Curriculum
for
Master of Science (MS)

Department of
Genetic Engineering and Biotechnology

University of Dhaka

Session: 2019-2020 onward

Preface

Updating and revision of the Curriculum at regular intervals is one of the most important criteria of Institutional Quality Assurance Cell (IQAC) of the University of Dhaka and a prime need for the graduate educational systems.

Biotechnology broadly refers to intentional manipulation of living organisms or their products to serve human needs. This technology is capable of revolutionizing the way we manufacture products and analyzing the relationships among all living systems. Despite being relatively a new science, the processes used in biotechnology today have their basis in nature long before. These processes, empowered with modern technologies, are now used to transfer genetic materials from one organism into another to obtain beneficial traits. Biotechnology possesses a great potential to affect a number of areas/fields including agriculture, health care, energy production, and the environment.

The curriculum of MS of the Department of Genetic Engineering and Biotechnology has been developed with an aim to generate skilled graduates with wide theoretical and practical knowledge.

Members of Self Assessment Committee and
Members of Academic Committee
Department of Genetic Engineering and Biotechnology,
University of Dhaka

1. Introduction to the Department

Genetic Engineering and Biotechnology (GEB) is an applied science subject. The technology used in genetic engineering is generally aimed at harnessing the natural biological capabilities of microbial, plant and animal cells for the benefit of human. This technology, more specifically termed "Biotechnology", couples scientific and engineering principles with commercial considerations to develop and improve products and processes made from living systems. In Bangladesh, University of Dhaka has taken the lead to establish a department "Genetic Engineering and Biotechnology" aiming at generating skilled manpower with wide theoretical and practical knowledge.

2. Introduction to the Program

2.1 Title of the program:

Master of Science (MS) in Genetic Engineering and Biotechnology

2.2 Duration of the Program:

The MS Program will be of 1 (one) academic year duration as distributed below:

Classes:	28 weeks
Preparation Time for Course Final Examination:	4 weeks
Course Final Examination (Theory):	4 weeks
Time for submission of Thesis/Projects/Practical/Seminar/Internship after completion of last Theory Examination	12 weeks
Results	4 weeks
Total	52 weeks

Results of final examination should be published within 4 weeks from the date of holding the last examination (theory/practical/viva-voce/thesis presentation whichever is the latest).

2.3 Eligibility for admission:

Students will be admitted to the MS program in the Department under the Faculty of Biological Sciences as per the existing rules of the university with a minimum CGPA of 2.50 in the scale of 4 in 4-Year BS (Hons) examination. However, the department may re-fix the minimum CGPA requirement to a higher level and get approved as such by the authorities. Students must be admitted to MS program within two academic years of completion of BS (Hons) program.

2.4 General objective of the Program:

Biotechnology is a multi-disciplinary science that engages knowledge in life sciences and technological applications to improve human lives and the environment. This program is designed to enable the students to acquire elaborate knowledge in related fields of biotechnology. A major focus of the program is to develop laboratory skills by engaging the students in research or by engaging them in practical experiments. This program will thereby allow the students to attain a perfect combination of sound theoretical and practical knowledge. The acquired knowledge will help the students to develop critical thinking and analytical reasoning skills in the context of modern biotechnology to contribute effectively in academics and related research fields.

3. Structure of Curriculum

Credit-wise distribution of courses (theory + others):

Courses	Credits
Theory courses	20 credits
Seminar	2 credits
Thesis/Laboratory work	6 credits
Viva-voce	2 credits
Total	30 credits

Note: For theoretical courses, a minimum of 15 class hours per session will constitute 1 (one) credit hour. Therefore, a minimum of 60, 45 and 30 contact hours per session should be allocated for 4, 3 and 2 credit courses, respectively.

The mode of Thesis distribution will be determined by the Department. However, the minimum CGPA in BS (Hons) should be 3.50 in a scale of 4.00.

4. Assessment system:

4.1 Number of In-course and Course Final Examination

The total performance of a student in a given course will be assessed on the basis of a scheme of continuous assessment and course final examinations.

i. For theory courses the continuous assessment will be made through a set of in-course examinations and class attendance.

ii. Continuous assessment of Practical (laboratory/field) courses will be made through observation of the student at work, *viva-voce*, assignments, evaluation of practical reports and in-course practical examinations, as preferred by the department.

iii. The scheme of continuous assessment that a teacher proposes to follow for a course will be announced by the teacher on the first day of classes.

iv. Distribution of marks for a Theory and Practical course:

Class attendance	5%
In-course assessment	35%
Course final examination	60%

v. The distribution of marks for Thesis:

Thesis presentation/defense	40%
Thesis evaluation by external examiners	60%

vi. Basis for awarding marks for class attendance will be as follows

Attendance	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

4.2 In-course Assessment (Theory courses):

i. In-course tests of minimum one-hour duration shall be conducted and evaluated by the course teacher. There will be at least 2 (two) written tests for 4/3-credit courses and at least 1 (one) written test for 2-credit courses. Maximum written tests for 4-, 3-, and 2-credit courses shall not exceed 4, 3, and 2, respectively.

ii. The course teacher will show the assessed in-course scripts to the students before the final examination.

iii. Make-up test: Make-up test will be arranged for a student who fails to appear in in-course tests. An absence in any in-course test will be counted as zero for calculating the average in in-course test for that course. However, a student can apply to the chairman of the department for make-up test. The chairman will only place the application before the Academic Committee if the particular student has undergone an accident or his/her parents have expired or s/he has gone through a surgical procedure one/two days before assessment exam date or any other such situation, which the Academic Committee feels can be considered.

4.3 The Course Final Examination (Theory Courses):

i. The course final examination will be conducted centrally by the Controller of Examinations as per existing system.

ii. The course final examinations will be of 3 hours duration for 4-credit courses, 2½ hours for 3-credit courses and 2 hours for 2- credit courses.

iii. For evaluation of the course final examination there will be two examiners: one internal (will be the course teacher/teachers) and the other external (will preferably be within the department provided that he/she was not a course teacher for the course paper to be examined).

iv. Under double-examiner system, in case of difference of more than 20% of marks between the two examiners in a particular, a 3rd examiner will be needed to evaluate the script. In this type of cases, the average mark of the nearest two examiners will be the final obtained mark of that course.

