormones, clotting factors, immunomodulators, etc. and the recently approved antisense oligonucleotides and recombinants antibodies represent new and innovative biotech drugs that are different from classical drugs in the development and production process.

Course Objectives

Upon satisfactory completion of the course, the students will be able to

1 Understand novel drug discovery and development processes using genomics, bioinformatics and proteomic approaches.
2 Know the modern techniques to produce biopharmaceuticals using genetic engineering, rDNA technology, cell culture and hybridoma technology.
3 Explain and compare methods for industrial production of low and high molecular pharmaceutical substances such as therapeutic enzymes, hormones, interferons, blood products and immunomodulators by means of biotechnology.
4 Understand some of the major breakthroughs that have been achieved using recombinant vaccine technologies, as well as new approaches and strategies for vaccine development, including potential shortcomings and risks.

Learning Outcomes

After completion of the course, the students will be able to

1 Learn the current approaches in the drug discovery and design process such as cutting-edge molecular engineering to design and fabricate active biopharmaceuticals, their advantages and limitations.
2 Demonstrate the important contributions of the different discipline areas, like rDNA technology, cell culture and hybridoma technology for biopharmaceuticals development process and learn how nucleic acid-based molecules are utilized for gene therapy, cancer therapy and molecular medicine.
3 Know and be able to explain and compare methods, for industrial production of low and high molecular pharmaceutical substances and for antibody engineering to treat various diseases.
4 Demonstrate an understanding of the research-based discovery and importance of the factors that influence vaccine design and development for current, emerging and, re-emerging infectious diseases in human and animals.

Unit	Course contents	Class hours
1	**Biopharmaceuticals from cloned genes:** Special vectors for expressing foreign genes: problems with the production of recombinant protein in *E. coli*; Production of recombinant protein by eukaryotic systems- yeast and filamentous fungi, animal cells and live animals and plants; *in vitro* translation systems.	4

2	**Drug discovery and development:** Drug pre-discovery and discovery; Combinatorial chemistry and rational drug design; Genomics, bioinformatics and proteomic approaches for drug discovery; Drug development, biotechnological improvement, trials and approval.	10
3	**Techniques in production of biopharmaceuticals:** Advantages and disadvantages with different production systems- bacteria, plant and animal cells for biotechnological drugs; rDNA technology, cell culture and hybridoma technology, and their protocols, advantages and disadvantages.	6
4	**Recombinant enzyme therapeutics:** Recombinant human deoxyribonuclease; Alginate lyase, Phenylalanine ammonia lyase; α_1-Antitrypsin; Glycosidases.	2
5	**Recombinant low and high molecular pharmaceuticals**: Development of recombinant insulin and engineered insulin; Synthesis of human growth hormones; Recombinant blood clotting factors; recombinant **i**nterferon, tumor necrosis factor alpha and other recombinant human proteins.	5
6	**Recombinant therapeutic antibodies:** Antibodies using hybridoma technology and engineered monoclonal antibodies; Hybrid human-mouse monoclonal antibodies; Antibody fragments- antigen-binding single protein chains, Peptide combinations and peptide-colicin adduct; Combinatorial libraries of antibody fragments and full-length antibodies; Shuffling CDR sequences; Dual-variable-domain antibodies; Immunotoxins and anticancer antibodies.	6
7	**Nucleic acids as therapeutic agents:** Antisense RNA and DNA technology; Ribozymes and deoxyribozymes; Chimeric RNA–DNA molecules, Initiating RNA interference (RNAi) and their applications; Engineering antibody genes against viruses and cancer; Nucleic acid delivery and gene therapy against autoimmune disorders and cancers.	6
8	**Production of vaccines:** Development of human vaccine, novel approaches with examples; Development of veterinary vaccines, novel approaches with examples.	6

Recommended Books

1 Pharmaceutical Biotechnology – Concepts and Applications. Gary Walsh. 2nd Edition. 2007. John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, West Sussex

