# List of Revised Courses

**Department : *Biotechnology***

**Program Name : *M.Sc.***

***Academic Year : 2021-22***

## *List of Revised Courses*

| Sr. No. | Course Code | Name of the Course |
|---|---|---|
| 1. | MBT 101 T | **Biochemistry** |
| 2. | MBT 102T | **Cell and Molecular Biology** |
| 3. | MBT 104T | **Microbiology** |
| 4. | MBT 106T | **Biostatistics** |
| 5. | MBT 201 T | **Genetic Engineering** |
| 6. | MBT 202T | **Immunology** |
| 7. | MBT 204T | **Genomics and Proteomics** |
| 8. | MBT 205T | **Molecular Diagnostics** |
| 9. | MBT 207T | **Environmental Biotechnology** |
| 10. | MBT 209T | **Nanobiotechnology** |
| 11. | MBT 301 T | **Bioprocess Engineering and Technology** |
| 12. | MBT 304T | **Bioentrepreneurship** |
| 13. | MBT 308T | **Microbial Technology** |
| 14. | MBT 311 T | **Vaccines** |

Signature & Seal of HoD

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# Minutes of Meetings (MoM) of Board of Studies (BoS)

**Academic Year : 2021-22**

**School** : ***School of Studies of Interdisciplinary Education and Research***

**Department** : ***Biotechnology***

**Date and Time** : ***09-11-2021– 12:00 Noon***

**Venue** : ***Room of Head, Department of Biotechnology***

## MINUTES OF THE MEETING OF BOARD OF STUDIES IN BIOTECHNOLOGY GURU GHASIDAS VISHWAVIDYALAYA, BILASPUR HELD ON 09/11/2021

A online meeting of the Board of Studies in Biotechnology under School of Interdisciplinary Education and Research was held on 09/11/2021 at 12:00 Noon under the chairmanship of Dr. RenuBhatt, Head Department of Biotechnology. The following members were present.

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|---|---|
| (i) Dr. Renu Bhatt, Head | Chairman |
| (ii) Prof. B.N. Tiwary, Professor | Member |
| (iii) Prof. Keshavkant Sahu, | Expert present online |
| (iv) Dr. Dhananjay Shukla | Member |

The following agenda were placed to discuss:

1.To revise syllabus of CBCS M.Sc Biotechnology Programme

2.To offer an elective course in M.Sc biotechnology

3. To discuss and approve the amendment in the ordinance number 74 of CBCS in M.Sc Biotechnology programme.

At the very outset the HOD, Chairman of Board of Studies welcomed all the BoS members and discussed the above agenda at length. Following resolutions were made in this meeting.

1. The syllabus of different courses (core and electives courses) taught in CBCS M.Sc Biotechnology programme was reviewed by the BoS members and overlapping in the different course content was identified. After thorough discussion the syllabus of each courses were revised accordingly and overlapping was removed after through discussion and approved by the BoS.

2. The open elective course will be offered to the Master students of the other department as per the guidelines of the university. The title and the course content of open elective course were approved by the BoS.

3. The amendment in the ordinance for M.Sc Biotechnology under CBCS pattern was discussed and approved by the Board of studies and recommended to be placed before Academic Council.

The meeting ended with a vote of thanks by the Chairman

| | | | |
|---|---|---|---|
| Dr. Renu Bhatt<br>Chairman | Prof. B. N. Tiwary<br>Member | Prof. Keshavkant Sahu<br>Expert present online | Dr Dhananjay Shukla<br>Member |

In the Meeting of BOS-Biotechnology on 09-07-2020, the following courses were revised in the syllabus of M.Sc.:

| Course Code | Name of the Course |
|---|---|
| MBT 101 T | **Biochemistry** |
| MBT 102T | **Cell and Molecular Biology** |
| MBT 104T | **Microbiology** |
| MBT 106T | **Biostatistics** |
| MBT 201 T | **Genetic Engineering** |
| MBT 202T | **Immunology** |
| MBT 204T | **Genomics and Proteomics** |
| MBT 205T | **Molecular Diagnostics** |
| MBT 207T | **Environmental Biotechnology** |
| MBT 209T | **Nanobiotechnology** |
| MBT 301 T | **Bioprocess Engineering and Technology** |
| MBT 304T | **Bioentrepreneurship** |
| MBT 308T | **Microbial Technology** |
| MBT 311 T | **Vaccines** |

The following new courses were introduced in the syllabus of M.Sc.:

| Course Code | Name of the Course |
|---|---|
| MBT 208T | Human Genomics |
| MBT 3 15T | Application in Biotechnology |

Signature & Seal of HoD

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गुरु घासीदास विश्वविद्यालय, बिलासपुर (छ.ग.)
Guru Ghasidas Vishwavidyalaya, Bilaspur (C.G.)