4.4 Assessment of Seminar Course:

Seminar 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. The distribution of marks and pattern of examination for seminar course will be determined by the academic committee of the department.

4.5 Assessment of Final Lab Experiment for non-thesis students:

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.

4.6 Assessment of Thesis:

i. Oral presentation/thesis defense will be evaluated by a committee of 5 members of which 4 are from examination committee and 1 is respective supervisor. 40% mark is allocated for oral presentation of thesis and the rest is for written thesis report.

ii. Written 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 examiner to examine. Marks of the nearest two examiners will be used to get average marks as final marks.

4.7 Viva-voce/Oral examination:

Viva-voce/Oral examination will be conducted by the respective Examination Committee approved by the University.

4.8 Types of Question:

i. **For in-course:** Questions for in-course tests should preferably be of the objective type; however, some short questions could be included. Questions will be set by the course teacher and no moderation of questions is required.

ii. **For Final Examination:** Questions for course final examinations should be a combination of short and descriptive type. However, there will be no objective type questions. Questions should be designed to test the conceptual knowledge and understanding of the basic concepts of the subject. There will be two question setters: one internal and the other external. The questions will be moderated by the respective examination committee. Total marks obtained for all the examination will be converted to the grade.

4.9 The Grading System:

Marks obtained for each course will be converted to grades. A basic four point (4.00) grading scale will be followed. 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
80% or above	A+	4.00
75% to less than 80%	A	3.75
70% to less than 75%	A-	3.50
65% to less than 70%	B+	3.25
60% to less than 65%	B	3.00
55% to less than 60%	B-	2.75
50% to less than 55%	C+	2.50
45% to less than 50%	C	2.25
40% to less than 45%	D	2.00
Less than 40%	F	0.00

Note: The fractional total marks for a course will be rounded up to next higher mark.

4.10 Grading description:

The explanations of letter grades are described as follows:

A: Exceptional performance; all course objectives achieved; objectives met in a consistently outstanding manner.

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.

C: Satisfactory performance; at least majority of the course objectives achieved; objectives met satisfactorily.

D: Minimally acceptable performance; less than the majority but more than the minimum required course objectives achieved; objectives achieved at a minimally acceptable level.

F: Unacceptable performance; minimum required course objectives not met; objectives not met at a minimally acceptable level; no credit earned.

4.11 Earned Credits:

A course in which a student has obtained 'D' or a higher grade will be counted as credits earned by him/her. Any course in which a student has obtained 'F' grade (Failed in the course) will not be counted towards his/her earned credits.

4.12 Calculation of GPA and CGPA:

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

$$\text{GPA} = \frac{\Sigma\,(\text{Grade points} \times \text{Credits})}{\Sigma\,(\text{Credits Attempted})}$$

The Grade point Average (GPA) is computed by dividing the total accumulated grade points earned during the MS program by total credit points attempted. For successful completion of MS program a student must earn 30 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 program and final GPA will be calculated using all the credits attempted.

4.13 Class Attendance:

i. A student must attend **at least 75%** of the total classes held in an academic year to be eligible for appearing in the final examination of that year without paying any penalty.
ii. A student attending **at least 60%** classes but less than 75% classes will be allowed to appear for the examination after paying non-collegiate fees fixed by the university.
iii. A student attending **less than 60%** classes will not be allowed to appear for final examination for that year/session.

4.14 Requirements for Graduation:

A student must earn GPA of 2.50 on 4.00 scale for obtaining MS degree.

4.15 Time Limits for Completion of Master's Degree:

A student must fulfill all the requirements for a Master's degree within a maximum period of two academic years, starting from the year of enrolment.

5. Structure of Course:

5.1 Course No., Title and Credit: Non-thesis Group (Group A)

Course No.	Course Title	Credits
GEB 501	Computational and Systems Biology	4
GEB 502	Recombinant DNA Technology	4
GEB 503	Medical Biotechnology	4
GEB 504	Industrial Biotechnology	4
GEB 505	Agricultural Biotechnology	4
GEB 506	Seminar	2
GEB 507	Laboratory Experiments and Assignment	6
GEB 508	Viva-voce	2
	Total	**30**

5.2 Course No., Title and Credit: Thesis Group (Group B)

Course No.	Course Title	Credits
GEB 501	Computational and Systems Biology	4
GEB 502	Recombinant DNA Technology	4
GEB 503	Medical Biotechnology	4
GEB 504	Industrial Biotechnology	4
GEB 505	Agricultural Biotechnology	4
GEB 506	Seminar	2
GEB 507	Thesis	6
GEB 508	Viva-voce	2
	Total	30

For theoretical Courses, a minimum of 15 class hours per session will constitute1 (one) credit hour. Therefore, a minimum of 60 contact hours per session should be allocated for 4 credit course.

The mode of Thesis distribution will be determined by the Department. However, the minimum CGPA in BS (Hons) should be 3.50 in a scale of 4.00.

Course Profile: MS

GEB-501 Computational and Systems Biology 4 Credit

Introduction to the Course:

Recent advances in biology, including the human genome project have created new opportunities to understand biological problems from a systems perspective. Systems Biology aims to explain how higher level properties of complex biological systems arises from the interactions among their parts. The application of computer science in biological data analysis and interpretation has made unprecedented impacts to reveal new information and allow looking at large datasets of complex biological systems which paved the way for systems biology. 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.

Specific objectives:

The study of this course will

- ☐ Introduce the students with 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 about the applications of computational and systems biology in innovation and critical analysis to generate new ideas.
- ☐ Explain systems approach and their future implications.

GEB-501 (Computational and Systems Biology) Course Content

1. The HGP Project and beyond

- ☐ Genomes to life
- ☐ Human Genome Project (HGP)
- ☐ Next-generation sequencing technologies.
- ☐ Cloud computing.
- ☐ Beyond HGP projects: the 1000 genomes; Human epigenome, microbiome, connectome project.

