AC ??/??/2014 Item no. ?.??

# UNIVERSITY OF MUMBAI

**Revised Syllabus**
Program - **Bachelor of Engineering**
Course - **Biotechnology**
(Third year - Sem V and VI)

under
**Faculty of Technology**
(As per Credit Based Semester and Grading System from 2014-15)

# General Guidelines

## Tutorials

- The number of tutorial batches can be decided based on facilities available in the institution.
- Tutorials can be creative assignments in the form of models, charts, projects, etc.

## Term Work

- Term work will be an evaluation of the tutorial work done over the entire semester.
- It is suggested that each tutorial be graded immediately and an average be taken at the end.
- A minimum of ten (unless specified in course syllabus) tutorials will form the basis for final evaluation.

## Theory Examination

- In general all theory examinations will be of 3 hours duration.
- Question paper will comprise of total six questions, each of 20 Marks.
- Only four questions need to be solved.
- Question one will be compulsory and based on maximum part of the syllabus.

**Note:** In question paper, weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus as far as possible.

## Practical Examination

- Duration for practical examination would be the same as assigned to the respective lab per week.
- A student becomes eligible for practical examination after completing a minimum of eight experiments out of ten experiments(unless specified minimum requirement in syllabus).

# University of Mumbai

## Scheme for TE: Semester-V

| Course Code | Course Name | Teaching Scheme | | | Credit Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Pract. | Tut. | Theory | Pract. | Tut. | Total |
| BTC501 | Bioinformatics-1 | 04 | – | – | 4.0 | – | – | 4.0 |
| BTC502 | Genetic Engineering | 04 | – | – | 4.0 | – | – | 4.0 |
| BTC503 | Biophysics | 03 | – | 01 | 3.0 | – | 1.0 | 4.0 |
| BTC504 | Thermodynamics & Biochemical Engineering | 03 | – | 01 | 3.0 | – | 1.0 | 4.0 |
| BTC505 | Bioreactor Analysis & technology | 03 | – | 01 | 3.0 | – | 1.0 | 4.0 |
| BTC506 | Business Communication & Ethics | – | 02* + 02 | – | – | 2.0 | – | 2.0 |
| BTL507 | Lab – I | – | 03 | – | – | 1.5 | – | 1.5 |
| BTL508 | Lab – II | – | 03 | – | – | 1.5 | – | 1.5 |
| | **Total** | 17 | 10 | 03 | 17.0 | 5.0 | 3.0 | 25.0 |

*Theory for entire class.

### Examination Scheme

| Course Code | Course Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory marks | | | | Term Work | Pract. | Oral | Total |
| | | Internal Assessment | | | End Sem. Exam | | | | |
| | | Test 1 | Test 2 | Avg. of Test 1 and Test 2 | | | | | |
| BTC501 | Bioinformatics-1 | 20 | 20 | 20 | 80 | – | – | – | 100 |
| BTC502 | Genetic Engineering | 20 | 20 | 20 | 80 | – | – | – | 100 |
| BTC503 | Biophysics | 20 | 20 | 20 | 80 | 25 | – | – | 125 |
| BTC504 | Thermodynamics & Biochemical Engineering | 20 | 20 | 20 | 80 | 25 | – | – | 125 |
| BTC505 | Bioreactor Analysis & technology | 20 | 20 | 20 | 80 | 25 | – | – | 125 |
| BTC506 | Business Communication & Ethics | – | – | – | – | 50 | – | – | 50 |
| BTL507 | Lab – I | – | – | – | – | – | 25 | – | 25 |
| BTL508 | Lab – II | – | – | – | – | – | 25 | 25 | 50 |
| | | | **Total** | 100 | 400 | 125 | 50 | 25 | 700 |

| Course Code | Course Name | Credits |
|---|---|---|
| BTC501 | Bioinformatics I | 4.0 |

## Prerequisites

Basic knowledge of computers, Biochemistry : Structures of DNA, RNA & Proteins.

## Course Objectives

The objectives of this course are to :

- To develop skills of the Students in the area of Bioinformatics particularly to make them to learn all the techniques used with biological data
- To study various databases of DNA & Proteins along with current bioinformatics concepts & their implementation
- To help students to easily handle proteins by studying in detail about protein structure.
- To become knowledgeable about the storage, retrieval, sharing and use of biological data, information, and tools.

## Course Outcomes

By learning this course the students will be able to :

- To cast a molecular biology problem as a bioinformatics problem, select relevant tools, optimize their settings and build pipelines to solve the set problem.
- To easily extract the required data from a given set of data & similarly be able to store it.
- To use conventional softwares and web-based applications.
- To analyze processed data with the support of analytical and visualization tools.

## Detail syllabus

| Module | Contents | No. of hrs |
|---|---|---|
| 1 | **Introduction to bioinformatics:**<br>Types of biological data, Sequencing Methods : DNA (Maxim Gilbert Method, Sangers Method ) & Protein (MS-MS Analysis), Genomic Sequencing, ESTs and SNPs, Applications of bioinformatics. | 10 |
| 2 | **Databases Types of databases:**<br>Based on storage techniques (Flat , Relational, Object Oriented ), Based on data ( Primary, Secondary , Specialized ) Search engines : Entrez & SRS Sequence databases: NCBI , EMBL , DDBJ<br>Structural databases : PDB<br>Protein Databases : PIR ,SWISS PROT<br>Other Databases : KEGG , TrEMBL , EBI. | 10 |
| 3 | Alignment: Global Alignment ,Local Alignment, Pair Wise Sequence Alignment: Dot Matrix Alignment<br>Dynamic programming Methods : Needleman Wunch Algorithm, Smith Waterman Algorithm, Heuristic Method : BLAST ,FASTA<br>Amino Acid Substitution Matrices: PAM , BLOSSUM<br>Multiple Alignment: CLUSTAL W<br>Phylogenetic Analysis. | 12 |

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| Module | Contents | No. of hrs |
|---|---|---|
| 4 | **Visualization:**<br>Methods for representing biological data, Rasmol, Swiss PDB, 3D Structure Viewers. | 05 |
| 5 | Proteins: Structure , Classification ,Classification databases<br>Protein Structure prediction : Primary Structure Prediction, Secondary Structure Prediction, Tertiary Structure Prediction, Homology Modelling, Chao-Fasman Algorithm, Neural Networks, Ab-Initio Modelling, Fold recognition (Threading) | 10 |
| 6 | Drug discovery Markov chains Hidden markov models. | 05 |

## References


1. Oreilly , Developing bioinformatics computer skills, Shroff publishers, 1st Indian edition
2. David mount, Bioinformatics sequence and genome analysis , CBS publishers, 2nd edition
3. N. Gautam , Bioinformatics databases & algorithm, Narosa publication
4. S. Ignacimuthu S.J , Basic bioinformatics , Narosa publications
5. T. K. Attwood , Introduction to bioinformatics, Pearson education, 8th reprint
6. R6 : S. C. Rastogi , Bioinformatics concepts ,skills & applications , CBS publishers, 1st edition

| Course Code | Course Name | Credits |
|---|---|---|
| BTC502 | Genetic Engineering | 4.0 |

## Prerequisites

Knowledge of Biochemistry, Microbiology, Molecular Biology, Genetics.