# Scheme and Syllabus

## Syllabus
## M.Sc.Biotechnology
## (2021-22)

| M.Sc. Biotechnology PG Semester I | | | | |
|---|---|---|---|---|
| Code | Course opted | Subjects | Hours/ week | Credits |
| MBT 101 T | Core -1 | Biochemistry | 03 | 3 |
| MBT 102T | Core -2 | Cell and Molecular Biology | 03 | 3 |
| MBT 103T | Core -3 | Plant and Animal Biotechnology | 03 | 3 |
| MBT 104T | Core -4 | Microbiology | 02 | 2 |
| MBT 105T | Core-5 | Genetics | 02 | 2 |
| MBT 106T | Core-6 | Biostatistics | 03 | 3 |
| | | Laboratory | | |
| MBT 107L | Lab 01 | Biochemistry and Analytical Techniques | 08 | 4 |
| MBT 108L | Lab 02 | Microbiology | 04 | 2 |
| MBT 109L | Lab 03 | Plant and Animal Biotechnology | 04 | 2 |
| | | Total | 32 | 24 |
| M.ScBiotechnologyPG Semester II | | | | |
| Code | Course opted | Subjects | Hours/ week | Credits |
| MBT 201 T | Core -1 | Genetic Engineering | 03 | 3 |
| MBT 202T | Core -2 | Immunology | 03 | 3 |
| MBT 203T | Core -3 | Bioinformatics | 03 | 3 |
| MBT 204T | Core-4 | Genomics and Proteomics | 02 | 2 |
| MBT 205T | Core -5 | Molecular Diagnostics | 02 | 2 |
| MBT 206T | Core -6 | Research Methodology and Scientific Communication Skills | 02 | 2 |
| MBT 207T | Elective-1 | Environmental Biotechnology | 02 | 2 |
| MBT 208T | Elective-1 | Human Genomics | | |
| MBT 209T | Elective-1 | Nanobiotechnology | | |
| *MBT 210S | Elective | MOOCs course to be selected/opted from SWAYAM portal (SWAYAM-BIOTECH-1) | | |
| | | Laboratory | | |
| MBT 211L | Lab 01 | Molecular Biology and Genetic Engineering | 08 | 4 |
| MBT 212 L | Lab 02 | Immunology | 06 | 3 |
| | | Total | 31 | 24 |
| M.ScBiotechnologyPG Semester III | | | | |
| Code | Course opted | Subjects | Hours/ week | Credits |
| MBT 301 T | Core -1 | Bioprocess Engineering and Technology | 03 | 3 |
| MBT 302T | Core -2 | Emerging Technologies | 02 | 2 |
| MBT 303T | Core -3 | Critical Analysis of Classical Papers | 02 | 2 |
| MBT 304T | Core-4 | Bioentrepreneurship | 02 | 2 |
| MBT 305T | Core -5 | Intellectual Property Rights, Biosafety and Bioethics | 02 | 2 |
| MBT 306T | Core -6 | Project Proposal Preparation and Presentation | 02 | 2 |
| MBT 307T | Core -7 | Research Seminar | 02 | 2 |

| | | | | |
|---|---|---|---|---|
| MBT 308T | Elective | Microbial Technology | 02 | 2 |
| MBT 309 T | Elective | Computational Biology | | |
| MBT 310 T | Elective | Drug Discovery and Development | | |
| MBT 311 T | Elective | Vaccines | | |
| MBT 312 T | Elective | Protein Engineering | | |
| MBT 313 T | Elective | Medical Microbiology and Infection Biology | | |
| MBT 314S | Elective | MOOCs course to be selected/opted from SWAYAM portal (SWAYAM-BIOTECH-1) | | |
| *MBT 3 15T | Open Elective | **Application in Biotechnology** (The students will have to opt an open elective course from the basket of elective courses offered by other departments of University) | 05 | 5 |
| | | **Laboratory** | | |
| MBT 315L | Lab 01 | **Laboratory VI: Bioprocess Engineering and Technology** | 08 | 4 |
| MBT 316 L | Lab 02 | **Laboratory VII: Bioinformatics** | 04 | 2 |
| | | **Total** | 34 | 28 |

**M.Sc. Biotechnology PG Semester IV**

| Code | Course opted | Subjects | Hours/ week | Credits |
|---|---|---|---|---|
| MBT 401 | Core -1 | Dissertation | 32 | 20 |
| | | **Total** | 32 | 20 |
| | | | Total Credits | 96 |

**Note:**

- The students will undertake industrial tour/visit during first year of M.Sc. programme as part of skill development. After visit students will be required to submit a report/certificate for record.
- The summer/winter training 4 – 8 weeks is compulsory for DBT sponsored students and optional for other M.Sc. students. After training, students will be required to submit the certificate for record.
- Open elective course will be offered in the odd or even semester as approved by the university.

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## Semester One

### Biochemistry

Credits: 3

**Course Objectives**

The objectives of this course are to build upon undergraduate level knowledge of biochemical principles with specific emphasisondifferentmetabolicpathways. The course shall make the students aware of various disease pathologies within the context of eachtopic.

**Student Learning Outcomes**

On completion of this course, students should be able to:

- Gain fundamental knowledge inbiochemistry;
- Understand the molecular basis of various pathological conditions from the perspective of biochemicalreactions.

| | |
|---|---|
| Unit I **Bioenergetics &Glycochemistry** | Bioenergetics-basic principles; equilibrium and concept of free energy.Metabolism: basic concepts and design. Coupled reactions, Interconnecting reactions, Electron transport, Oxidative phosphorylation, energetics of chemolithotrops and autotrophs, Synthesis of ATP and other energy rich compounds.Glycolytic pathways, Citric acid cycle, energy production, Carbohydrate Biosynthesis, Glyoxylate cycle, Gluconeogenesis, Glycogenolysis. |
| Unit II **Protein Biochemistry** | Protein structure (primary, secondary, tertiary &quartenary), Globular, Fibrous proteins; Ramachandran plot, Circular Dichroism, Hydrophobic and hydrophilic interactions, Protein folding, basic principles of protein purification.Nitrogen acquisition andassimilation,Biosynthesis amino acids, Mechanism of transamination reaction, Amino acid oxidation and production of urea, Urea cycle, Pathways of amino acid degradation |
| Unit III **Lipid Biochemistry** | Lipid biosynthesis, de *Novo biosynthesis*, biosynthesis of unsaturated fatty acids, Biosynthesis of membrane lipids and steroids, Essential fatty acids and biosynthesis of eicosanoids, Degradation of fatty acids, β oxidation, ω oxidation. Principles of lipid metabolic regulations |
| Unit IV **NucleicAcid** | Nucleic acids - structure, a historical perspective leading up to the proposition of DNA double helical structure;De Novo and salvage pathway of synthesis of purine and pyrimidine bases, Feedback regulation of nucleotide biosynthesis. Catabolism of purine and pyrimidine. |
| Unit V **Enzyme and Enzyme Technology** | Enzyme catalysis - general principles, quantitation of enzyme activity and efficiency; enzyme characterization and Michaelis-Menten kinetics; relevance of enzymes in metabolic regulation, concept of catalytic antibodies; catalytic strategies with specific examples of proteases, carbonic anhydrases and restriction enzymes, regulatory strategies with specific example of haemoglobin; isozymes: role of covalent modification in enzymatic activities: zymogens. |