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. Computational Systems Biology

☐ Introduction, areas, and challenges of computational systems biology.
☐ 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.

4. Biological Networks

☐ Review of basic principles of networks and network properties.
☐ 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.
☐ Metabolic networks: basic concept, network reconstruction models from genome and proteome information, metabolic network structural and functional analyses.
☐ Regulatory network: reconstruction, analysis and simulation; Gene Network: estimation, modeling and simulation.

5. Developmental systems biology

☐ General pattern formation models.
☐ Cell fate and cellular programming.
☐ Future of developmental and stem cell biology

6. Image informatics

☐ Basics of image informatics.
☐ Imaging in the quantitative studies of systems biology.
☐ biomedical image informatics

Suggested readings:

☐ National Human Genome Research Institute. NIH, Educational Resources.
☐ 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.
☐ Next-generation DNA sequencing Informatics. Brown, S.M. Cold Spring Harbor Press., 2013.
☐ CRISPR: gene editing is just the beginning. Ledford, H. Nature News, 531(7593), 156.
☐ An introduction to systems biology: design principles of biological circuits. Alon, U. CRC press., 2006.
☐ Systems Biology. A Textbook. Klipp, E., Liebermeister, W., Wierling, C., Kowald, A., Lehrach, H., Herwing, R. ISBN 978-3-527-31874-2., 2009.
☐ 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.
☐ Sequencing technologies—the next generation. Metzker, M. L. Nature reviews genetics, 11(1), 31-46., 2010.

- ☐ Next-generation DNA sequencing methods. Mardis, E. R. Annu. Rev. Genomics Hum. Genet., 9, 387-402., 2008.
- ☐ Networks: An Introduction. Newman, M.E.J. Oxford University Press., 2010.
- ☐ Genome-wide genetic marker discovery and genotyping using next-generation sequencing. Davey, J. W., Hohenlohe, P. A., Etter, P. D., Boone, J. Q., Catchen, J. M., & Blaxter, M. L. Nature Reviews Genetics, 12(7), 499-510., 2011.
- ☐ Discovering functions and revealing mechanisms at the molecular level from biological networks. Zhang, S., Jin, G., Zhang, X. S., & Chen, L. Proteomics, 7(16), 2856-2869., 2007.
- ☐ Supporting SBML as a model exchange format in software applications. Keating, S. M., & Le Novere, N. *In Silico* Systems Biology, 201-225., 2013.
- ☐ The systems biology markup language (SBML): a medium for representation and exchange of biochemical network models. Hucka, M., Finney, A., Sauro, H. M., Bolouri, H., Doyle, J. C., Kitano, H., & Cuellar, A. A. Bioinformatics, 19(4), 524-531., 2003.
- ☐ In vitro organogenesis in three dimensions: self-organizing stem cells. Sasai, Y., Eiraku, M., & Suga, H. Development, 139(22), 4111-4121., 2012.

Addition reading material and learning resources will be suggested by the respective course teacher(s).

Learning outcomes:

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

- ☐ Understand the goals and advancements through Human genome project and beyond.
- ☐ Acquainted with the quantitative nature of systems approach.
- ☐ Understand mathematical model building of biological systems that link mechanistic information on 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.

Unit-wise title, subtitle and number of classes per unit

Unit-wise Title and Sub-title	**No. of classes/unit**
The HGP Project and beyond	15
Comparative and Functional Genomics	20
Computational Systems Biology	5
Biological Networks	10
Developmental systems biology	5
Image informatics	5
Total	**60**

Instructional Strategies:

- ☐ Lecture with traditional method
- ☐ Lecture with power point/videos/models/pictures
- ☐ Obtain immediate feedback by asking questions

- ☐ Answer queries, if any
- ☐ Practice problem solving
- ☐ Arrange review classes
- ☐ Encourage group discussions
- ☐ Assignments for exploring creativity and knowledge in a topic

Assessment:

- ☐ Class participation: Attendance
- ☐ Continuous assessment: In-course examination, assignment
- ☐ Final Examination: Assessment of written test

GEB-502	Recombinant DNA Technology	4 Credit

Introduction to the Course:

This course introduces to the students the versatile tools and techniques employed in recombinant DNA technology. In addition, this course introduces the basic and the advanced techniques in regenerative medicine, immunotherapy, monoclonal antibody engineering, etc.

Specific objectives:

The study of this course will

- ☐ Enable students to have an understanding of the modern tools and techniques of recombinant DNA technology.
- ☐ Enable to learn the applications and potentials recombinant DNA technology.
- ☐ Enable to learn about the debates and concerns related to the use of recombinant DNA technology.

GEB-502 (Recombinant DNA Technology) Course Content

1. **Basic principles of rDNA technology:** Introduction to gene cloning and rDNA technology; DNA manipulative enzymes; Linkers andadaptors; Cloning and expression vectors; Transformation and transfection; Selectablemarkers; 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:** General features of 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 and knock-in technologies; Antisense RNA technology to control gene expression.
4. **Directed mutagenesis 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. **Large-Scale production of proteins from recombinant microorganism:** 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, Trans-differentiation capabilities of cells.
7. **Applications of rDNA technology:** Synthesis of commercial products using rDNA technology- Antibiotics, 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 and societal 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.
9. **Regulation of rDNA technologies:** Regulating recombinant DNA technology; Deliberate release of genetically modified microorganisms; Regulating GE food and food ingredients; Patenting rDNA technology derived products.

Suggested readings:

- ☐ Molecular Biotechnology: Principles and applications of recombinant DNA (4th Ed.), Glick BR and Pasternak JJ, ASM press, ISBN 978-1-55581-498-4.
- ☐ Gene cloning and DNA analysis: an introduction (6thEd.), Brown TA, John Wiley & Sons Ltd, ISBN 978-1-4051-8173-0.
- ☐ An Introduction to Genetic Engineering (3rd Ed.), Nicholl DST, Cambridge University Press.
- ☐ Biotechnology in medical sciences (2012 or a later edition)), Khan FA, CRC Press.
- ☐ Microbial Biotechnology: Fundamentals of Applied Microbiology, GlazerAN andNikaido H. Cambridge University Press.
- ☐ Recombinant DNA: Genes and Genomes- A Short Course (3rd a later edition). Watson JD, Myers RM, Caudy AA, Witkowski JA. W. H. Freeman.
- ☐ An Introduction to Genetic Engineering (2008 or a later edition) Nicholl DS. Cambridge University Press.
- ☐ Gene Manipulation: an Introduction to Genetic Engineering (3rd or a later edition) Old RW, Primrose SB. Blackwell Scientific.
- ☐ Introduction to Biotechnology (3rd or a later edition) Thieman WJ, Palladino MJ. Pearson.
- ☐ Basic Biotechnology. Ratledge C, Kristiansen B. Cambridge Univ. Press (1st edition 2001 or a later edition).