## Course Objectives

The objectives of this course are to

- Give insight into the functioning of Recombinant DNA molecules, their constructions, analysis and fine tuning. To engineer such molecules for making of difficult bio-molecules.
- This course also gives various ideas and approaches by different schools of thoughts.

## Course Outcomes

By learning this course the students will be able to

- Understand how recombinant molecules are created, analysed with respect to DNA, RNA, Protein.
- They also will be familiar with the problems they could encounter and how to trouble shoot them.
- They will be able to monitor both in-vitro and in-vivo activity.
- They will be able to suggest more rational approach to solve problem of a living system, at a molecular level.

## Detail syllabus

| Module | Contents | No. of hrs |
|---|---|---|
| 1 | DNA structure, topology, Superhelical and relaxed molecules. Plasmids in nature, Fundamentals of Density gradient Centrifugation and Alkaline lysis for Plasmid preparation. | 6 |
| 2 | Palindromes and repeat structures. Restriction Endonucleases and their action. Vectors used for Gene-cloning: Plasmids (e.g pUC type, conjugative, Ti etc.), Phages (Lambda and M13 type), Cosmids and Phagemids. | 8 |
| 3 | **Cloning strategies:**<br>Expression and Fusion vectors Stability of plasmids(PAR locus, High copy number etc) Library construction (Genomic and C-DNA type), and Screening for the clone. | 7 |
| 4 | **DNA transfer into cells:**<br>Transformation and Transfection<br>Membrane Fusion and Electroporation<br>Gene-Gun and Micro-injection | 7 |
| 5 | **Enzymes for Recombinant Technology:**<br>Restriction Endonucleases, DNA polymerases, Reverse Transcriptase, Polynucleotide Kinase, Terminal Transferase, Alkaline Phosphatase, S1-Nuclease, Bal-31, DNA Ligase. | 8 |

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| Module | Contents | No. of hrs |
|---|---|---|
| 6 | **DNA and Protein Analysis:** DNA: Southern and Northern Hybridization. PCR Amplification, DNA Sequence Analysis (e.g Sangers Method), Automated Sequencing, RFLP and RAPD. Protein: Western Blotting, ELISA and its variations. | 8 |
| 7 | Antisense and RNA interference Technology and their Applications. r-DNA in medicine, e.g. Insulin and Blood clotting factor VIII. Use of cell-lines in bio-molecules production. | 8 |

## References


1. Molecular Biology of the Cell: Alberts et al. 5th. Ed. Garland Publications.
2. Genes VIII: Benjamin Levine, Oxford University Press.
3. Principle of Gene Manipulations (2004): S. B. Primrose, R. M. Twyman & R. W. Old. Sixth edition. Blackwell Science.
4. Gene Cloning and DNA analysis: An Introduction.(2006). T. A. Brown. Blackwell Publishing.

| Course Code | Course Name | Credits |
|---|---|---|
| BTC503 | Biophysics | 4.0 |

## Prerequisites

Knowledge of Chemistry, Physics, Atomic physics, Biochemistry, Molecular Biology.

## Course Objectives

The objectives of this course are to:

- Give insight into the structure of various macro-molecules, their constructions, analysis and interactions.

## Course Outcomes

By learning this course the students will be able to:

- Understand how molecules are created, and studied.
- They will be able to monitor both in-vitro and in-vivo activity and interactions.

## Detail syllabus

| Module | Contents | No. of hrs |
|---|---|---|
| 1 | **Introduction to Biophysics.** Physicochemical properties of biological macromolecules and their complexes, Structural studies of Nucleic Acids, Proteins, lipids and Carbohydrates. Approaches: Electron Microscopy, Atomic Force Microscopy, X ray Crystallography, NMR Spectroscopy. | 8 |
| 2 | **Nucleic Acid interactions:** Different nucleic acid carrier proteins, Carrier RNA, snRNA, Interactions between DNA & protein, Zinc finger proteins, various nucleic acid binding proteins, Nuclear transport. | 8 |
| 3 | **Membrane Structure & Properties** The principles governing the structures of biological membrane, Two-dimensional fluids, Assembly of membrane components. | 7 |
| 4 | **Protein Structural study.** Proteins - Intra- and inter-molecular forces, helix-coil transitions and protein folding in a thermodynamical context, Secondary Motifs, Tertiary Architecture and Quaternary Organization, crystallization, diffraction theory, phasing techniques and structure validation. | 8 |
| 5 | **Lipids & their Interaction.** Details of Lipid Structures, Lipoproteins and Glycolipids. High density (HDL) and low density (LDL) lipoprotein, energetics-structure-function relationship in exchangeable apolipoproteins and lipoproteins, Disorder caused by saturated fat and cholesterol. Arteriosclerosis. | 8 |

## References


1. Cantor R, Samual P. R. (1985). Biophysical Chemistry. W. H. Freeman & Co.
2. Van Holde Johnson and Ho. (2006) Principles of Physical Biochemistry. Second Edition, Pearson Prentice Hall.
3. Igor N. Serdyuk, Nathan R. Zaccai, & Joseph Zac. Methods in Molecular Biophysics: Structure, dynamics and Function. Cambridge University Press.
4. Physical Biocheistry: Principles and applications by David Sheehan, Jon Wiley & Sons.

| Course Code | Course Name | Credits |
|---|---|---|
| BTC504 | Thermodynamics & Biochemical Engineering | 4.0 |

## Prerequisites

Knowledge of phase rule, knowledge of differentiation & Integration

## Course Objectives

- To study the basic concepts of the energy flow in and out of the system.
- To apply the thermodynamic principles to the biochemical reactions.
- To check the feasibility of the reaction.

## Course Outcomes

The student will be able to check the feasibility of a reaction.