**Recommended Textbooks and References:**

1. Stryer,L.(2002).*Biochemistry*.NewYork:Freeman.
2. Lehninger,A.L.(2004).*PrinciplesofBiochemistry*(4th ed.).NewYork,NY:Worth.
3. Voet,D.,&Voet,J.G.(2004).*Biochemistry*(4th ed.).Hoboken,NJ:J.Wiley&Sons.
4. Dobson,C.M.(2003).*ProteinFoldingandMisfolding*.Nature,426(6968),884-890. doi:10.1038/nature02261.
5. Richards,F.M.(1991).*TheProteinFoldingProblem*.ScientificAmerican, 264(1), 54-63.doi:10.1038/scientificamerican0191-54.

Department of Biotechnology, GGV

# Cell and Molecular Biology

Credits: 3

**Course Objectives**

The objectives of this course are to sensitize the students to the fact that as we go down the scale of magnitude from cells to organelles to molecules, the understanding of various biological processesbecomesdeeperandinclusive.

**Student Learning Outcomes**

Student should be equipped to understand three fundamental aspects in biological phenomenon: a) what to seek; b) how to seek; c) why to seek?

**Unit I**

**Cellular transport, trafficking and cytoskelet on**

Cell membranes: methods to study organization of membranes, Molecular mechanisms of membrane transport, nuclear transport, transport across mitochondria and chloroplasts; Intracellular vesicular trafficking from endoplasmic reticulum through Golgi apparatus to lysosomes/cell exterior; Cytoskeleton: Composition, organization and functions of Microfilaments, microtubules,intermediate filaments and associated proteins.

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| Unit II<br>**Chromatin structure and dynamics**<br>12 lectures | Chromatin structure, DNA-replication, Gene expression in prokaryotes, Genetic code, Transcription and its regulation: eperons, attenuation, anti-termination and anti-sense controls. Prokaryotic translation machinery, Gene expression in eukaryotes: Transcription, general and specific transcription factors, regulatory elements and mechanism of regulation, processing of transcripts. Eukaryotic Translation, Inhibitors of Transcription and Translation in prokaryotes and eukaryotes |
| Unit III<br>**Cellular Signaling and cell adhesion**<br>6 lectures | Basic concept of signal transduction, Cell receptors, Second messengers, intracellular signaling cascade, Cell adhesion; cell junctions, cell adhesion molecules. |
| Unit IV<br>**Cell cycles and its regulation**<br>6 lectures | Cell cycle, Cell cycle checkpoints, regulation of cell cycle; cell death: different modes of cell death and their regulation. |
| Unit V<br>**Cancer**<br>3 lectures | Biology of cancer cells; Carcinogens; Proto-oncogenes, viral and cellular oncogenes; oncogenic transformation; tumor suppressor genes; structure, function and mechanism of action; activation and suppression of tumor suppressor genes. |

Recommended Textbooks and References:

1 Alberts,B.,Johnson,A.,Lewis,J.,Raff,M.,Roberts,K.,&Walter,P.(2008). *Molecular Biology of the Cell* (5th Ed.). New York: Garland Science.
2 Lodish,H.F.(2016).*MolecularCellBiology*(8thEd.).NewYork:W.H.Freeman.
3 Krebs,J.E.,Lewin,B.,Kilpatrick,S.T.,&Goldstein,E.S.(2014).*Lewin'sGenesXI*. Burlington, MA: Jones &BartlettLearning.
4 Cooper,G.M.,&Hausman,R.E.(2013).*TheCell:aMolecularApproach*(6thEd.). Washington: ASM ;Sunderland.
5 Hardin,J.,Bertoni,G.,Kleinsmith,L.J.,&Becker,W.M.(2012).*Becker'sWorldof theCell*.Boston(8thEd.). BenjaminCummings.
6 Watson,J.D.(2008).*MolecularBiologyoftheGene*(5thed.).MenloPark,CA: Benjamin/Cummings.

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# Microbiology

Credits

2

**CourseObjectives**

The objectives of this course are to introduce field of microbiology with special emphasis on microbial diversity, morphology, physiology and nutrition; methods for control of microbes andhost-microbeinteractions.

**Student Learning Outcomes**

Students should be able to:

- Identify major categories of microorganisms and analyze their classification,diversity,andubiquity;
- Identify and demonstrate structural, physiological, genetic similarities and differences of major categories ofmicroorganisms;
- Identify and demonstrate how to control microbialgrowth;
- Demonstrate and evaluate interactions between microbes, hosts and environment.

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|---|---|
| Unit I<br>**Microbial characteristics**<br>6 lectures | History and scope of microbiology, a brief idea of microbial diversity, Principles of classification of microbes: Morphological, metabolic and molecular criteria for the classification. |
| Unit II<br>**Microbial diversity**<br>9 lectures | Ultra structure and classification of bacteria, fungi, algae and virus, extremophiles. Biotechnological potential of microbes, Growth and nutrition of bacteria, bacterial growth curve, bacterial culture methods (isolation, purification, enrichment techniques and maintenance and enumeration), mode of nutrition |

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|---|---|
| Unit III<br>**Control of microorganisms**<br>3 lectures | Sterilization, disinfection and antisepsis: physical and chemical methods for control of microorganisms. Antibiotics, antiviral, antifungal, antimicrobial resistance |
| Unit IV<br>**Microbial genetics**<br>5 lectures | Microbial genetics: modes of genetic exchange in microbe, transformation, transduction, conjugation, evolutionary significance. |
| Unit V<br>**Host-microbes interaction**<br>5 lectures | Host-pathogen interaction, ecological impact of microbes; symbiosis, microbes and nutrient cycles; microbial communication system; bacterial quorum sensing, microbial fuel cells, prebiotics and probiotics, industrial and environmental application of microbes |

**Recommended Textbooks and References:**

1. Pelczar,M.J.,Reid,R.D.,&Chan,E.C.(2001).*Microbiology*(5th ed.). New York:McGraw-Hill.
2. Willey,J.M.,Sherwood,L.,Woolverton,C.J.,Prescott,L.M.,&Willey,J.M.(2011). *Prescott's Microbiology*. New York: McGraw-Hill.
3. Matthai,W.,Berg,C.Y.,&Black,J.G.(2005).*Microbiology,Principlesand Explorations*.Boston,MA:JohnWiley&Sons.