Additional reading materials and internet learning resources will be suggested by the course instructors.

Learning outcomes:

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

- ☐ Learn the versatile tools and techniques employed in recombinant DNA technology.
- ☐ Learn the applications and promises of recombinant DNA technology.
- ☐ Learn to use microbes and mammalian cells for the production of therapeutic products.
- ☐ Learn the advanced techniques in regenerative medicine, immunotherapy, antibody engineering, etc.
- ☐ Know about the debates and concerns related to the use of recombinant DNA technology.
- ☐ Develop analytical skills to evaluate the information from a wide variety of sources to understand the key concepts of rDNA technology;
- ☐ Read, interpret and discuss ground-breaking recent knowledge on Genetic Engineering;
- ☐ Introduce with microbial and eukaryotic systems to be used in modern biotechnology;

Unit-wise title, subtitle and number of classes per unit:

Unit-wise Title and Sub-title	**No. of classes/unit**
Basic principles of rDNA technology:	7
Manipulation of gene expression in prokaryotes:	8
Manipulation of gene expression in eukaryotic systems:	8
Directed mutagenesis and protein engineering:	7
Large-Scale production of proteins from recombinant microorganism:	5
Tissue engineering:	5
Applications of rDNA technology:	10
Ethical and societal issues in biotechnology:	5
Regulation of rDNA technologies:	5
Total	**60**

Instructional strategies:

- ☐ Lecture with traditional method
- ☐ Lecture with power point/videos/models/pictures
- ☐ Obtain immediate feedback by asking questions
- ☐ Answer queries, if any
- ☐ Practice problem solving
- ☐ Arrange review classes
- ☐ Encourage group discussions
- ☐ Assignments for exploring creativity and knowledge in a topic

Assessment:

- ☐ Class participation: Attendance
- ☐ Continuous assessment: In-course examination, assignment
- ☐ Final Examination: Assessment of written test

GEB-503	Medical Biotechnology	4 Credit

Introduction to the Course:
The biotechnology in the field of medicine has an immense impact on diagnostic and preventive purposes. Medical biotechnology has played a dynamic role in improving the obstacles regarding health and medicine as it has the flexibility to reduce global health differences by the provision of promising technologies. This course will cover different prospects and applications of medical biotechnology.

Specific objectives:
The study of this course will

- ☐ Provide an in-depth understanding of the core principles and methodologies underlying modern medical biotechnology.
- ☐ Provide a broad grounding in genetic diseases, with the emphasis on the molecular aspects of disease diagnosis and pharmacogenomics, particularly in relation to human disease.
- ☐ Enable to understand the concepts of personalized medicine and gene therapy as a new mode of disease treatment.
- ☐ Enable graduates with the relevant skills to pursue careers in medical biotechnology.

GEB-503 (Medical Biotechnology) Course Content

1. Introduction: Importance, scopes and applications of medical biotechnology.

2. Genetic diseases: Molecular basis of genetic diseases; Pathogenic mutations; Gain of function mutations; Loss of function mutations; Dynamic mutations; Copy number variations. Classification of genetic diseases- Chromosomal disorders; Numerical disorders e.g. trisomies and monosomies; Structural disorders e.g. deletions, duplications, translocations and inversions; Chromosomal instability syndromes; Gene controlled diseases; Autosomal dominant and recessive, X-linked disorders; Mitochondrial disorders.

3. Diagnosis of diseases using molecular techniques: Molecular diagnosis – past, present and future; Immunological approach to detect protein biomarkers -ELISA, Sandwich-ELISA, Indirect-ELISA, HLA typing; Karyotyping, FISH, KISH etc; PCR and its variants - PCR-Electrophoresis, PCR-RFLP, PCR-SSP, PCR-SSOP, QF-PCR, MLPA (multiplex ligation dependent probe amplification); Real time PCR (qualitative and quantitative), multiplex real-time PCR; DNA sequencing – targeted sequencing, multiplex mini-sequencing (Sanger based), NGS based application in diagnosis.

4. Pharmacogenomics and personalized medicine: Drug development and drug targets - challenges of current drug discovery; Better and safer drugs, determining accurate drug dosage; Difference in drug response due to genetic variation and/or polymorphism of the drug metabolizing enzymes; Concept of personalized medicine.

5. Stem cell technology and gene therapy: Significance and importance of gene therapy, types of stem cells, stem cell based therapy, stem cell transplantation; Concept of gene therapy and

types – *ex vivo* and *in vivo* gene therapy, importance of vectors in gene therapy; Applications of gene therapy – ADA-SCID, cancer, neurological and eye disorders; CRISPR and the future of gene editing.

6. Ethical issues: Bioethics; Ethical issues for mammalian cloning; Organ transplantation; Embryo screening; Xenotransplantation; Human embryonic stem cells.

7. Genetic Counseling: History and development of genetic counseling; Fundamental principles in prenatal, pediatrics and adult genetic counseling; Clinical aspects of human genetics with focus on single gene, chromosomal and multi-factorial genetic diseases; Underlying molecular and biochemical principles, mode of inheritance, determination of genetic risks.

Suggested readings:

- ☐ Medical Biotechnology. Glick, B.R., Patten, C.L., &Delovitch, T.L. Washington, DC: ASM Press., 2014.
- ☐ Biotechnology in medical sciences. Khan, F.A. 6000 Broken Sound Parkway NW, Suite 300: CRC Press/ Francis Taylor Group., 2014.
- ☐ Medical Biotechnology. Pongracz, J., & Keen, M. Elsevier Health Sciences. 2009.
- ☐ Molecular Diagnostics. Patrinos, G.P. &Ansorge, W.J. (Eds.). Elsevier Ltd., 2016.
- ☐ Clinical Genetics. Andrw Read & Dian Donnai, Scion Publishing Ltd. 2007.
- ☐ Emery's Elements of Medical Genetics (12th Ed.). Peter D. Turnpenny& Sian Ellard, Elsevier. 2001.

Addition reading material and learning resources will be suggested by the respective course teacher(s).

Learning outcomes:

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

- ☐ Understand the mode of genetic diseases and the ways to diagnose and prevent these diseases.
- ☐ Learn the tools used for the diagnostic purposes of genetic diseases.
- ☐ Understand different molecular techniques used in the diagnosis of both infectious and genetic diseases.
- ☐ Equip with the knowledge on stem cell and gene therapy as a treatment opportunity.
- ☐ Get introduced with the idea of medical ethics and strategies of genetic counselling.
- ☐ Build up a career in the medical biotechnology field.

Unit-wise title and sub-title and number of classes per unit:

Unit-wise Title and Sub-title	**No. of classes/unit**
Introduction:	2
Genetic diseases:	14
Diagnosis of diseases using molecular techniques:	14
Pharmacogenomics and personalized medicine:	10

Stem cell technology and gene therapy:	10
Ethical issues:	5
Genetic Counseling:	5
Total	**60**

Instructional strategies:

- ☐ Lecture with traditional method
- ☐ Lecture with power point/videos/models/pictures
- ☐ Obtain immediate feedback by asking questions
- ☐ Answer queries, if any
- ☐ Practice problem solving
- ☐ Arrange review classes
- ☐ Encourage group discussions
- ☐ Assignments for exploring creativity and knowledge in a topic

Assessment:

- ☐ Class participation: Attendance
- ☐ Continuous assessment: In-course examination, assignment
- ☐ Final Examination: Assessment of written test

GEB-504	Industrial Biotechnology	4 Credit

Introduction to the Course:

The applications of biotechnology in the fields of industrial production and process development have a very old history. However, the modern principles, tools, and techniques in molecular biology and its combination with technological development have revolutionized the whole field and it has huge impacts on our life. Starting from your morning breakfast to your pharmaceuticals, neutraceuticals, proteins, vitamins and other organic chemicals of industrial importance, industrial biotechnology has an intricate relationship in our daily life. In this course we will explore the vast promise of industrial biotechnology in our day to life.

Specific objectives:

The study of this course will

- ☐ Enable students to understand the importance of adoption, development and breakthroughs of industrial biotechnology and its impact in global, social and personal life.
- ☐ Equip students with the applications of various tools and technologies in industrial biotechnology.
- ☐ Provide in-depth understanding of the principles and processes of biotechnological product development at industrial scale.
- ☐ Give understanding of patentable subject matter and about protecting own discovery and innovations.

GEB-504 (Industrial Biotechnology) Course Content

Introduction: History and scope of industrial biotechnology; Nature of industrial biotechnology; Public perceptions of industrial biotechnology; Social and legal issues in industrial biotechnology; Hurdles and challenges for the smooth introduction of an acceptable sustainable industrial biotechnology product.
Pharmaceutical biotechnology: Biotechnology versus pharmaceutical biotechnology; Pharmaceuticals of animal, plant and microbial origin.
Drugs and diagnostic kit development: Transferring new molecular entities into drug; Application of biotechnologies in drug development; Drug approval, clinical and preclinical trials, and development of kit based diagnostic tools.
Production of therapeutics: Antibodies, hormones, interferon, antibiotics, enzymes, vaccine, blood products, nucleic acid therapies.
Immobilization of enzymes and cells: Rational of immobilization; Methods of immobilization of enzymes and cells and their application.
Fermented food products: Culture development for food fermentation**;** Principles of culture maintenance and preparation of bacterial, yeast and mold cultures; Production of bread, malt, beverage, dairy products, vinegar, oriental fermented food; Recovery and purification of fermented products.
Foods and enzymes from microbial origin: Microorganisms as food, SCP, probiotics, and prebiotics; Production of amino acids, production of food and feed additives; Source and production of enzymes required for food and feed processing.
Practices in industrial biotechnology: Good Manufacturing Practice (GMP), Good Laboratory Practice (GLP); Hazard Analysis and Critical Control Points (HACCP), Standard Operating Procedure (SOP); Quality management and standard operating procedures.
Intellectual Property: Patentable subject matter; Patent claims and ownership of intellectual property; Disclosure requirements; Procedural aspects of patent litigation; recent developments in the patent system and patentability of the biotechnological invention.

Suggested readings:

- ☐ Industrial Biotechnology: Sustainable Growth and Economic Success. Soetaert, W., & Vandamme, E.J. WILEY-VCH Verlag GmbH & Co.KGaA, Weinheim., 2010.
- ☐ Industrial Biotechnology. Yadav, P.R., & Tyagi, R. Discovery Publishing House, New Delhi., 2005.
- ☐ Industrial Microbiology: An Introduction. Waites, M.J., Morgan, N.L., Rockey, J.S., & Higton, G. Blackwell Science Ltd., 2001.
- ☐ Industrial Biotechnology. Nedwin, G.E., MoT., Walker, L.P. ISSN: 1550-9087. Mary Ann Liebert Inc Publisher., 2016.
- ☐ Basic Industrial Biotechnology. Reddy, S.M. Newage International Publisher., 2010.
- ☐ Industrial Biotechnology. Mathuriya, A.S. Ane Books private ltd., India., 2010.
- ☐ The Coming Biotech Age: The Business of Bio-Materials. Oliver, R. McGraw-Hill Companies. ISBN-10: 0071350209., 1999.
- ☐ Prescott & Dunn's Industrial Microbiology. Reed, G. CBS Publishers & Distributors, ISBN-10: 8123910010., 2004.
- ☐ Biopharmaceuticals: Biochemistry and Biotechnology. Walsh, G. Wiley-Blackwell, ISBN-10: 0470843276., 2003.
- ☐ Biotechnology and Biopharmaceuticals: Ho, R.J. Y., & Gibaldi, M. Wiley publisher, ISBN: 9780471206903., 2004.