## Detail syllabus

| Module | Contents | No. of hrs |
|---|---|---|
| 1 | **Basic Concepts:**<br>System, Surrounding & Processes, Closed and Open systems, State and Properties, Intensive & Extensive Properties, State and Path functions, Equilibrium state and Phase rule, Zeroth law of Thermodynamics, Heat reservoir and Heat engines, Reversible and Irreversible processes. | 04 |
| 2 | **Laws of Thermodynamics:**<br>General statement of First law of Thermodynamics, First law for Cyclic Process, Non-Flow Process, Flow process, Heat capacity. General statements of the second law, Concept of entropy, The Carnot principle, Calculation of entropy changes, Clausius inequality, Entropy and Irreversibility, Third law of Thermodynamics. | 5 |
| 3 | **PVT Behaviour:**<br>PVT behaviour of pure fluids, equations of state and ideal gas law, Processes involving ideal gas law: Constant volume, constant pressure constant temperature, adiabatic and polytrophic processes. Equations of state for real gases: Van-der Waals equation, Redlich- Kwong equation, Peng-Robinson equation, virial equation. | 5 |
| 4 | **Biochemical Energetics:**<br>Coupled reactions and energy rise compounds,Reaction Stoichiometry, criteria of biochemical reaction equilibrium,equilibrium constant and standard free energy change, effect of temperature, pressure on free energy change,effect of temperature, pressure on equilibrium constants and other- factors affecting equilibrium conversion.<br>Le Chateliers principle, liquid phase reactions, heterogeneous bioreaction equilibria, phase rule for reacting systems . | 5 |

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| Module | Contents | No. of hrs |
|---|---|---|
| 5 | **Properties of Pure Fluids:** Principles of corresponding states, Generalized compressibility charts. Reference properties,energy properties, Derived properties, Helmholtz free energy, Gibbs free energy, Relationships among thermodynamic Properties: Exact differential equations, fundamental property relations, Maxwell's equations, Clapeyron equations, Entropy heat capacity relations, modified equations for internal energy (U) & enthalpy (H), Effect of temperature on U, H & Entropy (S), Relationships between Cp & Cv, Gibbs- Helmholtz equation. | 6 |
| 6 | **Fugacity and Activity:** Fugacity: Fugacity, Fugacity coefficient, effect of temperature and pressure on fugacity, Determination of fugacity of pure gases, Fugacities of solids and liquids, Activity: Effect of temperature and pressure on activity. Departure functions and generalized charts, thermodynamic diagrams types of diagrams and construction of thermodynamic diagrams. | 4 |
| 7 | **Properties of Solutions:** Partial molar properties - Partial molar properties of solutions,determination of partial molar properties, chemical potential effect of temperature and pressure, lewis randall rule, Raoults law for ideal solutions, Henry's law and dilute solutions ideal behavior of real solutions and Henrys law, Activity in solutions, Activity coefficients effect of temperature and pressure, Gibbs - Duhem equation, Property changes of mixing, excess properties excess Gibbs free energy. | 6 |
| 8 | **Phase Equilibria:** Criteria of phase Equilibria, criterion of stability, Duhem's theorem, Vapour-Liquid Equilibria, VLE in ideal solutions, Non-Ideal solutions - azeotropes, VLE at low pressures activity co efficient equation, bubble point and dew point equilibria, Consistency test for VLE data using slope of ln ? curves, using partial pressure data, calculation of activity coefficients using Gibbs - Duhem equation, Liquid-Liquid Equilibrium diagrams binary liquid Equilibrium diagrams. | 4 |

## References


1. Smith, J.M., Van Ness, H.C., and Abbott, M.M.,Introduction to Chemical Engineering Thermodynamics,McGraw-Hill, Inc..
2. Kyle, B.G., Chemical and Process Thermodynamics, Prentice Hall, Inc.
3. Hougen, O.A., Watson, K.M., and Ragatz, R.A., Chemical Process Principles Part II, John Wiley & Sons, (CBS Publishers & Distributors, New Delhi).

| Course Code | Course Name | Credits |
|---|---|---|
| BTC505 | Bioreactor Analysis & Technology | 4.0 |

## Prerequisites

Knowledge of chemical reaction kinetics, Knowledge of differentiation and integration

## Course Objectives

- To understand the basic concepts of Bioreactor design.
- To select the relevant principles and data for practical process engineering purposes.

## Course Outcomes

- Student will be able to understand the different types of ideal and non- ideal reactors.
- Student will be able to design the reactors required for a particular processes.

## Detail syllabus

| Module | Contents | No. of hrs |
|---|---|---|
| 1 | Basic Reaction Kinetics: Reaction thermodynamics, order and molecularity of reaction, homogeneous and heterogeneous reactions, elementary and non elementary reactions, reaction yield, reaction rate, calculation of reaction rates from experimental data, general reaction kinetics for biological system, production kinetics in cell culture, kinetics of substrate uptake in cell culture, growth kinetics with plasmid instability | 7 |
| 2 | Ideal Reactors: Constant volume and variable reactors, batch operation of a well mixed enzyme and cell culture reactor, fed batch operation of a well mixed enzyme and cell culture reactor, continuous operation of well mixed enzyme and cell culture reactor, continuous operation of plug flow enzyme and cell culture reactor, autocatalytic reactions, recycle reactors-plug flow reactor and continuous stirred tank reactor, comparison between major modes of reactor operation. | 8 |
| 3 | Multiple Reactors and Reaction Systems: Continuous stirred tank reactors of equal size in series, continuous stirred tank reactors of unequal size in series, finding conversion in given system, determining the best system for a given conversion, plug flow reactors in series and parallel, reactors of different types in series. Simple reactions ,stepwise reactions, parallel reactions ,series reactions, maximizing R in batch reactor , plug flow reactor and continuous stirred tank reactor, reactor choice for series reactions and series parallel reactions, concepts of reversible reactions. | 8 |
| 4 | Heterogeneous Reactions: Heterogeneous reactions in Bioprocessing, Concentration gradients and reaction rates in solid catalysts, Internal mass transfer and reactions, steady state mass balance (spherical geometry), Concentration profile for first order kinetics, Concentration profile for zero order kinetics, Concentration profile for Michaelis-Menten kinetics, Effectiveness factor and Thiele Modulus, External mass transfer | 7 |

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| Module | Contents | No. of hrs |
|---|---|---|
| 5 | Deviations from ideal reactors: Concept of non ideality, reasons of non ideality, RTD studies, F curve, C curve, E curve, diagnosis of ills of flow reactors, modeling of non ideal behaviour-dispersion model, tanks in series model. | 5 |
| 6 | Working principle of unconventional reactors: Selection criterion for bioreactors, Bubble column, Air lift reactor, Fluidized bed reactor, perfusion reactors, membrane reactors | 4 |

## References


1. D.G.Rao, Introduction to Biochemical Engg,, Tata McGraw Hill Edu. Pvt. Ltd., Second edition .
2. P.M.Doran, Bioprocesses Engg. Principles, Academic Press, London, Second edition.
3. E.H. Perry 7 D.W. Green, Perrys Chemical Engineering Handbook, Seventh edition.
4. Octave Levenspiel, Chemical Reaction Engineering, John Wiley Publication, Third Edn
5. H Scott Fogler"Elements of Chemical Reaction engineering"Prentice Hall, 2006

| Course Code | Course Name | Credits |
|---|---|---|
| BTC506 | Business Communication & Ethics | 2.0 |

## Course Objectives

- To inculcate in students professional and ethical attitude, effective communication skills, teamwork, skills, multidisciplinary approach and an ability to understand engineers social responsibilities.
- To provide students with an academic environment where they will be aware of the excellence, leadership and lifelong learning needed for a successful professional career.
- To inculcate professional ethics and codes of professional practice.
- To prepare students for successful careers that meets the global Industrial and Corporate requirement provide an environment for students to work on Multidisciplinary projects as part of different teams to enhance their team building capabilities like leadership, motivation, teamwork etc.