## Bio-Statistics

Credits

2

**Course Objectives** The objective of this course is to give conceptual exposure of statistics, error analysis, hypothesis testing, and design of experiments in biological systems

**Student Learning Outcomes**

On completion of this course, students should be able to:
- Understand how to summarise statistical data;
- Apply appropriate statistical tests based on an understanding of study question, type of study and type ofdata;
- Interpret results of statistical tests and application in biologicalsystems.

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| Unit1<br>**Introduction**<br>5 lectures | Types of biological data (ordinal scale, nominal scale, continuous and discrete logical systems data), frequency distribution and graphical representations (bar graph, histogram, box plot and frequency polygon), cumulative frequency distribution, populations, samples, simple random, stratified and systematic sampling. |

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| | |
|---|---|
| Unit II<br>**Descriptive statistics, Probability and distribution**<br>10 lectures | Measures of Location. Properties of Arithmetic Mean, median, mode, range, Properties of the Variance and Standard Deviation, Coefficient of Variation, Grouped Data, Graphic Methods, Obtaining Descriptive Statistics on the Computer, Case study. Introduction to probability and laws of probability, Random Events, Events-exhaustive, Mutually exclusive and equally likely (with simple exercises), Definition and properties of binomial distribution, Poisson distribution and normaldistribution. |
| Unit III<br>**Correlation and regression analysis, Statistical hypothesis**<br>10 lectures | Correlation, Covariance, calculation of covariance and correlation, Correlation coefficient from ungrouped data Spearson's Rank Correlation Coefficient, scatter and dot diagram, General Concepts of regression, Fitting Regression Lines, regression coefficient, properties of Regression Coefficients, Standard error of estimate. Making assumption, Null and alternate hypothesis, error in hypothesis testing, confidence interval, one-tailed and two-tailed testing, decision making. |
| Unit IV<br>**Tests of significance**<br>8 lectures | Steps in testing statistical significance, selection and computation of test of significance and interpretation of results; Sampling distribution of mean and standard error, Large sample tests (test for an assumed mean and equality of two population means with known S.D.), z-test; Small sample tests (t-test for an assumed mean and equality of means of two populations when sample observations are independent); parametric and Non parametric tests (Mann-Whitney test); paired and unpaired t-test, chi square test. |
| Unit V<br>**Experimental designs**<br>8lectures | Introduction to study designs: Longitudinal, cross-sectional, retrospective and prospective study, Principles of experimental designs, Randomized block, and Simple factorial designs, Analysis of variance (ANOVA) and its use in analysis of Randomized block Design, introduction to meta-analysis and systematic reviews, ethics in statistics. |

Recommended Textbooks and References:

1. Jaype Brothers, (2011), Methods in Biostatistics for Medical Students and Research Workers (English), 7thEdition
2. Norman T.J. Bailey, (1995), Statistical Methods in Biology, 3rd Edition, Cambridge UniversityPress.
3. P. N. Arora and P. K. Malhan, (2006), Biostatistics, 2nd Edition, Himalaya PublishingHouse.
4. Jerold Zar, Biostatistical Analysis, 4th Edition. PearsonEducation.
5. Biostatistics: a Foundation for Analysis in the Health Sciences, 7th Edition, Wiley.
6. ML Samuels, JA Witmer (2003) Statistics for the Life Sciences, 3rd edition. PrenticeHall.

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## Semester Two

# Genetic Engineering

Credits 3

**Course Objectives**

The objectives of this course are to teach students with various approaches to conducting genetic engineering and their applicationsinbiologicalresearchaswell as in biotechnology industries. Genetic engineering is a technology that hasbeen developed based on our fundamental understanding of the principles of molecular biology and this is reflectedin the contents of thiscourse.

**Student Learning Outcomes**

Given the impact of genetic engineering in modern society, the students should be endowed with strong theoretical knowledge of this technology. In conjunction with the practicals in molecularbiology&geneticengineering, the students should be able to takeup biological research as well as placement in the relevant biotech industry.

**Unit I**
**Introduction and tools forgeneticengineering**
6 lectures

Restriction endonucleases and methylases; DNA ligase, Klenow enzyme, T4 DNA polymerase, polynucleotide kinase, alkaline phosphatase; cohesive and blunt end ligation; linkers; adaptors; homopolymeric tailing; labeling of DNA: nick translation, random priming, radioactive and non-radioactive probes, hybridization techniques: northern, southern, south-western and far-western and colony hybridization, fluorescence in situ hybridization.

**Unit II**
**Different types of vectors**
7 lectures

Plasmids; Bacteriophages; Ml3 mp vectors; PUC19 and Bluescript vectors, Phagemids; Lambda vectors; Insertion and Replacement vectors; cosmids; Aftificial chromosome vectors (YACs; BACs); Principles for maximizing gene expression, expression vectors; pMal; GST; pET-based vectors; Protein purification; His-tag; GST-tag; MBP-tag etc.; Intein-based vectors; Inclusion bodies; Mammalian expression and replicating vectors; Baculovirus and Pichia vectors system, plant based vectors, Ti and Ri as vectors.

**Unit III**
**Different types of PCR techniques**
7 lectures

Principles of PCR: primer design; fidelity of thermostable enzymes; DNA polymerases; types of PCR - cloning of PCR products; T-vectors; proof reading enzymes; PCR based site specific mutagenesis; PCR in molecular diagnostics: viral and bacterial detection; sequencing methods; enzymatic DNA sequencing; chemical sequencing of DNA; automated DNA sequencing; RNA sequencing; chemical synthesis of oligonucleotides; mutation detection: SSCP, DGGE, RFLP.