2 Pharmaceutical Biotechnology: Fundamentals and Applications, Crommelin DJA, Sindelar RD & Meibohm B. 3rd Edition. 2008. Informa Healthcare, New York

3 Molecular Biotechnology: Principles and Applications of Recombinant DNA, Bernard R Glick, Jack J Pasternak and Cheryl L Patten. 4th Edition. 2010. ASM Press, American Society for Microbiology, Washington DC

4 Microbial Biotechnology: Fundamentals of Applied Microbiology. Alexander N Glazer and Hiroshi Nikaido. 2nd Edition 2007. Cambridge University Press, Cambridge

5 Gene Cloning and DNA Analysis: An Introduction. Brown TA. 7th Edition. 2016. John Wiley & Sons Ltd., West Sussex

6 Bailey & Scott's Diagnostic Microbiology. Betty A Forbes, Daniel F Sahm and Alice S Weissfeld. 12th Edition. 2007. Mosby, St. Louise

7 Bacterial Pathogenesis: A Molecular Approach. Brenda A Wilson, Abigail A Salyers, Dixie D Whitt and Malcolm E Winkler. 3rd Edition. 2011. ASM Press, American Society of Microbiology, Washington DC

8 Foundations in Pharmaceutical Biotechnology. BP Nagori and Roshan Issarani. 2012. PharmaMed Press Pvt Ltd, Andhra Pradesh

9 Text Book of Pharmaceutical Biotechnology, K Sambamurthy and Ashutosh Kar. 1st Edition. 2006. New Age International Ltd., Publishers, New Delhi

10 Biotechnology and Biopharmaceuticals: Transforming Proteins and Genes into Drugs, by Rodney Ho, Second Edition, Wiley

MPG 513 Practical/Laboratory works Credits: 4 Class: 100 hours

The optional theoretical courses with relevant parts in the laboratory works are offered to the students during their MS as their choice of interests. This applied and professional Laboratory course, divided in units represent the relevant topics and themes of the corresponding theoretical courses. The students will have to conduct an in-depth study of the theme and to come up themselves in teams with research questions; the instructor/ supervisor will act as a 'hands-on' expert and motivator in this process. The Department will provide all laboratory facilities to the students for the practical works.

Course Objectives

The main objective of the course is to achieve the specialized knowledge and intellectual skills in the Laboratory Works in different fields of microbiological sciences. The specific objectives include integration of knowledge, exercising designed concepts and developing laboratory skills for service, teaching and research laboratories.

Learning Outcomes

After successful completion of the laboratory works, students will be able to exercise their specialized laboratory skills in service, teaching and innovations in different field of microbiology including virology, immunology, genomics and genetic engineering, biotechnology and food industry, analytical and diagnostic microbiology, disease control and bioremediation of natural and man-made hazards in terrestrial and marine environments.

Unit	Course Content
1	**Environmental Biotechnology** 1. Detection of microbiological hazards from environmental samples using PCR 2. Isolation and purification of degradative plasmid of microbes growing in polluted environments 3. Determination of indices of pollution by measuring BOD/COD of different effluents 4. Effects of pesticides on microbes from environmental samples 5. Visit to local polluted site - observations and remedial measures
2	**Advanced Molecular Genetics** 1. Extraction of chromosomal DNA from bacteria and plant 2. Analysis of chromosomal DNA by RAPD and RFLP analysis 3. Total protein extraction from Bacteria, SDS-PAGE analysis and Western blot analysis
3	**Immunopathology and Vaccine Development** 1. In vitro cytotoxic activities of some plant extracts on HeLa 2. Preparation of feeder layer for monoclonal antibody production 3. Screening or antibody producing cell line 4. Production of Killed/ Attenuated/ Subunit vaccines

4	**Bioprocess Engineering and Technology** 1. Determination of growth curve of a supplied microorganism and it's substrate degradation profile. Compute specific growth rate (m), growth yield (Yx/s) from the above. 2. Kinetics of growth in batch cultivation- estimation of Monod kinetic parameters 3. Production, recovery and purification of microbial enzymes, citric acid, ethanol, baker's yeast, etc.
5	**Enzyme and Protein Biotechnology** 1. Expression of recombinant protein by induction 2. Extraction of protein and SDS-PAGE analysis
6	**Advanced Bioinformatics** 1. Analysis of: a) NGS data / NGS based Whole Genome Sequencing (WGS) data, b) Metagenome data. c) Microarray data, d) RNA-seq data, and e) Peptide mass fingerprinting data 2. Reproduction of a research work from the current literature
7	**Epidemiology of Infectious Diseases** 1. Identification of a pathogen using phenotypic and genotypic characters: a. Phenotypic: cultural, biochemical tests b. Genotypic: detection of virulence genes 2. Use of antimicrobial susceptibility/ bacteriocin production in epidemiological typing 3. Molecular typing of bacteria: Use of PCR for typing of bacteria
8	**Microbial Food Safety Management** 1. Assessment of microbiological hazards in different categories of food samples 2. Assessment of hygienic status of food, food handlers and food premises 3. Implementation of HACCP in different situations (ISO 22000 Food Safety Procedure)
9	**Bioenergy and Biofuel Technology** 1. Production of biodiesel from oil (oil extraction, oil viscosity, biodiesel production) 2. Production of bioethanol from fermentable sugars (sugar extraction, carbohydrate testing, yeast fermentation) 3. Generation of biogas from organic wastes
10	**Molecular Virology and Oncology** 1. Cultivation of viruses in susceptible cell line and observation of cytopathic effect 2. Detection of oncogenic viruses in the sera of patients with cervical cancer/ and or with lymphoma 3. Study of polymorphisms in oncogenes/ anti-oncogenes of patients with cancer 4. Observation of histology pathology of cancer by permanent slides
11	**Extremophiles and Novel Biological Products** 1. Isolation and characterization of halophiles from seawater and screening for their potential for industrially important enzyme production. 2. Isolation of halophiles from solar salterns, their Morphological and biochemical characterization, and study of their antibacterial potential 3. Isolation of alkaliphiles from the environment.
12	**Pharmaceutical Biotechnology** 1. Isolation and screening of antibiotic producing bacteria from soil 2. In silico drug designing approaches for known or unknown targets

MPG 514 Short Project **Credits: 2**

The Department will provide all laboratory facilities to the students for the project works. The students may also avail the opportunity to work in other reputed research laboratories for carrying out part of their works. Upon completion of the short project, students prepare written reports based on his or her research findings and are reviewed by the respective project supervisor, and the project report is presented in a final examination along with a prescribed submission form provided by the Department. Students are expected to present their works at scientific meetings and prepare manuscripts for publication in peer-reviewed scientific journals

MPG 515 Thesis/ Dissertation **Credits: 6**

The Department will provide all laboratory facilities to the students for the Thesis works. The students may also avail the opportunity to work in other reputed research laboratories for carrying out part of their works. Upon completion of the works, the MS student prepares a thesis based on his or her own research findings. This document is reviewed by the respective supervisor before submission for Final Examination by externals and defended in a final presentation. The students will also submit a prescribed submission form provided by the Department. It is expected that students will present their works in scientific meetings and prepare manuscripts for publication in peer-reviewed scientific journals.

MPG 516 Seminar Presentation **Credits: 2**

During the progress of courses, the students of both groups shall deliver at least one seminar related to their thesis work/ project work or recent advancement of microbiological sciences. The students participate in research seminars and other seminars arranged by the Department throughout their tenure in the MS programme.

MPG 517 Viva-Voce **Credits: 2**

The oral examination is designed to assess the student's aptitude and potential to ultimately perform as an independent microbiologist.