## Course Outcomes

A learner will be able to

- Communicate effectively in both verbal and written form and demonstrate knowledge of professional and ethical responsibilities,
- participate and succeed in Campus placements and competitive examinations like GATE, CET,
- possess entrepreneurial approach and ability for life-long learning,
- have education necessary for understanding the impact of engineering solutions on Society and demonstrate awareness of contemporary issues.

## Detail syllabus

| Module | Contents | No. of hrs |
|---|---|---|
| 1 | Report Writing: Objectives of report writing Language and Style in a report Types of reports Formats of reports: Memo, letter, project and survey based | 7 |
| 2 | Technical Proposals Objective of technical proposals Parts of proposal | 2 |
| 3 | Introduction to Interpersonal Skills Emotional Intelligence Leadership Team Buliding Assertiveness Conflict Resolution Negotiation Skills Motivation Time Management | 7 |
| 4 | Meetings and Documentation Strategies for conducting effective meetings Notice Agenda Minutes of the meeting | 2 |
| 5 | Introduction to Corporate Ethics and etiquettes Business Meeting etiquettes, Interview etiquettes, Professional and work etiquettes, Social skills Greetings and Art of Conversation Dressing and Grooming Dinning etiquette Ethical codes of conduct in business and corporate activities (Personal ethics, conflicting values, choosing a moral response, the process of making ethical decisions) | 2 |
| 6 | Employment Skills Cover letter Resume Group Discussion Presentation Skills Interview Skills | 6 |

## References


1. Fred Luthans, Organizational Behavior , Mc Graw Hill, edition
2. Lesiker and Petit, Report Writing for Business , Mc Graw Hill, edition
3. Huckin and Olsen, Technical Writing and Professional Communication, McGraw Hill
4. Wallace and Masters, Personal Development for Life and Work , Thomson Learning, 12th edition
5. Heta Murphy, Effective Business Communication , Mc Graw Hill, edition
6. R.C Sharma and Krishna Mohan, Business Correspondence and Report Writing,
7. B N Ghosh, Managing Soft Skills for Personality Development, Tata McGraw Hill. Lehman,
8. Dufrene, Sinha, BCOM, Cengage Learning, 2nd edition
9. Bell . Smith, Management Communication Wiley India Edition,3rd edition.
10. Dr. K. Alex ,Soft Skills, S Chand and Company
11. Dr.KAlex,SoftSkills,S Chand and Company
12. R.Subramaniam, Professional Ethics Oxford University Press 2013.

| Course Code | Course Name | Credits |
|---|---|---|
| BTL507 | Lab I | 1.5 |

## Suggested experiments

- Physical method of microbial control.
- Chemical method of microbial control.
- Isolation of bioluminescent organisms.
- Diauxic growth curve of E.Coli.
- Detection of Amino acid producer from soil.
- Acid fast staining for mycobacteria.
- Study of air microflora & determination of sedimentation rate.
- Blood film preparation and identification of cells
- Antibiotic susceptibility test.
- E Test
- Blood group typing using haemagglutination tests.
- To detect the antigen/antibody using Enzyme Linked Immuno Sorbent Assay (ELISA)
- To test the pattern of antigen-antibody interaction through Ouchterlony double diffusion assay
- RID
- Lymphoid organs and their microscopic organization
- Separation of mononuclear cells by Ficoll-Hypaque
- VDRL test (Demonstration)
- Immunodiagnostics (demonstration using commercial kits)
- Determination of MIC of antibacterial drugs
- Identification of Ag  Ab complex by Slide agglutination test

| Course Code | Course Name | Credits |
|---|---|---|
| BTL508 | Lab II | 1.5 |

## Suggested experiments

- Making the bacterial cells competent
- Transformation of E.coli.
- In vitro DNA ligation
- Bacterial conjugation
- Northern blotting technique
- Southern blotting
- RFLP technique
- PCR analysis of DNA fragments by agarose gel electrophoresis
- Protein Analysis by SDS-PAGE
- Isolation of Genomic DNA
- Bacterial survival against UV irradiation and mutagenesis
- Isolation, purification, quantification and separation of plasmid DNA by miniprep method (Boiling lysis)
- Isolation, purification, quantification and separation of plasmid DNA by maxiprep method (Alkaline lysis)
- separation of DNA by Agarose gel electrophoresis
- Isolation of mutants, e.g. auxotrophs, by chemical mutagenesis. (Acridine orange/ Ethydium bromide)
- $\beta$-galactosidase activity of lac+ & lac– mutant of E.coli
- Primary screening of antibiotic producers from soil

# University of Mumbai

## Scheme for TE: Semester-VI

| Subject Code | Subject Name | Teaching Scheme | | | Credit Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Pract. | Tut. | Theory | Pract. | Tut. | Total |
| CHC601 | Bioinformatics-II | 03 | – | – | 3.0 | – | – | 3.0 |
| CHC602 | Cell & Tissue Culture | 04 | – | – | 4.0 | – | – | 4.0 |
| CHC603 | Enzyme Engineering | 03 | – | – | 3.0 | – | – | 3.0 |
| CHC604 | IPR,Bioethics & Biosafety | 03 | – | 01 | 3.0 | – | 1.0 | 4.0 |
| CHC605 | Process Control & Instrumentation | 03 | – | 01 | 3.0 | – | 1.0 | 4.0 |
| CHE606 | Elective – I | 03 | – | 01 | 3.0 | – | 1.0 | 4.0 |
| CHL607 | Lab – III | – | 03 | – | – | 1.5 | – | 1.5 |
| CHL608 | Lab – IV | – | 03 | – | – | 1.5 | – | 1.5 |
| CHL609 | Lab – V | – | 02 | – | – | 1.0 | – | 1.0 |
| | **Total** | 19 | 08 | 03 | 19.0 | 4.0 | 3.0 | 26.0 |

### Examination Scheme

| Subject Code | Subject Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory marks | | | | Term Work | Pract. | Oral | Total |
| | | Internal Assessment | | | End Sem. Exam | | | | |
| | | Test 1 | Test 2 | Avg. of Test 1 and Test 2 | | | | | |
| CHC601 | Bioinformatics-II | 20 | 20 | 20 | 80 | – | – | – | 100 |
| CHC602 | Cell & Tissue Culture | 20 | 20 | 20 | 80 | – | – | – | 100 |
| CHC603 | Enzyme Engineering | 20 | 20 | 20 | 80 | – | – | – | 100 |
| CHC604 | IPR,Bioethics & Biosafety | 20 | 20 | 20 | 80 | 25 | – | – | 125 |
| CHC605 | Process Control & Instrumentation | 20 | 20 | 20 | 80 | 25 | – | – | 125 |
| CHE606 | Elective – I | 20 | 20 | 20 | 80 | 25 | – | – | 125 |
| CHL607 | Lab – III | – | – | – | – | – | 25 | – | 25 |
| CHL609 | Lab – IV | – | – | – | – | – | 25 | – | 25 |
| CHL610 | Lab – V | – | – | – | – | – | 25 | – | 25 |
| | | | **Total** | 120 | 480 | 75 | 75 | – | 750 |

### Elective Streams(CHE606)

| | |
|---|---|
| a | Research Methodology and Scientific writing |
| b | Stem Cell Biology |
| c | Good Laboratory Practices (GLP) & Process Safety |

| Course Code | Course Name | Credits |
|---|---|---|
| BTC601 | Bioinformatics II | 3.0 |

## Prerequisites

Bioinformatics I, Knowledge of protein structure.