**Unit IV**
**Genemanipulation and protein-DNA interaction**
7 lectures

Insertion of foreign DNA into host cells; transformation, electroporation, transfection; construction of libraries; isolation of mRNA and total RNA; reverse transcriptase and cDNA synthesis; cDNA and genomic libraries; construction of microarrays – genomic arrays, cDNA arrays and oligo arrays; study of protein-DNA interactions: electrophoretic mobility shift assay; DNasefootprinting; methyl interference assay, chromatin immunoprecipitation ; protein-protein interactions using yeast two-hybrid system; phage display.

**Unit V**
**Gene silencing and genome editing technologies**
13 lectures

Gene silencing techniques; Micro RNA; construction of siRNA vectors; principle and application of gene silencing; gene knockouts and gene therapy; Transgenics- gene replacement; gene targeting; creation of transgenic and knock-out mice; disease model; introduction to genome editing by CRISPR-CAS.

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Recommended Textbooks and References:

1 Old,R.W.,Primrose,S.B.,&Twyman,R.M.(2001).*PrinciplesofGeneManipulation:anIntroductiontoGeneticEngineering*.Oxford:BlackwellScientificPublications.
2 Green,M.R.,&Sambrook,J.(2012).*MolecularCloning:aLaboratoryManual*.Cold Spring Harbor, NY: Cold Spring Harbor LaboratoryPress.
3 Brown,T.A.(2006).*Genomes* (3rd ed.).NewYork:GarlandSciencePub.
4 Selectedpapersfromscientificjournals,particularlyNature&Science.
5 TechnicalLiteraturefromStratagene,Promega,Novagen,NewEnglandBiolabetc.

# Immunology

Credits 3

**Course Objectives**

The objectives of this course are to learn about structural features of components of immune system as well as their function. The major emphasis of this course will be on development of immune system and mechanisms by which our body elicits immune response. This will be imperative for students as it will help them to predict about nature of immune response that developsagainstbacterial,viralorparasitic infection, and prove it by designing new experiments.

**Student Learning Outcomes**

On completion of this course, students should be able to:

- Evaluate usefulness ofimmunology in different pharmaceutical companies;
- Identify proper research lab working in area of their owninterests;
- Apply their knowledge and design immunological experiments to demonstrate innate, humoralorcytotoxicT lymphocyte responses and figure out kind of immune responses in thesettingofinfection(viralorbacterial).

| | | |
|---|---|---|
| Unit I | **Fundamental of immune system** 5 lectures | Introduction and History of Immunology, Molecular and Cellular components of Immune system.Lymphoidorgans.Innate and adaptive immune response.Humoral and cell mediated immune response. Antigens, haptens; Antibody structure and Function; Antigen-Antibody reaction and Application. |
| Unit II | **Immuneresponses** 8 lectures | Inflammatory responses; Major Histocompatibility Complex and Antigen processing and presentation; Complement System; Molecular patterns and their receptors; Cytokines; Activation of innate immune cells. Macrophages-mediated cytotoxicity |
| Unit III | **Lymphocyte Biology** 6 lectures | Immunoglobulin genes; Gene rearrangement of Ig Genes and Antibody diversity; Generation, activation and differentiation of B cells and T cells maturation, Functional subsets of lymphocytes. Cell-mediated cytotoxicity –T cell; NK cell; ADCC;; Lymphocyte trafficking,immune tolerance |

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# Genomics and Proteomics

Credits

2

Course Objectives

The objectives of this course is to provide introductory knowledge concerning genomics, proteomics and their applications.

Student Learning Outcomes

Students should be able to acquire knowledge and understanding of fundamentals of genomics and proteomics, transcriptomics and metabolomics and their applications in various applied areas of biology.

| | | |
|---|---|---|
| Unit I | **Basics of genomics** | 3 lectures |
| Brief overview of prokaryotic and eukaryotic genome organization. Extrachromosomal DNA: bacterial plasmids, mitochondria and chloroplast DNA | | |
| Unit II | **Genome mapping** | 4 lectures |
| Genetic and physical maps; markers for genetic mapping; methods and techniques used for gene mapping, physical mapping, linkage analysis, cytogenetic techniques, FISH technique in gene mapping, somatic cell hybridization, radiation hybrid maps, *in situ* hybridization, comparative gene mapping. | | |
| Unit III | **Genome sequencing** | 3 lectures |
| Genome sequencing, methods for whole genome sequencing. Contig assembly, chromosome walking and characterization of chromosomes, gene identification, gene annotation, forward and reverse genetics. Human Genome Project, genome sequencing projects for microbes, plants and animals, accessing and retrieving genome project information from the web. | | |
| Unit IV | **Comparative genomics** | 5 lectures |
| Identification and classification of organisms using molecular markers- 16S rRNA typing/sequencing, SNPs; Transcriptome analysis, gene ethics; genomics as a tool for evolutionary studies, disease diagnosis and drug designing; Introduction to metabolomics, lipidomics, metagenomics and systems biology. | | |
| Unit V | **Proteomics** | 5 lectures |
| Proteomics: Aims, strategies and challenges; proteomics technologies: 2D-PAGE, isoelectric focusing, mass spectrometry, MALDI-TOF, yeast 2-hybrid system, proteome databases, protein chips and functional proteomics; protein-protein and protein-DNA interactions, clinical and biomedical applications of proteomics | | |

Recommended Textbooks and References:

1. Primrose, S.B., Twyman, R.M., Primrose, S.B., & Primrose, S.B. (2006). *Principles of Gene Manipulation and Genomics*. Malden, MA: Blackwell Pub.
2. Liebler, D.C. (2002). *Introduction to Proteomics: Tools for the New Biology*. Totowa, NJ: Humana Press.
3. Campbell, A.M., & Heyer, L.J. (2003). *Discovering Genomics, Proteomics, and Bioinformatics*. San Francisco: Benjamin Cummings.