- ☐ Food Microbiology (5th ed.). Westhoff, D.C., Frazier, W.C. McGraw Hill Education publisher, ISBN 10: 1259062511., 2013.
- ☐ Biotechnology and Intellectual Property Rights-Legal and Social Implications. Singh, K.K. Springer International Publishing AG, ISBN 978-81-322-2059-6., 2016.
- ☐ Biotechnology and its applications in pharmacy. Kulkarni, G.T. Jaypee Brothers, New Delhi, ISBN 81-7179-776-8., 2002.
- ☐ Pharmaceutical Biotechnology. Vyas S.P., Dixit V.K. CBS Publishers & Distributors Pvt. Ltd., ISBN 10: 8123906145., 2010.

Additional reading materials and learning resources will be suggested by the respective course teacher(s).

Learning outcomes:

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

- ☐ Understand green chemistry; inherently clean processes with minimum waste generation, and energy use and the historical background and progress in industrial biotechnology.
- ☐ Recognize fields and applications of biotechnology tools and techniques used in industrial sectors.
- ☐ Gain knowledge about the scope, hurdles and challenges for introduction of a sustainable industrial biotechnology product.
- ☐ Critically evaluate and manage standard operating procedures related to the practices of industrial biotechnology.
- ☐ Understand patent and how to protect own IPs in the field of industrial biotechnology.

Unit-wise title, sub-title and number of classes per unit:

Unit-wise Title and Sub-title	**No. of classes/unit**
Introduction:	**5**
Pharmaceutical biotechnology:	**8**
Drugs and diagnostic kit development:	**10**
Production of therapeutics:	**5**
Immobilization of enzymes and cells:	**2**
Fermented food products:	**10**
Foods and enzymes from microbial origin:	**8**
Practices in industrial biotechnology:	**7**
Intellectual Property:	**5**
Total	**60**

Instructional strategies:

- ☐ Lecture with traditional method
- ☐ Lecture with power point/videos/models/pictures
- ☐ Obtain immediate feedback by asking questions

- ☐ Answer queries, if any
- ☐ Practice problem solving
- ☐ Arrange review classes
- ☐ Encourage group discussions
- ☐ Assignments for exploring creativity and knowledge in a topic

Assessment:

- ☐ Class participation: Attendance
- ☐ Continuous assessment: In-course examination, assignment
- ☐ Final Examination: Assessment of written test

GEB-505	Agricultural Biotechnology	4 Credit

Introduction to the Course:

Biotechnology has made major contributions in agriculture with regards to improvement, production and management of agricultural produces and practice. From hybrid technology to precise genetic manipulation—everything has impacted this sector profoundly. The course will deal with the basic principles and applications of agricultural biotechnology in order to support the increasing needs for agricultural foods/products.

Specific objectives:

The study of this course will

- ☐ Expose students to scientific evidence and technical aspects of plant/crop and other agricultural product improvement.
- ☐ Enable students to learn and understand the latest innovations and discoveries that have been applied in the fields of agricultural biotechnology
- ☐ Raise awareness about the prospects and cautions of releasing GMOs in the environment.

GEB-505 (Agricultural Biotechnology) Course Content

Plant growth and development: Plant growth regulators; Biological nitrogen fixation; Biofertilizers-types, production, VAM, *Rhizobium*, *Azotobacter*, *Mycorhiza*, *Actinorhiza*; Vermicomposting technology; Biopesticides.

Plant tissue culture techniques and their application: *In vitro* morphogenesis and totipotency of seedling eexplants; Effects of hormone balance on explants growth and morphogenesis; Establishment of suspension cultures, anther culture, microspore culture; Micropropagation; Meristem culture and production of virus-free plants; Embryo and ovary culture; Protoplast isolation, protoplast fusion; Somatic hybrids, hybrids; Soma clones; Synthetic seeds; Cryopreservation; Germplasm collection and conservation; Plant tissue culture certification.

Plant transformation techniques: Agrobacterium mediated gene transfer: Ti and Ri plasmids as vectors, design of expression vectors; 35S promoter, genetic markers, reporter genes; Binary

vectors, plasmid vectors, viral vectors; Direct gene transfer methods; Transgene stability and gene silencing.

GM technology: Introduction, crop improvement, productivity, performance and fortification of agricultural products; Nutrient uptake efficiency; Genetic engineering for biotic stress tolerance; Golden rice and transgenic sweet potato; Genetic engineering for abiotic stress; Current status of transgenic plants; Ethical issues associated with GM crops and GM food; Labeling of GM plants and products; Importance of integrated pest management and terminator gene technology. Environmental impact of herbicide resistance crops and super weeds.

Genetic Engineering for quality improvement: Seed storage proteins, essential amino acids, vitamins and minerals; heterologous protein production in transgenic plants for agriculture, industry and pharmaceuticals uses; Plants as bioreactor, Extending shelf life of fruits and flowers , delay of softening and ripening of fleshy fruits; Post-harvest protection of cereals, millets and pulses.

Metabolic engineering of plants: Plant cell culture for the production of useful chemicals and secondary metabolites (Hairy root culture, biotransformation, elicitation); Pigments, flavanoids, alkaloids; mechanism and manipulation of shikimate pathway.

Biotechnology and its applications in aquaculture: Biotechnology in fish breeding; Transgenesis, chromosome engineering, surrogate broodstock technology. Biotechnology in fish health management; Cryopreservation of gametes or gene banking; Producing GM fish, Environmental and regulatory safety assessment of new fish variety produced via GM and conventional methods.

Agricultural biodiversity and Intellectual Property Rights (IPR): Historical and geographical causes for diversity; Genetic diversity, molecular diversity; Species and population biodiversity; Quantifying biodiversity maintenance of ecological biodiversity; Collection and conservation of biodiversity; Relevant types of IP for agriculture; Types of IP contributions to innovation in agriculture.

Agro economics: Finance, marketing and planning.

Suggested readings:

- ☐ Plants, Genes and Agriculture. Chrispeels, M.J., &Sadava, D.E. Boston: Jones and Bartlett Publishers.,1994.
- ☐ Plant cell, tissue and organ culture: Fundamental methods. Gamborg, O.L., & Philips, G.C. Berlin: Springer-verlag., 2013.
- ☐ Plant Biotechnology: New Products and Applications. Hammound, J., McGravey, P., &Yusibov, V. Berlin: Springer-verlag., 2012.
- ☐ Plant Biochemistry and Molecular Biology. Heldt, H.W. Delhi: Oxford and IBH Publishing Co. Pvt. Ltd.1997.
- ☐ Plants from test tubes. An introduction to Micropropagation. Kyte, L., &Kleyn, J.Portland: Timber Press., 1996.

- ☐ Advanced methods in plant breeding and biotechnology. Murray, D.R. Panima Publishing Corporation., 1996.
- ☐ Plant cell electroporation and electrofusion protocols. Nickoloff, J.A. USA: Humana press Inc., 1995.
- ☐ Plant genetic transformation technology. Sawahel, W.A.Delhi:Daya Publishing House., 1997.
- ☐ Hand book of Plant Biotechnology (Vol. I & II). Gistou, P., &Klu, H. John Publication., 2004.
- ☐ The genetic manipulation of plant. Slater, A., Scott, N., & Fowler, M. Oxford University Press., 2008. 11. Recent Advances in Plant Biotechnology. Kirakosyan, A., & Kaufman, P.B. Springer Publishers.,2009.
- ☐ Plant biotechnology: current and future applications of genetically modified crops.Halford, N.G. John Wiely Publishers., 2006.
- ☐ Agricultural biotechnology innovations versus intellectual property rights. Boyd, S.L., W.A. Kerr and N. Perdikis, The Journal of World Intellectual Property, Vol. 6(2), pp. 211-232., 2005.

Addition reading material and learning resources will be suggested by the respective course teacher(s).

Learning outcomes:

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

- ☐ Learn about the available tools and technologies of modern biotechnology and their applications in the field of agriculture.
- ☐ Apply their knowledge to improve, conserve and maintain the integrity of the modern farming by minimizing negative impacts
- ☐ Understand how to communicate the social and economic issues with relevant stakeholders of this field.

Unit-wise title, sub-title and number of classes per unit:

Unit-wise Title and Sub-title	**No. of classes/unit**
Plant growth and development:	5
Plant tissue culture techniques and their application:	8
Plant transformation techniques:	10
GM technology:	5
Genetic Engineering for quality improvement:	2
Metabolic engineering of plants:	10
Biotechnology and its applications in aquaculture:	8
Agricultural biodiversity and Intellectual Property Rights (IPR):	7
Agro economics:	5
Total	**60**

Instructional strategies:

- ☐ Lecture with traditional method
- ☐ Lecture with power point/videos/models/pictures

- ☐ Obtain immediate feedback by asking questions
- ☐ Answer queries, if any
- ☐ Practice problem solving
- ☐ Arrange review classes
- ☐ Encourage group discussions
- ☐ Assignments for exploring creativity and knowledge in a topic

Assessment:

- ☐ Class participation: Attendance
- ☐ Continuous assessment: In-course examination, assignment
- ☐ Final Examination: Assessment of written test

GEB-506	Seminar	2 Credit

Introduction to the Course:

The general purpose of the seminar course is to facilitate review of a specific research study and to discuss implications of the study for gaining knowledge. This course offers opportunity for the students to critically evaluate recent novel articles related to any field of biosciences/biotechnology that have been published in reputed journals. The student will prepare power point slides and present the selected article in front of an audience. This course thus creates an opportunity for the students to talk in a forum to keep them updated with the recent scientific literature.

Specific objectives:

This course will help the students to

- ☐ Become more familiar with the advanced literature in their study subject.
- ☐ Improve their skills of understanding and debating current topics of their interest.
- ☐ Develop abilities to critically analyse the literature.
- ☐ Generate questions and disseminate knowledge
- ☐ Discuss controversies of the findings, if any.
- ☐ Generate ideas for future research.
- ☐ Develop skills to speak in front of an audience.

Learning outcomes:

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

- ☐ Attain confidence to deliver oral presentations in front of an audience.
- ☐ Acquire skills in preparing and delivering presentations.
- ☐ Acquire more in-depth knowledge in related field of biotechnology, including deeper insight into current research and future prospects.
- ☐ Increase capability to critically evaluate recent novel findings
- ☐ Attain capability to discuss the conclusions of recent scientific literatures.
- ☐ Learn how to answer questions and tackle problems during the presentation.

Instructional strategies:

- ☐ Choosing a recent article that has novel/interesting finding
- ☐ Avoid choosing reviews, editorials or industry sponsored articles

- ☐ Reading the article thoroughly and critically after selecting it
- ☐ Understanding what question is asked in the article (purpose), how the question is answered (method), and what the take-home points are (conclusions)
- ☐ Clear understanding enhances confidence of delivering presentation
- ☐ Try to present in a clear, loud voice and do not rush

Assessment:

- ☐ Class participation: Attendance
- ☐ In-course examination (oral presentation of a selected article)
- ☐ Final Examination (oral presentation of a selected article)

GEB-507	Laboratory Experiments and Assignment	6 Credit

Introduction to the Course:

This course is designed to let the students of non-thesis group (Group A) to perform experiments in Labs to facilitate an experiential and methodological learning environment. Students will gain significant hands-on training experience by performing in-depth lab experiments on various methods/techniques of molecular biology and biotechnology. This course also has a scope of engaging students in short-term laboratory/field work or in specific biotechnology-related assignment to promote research aptitude. The field work or the assignment will be determined by the respective course teachers.

Specific objectives:

This course will

- ☐ Enable the students to apply and investigate theoretical and conceptual knowledge.
- ☐ Enable to use advanced molecular biotechnology techniques.
- ☐ Help to develop skills in performing PCR, electrophoresis, blotting, transformation, cloning.
- ☐ Enable to record experimental data, analyze/interpret them and present their finding in written format.
- ☐ Provide students a scope of research opportunities while performing assignments/field work.

GEB-507 (Laboratory Experiments and Assignment) Course Content

Wet Lab Experiments:

1. Separation and counting Erythrocytes, Leucocytes and Platelets in human blood samples.
2. Cytotoxic effects of a small molecule on human red blood cells.
3. Separation of Amino acids by paper chromatography.
4. Analysis of a medicinal plant extract by HPLC.
5. Restriction mapping, digestion and RFLP analysis of the human *HBB* gene.
6. Preparation of growth media and culture microbial flora from sewage water with subsequent test for antibiotic sensitivity.
7. Media standardization for maximum biomass production of an industrially important microorganism (such as *S. cerevisiae*, or *Lactobacilli*)

8. Preparation of plant tissue culture medium and preparing plant materials for culture.
9. Protoplast isolation from plant leaves and culture in tissue culture medium.
10. Brewing vinegar from ethanol.

Dry Lab Experiments:

1. Sequence identity search- Sequence similarity search using BLAST
2. Sequence similarity search using FASTA
3. Sequence similarity search using PSI BLAST
4. Pattern Search (Domains & Motifs) using Pfam
5. ORF gene Search – Genscan
6. Sequence translation using ExPASy translate tool
7. Characterization of retrieved protein sequence by ProtParam tool
8. Pair-wise global sequence alignment using EBI-EMBOSS Needleman Wunsch tool
9. Multiple sequence alignment using EBI-CLUSTALW2.
10. PHYLOGENY- Phylogenetic tree using PHYLIP.
11. Molecular visualization of proteins using RASMOL.

Learning outcomes:

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

- ☐ Familiarize the advanced molecular biotechnology techniques for analyzing bio-molecules such as DNA/RNA/protein
- ☐ Perform qualitative and quantitative analysis of bio-molecules using gel electrophoresis and blotting techniques.
- ☐ Understand the basis of PCR reactions and perform amplification reactions using thermal cycler.
- ☐ Carry out methodologies for transformation and gene expression.
- ☐ Enhance their capability to plan and carry out assignment work in a given topic.

Instructional strategies:

- ☐ Interactive class Lectures on principle, procedure and application of each experiment
- ☐ Obtain immediate feedback by asking questions
- ☐ Answer queries, if any
- ☐ Practice problem solving
- ☐ Hands-on Laboratory training
- ☐ Encourage group discussions

Assessment:

- ☐ Class participation: Attendance
- ☐ Continuous assessment: In-course examination, assignment
- ☐ Practical note-book assessment

- ☐ Final Examination: Assessment of written test
- ☐ Viva voce

GEB-507	Thesis	6 Credit

Introduction to the Course:

All MS students of thesis group (Group B) must undergo a thesis work, which must encompasses originality, clarity of purpose and critical analysis in some areas of biotechnology under supervision of a faculty member. Students are expected to have an in-depth discussion with his/her supervisor before choosing a topic for thesis work. Students are encouraged to begin exploring/sharing ideas with his/her supervisor for initiating thesis work early in their program of study. After completion of the thesis work, students have to submit a dissertation and face a board for a defense.

Specific objectives:

This course will help the students to

- ☐ Develop deeper knowledge, understanding and investigation capability in the study field.
- ☐ Learn about the research process, including its guiding principles and common procedures.
- ☐ Engage in deeper study of specific areas of interest.
- ☐ Identify a research question, engage in a literature review, and become familiar with applying methodologies to investigate it.
- ☐ Increase knowledge of arguing the findings of a research work.
- ☐ Interpret and present the obtained results in the form of a dissertation.
- ☐ Develop motivation, skills and attitude that will enable them to be engaged in innovative research in future.

Learning outcomes:

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

- ☐ Formulate scientific questions, plan an investigation and design experiments.
- ☐ Analyze experimental results, differentiate between expected and unexpected results, manage trouble shooting, interpret results and make conclusions.
- ☐ Acquire more in-depth knowledge in the field of study, including deeper insight into current research and future prospects.
- ☐ Increase capability to analyze and critically evaluate research findings.
- ☐ Attain capability to present research findings orally and in written format, and discuss the conclusions as well as the knowledge and arguments that form the basis for the findings.
- ☐ Learn how to answer questions and tackle problems during oral presentation.

Instructional strategies:

The supervisor will:

- ☐ Discuss the research plan with the student and suggest how to conduct it
- ☐ Advise on the appropriate materials and methods for carrying out the research.
- ☐ Offer advice on sources of information for the work.
- ☐ Discuss any issue regarding data collection
- ☐ Arrange regular meetings/discussions to monitor progress of the work.
- ☐ Give detail advice on issues relating to writing up the thesis report

Assessment:

- ☐ Assessment of oral presentation (defense) of the thesis
- ☐ Assessment of submitted thesis report

GEB-508	Viva voce	2 Credit

Introduction to the Course:

After completion of all theory course examinations, students will face a viva voce (oral examination) conducted by the respective examination committee approved by the University. The viva voce is an important mode of assessment, providing an opportunity for the students to demonstrate their knowledge, approach and understandings with the examiners.

Specific objectives:

Oral examination will

- ☐ Help to develop students' confidence in answering questions asked by the examiners.
- ☐ Prepare students to be ready for answering any related questions covering the whole courses offered in the academic year.
- ☐ Provide opportunity for students to test their communication skills.
- ☐ Offer scopes for those who are less confident in the written exams to demonstrate their learning orally.
- ☐ Create opportunity to practise for job interviews.

GEB-508 (Viva voce) Course Content

All courses offered in MS.

Learning outcomes:

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

- ☐ Know how to present (posture, eye contact, resonance etc.) him or herself in front of a viva-board.
- ☐ Know how to answer a question in a very logical way.
- ☐ Improve capacity of oral delivery.
- ☐ Reduce fear to face a viva board.
- ☐ Enhance confidence to face job interviews.

Assessment:

After a student finishes his/her viva-voce, the members of the examination committee will discuss about the student's performance and provide a mark getting consensus from all members.