## Course Objectives

The objectives of this course are to

- Study the development and implementation of tools that enables to efficiently access and manage various types of information.
- Study the development of new algorithms (mathematical formulas) and statistics used to assess relationships among members of large data sets. For example, methods to locate a gene within a sequence, predict protein structure and/or function, and cluster protein sequences into families of related sequences.
- The primary goal of bioinformatics is to increase the understanding of biological processes. What sets it apart from other approaches, however, is its focus on developing and applying computationally intensive techniques to achieve this goal.
- Help have a better knowledge of pharmaceutical biology & its relation with information technology.

## Course Outcomes

By learning this course the students will be able to:

- Describe the contents and properties of the most important bioinformatical databases, perform text- and sequence-based searches, and analyse and discuss the results in light of molecular biological knowledge
- Explain the major steps in pairwise and multiple sequence alignment, explain the principle for, and execute pairwise sequence alignment by dynamic programming
- Explain the major features of evolution of genes and proteins and explain how different methods can be used to construct phylogenetic trees.
- Explain the major features of methods for modelling protein structures and use programs for visualizing and analysing such structures.
- Give examples of methods for describing and analysing genes, genomes and gene expression
- To solve any biological sequence analysis problem, with choosing & modifying suitable computational model to solve it.

## Detail syllabus

| Module | Contents | No. of hrs |
|---|---|---|
| 1 | Introduction to concepts of molecular modelling, Methods of molecular modelling: Molecular mechanics, Abinitio Quantum mechanics, Semi empirical quantum mechanics, Energy minimization of molecules: local & global energy minima. | 10 |

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| Module | Contents | No. of hrs |
|---|---|---|
| 2 | Interactions: Protein ligand interactions, Torsion angle, Ramchandran plot, Protein folding & Chaperones. Cartesian coordidates | 10 |
| 3 | Overview: Machine learning, Genetic algorithms, Simulated annealing.<br>Interoperability: Introduction, Its role in bioinformatics.<br>Interexchange Languages: XML, CORBA, And UMLS. Clustering algorithms. | 08 |
| 4 | Drug designing: Drug optimization, Identification of pharmacophore, Optimizing access to target, Prodrugs, Endogenous compounds as drugs, Quantitative structure- activity relationship (QSAR). | 05 |
| 5 | Docking: Introduction, Protein protein docking, Protein Ligand docking, Applications of docking. | 06 |

## References


1. Cynthia Gibas & Per Jambeck, Developing Bioinformatics computer skills, third edition.
2. S.C. Rastogi, Bioinformatics concepts, skills & applications, first edition.
3. DovStekel, Microarray Bioinformatics.
4. David W.Mount, Bioinformatics sequence and genome analysis.
5. N.Claude Cohen, Molecular modeling in drug design.
6. Oreilly , Developing bioinformatics computer skills, Shroff publishers, 1st Indian edition.

| Course Code | Course Name | Credits |
|---|---|---|
| BTC602 | Cell and Tissue Culture | 4.0 |

## Prerequisites

Basic knowledge of Cell Biology, Microbiology and Plant and Animal Physiology

## Course Objectives

The objectives of this course are to :

- To examine and analyse practical and theoretical principles of cell culture
- To explain the conditions under which cells can be cultured outside the body
- To explain the advantages and limitations of cell culture in biomedical research and applications.

## Course Outcomes

By learning this course the students will be able to :

- Plan experiments using cultured cells
- Carry out cell culture, and associated laboratory techniques
- Carry out the most common analysis techniques associated with cell culture
- Perform adequate statistical processing of data generated by cell culture
- Present and analyse literature which covers cell culture

## Detail syllabus

| Module | Contents | No. of hrs |
|---|---|---|
| 1 | **Plant tissue culture Introduction:** Internal organization of plant, Plant Tissue Culture Media, Plant growth hormones, Concept of Totipotency, Study of various types of Organ Culture, Organogenesis, Micropropagation | 7 |
| 2 | **Plant Cell Culture And its Applications:** Plant Cell Suspension Culture, Single Cell Culture, Somatic Embryogenesis, Artificial Seeds, Protoplast Culture & Somatic Hybridization, Scale-up and Automation of Plant Cell Culture | 8 |
| 3 | **Transformation of Plants:** Agrobacterium mediated Gene transfer, Direct Methods of Gene Transfer, Chemical Methods, Electroporation, Microinjection, Particle Bombardment, Virus Mediated Gene Transfer, Transgenic Plants, Applications of Plant Biotechnology for Production of Quality Oil, Industrial Enzymes and Plantibodies | 8 |
| 4 | Introduction to Animal Cell Culture: Historical Background, Advantages of Tissue Culture, Limitations, Major Types of Tissue Culture | 5 |

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| Module | Contents | No. of hrs |
|---|---|---|
| 5 | Laboratory Design & Layout of ATC laboratory, Equipments and Materials Of a Tissue Culture Laboratory, Media Preparation and Sterilization techniques, The Culture Environment, Cell Adhesion, Cell Proliferation, Differentiation, Cell Signaling, Energy Metabolism. | 10 |
| 6 | **Primary Culture:** Initiation of a Primary Cell Culture, Isolation of the Tissue, Types of Primary Culture, Subculture and Cell Lines. | 7 |
| 7 | Cloning and Selection of Animal Cells, Cell Separation, Characterization, Differentiation, Cryopreservation, Scale-up & Automation, Antibody Engineering and Large scale Production of Pharmaceutical Products, Stem cell Cultures, Embryonic Stem Cell Cultures and their Applications | 7 |

## References


1. Plant Tissue Culture: Theory and Practice: Theory and Practice By S.S. Bhojwani, M.K. Razdan; Elsevier Publishers
2. Plant Tissue Culture by Kalyan Kumar De; Published by New Central Book Agency, 1997
3. Plant Tissue and Cell Culture; Volume 11 of Botanical monographs, by Herbert Edward Street; Publisher: University of California Press, 1973
4. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications By R. Ian Freshney; Wiley Publishers
5. Animal Cell Culture ( Introduction to Biotechniques): Sara j. Morgan, David C. Darling; Published by BIOS Scientific Publishers Ltd., 1993

| Course Code | Course Name | Credits |
|---|---|---|
| BTC603 | Enzyme Engineering | 3.0 |

## Prerequisites

Knowledge of Biochemistry, Microbiology, Molecular Biology.