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# Molecular Diagnostics

Credits

2

**Course Objectives**

The objectives of this course are to sensitize students about recent advances in molecular biology and various facets of molecular medicine which has potential to profoundly alter many aspects of modern medicine including pre- or post-natal analysis of genetic diseases and identification of individuals predisposed to disease ranging from common cold to cancer.

**Student Learning Outcomes**

Students should be able to understand various facets of molecular procedures and basics of genomics, proteomics and metabolomics that could be employed in early diagnosis and prognosis of human diseases.

| | |
|---|---|
| Unit I<br>**Genome biology in health and disease**<br>4 lectures | Central dogma of molecular biology; human identity; chromosomal abbreviations and diseases; gene linked disorders; clinical variability and genetically determined adverse reactions to drugs. |
| Unit II<br>**Genome: resolution, detection & analysis**<br>8 lectures | PCR and its variants (Real-time; ARMS, Multiplex); In-situ hybridization; Fluorescence in-situ hybridization (FISH); Nucleic acid sequencing; Microarray; Molecular markers; Diagnostic proteomics |
| Unit III<br>**Detection of inherited diseases**<br>8 lectures | Direct detection and identification of pathogenic organisms (culturable and unculturable) Detection of inherited diseases, mutational mechanism of unstable triplet repeats, familial cancer syndromes. |
| Unit VI<br>**Molecular oncology**<br>6 lectures | Detection of recognized genetic aberrations in clinical samples from cancer patients; Predictive biomarkers for personalized onco-therapy of human diseases such as chronic myeloid leukemia, colon, breast, lung cancer and melanoma, targeted therapies |
| Unit VII<br>**Diagnostic metabolomics, Quality assurance and control**<br>4 lecture | Metabolite profile for biomarker detection in the body fluids/tissues in various metabolic disorders by using LCMS & NMR technological platforms.Quality oversight; regulations and approved testing. |

Recommended Textbooks and References:

1. Campbell,A.M.,&Heyer,L.J.(2006).*DiscoveringGenomics,Proteomics, and Bioinformatics*. San Francisco:BenjaminCummings.
2. Brooker,R.J.(2009).*Genetics:Analysis&Principles*.NewYork,NY:McGraw-Hill.

9/11/2021

# Bioprocess Engineering &Technology

Credits

3

Course Objectives

Theobjectivesofthiscoursearetoeducate students about the fundamental concepts of bioprocess technology and its related applications, thus preparing them to meet the challenges of the new and emerging areas of biotechnologyindustry.

Student Learning Outcomes

Students should be able to:

- Appreciate relevance of microorganisms from industrialcontext;
- Carry out stoichiometric calculations and specify models oftheirgrowth;
- Give an account of design and operations of variousfermenters;
- Present unit operations together with the fundamental principles for basic methods in production technique for bio-basedproducts;
- Calculate yield and production rates in a biological production process, and also interpretdata;
- Calculate the need for oxygenandoxygentransfer;
- Criticallyanalyzeanybioprocessfrom market point ofview;
- Give an account of important microbial/enzymatic industrial processes in food andfuelindustry.

9/11/2021

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|---|---|
| Unit I<br>**Basic principles of biochemical engineering** | Isolation, screening and maintenance of industrially important microbes; microbial growth and death kinetics, strain improvement for increased yield and other desirable characteristics. Yield coefficients; unstructured models of microbial growth; structured models of microbial growth |
| Unit II<br>**Bioreactor design and analysis** | Batch, fed-batch and continuous fermenters; immobilized cell systems; large scale animal and plant cell cultivation; upstream processing: media formulation and optimization; sterilization; aeration, agitation and heat transfer in bioprocess; scale up and scale down; measurement and control of bioprocess parameters. |
| Unit III<br>**Downstream processing and product recovery** | Downstream processing: Separation of insoluble products - filtration, centrifugation, sedimentation, flocculation; Cell disruption; separation of soluble products: liquid-liquid extraction, precipitation, chromatographic techniques, reverse osmosis, ultra and micro filtration, electrophoresis; final purification: drying; crystallization; storage and packaging, effluent treatment and disposal. |
| Unit IV<br>**Applications of enzyme technology in food processing** | Mechanism of enzyme function and reactions in process techniques; enzymatic bioconversions *e.g.* starch and sugar conversion processes, inter-esterified fat; hydrolyzed protein *etc.* and their downstream processing; baking by amylases, deoxygenation and desugaring by glucoses oxidase, beer mashing and chill proofing; cheese making by proteases and various other enzyme catalytic actions in food processing. |
| Unit V<br>**Applications of microbial technology** | Fermented foods and beverages; food ingredients and additives prepared by fermentation and their purification; fermentation as a method of preparing and preserving foods; microbes and their use in pickling, producing colours and flavours, alcoholic beverages and other products; process wastes-whey, molasses, starch substrates and other food wastes for bioconversion to useful products; bacteriocins from lactic acid bacteria – production and applications in food preservation; biofuels and biorefinery. |

**Recommended Textbooks and References:**

1. Shuler,M.L.,&Kargi,F.(2002).*BioprocessEngineering:BasicConcepts.* Upper Saddle River, NJ: Prentice Hall.
2. Stanbury,P.F.,&Whitaker,A.(2010).*PrinciplesofFermentationTechnology.*Oxford: PergamonPress.
3. Blanch,H.W.,&Clark,D.S.(1997).*BiochemicalEngineering.*NewYork:M.Dekker.
4. Bailey,J.E.,&Ollis,D.F.(1986).*BiochemicalEngineeringFundamentals.*NewYork: McGraw-Hill.

Department of Biotechnology, GGV

# Environmental Biotechnology

Credits 2

**Course Objectives**

This course aims to introduce fundamentals of Environmental Biotechnology. The course will introduce major groups of microorganisms-tools in biotechnology and their most important environmental applications. The environmental applications of biotechnology will be presented in detail and will be supported by examples from the national and international literature.