## Course Objectives

The objectives of this course are to:

- Give insight into the functioning of Enzyme molecules(Biological Catalyst), their constructions, Structure, interactions with other cellular molecules, and the process of catalysis.
- Students will learn to use such molecules for making of difficult bio-molecules.
- They will also be able to understand Industrial uses and applications of Enzymes.

## Course Outcomes

By learning this course the students will be able to:

- Understand how Enzymes are created as a functional bio-catalysts, analysed with respect to their efficiencies,their lability, and ways to make them durable.
- They also will be familiar with the problems they could encounter and how to trouble shoot them.
- They will be able to monitor both in-vitro and in-vivo activity.

## Detail syllabus

| Module | Contents | No. of hrs |
|---|---|---|
| 1 | Enzyme as a Biological Catalysts. Chemical nature, polypeptide structures Models of Enzyme-substrate interactions, Catalytic and Allosteric sites. Activation Energy and catalysis. | 4 |
| 2 | Structures of Enzymes (Primary, Secondary, Tertiary etc.), Effect of pH, Temperature and Salts on Enzyme efficiency and Inhibition. Enzyme Kinetics, models and degree of efficiencies/Inhibition, their types and analysis. | 8 |
| 3 | Enzyme activity Analysis: pH-change, Viscometry, Manometry, Colorimetry, Spectrophotometry, etc. Fundamentals of each method, constants and variables involved. Criteria for the Degree of accuracy. | 6 |
| 4 | Working with Enzyme: Detection, Isolation and Purification of Enzyme under study. Stability of Enzyme. Genetic Modification of Enzyme. Immobilization of Enzyme for repeat use. | 8 |
| 5 | Criteria of Enzyme Purity, Specific Activity, Subunit Analysis, Western Blotting. | 4 |

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| Module | Contents | No. of hrs |
|---|---|---|
| 6 | Process design and Operation strategies for Enzyme based reactors. Operational problems, Decline and loss of Enzyme efficiency, Remedies! | 5 |
| 7 | Application of Enzyme in Industries: Food, Leather, Beverage, Detergents, Pharmaceuticals and Medicines, Analytical/ Diagnostics and Biosensors, Therapeutics. | 4 |

## References


1. Enzymes-Palmer;T,(Affiliated East West Press Pvt.Ltd.), 2004.
2. Biochemistry- Stryer,Berg, 6thEdition, (W.H.Freeman and Co.), 2007.
3. Biochemistry-Metzler;DE, 2ndEdn., (Academic press) 2001.
4. Lehninger Principles of biochemistry-Nesson,Cox, 4thEdn., (W.H.Freeman and Co.), 2005.
5. Biochemistry Voet & Voet;J, 3rd Edn. (John Wiley and sons Inc.), 2004.
6. Outlines of Biochemistry-Conn;E,Stumpf, 5thEdn. (Tata-McGraw Hill), 1988.
7. Enzyme Biotechnology- Tripathi;G, (ABD Publishers), 2003.
8. Enzyme Technology, M.F. Chaplin and C. Bucke. Cambridge University Press
9. Industrial Enzymes & their applications, H. Uhlig, (John Wiley and Sons Inc.)

| Course Code | Course Name | Credits |
|---|---|---|
| BTC604 | IPR, Bioethics and Biosafety | 4.0 |

## Prerequisites

Knowledge of materials to be classified as biohazard, knowledge about current scenario of biotechnological issues

## Course Objectives

- To understand the laws governing biotechnology and related field at national and international level
- To gain knowledge about safety precautions necessary during biotechnological work
- To understand the ethical perspective of handling biomaterials

## Course Outcomes

- To be aware of rules and regulations setup at international level for various biotechnology related work so that any further research can be formulated accordingly
- To know the social and legal state of the society with respect to genetically engineered products or other outcomes of biotechnology
- Work according to the safety precautions set up by international bodies while handling biohazardous material

## Detail syllabus

| Module | Contents | No. of hrs |
|---|---|---|
| 1 | **Introduction to Intellectual Property:** Concept of Intellectual Property Kinds of Intellectual Property Patents, Copyrights, Designs, Trademarks, Geographical Indication. Infringement of IPR, Its protection and Remedies Licensing and its types | 10 |
| 2 | **International Scenario:** Introduction to the leading international instruments concerning intellectual property rights: The Berne Convention, GATT, WTO, Indian Patent Act, Universal Copyright Convention, The Paris Convention, TRIPS, The World Intellectual Property Rights Organization (WIPO), Budapest treaty | 6 |
| 3 | **Patents:** Requirement of patentable novelty, inventive step, prior art Classifying products as patentable and non-patentable Procedure for applying for patent Patent Infringement and related case studies Biological Patentability | 7 |

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| Module | Contents | No. of hrs |
|---|---|---|
| 4 | **IPR and Biotechnology:** Biopiracy and Bioprospecting Farmers Rights and Plant breeders rights Biodiversity | 5 |
| 5 | **Biosafety:** Good Lab Practices Introduction to Biological Safety Cabinets Primary Containment for Biohazards Biosafety Levels GMOs and LMOs and their environmental impact Roles of Institutional Biosafety Committee, RCGM, GEAC etc. For GMO applications in food and agriculture Risk analysis, assessment and management | 7 |
| 6 | **Bioethics:** Bioethical issues related to Healthcare & medicine Food & agriculture Genetic engineering The Human Genome Project and Genetic Testing Environmental problems | 4 |

## References


1. IPR, Biosafety and Bioethics by Deepa Goel and Shomini Parasha
2. Intellectual property rights by Dr. Reddy

| Course Code | Course Name | Credits |
|---|---|---|
| BTC605 | Process Control & Instrumentation | 4.0 |

## Prerequisites

Knowledge of Laplace Transforms, Knowledge of differentiation and Integration

## Course Objectives

- To understand the basic concepts of process parameter control
- To understand the closed loop and open loop control system
- To carry out the stability analysis for a given process

## Course Outcomes

- Student will be able to design the process control of a parameter.
- Student will be able to carry out the stability analysis for a process.

## Detail syllabus

| Module | Contents | No. of hrs |
|---|---|---|
| 1 | **Instrumentation** Instrumentation principles, Introduction to temperature and liquid level measurements, measurement of important physico-chemical and biochemical parameters, methods of on-line and off-line biomass estimation, flow injection analysis for measurement of substrates, products and other metabolites. | 5 |
| 2 | **First order systems** Process characteristics, Laplace transforms, first order systems examples, mercury in glass thermometer, liquid level system, linearization, response of first order system for step, pulse, impulse and sinusoidal changes in input, conceptual numericals. | 6 |
| 3 | **First order systems in series** Interacting and non-interacting systems and their dynamic response to step, pulse and impulse inputs; conceptual numericals. | 4 |
| 4 | **Second order systems** Second order systems with transfer functions (spring-damper, control valve, U-tube manometer), response of second order system to step, pulse / impulse and sinusoidal input Overdamped, underdamped and critically damped condition of second order system, transportation lag. | 5 |

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| Module | Contents | No. of hrs |
|---|---|---|
| 5 | **Controllers and final control elements** Actuators, Positioners, Valve body, Valve plugs, Characteristics of final control elements, controllers two position control, proportional control, derivative control, integral control, P-I (proportional-integral) control, P-D (proportional- derivative) control, P-I-D (proportional-integral- derivative) control, conceptual numericals. | 5 |
| 6 | **Closed loop control systems** Block diagrams for servo and regulatory problems. Transient response of first and second order processes for set point changes and load changes with proportional and PI controllers, conceptual numericals. | 4 |
| 7 | **Controller design and stability** Criteria for stability, Routh test; Root locus analysis, Introduction to frequency response, Qualitative discussion about Bode criteria and Nyquist criteria, Controller tuning- Gain & Phase margin; Conceptual numerical on Routh test, Root locus and Bode plot. | 6 |
| 8 | **Bioprocesses dynamics and control** Dynamics and control of bioreactors & sterilizers. On-line data analysis for state and parameter estimation techniques for biochemical processes, Complex control strategies such as feed forward, cascade, adapter, supervisory, multi variable controls and their application for optimum controls. | 4 |

## References


1. Coughnanowr., Process Systems Analysis and Control.
2. Stephanopoulos, G., Chemical Process Control, Prentice Hall of India., 1990.
3. Richardson, J. F., Peacock, D. G., Coulson & Richardson's Chemical Engineering, Vo. 3., ed. 3., Asian Books Pvt Ltd, New Delhi, 1994.
4. William L.Luyben, Process Modeling Simulation and Control for Chemical Engineers, McGraw Hill International Edition. 1990.
5. B.Wayne Bequette Process Control Modeling, Design and Simulation, Prentice Hall of India Pvt.Ltd.

| Course Code | Course Name | Credits |
|---|---|---|
| BTE606 | Research Methodology | 4.0 |

## Prerequisites

Knowledge of Biochemistry, Microbiology, Molecular Biolog, Genetics.

## Course Objectives

- To learn to express a scientific idea, or observation, logically and scientifically.
- To learn how to gather data, analyse them, and express them.
- To understand how an expression can cause an error or confusion, and how to avoid it.

## Course Outcomes

- One learns to collect data and analyse it, express scientific finding in a logical and an understandable form.
- One also learns to cite references.

## Detail syllabus

| Module | Contents | No. of hrs |
|---|---|---|
| 1 | **Methodology and Literature collection:** Introduction to Research Methodology - Meaning of Research, Type of Research: Basic, Applied, Researches, Criterions of good Research, Problems Defining the Research Problem. Literature collection - Review process. Discriminative Reading, Consulting Source material. Literature citation - Different Systems of citing Reference:- Name Year System citation in the text, Name Year System List of Reference. | 11 |
| 2 | **Research, Data collection and Analysis.** Research Design - Sample Collection - Criteria of Selecting a Sampling Procedure, Observation/Interview/Collection through Questionnaires/Schedules, Case study method. Processing and Analysis of data. Reporting of results. Interpretations and Discussion. | 14 |
| 3 | **Scientific Writing:** Report Writing: Steps in Report Writing. Title, Authors, Abstract, (Summary/Synopsis), Key Words, Introduction, Materials and Methods, Results, Discussion, Acknowledgements, Appendix, references. Use of Table / Figures in Report Writing . (Placement of Table / figure, Numbering, Box Heading, Caption photographs. Formatting and Typing Introduction, Margins, Spacing, Alignment, Fonts, etc., Format of Thesis.) | 14 |

## References


1. Research Methodology for Biological Sciences (2006), N. Gurumani MJP Publishers
2. Research Methodology : Methods and Techniques. 2nd Edition C.R.Kothari, New age international Publishers 2004
3. Research methods for the bioscience: 2006 International Student Edition. Oxford University Press, Edition, D. Holmes, P. MP. Moody, D. Dine. ISBN 13 : 978-0-19-568631-9

| Course Code | Course Name | Credits |
|---|---|---|
| BTE606 | Stem Cell Biology | 4.0 |

## Prerequisites

Cell Biology, Developmental Biology, Biochemistry, Molecular Biology and Genetics.

## Course Objectives

- To understand the developmental processes in a complex living system.
- To manipulate the cells to change and perform tasks in a carefully directed fashion.
- To understand the possibilities this technology offers in a medical field

## Course Outcomes

- Students will be well-versed with the new technology of Stem-cell.
- They will have understood Developmental biology at a cellular level, possibility of use of Stem cells for therapeutic purposes.

## Detail syllabus

| Module | Contents | No. of hrs |
|---|---|---|
| 1 | **Introduction:** Universal mechanism of development: Cell proliferation, Specialization, Interaction and Movement. Case study of. C. Elegans. | 6 |
| 2 | **Cell proliferation and development:** Morphogens and their gradients, Intrinsic programming, Sequential induction. | 6 |
| 3 | **Plant Development:** Root, Shoot, Flower, Seed & Meristem. Plant part generation, Plant growth regulators. Maintaining of the Meristem cells. | 6 |
| 4 | **Stem cells:** Epidermis renewal by stem cells, Maintaining population of stem cells, Transit amplifying cells, Multipotent stem cells and Blood cell formation. | 7 |
| 5 | **Types of stem cell:** Embryonic, Bone marrow (Hematopoietic), Pluripotent stem cells and methods of generating them. | 7 |
| 6 | **Application of stem cells:** Repairing Nervous system, Liver cell proliferation and repair, Cardiac repair, Diabetes treatment, GM stem cells and Gene therapy | 7 |

## References


1. Molecular biology of Cell: Alberts et al. 2014. (Chapter on Stem Cells.)
2. Please refer to on-line information for various sub topics, available an peered review research articles.

| Course Code | Course Name | Credits |
|---|---|---|
| BTE606 | Good Laboratory Practices (GLP) & Process Safety | 4.0 |

## Prerequisites

Knowledge of various pharmaceutical and biotechnological products and techniques invovled in such industries.

## Course Objectives

- To learn the regulations and various guidelines, and how these regulations apply to the manufacturing nad distribution of pharmaceitical and biological products.
- To impart knowledge of the principles of GLP/GMP and their practical applications
- To attain knowledge of the safety procedures carried out in Bioprocess and chemical plants.
- To familiarize the basic concepts of safety and biosafety guideline.

## Course Outcomes

- Gain the skills and knowledge necessary to understand and work in GLP/GMP compliant environment.
- Understand the purpose and reasoning of GLP/GMP regulations and their practical applications through key quality systems.
- Understand QA-GMP-QC relationship.
- Gain knowledge of the various safety procedures to be followed in laboratory and production units.