**Student Learning Outcomes**

On completion of course, students will be able to understand use of basic microbiological, molecular and analytical methods, which are extensively used in environmental biotechnology.

| | |
|---|---|
| Unit I<br>**Introduction to environment**<br>6 lectures | Introduction to environment; Pollution: air, water, soil, noise; pollution indicators; Climate change, Biodiversity and its conservation; bio geochemical cycles; microbial ecology. |
| Unit II<br>**Waste Management**<br>8 lectures | Waste management: domestic, industrial, and hazardous wastes (storage, transportation, treatment and disposal); solid waste management, wastewater characteristics and treatment, treatment strategies for effluent generated by distillery, paper and pulp industries, textile industries; waste to energy, recycling and reuse. |
| Unit III<br>**Bioremediation**<br>8 lectures | Bioremediation: Fundamentals, technological aspects and strategies, bioremediation of metals, radionuclides, organic pollutants/xenobiotic; Application of bacteria and fungi in bioremediation; Phytoremediation: Fundamentals and description of major methods of application (phytoaccumulation, phytovolatilization, rhizofiltration, phytostabilization). |
| Unit IV<br>**Biotechnology and agriculture**<br>11 lectures | Biopesticides, Bioinsecticides, Biofungicides, Bioherbicides: genetic modifications mode of actions; Biofertilizers: Symbiotic systems between plants–microorganisms, Plant growth promoting rhizobacteria (PGPR) – uses, practical aspects and problems in application. |
| Unit V<br>**Biofuels**<br>8 lectures | Biofuels: production of biogas; bioethanol; biodiesel; Utilizable biomass, microorganisms and biotechnological interventions for optimization of production, Microbial Fuel Cells, Microbiologically enhanced oil recovery (MEOR); Bioleaching of metals; Bioplastic. |

Recommended Textbooks and References:

1. G.M. Evans and J.C. Furlong (2003), *Environmental Biotechnology: Theory*

# Nano-biotechnology

Credits: 3

**Course Objectives**

The course aims at providing a generaland broad introduction to multi-disciplinary field of nanotechnology. It will familiarize students with the combination ofthe top-down approach of microelectronics and micromechanics with the bottom-up approach of chemistry/biochemistry; a development that is creating new and excitingcross-disciplinaryresearchfields andtechnologies.Thecoursewillalsogive an insight into complete systems where nanotechnology can be used to improve our everydaylife.

**Student Learning Outcomes**

On successful completion of this course, students should be able to describe basic science behind the properties of materials at nanometre scale, and the principles behind advanced experimental and computational techniques for studying nanomaterials.

**Unit I — Introduction to nanobiotechnology**

Introduction to Nanobiotechnology; Concepts, historical perspective; Classification of nanomaterials with example for specific cases; Cellular Nanostructures; Nanopores; Biomolecular motors; Bio-inspired Nanostructures, Synthesis and characterization of different nanomaterials

**Unit II — Nano – films**

Nano - films Thin films; Colloidal nanostructures; Self Assembly, Nanovesicles; Nanospheres; Nanocapsules and their characterisation. Nanomaterials for catalysis, development and characterization of nanobiocatalysts, applications of nanobiocatalysis in the production of drugs

**Unit III — Nano – particles**

Nanoparticles for drug delivery, concepts, optimization of nanoparticle properties for suitability of administration through various routes of delivery, advantages, strategies for cellular internalization and long circulation, strategies for enhanced permeation through various anatomical barriers.

**Unit IV — Applications Of nano–particles**

Nanoparticles for diagnostics and imaging (theranostics); concepts of smart stimuli responsive nanoparticles, implications in cancer therapy, nanodevices for biosensor development. Applications of nano-particles

**Unit V — Nano–toxicity**

6 lectures

Nano-toxicity: Introduction to Safety of nanomaterials, Basics of nanotoxicity, Models and assays for Nanotoxicity assessment; Fate of nanomaterials in different stratas of environment; Ecotoxicity models and assays.

Recommended Textbooks and References:

1. GeroDecher, Joseph B. Schlenoff,(2003); *Multilayer Thin Films: Sequential Assembly ofNanocompositeMaterials*,Wiley-VCHVerlagGmbH&Co.KGaA
2. DavidS.Goodsell,(2004);*Bionanotechnology:LessonsfromNature*;Wiley-Liss
3. NeelinaH.Malsch(2005),*BiomedicalNanotechnology*,CRCPress
4. GregT.Hermanson,(2013);*BioconjugateTechniques*,(3rdEdition);Elsevier
5. Recentreviewpapersinthearea ofNanomedicine.

## Vaccines

Credits: 3

**Course Objectives**
This course will provide students with an overview of current developments in different areas of vaccines.

**Student Learning Outcomes**
By the end of this course, students should be able to:
- Understand fundamental concepts of human immune system and basic immunology;
- Differentiate and understand immune responses in relation to infection and vaccination;
- Understand requirement and designing of different types of vaccines;
- Understand importance of conventional and new emerging vaccine technologies.

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|---|---|
| Unit I<br>**Fundamentals of Immune system**<br>6 lectures | Human Immune system: Effectors of immune system; Innate & Adaptive Immunity; Activation of the Innate Immunity; Adaptive Immunity; T and B cells in adaptive immunity; Immune response in infection; Correlates of protection |
| Unit II<br>**Immune response to infection and Cancer**<br>9 lectures | Protective immune response in Infections (bacterial; viral and parasitic infections;) and Cancer. Antigen presenting cells: Dendritic cells in immune response; Cell mediated responses: T cell, B Cell, DC, NK: Memory and effector T and B cells, Generation and Maintenance of memory T and B cells. |
| Unit III<br>**Immune response to vaccination**<br>8 lectures | Vaccination and immune response; Adjuvants in Vaccination; Modulation of immune responses: Induction of Th1 and Th2 responses by using appropriate adjuvants and antigen delivery systems-Microbial-adjuvants, Liposomal and Microparticles as delivery systems; Chemokines and cytokines; Role of soluble mediators in vaccination; Oral immunization and Mucosal Immunity. |
| Unit IV<br>**Vaccine types & design**<br>3 lectures | History of vaccines, Conventional vaccines; Bacterial vaccines; Viral Vaccines; Vaccines based on routes of administration: parenteral, oral, mucosal; Live attenuated and inactivated vaccine; Subunit Vaccines and Toxoids; Peptide Vaccine. |