## Detail syllabus

| Module | Contents | No. of hrs |
|---|---|---|
| 1 | **Introduction to GLP:** Good laboratory practices-Introduction, WHO guidlines on GLP and GMP History of Good Laboratory Practices Quality assurances in Good Laboratory Practices | 06 |
| 2 | **Quality standards and Quality Assurances:** Quality Standards- Advantages and Disadvantages, Concept of Quality Control Quality Assurance- Their functions and advantages Quality assurance and quality management in industry Customer requirement of quality Government and trade standards of quality Federal Food and Drug Law FDA Action BSTI Laws, BSTI action and activities Other food laws (Legalization), Trade and Company Standards Control by National, International, Social Organizations (example:FAO, WHO, UNICEF, CAB), Society (example: NSB, Professional societies) | 06 |

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| Module | Contents | No. of hrs |
|---|---|---|
| 3 | **Good Manufacturing Practices in Pharmaceutical and Food Industries:** Types of validation in Pharma industry Scope and importance of Validation, Limitations, Organization and Elements of validation (Q, OQ, PQ and DQ) Cleaning Validation, Validation of Analytical Procedures as per ICH Guidelines Implications of cGMP and Food plant sanitation The regulationsof cGMPs Planning of Plant Sanitation Programs and Construction factors Hygeinic design of food plants and equipments Sanitation in warehousing, storage, shipping, receiving, containers and packaging materials Control of rats, rodents, birds, insects and microbes. Cleaning and Disinfection: Physical and Microbiological Approach | 09 |
| 4 | **Quality Control:** Introdution to Quality control and Total Quality Control in the food industry Various Quality Attributes of food such as size, shape, texture, color, viscosity and flavor Instrumental chemical and microbial quality control Sensory evaluation of food and statistical analysis Food Regulation and Compliance Food Inspection and Food Law Critical Control Points in Food Industries: Critical Quality control point in different stages of production including raw materials and processing materials Food Quality and Quality control including the HACCP system (Critical quality control points in different stages of production including raw materials and proccessing materials) | 06 |
| 5 | **Biosafety:** Introduction: Historical Background, Biosafety in Laboratory/ institution. Laboratory associated infections and other hazards, assessment of Biological Hazards and levels of biosafety, prudent biosafety practices in the laboratory/institution Introduction to Biological safety cabinets, Primary Containment of Biohazards, Biosafety Levels, Recommended Biosafety Levels for Infectious Agents and Infected Animals Biosafet guidelines, Government of India Guidelines Definition of Genetically Modified Organisms (GMOs) | 06 |
| 6 | **Safety and Hazard Analysis Hazards:** Chemical Hazards Classification, Radiation hazards and control of exposure to radiation Fire triangle, fire prevention methods Industrial hygiene: Introduction, evaluation and control Toxicology: Routes of entry of toxic substances, Toxic studies Safe Housekeeping instrumentation for safe operation, personal protective equipments | 09 |

## References


1. Quality Control of Herbal Drugs- Dr. Pulok a. Mukherjee (Bussiness Horizons Pharmaceutical Publishers)
2. cGMP for Pharmaceuticals- Manohar A. Potdar (Pharma Med Press)

3. Validation of Active Pharmaceuticals-Ira R. Berry (CRC Press)

4. Guidelines on cGMP and Quality of Pharmaceutical Products-S Iyer (DK Publications)

5. Quality Assurance and Quality Management in Pharmaceutical Industry-Y. Anjaneyulu (Pharma Book Syndicate)

6. Quality Assurance in Analytical Chemistry, B.W.Wenclawiak, M.Koch E. Hadjicostas

7. WHO Library Cataloguing in Publication Data

8. Handbook: Good Laboratory Practices (GLP): quality practices for regulated non-clinical research and development-2nd ed.

| Course Code | Course Name | Credits |
|---|---|---|
| BTL607 | Lab III | 1.5 |

## Suggested experiments

- Medium Preparations
- Callus induction and Regenerations
- Callus propagation
- Organogenesis
- Haploid Culture
- Embryo Culture
- Somatic Embryogenesis
- Suspension Culture
- Anther culture for production of haploid plants
- In vitro seed germination
- Inoculate the tissue culture raised shoots on suitable medium for in vitro rooting
- Hardening and acclimatization of in vitro raised rooted shoots
- Hairy root induction by Agrobacterium tumefaciens
- seed anti-mitotic assay
- Meristem culture for obtaining Virus free plants
- Effect of plant growth regulators on callus induction : effect of hormone variation
- Encapsulate the shoot buds, seeds to demonstrate the production of synthetic seeds
- Sterilization procedures and media preparation for Animal Cell cultures
- Establishment of Primary cell culture from chick embryo
- Animal cell culture: viable cell counting by Haemocytometer

| Course Code | Course Name | Credits |
|---|---|---|
| BTL608 | Lab IV | 1.5 |

## Suggested experiments

- Isolation of enzyme from a plant source
- Isolation of enzyme from an animal source
- Isolation of intracellular enzyme
- Determination of specific activity of enzyme
- Determination of the optimum pH & temperature of enzyme
- Determine the stability of enzyme
- Immobilization of enzyme
- Determination of kinetic parameters ($K_m$ and $V_{max}$)
- Purification of enzymes
- Enzyme Inhibition studies
- Characterization of enzymes/ Determination of molecular weight of enzyme.
- Studies of various enzyme reactors
- Bacteriological testing of milk (MBRT)
- Estimation of Calcium by EDTA method
- Isolation and separation of chloroplast by sucrose density gradient centrifugation
- Production of Grape wine and is biochemical analysis
- Determination of starch and sugar in plant tissue
- Clarification of fruit juices
- Study of pectinase activity
- Primary screening of Amylase producing bacteria and fungi from soil

| Course Code | Course Name | Credits |
|---|---|---|
| BTL609 | Lab V | 1.0 |

## Suggested experiments

- Access & use of different databases using NCBI metadatabase.
- To study use of ORF finder to find the correct reading frame.
- To study the characteristics of protein using PROT SCALE.
- To study prediction of coding sequence (CDS) of a gene using NCBI & Genemark and compare the results for percentage accuracy.
- To access & use different online gene & protein alignment softwares.
- Protein structure visualization using 'RASMOL' graphical user interface.
- Protein structure visualization using 'RASMOL' command line interface.
- Secondary structure prediction for amino acid sequences of a given protein.
- Homology modelling of protein using SWISS-PDB modeller.
- To study chemical structure of drugs using Chemsketch & Marvinsketch.
- To find & study phylogenetic relationships among different given species using CLUSTAL OMEGA.
- To study multiple sequence alignment (MSA) tools & compare the results.
- To study BLOCKS using Interpro.
- To study EXPASY tool for protein structure analysis.
- To find and study gene using MAP-VIEWER.