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| Unit V<br>**Vaccine technologies**<br>4 lectures | New Vaccine Technologies; Rationally designed Vaccines; DNA Vaccination; Mucosal vaccination; New approaches for vaccine delivery; Reverse Vaccinology; Engineering virus vectors for vaccination; Vaccines for targeted delivery (Vaccine Delivery systems); Disease specific vaccine design: Tuberculosis Vaccine; Malaria Vaccine; HIV/AIDS vaccine; New emerging diseases and vaccine needs (Ebola, Zika). |

Recommended Textbooks and References:

1. Janeway, C.A., Travers, P., Walport, M., & Shlomchik, M.J. (2005). *ImmunoBiology: the Immune System in Health and Disease*. USA: Garland Science Pub.
2. Kindt, T.J., Osborne, B.A., Goldsby, R.A., & Kuby, J. (2013). *Kuby Immunology*. New York: W.H. Freeman.
3. Kaufmann, S.H. (2004). *Novel Vaccination Strategies*. Weinheim: Wiley-VCH.
4. Journal Articles (relevant issues) from: Annual Review of Immunology, Annual Review of Microbiology, Current Opinion in Immunology, Nature Immunology, Expert review of vaccines.

## Microbial Technology

Credits

3

Course Objectives
The objectives of this course are to introduce students to developments/ advances made in field of microbial technology for use in human welfare and solving problems of the society.

Student Learning Outcomes
On completion of this course, students would develop deeper understanding of the microbial technology and its applications.

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| Unit I<br>**Introduction to microbial technology**<br>8 lectures | Microbial technology in human welfare; Isolation and screening of microbes important for industry; extremophiles: halophiles, thermophiles, psychrophiles as source of industrially important products, advantages of microbial technology |
| Unit II<br>**Environmental applications of microbial technology**<br>6 lectures | Environmental application of microbes; bioleaching; Biodegradation; Bioremediation - toxic waste removal and soil remediation; Global Biogeochemical cycles; Environment sensing (sensor organisms/ biological sensors); International and National guidelines regarding use of genetically modified organisms in environment, food and pharmaceuticals. |
| Unit III<br>**Pharmaceutical applications of microbial technology**<br>8 lectures | Microbial products in pharmaceutical industry, Recombinant protein and pharmaceuticals production in microbes; Antibiotics and enzymes production, Microbial cell factories; Downstream processing approaches used in industrial production process, microbes in targeted delivery application – drugs and vaccines (bacterial and viral vectors) |
| Unit IV<br>**Food applications of microbial technology**<br>7 lectures | Application of microbes and microbial processes in food, food preservation, Non-recombinant ways of introducing desirable properties in Generally recognized as safe (GRAS); microbes to be used in food (*e.g.*, Yeast), fermented food products (beverages and dairy products), genetically modified foods. |
| Unit V<br>**Advances in microbial technology**<br>8 lectures | Microbial genomics for discovery of novel enzymes, drugs/ antibiotics;Metagenomics and metatranscriptomics,metagenomic library construction and functional screening in suitable hosts, Advanced genome and epigenome editing tools |

## Bioentrepreneurship

Credits 3

Research and business belong together and both are needed. In a rapidly developing life science industry, there is an urgent need for people who combine business knowledge with the understanding of science & technology.
Bio-entrepreneurship, an interdisciplinary course, revolves around the central theme of how to manage and develop life science companies and projects. The objectives of this course are to teach students about concepts of entrepreneurship including identifying a winning business opportunity, gathering funding and launching a business, growing and nurturing the organization and harvesting there wards.

Students should be able to gain entrepreneurial skills, understand the various operations involved in venture creation, idenrify scope for entrepreneurship in biosciences and utilize the schemes promoted through knowledge centers and various agencies. The knowledge pertaining to management should also help students to be able to build up a strong network within the industry.

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| Unit I<br>**Innovation and entrepreneurship in bio-business**<br>8 lectures | Introduction and scope in Bio-entrepreneurship, Types of bio-industries and competitive dynamics between the sub-industries of the bio-sector (*e.g.* pharmaceuticals vs. Industrial biotech), Strategy and operations of bio-sector firms: Factors shaping opportunities for innovation and entrepreneurship in bio-sectors, and the business implications of those opportunities |
| Unit II<br>**Management and funding agencies**<br>**4 lectures** | Management definition, scope, function, levels, roles, Entrepreneurship development programs of public and private agencies including Small & Medium Enterprises (MSME),DBT, BIRAC, Make in India, strategic dimensions of patenting & commercialization strategies |
| Unit III<br>**Bio-markets and Marketing**<br>**4 lectures** | Negotiating the road from lab to the market, strategies and processes of negotiation with financiers, government and regulatory authorities, Pricing strategy, market development expansion, Ansoff Matrix, market development tools and concepts, PTM matrix |
| Unit IV<br>**Finance and accounting**<br>4 lectures | Basic contract principles, different types of agreement and contract terms typically found in joint venture and development agreements, Dispute resolution skills. Business plan preparation including statutory and legal requirements, Business feasibility study, Collaborations & partnership, Information technology |
| Unit V<br>**Technology management**<br>8 lectures | Quality control & transfer of foreign technologies, Knowledge centers and Technology transfer agencies, Understanding of regulatory compliances and procedures of Central Drugs Standard Control Organisation (CDSCO),differences between Good Laboratory Practice (GLP) regulations, Good Clinical Practice (GCP), and Good Manufacturing Practice (GMP) regulations |

Recommended Textbooks and References: