University of Rajasthan
Jaipur

SYLLABUS SEMESTER SCHEME

M.Sc. BIOTECHNOLOGY

III/IV Semester Examination 2018-19
- Scheme of Examination:

1. Each theory paper EoSE shall carry 100 marks. The EoSE will be of 3 hours duration. Part A of theory paper shall contain 10 Short Answer Questions of 20 marks based on knowledge, understanding and applications of the topics/texts covered in the syllabus. Each question will carry two marks for correct answer.

2. Part “B” of paper will consist of four questions with internal choice (except in case where a different scheme is specified in the syllabus) of 20 marks each.

3. Each Laboratory EoSE will be of six hours duration and involve laboratory experiments/exercises, and viva-voce examination with weightage in ratio of 75:25.

2. Course Structure:

The details of the courses with code, title and the credits assigned are as given below.

Abbreviations Used

**Course Category**
- CCC: Compulsory Core Course
- ECC: Elective Core Course
- OEC: Open Elective Course
- SC: Supportive Course
- SSC: Self Study Course
- SEM: Seminar
- PRJ: Project Work

Contact Hours
- L: Lecture
- T: Tutorial
- P: Practical
- S: Self Study

The medium of instruction and examination shall be English only.

Dy. Registrar
(Academic)
University of Rajasthan
JAIPUR
### M.Sc. BIOTECHNOLOGY (SESSION 2018-19)
#### THIRD SEMESTER

<table>
<thead>
<tr>
<th>S. No.</th>
<th>SUBJECT CODE</th>
<th>Course Title</th>
<th>Course Category</th>
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<th>Contact hours per week</th>
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Dy. Registrar

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Note:-

1. Elective core courses lab can be opted only if the respective Elective theory has been opted by the student. ECC lab. Examination will be based on ECC lab. work of above papers wherever applicable.

2. Department will offer minimum three and maximum six theory elective courses for the semester based on options submitted by the students and availability of faculty to teach the course.

Theory Elective Courses

Specialization Clusters:-

A. GEN - General
B. IB - Industrial Biotechnology
C. EB - Environmental Biotechnology
D. PE - Protein Engineering

Theory Elective Courses

<table>
<thead>
<tr>
<th>Elective Course Code</th>
<th>Specialization</th>
<th>Course Title</th>
<th>Prerequisite</th>
<th>Semester In which course will be available</th>
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<td>II</td>
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BTH 901— Genetic Engineering

Genetic engineering tools and their applications: Restriction-modification system & enzymes, modification enzymes (methylases and other enzymes needed in genetic engineering), DNA and RNA markers. Gene Cloning Vectors— Plasmids, bacteriophages, phagemids, cosmids. Artificial chromosome vectors (YAC, BAC, MAC), CHEF analysis, virus derived vectors-SV40, M13, retroviral vectors, and general applications.

Nucleic Acid Sequencing and Amplification: Sequencing methods and their Applications— Maxam & Gilbert's and Sanger's methods, Pyrosequencing, Thermal PCR, Shot gun sequencing and Automated method. Nucleic Acid purification and Yield Analysis; PCR—Types and applications.


Study Gene Regulation and analysis of gene Expression: DNA transfection methods, Northern blot, Primer extension, SI mapping, RNase protection assays, Reporter assays.

Southern and Western blotting, DNA fingerprinting, Chromosome walking, Southern and Fluorescence in situ hybridization;

Mutagenesis, Protein Engineering & Processing of Recombinant proteins - Directed Mutagenesis—Oligonucleotide with M13 DNA, PCR amplified oligonucleotide and Random mutagenesis. Protein Engineering: adding disulfide bonds, reducing number of free sulfhydryl residues, changing aminoacids, increasing and modifying enzymatic activity. Processing of Recombinant proteins: Purification and refolding, characterization of recombinant proteins, stabilization of proteins.


Expression Strategies for Heterologous Proteins: Vector engineering, host engineering, in vitro transcription and translation, expression in bacteria, yeast, insects and insect cells, expression in mammalian cells and plants.

Application of genetic engineering: Uses of transgenic plants and animals; production of recombinant pharmaceuticals, disease diagnoses and nanotechnology.

Suggested Laboratory Exercises:

1. Growth characteristics of E. coli using plating and turbidometric methods. Growth Curve
2. Bacterial culture and antibiotic selection on media.
3. Isolation of plasmid from E. coli by alkaline lysis method and its quantification by spectrophotometer.
4. Amplification of DNA by PCR.
5. Restriction enzyme digestion of genomic DNA and plasmid DNA from E. coli and estimation of size of DNA fragments after electrophoresis using DNA markers.
6. RFLP analysis
7. RAPD analysis
8. Demonstration of DNA fingerprinting. Humane Forensic
9. Restriction digestion of the plasmid and estimation of the size of various DNA fragments & Construction of Restriction digestion map.
10. Cloning of DNA fragment in a plasmid vector.
11. Transformation of the given bacterial population and selection of recombinants.
12. Co-cultivation of the plant material (e.g. leaf discs) with Agrobacterium and study GUS activity histochemically.
13. Any other practical based on theory syllabus.

Suggested Reading:


BTH 902- Animal Biotechnology

Tools and Culture Media: Equipments and materials for animal cell culture technology. Introduction to the balance salt solutions and simple growth medium. Brief account on the chemical, physical and metabolic functions of different constituents of culture medium. Role of carbon dioxide. Role of serum and supplements, Serum & protein free defined media and their application.

Basic understanding for cell culture: Structure and organization of animal cell. Cell physiology. Primary and established cell line cultures. Biology and characterization of the cultured cells and measuring their growth.

Techniques of cell culture: Basic techniques of mammalian cell culture in vitro: disaggregation of tissue and primary culture; maintenance of cell culture; cell separation. Scaling up of animal cell

Mammalian Cell transformation: Establishment of immortal cell lines, transfection, selection by selectable markers, gene amplification for high level protein expression. Specialized methods to transfer difficult cell types; Uses of viral vectors. Vaccinia and Baculovirus and Retrovirus in gene transfer; and use of antisense RNA and DNA in controlling gene function. Mice as the experimental material for gene introduction.

Impact of Recombinant DNA on human Genetics: Mapping and cloning human disease genes. Positional cloning, subchromosomal mapping and markers, in situ hybridization to chromosomes and RFLP.

Applications of Animal cell and Recombinant DNA technology: Cell culture based vaccines. Somatic cell genetics. Organ and histotypic cultures. Development of Transgenic animals (Mice, Cattle, Sheep, Goat, Pigs, Birds and Fish) and their uses. DNA based diagnosis of genetic diseases. Human somatic cell gene therapy for single-gene disorders.

Suggested Laboratory Exercises:-

1. Preparation of tissue culture medium and membrane filtration.
2. Preparation of single cell suspension from spleen and thymus.
3. Cell counting and cell viability.
4. Macrophage monolayer from PEC, and measurement of pathogenicity activity.
5. Trypsinization of monolayer and subculturing.
6. Cryopreservation and thawing.
8. Role of serum in cell culture.
9. Preparation metaphase chromosome from cultured cells.
10. Isolation of and demonstration of apoptosis of DNA laddering.
11. MTT assay for cell viability and growth.
12. Cell fusion with PEG.
13. Any other practical based on theory syllabus

Suggested Readings:-
BTH 903- Seminar, Scientific Writing & Presentation

Practical's through Assignments: 100

1. Writing Review of Literature: Review of the Literature/Annotated Bibliography
   Locate, analyze, summarize, and evaluate at least 3 scholarly and 3 popular sources in
   an area of interest and produce an Annotated Bibliography/Review of the Literature
   using appropriate citation style, to support the Long Article (4-6 pages).

2. Data analysis and presentation: How to present data? Which diagrams to use? What
   programs and data formats to use for data visualization?

3. Types of graphs (Microsoft graphics 3D): Different graphs for different purposes
   (poster, talk, manuscript). Students will be able to correctly identify and describe four
   kinds of graphs commonly used in science: pie charts, line graphs, scatter plots, and
   bar graphs.

4. How to give a Seminar: introduction and background information on topic, What
   relevant research has been performed previously? State the problem(s) that remain
unanswered. State objectives and specific hypotheses you wish to test. Describe the methodology used to test your hypotheses. Present Data, Results, Discussion and Interpretations (fact vs. fiction) and explain the significance of your findings.

5. Scientific presentations/Poster/Power Point (short and long): Document Analysis Presentation (Information Literacy) Through multimedia presentation (PowerPoint or Poster Session) by analyzing selected articles and scholarly and popular science writing and journals. Use visuals. What does a good poster need? Structure of a good poster.

Suggested Reading:-


Examination Scheme:-

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<tr>
<td>Presentation</td>
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<tr>
<td>Poster Presentation (on Computer)</td>
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<td>Viva-Voce</td>
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University of Rajasthan
BTH X01- Plant Biotechnology


Plant tissue culture technology: Shoot morphogenesis and organogenesis, rooting, hardening and field transfer; Micropropagation, production of virus free plants, callus and suspension cultures, single cell culture. Ovary, anther and microspore culture for production of haploid plants. Somatic embryogenesis, synthetic seeds and its cryopreservation. Plant tissue culture as a technique to produce novel plants, somaclonal variations. Overview of Plant Tissue Culture Applications.

Protoplast technology: Protoplast isolation, purification, viability tests, plating efficiency, culture, Somatic cell hybridization, selection of hybrid, cybrids and their regeneration.

Plant transformation (Recombinant DNA) technology: Tools and techniques. Vectors for plant transformation (Viral and Bacterial), Basic molecular characteristics of Agrobacterium. Basis of tumor and hairy-root formation, Characteristic features of vectors (Co-integrative and binary vectors, Ti, Ri plasmids, 3SS and other promoters and terminators, selectable markers, reporter genes, origin of replication etc.).


Transgenic approaches to crop improvement: Resistant against biotic (virus, fungi, bacteria, nematode, insect, weed) and abiotic stress (salinity, drought, herbicide, cold, metals), longer shelf life. Improvement of crop yield and quality - golden rice and other developments. Extension of flower life, pigmentation and fragrance.

Manufacture of valuable products: Industrial applications of plant cell culture; Plant cell culture and biosynthesis of secondary products; Manufacture of - antigens, antibodies, edible vaccines, enzymes, proteins.

Suggested Laboratory Exercises:

1. Preparation of Stock solutions for MS medium
2. Preparation of medium.
3. Micro propagation technique
4. Surface sterilization and Organ culture.
5. Callus induction, propagation, and differentiation
7. Hardening and transfer of plants to soil.
8. Study of somatic embryogenesis.
10. Ovary culture
11. Somatic embryogenesis using appropriate explants and Preparation of synthetic seeds
13. Demonstration of protoplast fusion employing PEG
15. Isolation & Identification of Sec. metabolite from Plant Cell Cultures.
16. Agrobacterium culture, selection of transformants, reporter gene GUS assays
Suggested Readings:-


BTH X02- IPR & Biosafety


Concept of ‘prior art’
Invention in context of “prior art”, Patent databases, Searching International Databases, Country-wise patent searches (USPTO, EPO, India etc.), Analysis and report formation

Basics of Patents:

Patent filing and Infringement
Patent application- forms and guidelines, fee structure, time frames, Types of patent applications: provisional and complete specifications, PCT and convention patent applications, International patenting requirement, procedures and costs, Financial assistance for patenting-introduction to existing schemes, Publication of patents-gazette of India, status in Europe and US Patenting by research students, lecturers and scientists, University/organizational rules in India and abroad, credit sharing by workers, financial incentives Patent infringement- meaning, scope, litigation, case studies and examples

Biosafety
Introduction, Historical Background, Introduction to Biological Safety Cabinets, Primary Containment for Biohazards, Biosafety Levels, Biosafety Levels of Specific Microorganisms, Recommended Biosafety Levels for Infectious Agents and Infected Animals, Biosafety Protection of New GMOs, guidelines - Government of India, Definition of GMOs & LMOs, Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture, Environmental release of GMOs, Risk Analysis, Risk
management and communication; Overview of National Regulations and relevant International Agreements including Cartagena Protocol.

Suggested Exercises:

1. List of Patent offices in India
2. Preparation of Patent document
3. Case studies of Biotechnology patents
4. List of contemporary GMOs and their challenges
5. Exercises as per syllabus

Important Links
http://www.w3.org/IPR/
http://www.wipo.int/portal/index.html.en
http://www.ipr.co.uk/IP_conventions/patent_cooperation_treaty.html www.patentoffice.nic.in
www.iprlawindia.org/-31k-Cached-Similar page
http://www.cbd.int/biosafety/background.shtml
http://web.princeton.edu/sites/ehs/biosafety/biosafetypage/section3.html

BTH X03-Dissertation & Industrial Training

The project work will involve in-depth practical work on a problem suggested by the supervisor of the candidate. The evaluation of the dissertation will be done by the external examiner. The dissertation submitted by the candidate shall be evaluated by one external expert, Head of the department and supervisor of the candidate. The seminars, in-plant training and industrial visit reports will also be submitted by the candidate to the Head of the Department who will submit these to the external examiner. The examination shall be held in the department and the dissertation etc. will NOT be required to be mailed to the external examiner. The distribution of the marks will be as under:

M.M. 100

Dissertation Report 50
Evaluation
(PPT & Viva-voce) 50

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Academia
University of Rajasthan
Jaipur
Theory Elective Course

Cluster: GEN- GENERAL

BTH A01: GEN: Analytical Techniques

Basic Techniques

Buffers; Methods of cell disintegration; Enzyme assays and controls; Detergents and membrane proteins; Dialysis

Spectroscopy Techniques

UV, Visible and Raman Spectroscopy; Theory and application of Circular Dichroism; Fluorescence; MS, NMR, PMR, ESR and Plasma Emission spectroscopy

Chromatography Techniques

TLC and Paper chromatography; Chromatographic methods for macromolecule separation - Gel permeation, Ion exchange, Hydrophobic, Reverse-phase and Affinity chromatography; HPLC and FPLC; Criteria of protein purity

Electrophoretic techniques

Theory and application of Polyacrylamide and Agarose gel electrophoresis; Capillary electrophoresis; 2D Electrophoresis; Disc gel electrophoresis; Gradient electrophoresis; Pulsed field gel electrophoresis

Centrifugation

Basic principles: Mathematics & Theory (RCF, Sedimentation coefficient etc); Types of centrifuge - Microcentrifuge, High speed & Ultracentrifuges; Preparative centrifugation; Differential & density gradient centrifugation; Applications (Isolation of cell components); Analytical centrifugation; Determination of molecular weight by sedimentation velocity & sedimentation equilibrium methods

Radioactivity

Radioactive & stable isotopes; Pattern and rate of radioactive decay; Units of radioactivity; Measurement of radioactivity; Geiger-Müller counter; Solid & Liquid scintillation counters (Basic principle, Instrumentation & technique); Brief idea of radiation dosimetry; Cerenkov radiation; Autoradiography; Measurement of stable isotopes; Falling drop method: Applications of isotopes in biochemistry; Radiotracer techniques; Distribution studies; Isotope dilution technique; Metabolic studies; Clinical application; Radioimmunoassay

Advanced Techniques

Protein crystallization. Theory and methods; API-electrospray and MALDI-TOF Mass spectrometry; Enzyme and cell immobilization techniques; DNA & Peptide Synthesis. Ultrafiltration and other membrane techniques
Elective Practical Lab BTH A11: Analytical Techniques

Suggested Laboratory Exercises:

1. Preparation of buffers
2. Study of enzyme kinetics for effect of time/enzyme concentration/pH
3. Extraction of proteins from plant tissue and their quantitative (Bradford's) and qualitative (SDS, PAGE gel) analysis.
4. Isolation of DNA/RNA from plant tissue and agarose gel electrophoresis.
5. Quantification of nucleic acids by spectrophotometer
6. Qualitative and quantitative analysis of photosynthetic pigments and anthocyanins by spectrophotometric and chromatographic techniques.
7. Isolation of bioactive compounds from medicinal plants using column chromatography and TLC.
8. Isolation and purification of nuclei, mitochondria or chloroplasts or other cell components
9. Analysis of crude extracts from medicinal plants using HPLC.
10. 2D electrophoresis
11. Any lab exercise based on analytical techniques

Texts/References

5. Selected readings from Methods in Enzymology

BTH A02: GEN: Bioinformatics & Biostatistics

Concepts of Bioinformatics: Introduction and future prospects: Applications in genomics and proteomics; Public databases; Gene bank; Database searches: sequence retrieval systems. Similarity searching: BLAST, FASTA; Multiple sequence alignment: CLUSTAL W. Detecting functional sites in DNA; Motif and domain prediction and analysis; Identification of open reading frames (ORF). Gene annotation technology.

Databases and online tools: Biological Databases: - Types and applications; Sequence databases - GenBank, EMBL, DDBJ, PIR-PSD, SWISS-PROT; Structure Databases - PDB, SCOP, NDB; Derived Databases: - PROSITE, PRINTS, TIGR; Online tools: - Genetool, STRING, I-TASSER, Bioedit, BioGRID, MEGA; Sequin, Bankit
Applications of Bioinformatics: Computational methods for sequence analysis: Dot blot and dynamic programming methods; Phylogenetic analysis; Virtual and electronic cell; Internet tools for DNA sequence translation; Restriction enzyme mapping; Prediction of secondary structure of proteins; Application tools- primer designing, molecular mapping and concept and tools of computer aided drug designing

Fundamentals of statistics: Arithmetic mean, median, mode: theory and simple numerical problem. Measures of variation: standard deviation, variance, coefficient of variation; Correlation, types and methods: simple, multiple, linear and nonlinear correlation, spearman’s correlation, rank correlation. Regression: linear and curvilinear regression (for two variable X and Y only), Regression lines by least square method; regression equations of X on Y and Y on X only; Sample size; Power of study.

Tests of significance: Null hypothesis; Standard error; Level of significance; Degrees of freedom. Significance of mean for large samples; Significance in means for small samples (students t-test); Significance in ratio of two samples; F test (for difference between variance of two samples). Chi square test; Analysis of variance test (ANOVA) for one and two way classification; Calculation of an unknown variable using regression equation.

Laws of probability, theorem of total probability

Elective Practical Lab B'TH A12: Bioinformatics & Biostatistics

Suggested Lab Exercises:

1. Introduction to bioinformatics databases (any three): NCBI/PDB/DDBJ, Uniprot, PDB etc.
2. Sequence retrieval using BLAST
3. Sequence alignment
4. Phylogenetic analysis using clustalW
5. Protein structure prediction
6. Picking out a given gene from genomes using Genscan or other softwares (promoter region identification, repeat in genome, ORF prediction)
7. Prediction of different features of a functional gene
8. Determination of Statistical averages/central tendencies
   a) Arithmetic mean b) Median c) Mode
9. Determination of measures of Dispersion a) Mean deviation b) Standard deviation and coefficient of variation c) Quartile deviation
10. Tests of Significance-Application of following a) Chi- Square test b) t-test c) Standard error
To learn graphical representations of statistical data with the help of computers (e.g., MS Excel).

**Suggested Reading**

1. Introduction to Bioinformatics, Arthur M. Lesk, Oxford University Press.
2. Introduction to Bioinformatics, Attwood, Pearson Education.
8. Bioinformatics - from Genomes to drug, 2 volumes by Lenganer.
11. Introduction to Bioinformatics by Altwood.
19. Introduction to Biostatistics, Le and Chap (2009), Wilay and Sons.

**BTH A03:GEN: Entrepreneurship & Ethics**

**Entrepreneurship:** concept, definition, structure and theories of entrepreneurship. Types of start-up, Types of entrepreneurship, environment, process of entrepreneurial development. Entrepreneurial culture, entrepreneurial leadership, product planning and development. Project management. Search for business idea. Concept of projects. Project identification, formulation, design and network analysis. Project report and project appraisal.

**Entrepreneurship in Biotechnology:**

Integration of Science, technology and business, Basic principles and practices of management. Definition, concepts and application. Organization types, coordination, control.
and decision making in management. Conceptual framework and characteristics for being an entrepreneur in biotechnology. Case studies of successful and unsuccessful bio-entrepreneurs.

8

Biotechnology: emerging industries with examples from Transgenics, Environmental biotechnology, New drug development, DNA chip technology, Stem cell research, Tissue engineering. Contract Research Organization, marketing consultancy, bio-learning module.

10

Business development in biotechnology: Factors affecting biotech business: finance, infrastructure, equipment, manpower, resources, project location, end product, quality issues etc.

Core concept of Market: Identification and evaluation of market potential of various bio-entrepreneur sectors. Marketing, marketing research-concept and techniques. Role of government and schemes, financial institutions in fostering bio-entrepreneurship.

15

Skills in bio-entrepreneurship:

Personality and attitude, Organizational behavior, Leadership, Principles of effective communication: Body language, public speaking, presentation, business proposal writing. Communication aid and application of technology.

6

Ethical issues: Introduction - causes of unethical acts, ignorance of laws, codes, policies and procedures, recognition, friendship, personal gains. Professional ethics - professional conduct. Ethical decision making, ethical dilemmas. Teaching ethical values to scientists, good laboratory practices, manufacturing practices, laboratory accreditation, IPR, Forms of IPR.

Elective Practical Lab BTH A13: Entrepreneurship & Ethics

Suggested Laboratory Exercises:

1. Innovation and Entrepreneurship
2. Development of Networking
3. Business Communication
4. Forms of IPR
5. Industrial visit (Report)
6. Success stories of Entrepreneurs
7. Support & Start up schemes.

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5. Business modeling

Suggested Readings:

3. Hassan, E., Yaqub, O., Diepeveen, D. (2010). Intellectual Property and Developing Countries: A review of the literature, the RAND Corporation, 1776 Main Street, P.O. Box 2138, Santa Monica, CA 90407-2138
12. McGee, G. “Primer on Ethics and Human Cloning”
   http://www.actionbioscience.org/biotech/mcgee.html
13. “Primer on Ethics and Crossing Species Boundaries”
   http://www.actionbioscience.org/biotech/baylis_robert.html
14. Grey, ST. “Genetic Engineering and Xenotransplantation”
   http://www.actionbioscience.org/biotech/grey.html
15. Kolehmainen, S.M. “The Dangerous Promise of Gene Therapy”
   http://www.actionbioscience.org/biotech/kolehmainen.html
BTH A04: GEN: VIROLOGY

Innate Immunity

Activation of the Innate Immunity through TLR mediated signaling: Adaptive Immunity: T and B cells in adaptive immunity; Immune response in infection. Protective immune response in bacterial, Viral and parasitic infections; Correlates of protection

Vaccination and immune response

Appropriate and inappropriate immune response during infection: CD4+ and CD8+ memory T cells; Memory B cells; Generation and Maintenance of memory T and B cells. Dendritic cells in immune response

Adjuvants in Vaccination

Induction of Th1 and Th2 responses by using appropriate adjuvants; Microbial. Liposomal and Microparticles as adjuvant; Chemokines and cytokines: Role of soluble mediators in vaccination; Oral immunization and mucosal Immunity

Conventional vaccines

Bacterial vaccines: Live attenuated and inactivated vaccine; Subunit Vaccines and Toxoids; Peptide Vaccine

New Vaccine Technologies

Rationally designed Vaccines; DNA Vaccination; Mucosal vaccination, New approaches for vaccine delivery: Engineering virus vectors for vaccination; Vaccines for specific targets; Tuberculosis Vaccine; Malaria Vaccine; HIV vaccine

Elective Practical Lab BTH A14: Virology

Suggested Laboratory Exercises:
1. Widal Test
2. Ouchterlony double diffusion
3. Radio Immune Diffusion
4. Precipitation reaction
5. ELISA
Cluster: IB- Industrial Biotechnology

BTH B01:IB: Enzyme Technology

Introduction to enzyme and enzyme technology: History and scope of enzymes and enzyme technology, nomenclature of enzymes, enzyme activity units, enzyme business, major manufacturers of enzymes in India and World.

Enzyme Kinetics – Activation Energy & Transition State concept. Mechanism of enzyme catalysis, simple kinetics of enzyme action, effect of pH, ionic strength, temperature and pressure on enzyme activity, reversible reaction, enzyme inhibition, determination of Vmax and Km values.

Sources and preparation of enzymes — Sources of enzymes, screening strategies for novel enzymes, media for enzyme production, methods of purification and concentration of intracellular and extracellular enzymes, factors affecting enzyme stability, preparation of enzymes for sale, customer service, safety and regulatory aspects of enzyme use.

Large scale use of enzymes in solution: Use of enzymes in detergents, food industry, fruit juice, wine, brewing and distilling industries, textile industries, pharmaceutical and chemical industries, application of enzymes in medicine.

Immobilised enzymes and their use: -- Enzyme reactors, stirred tank reactors, plug flow reactors, continuous flow stirred tank fluidized bed reactor, Membrane/hollow fiber reactors. selection of reactors, productivity and performance of various types of reactors. immobilised enzyme processes - production of high fructose corn syrups, production of antibiotics, production of acrylamide and use of immobilisedinvertase, lactase, raffinase.

Biosensors: - Use of enzymes in analysis, biosensors- calorimetric, potentiometric, amperometric, optical piezoelectric biosensors and immunosensors.

Advanced topics in enzyme technology: -- Enzyme reactions in biphasic liquid systems: proteases, glycosidases and lipases in synthetic reactions, interesterification of lipids, artificial enzymes, unnatural substrates, enzyme engineering, extremophilic enzymes.

Elective Practical Lab BTH B11: Enzyme Technology

Suggested Laboratory Exercise:-

1. Assay of some common enzymes (amylase, protease, pectinase, lipase etc.)
2. Microbial production of an enzyme.
3. Purification of enzyme, determination of Vmax and Km values.
5. Immobilization of enzymes/whole cells by adsorption, covalent linkage, entrapment methods
7. Application of enzymes in detergents, chemical production, juice clarification and bioprocessing

List of Books :-

1. Enzyme Technology - M.F. Chaplin and D.C. Bucks
2. Industrial Enzymology – Godfrey and West
3. Enzyme – Copeland
4. Enzymes in Industry – W. Gerhardt
BTH B02:IB: Bioprocess Engineering

Introduction to Bioprocess Engineering: Idea about Bioprocess Engineering; Measurement and control of Bioprocess parameters. Classification of Bioreactor types.

Types of fermentation processes: Analysis of batch, fed batch and continuous bioreactions, biotransformation. Downstream Processing.


Industrial production of chemicals, utilizing wastes: Alcohol (ethanol), Acids (acetic, acetic, and gluconic), Solvents (glycerol, acetone, butanol), Antibiotics (penicillin, streptomycin, tetracycline), Amino acids (lysine, glutamic acid), Single cell protein.

Introduction to food technology: principles of food processing. Elementary idea of canning and packing, sterilization and pasteurization of food products, technology of typical food products (Bread, cheese, idly); food preservation.

Elective Practical Lab BTH B12: Bioprocess Engineering

Suggested Laboratory Exercises:-

1. Isolation and preservation of industrially important microorganisms for microbial processes
2. Determination of thermal death point (TDP) and thermal death time (TDT) of microorganism for design of a sterilizer.
3. Comparative studies of Ethanol production using different substrates.
5. Use of alginate for cell immobilization.
6. Microbial production of single cell protein.
Suggested Readings:


BTH B03:IB: Industrial Biotechnology and Biosafety


Microbial fermented products: Organic acids (lactic acid, acetic acid & gluconic acid), Amino acid (Aspartic acids), Alcohol and beverages (acetone- butanol, beer, wine). Enzymes (proteases, amylases, lipases, cellulases & pectinases). Microbial Secondary metabolites production.

Health care products and food additives: Antibiotics- penicillin, streptomycin and erythromycin. Vaccines- BCG, hepatitis- B & recombinant vaccines; Vitamins- B; D & C; dairy products- cheese, yoghurt and other products, health care and environment.


Biosafety: Security measures, laboratory information management system (LIMS).

Laboratory safety- safety policies. Health hazardous compounds, chemicals (xenobiotic compounds), solvents, poisons, isotopes, radioactive materials, explosives and biological strains (bacterial, fungal etc.) and their waste management. Biosafety Cabinets, Storage of hazardous material and disposal of biological and radioisotope wastes. Biosafety regulation.

Elective Practical Lab BTH B13: Industrial Biotechnology & Biosafety

Suggested Laboratory Exercises:
1. Isolation of industrially important microorganisms for microbial processes.
2. Comparative studies of Ethanol production using different substrates.
Microbial production of citric acid using *Aspergillus niger*.

4. Microbial production of antibiotics (Penicillin).

5. Cultivation techniques of mushrooms.

6. Selection of efficient PGPR and mycorrhizae and their affect on growth.

7. Preparation of list of the hazardous chemical and their biosafety measures.

8. Any other practical based on theory syllabus.

*Suggested Readings:*


BTH B04:IB: Nanobiotechnology

Introduction: History- The purple of Cassius, the Lycurgus cup, Michael Faraday and "divided metals", Richard Feynman, His theory and predictions, Moore's Law, Miniaturization of microprocessors, the story of the Damascus sword. What is "nano"? Comparison with familiar objects. From nanoscience to nanotechnology: Eric Drexler.

Nanoscience: The multidisciplinary science, Bottom-up and top-down approach of research with examples, Different types of Nanomaterials, one-dimensional: CNTs, its types and characteristics, Two-dimensional: Nanofilms, nanosheets, nanowalls.

Properties of Nanomaterials, Different types of Nanomaterials and their size, Quantum effects. Seeing Nanomaterials: Microscopes (SEM, TEM, STM, AFM). How do the different types of microscope work with Nanomaterials. Preparation of Nanomaterials: Physical Method (hydrothermal and solvo thermal) Chemical methods, Biological methods (Green synthesis using plants, microbes & other living organisms).

Nanobiotechnology: Nanomedicine, Nanocosmetics, Textiles, Nanosensors (Biological, chemical, Biosensors, Gas sensors, mechanical), Drug delivery, Cancer therapy, Tissue engineering, water purification, Lab-on-a-chip (LOC), Nanocomputers, DNA computer, MRI with magnetic nanoparticles. Current trends of research in Nanobiotechnology, particularly health sciences.


Elective Practical Lab BTH B14: Nanobiotechnology

Suggested Laboratory Exercises:-
2. Green synthesis of Nanoparticles using Plant system from Leaves, fruit, callus etc.
3. Characterization of Nanoparticles using UV Visible Spectroscopy, XRD, FTIR
4. Visualization of Nanomaterials using SEM, TEM, AFM.
5. To check the bioactivity of Nanomaterials on various pathological Fungi and Bacteria
6. To check the effect of Nanomaterials on Plant germination parameters.

Suggested Readings:-
Cluster: EB- Environmental Biotechnology

BTH C01:EB: BIODIVERSITY, ECOLOGY AND EVOLUTION

Introduction to Biodiversity, Different types of Biodiversity and Concepts. Values and uses of Biodiversity (food, genes, biocontrol agents, natural products and medicines). Measures of biodiversity (alpha, beta- and gamma).


Vegetation types of India. Hotspot biodiversity areas in India. Red Listed plants and RED Data Book. Threatened plants and animals of India. Role of biotechnology in reintroducing commercially and economically important plants to wild.

Conservation biodiversity, Sustainable use of plant genetic resources and biotechnology assisted plant conservation - In situ and ex situ methods. Molecular markers and their application in plant conservation.


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Elective Practical Lab BTH C11: Biodiversity, Ecology and Evolution

Suggested Laboratory Exercises:

1. Vegetation Maps of India
2. Identification of locally available Medicinal Plants and their use.
3. Evaluating Diversity in fruits and vegetables and their Morphological differences
4. Study and simple tests for gums, resins, dyes, fibres from plants
5. Any other practical according to theory syllabus.

REFERENCES:

11. Singh, T &Purohit S.S.- Microbial Ecology 2012 Agrobies India

BTH C02:EB: Applied Environmental Biotechnology

Bioremediation & Phytoremediation: Biofeasibility, applications of bioremediation, Bioreduction, Phytoremediation.
Bioadsorption and Bioleaching of heavy metals: Cadmium, Lead, Mercury, Metal binding targets and organisms, Bioabsorption, Metal microbial interaction, Biomethylation of elements (Methylation of mercury and arsenic), Commercial biosorbents, bioleaching, metal precipitation, advantages and disadvantages of bioleaching.

Waste water Treatment: Biological treatment system (Oxidative ponds, aerobic and anaerobic ponds, facultative ponds, aerated ponds), Biological waster treatment, activated sludge treatment, microbial pollution in activated sludge, percolating filters, wastewater treatment by biofilms. Treatment scheme of Dairy, Distillery, Tannery, Sugar, Fertilizers, Refinery, Chemical and Antibiotic waste.


Elective Practical Lab BTH C12: Applied Environmental Biotechnology

Suggested Laboratory Exercises:-
Visit to
- Sewage waste water treatment plants,
- Farms doing floriculture, vegetable farming,
- Dairy/sugar/dye industry treatment plants
- Krishivaigyanikkendas for composting
Report writing of various visits.

REFERENCES—
1. Industrial Waste Water Treatment (2008) By A D Patwardhan, Prentice Hall Of India, New Delhi
4. The Complete Technology Book On Biofertilizer And Organic Farming (2nd Revised Edition) [Ni115] By Nirs Board,
5. The Complete Technology Book On Vermiculture And Vermicompost [Ni116] By Npcs Board Of Consultants And Engineers,
Cluster: PE- Protein Engineering

BTH D01: PE: Protein Engineering


Introduction to Protein engineering: definition, basic principles; Features or characteristics of protein that can be engineered (definition and methods of study), affinity and specificity, spectroscopic properties; Stability to changes in parameters as pH, temperature and amino acid sequence, aggregation propensities etc.

Method for Protein engineering: Rational design, Directed mutagenesis, Random mutagenesis, DNA shuffling, Evolutionary methods/directed evolution, Homology modelling, De novo enzyme engineering, strategies and case studies: Addition of disulfide bonds- T4 Lysozyme, Xylanase, Human pancreatic Ribonuclease; changing asparagine to other amino acids, reducing the number of free sulphhydryl residues, increasing enzyme activity, modifying metal cofactor requirements, decreasing protease sensitivity, modifying protein specificity FokI endonuclease, Antibodies, increasing enzyme stability and specificity- altering multiple properties (Subtilisin, Peroxidase).

Computational approaches to protein engineering: sequence and 3D structure analysis, bioinformatics tools for protein study, Data mining, Ramachandran map, Mecahnism of stabilization of protein from psychrophiles and thermophiles vis-a-vis those from mesophiles. Protein design.


Elective Practical Lab BTH D11: Protein Engineering

Suggested Laboratory Exercises:-
1. Isolation and purification of protein
2. SDS - PAGE
3. Demonstration of Mass spectroscopy MOLDI TOF
4. Gel filtrations chromatography
5. Affinity chromatography
6. To find out capacity & nature of the given ion exchange resin
7. Effect of pH, temperature on activity or stability of protein
8. Protein structure prediction by bioinformatics

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9. Protein structure prediction and classification
10. Application of Bioinformatics tools in support of protein research
11. Searching protein sequence databases
12. Protein structure visualization
13. Secondary structure prediction
14. Protein structure prediction
15. Structural prediction through homology modelling
16. Ant other exercise based on theory paper content

Suggested Readings:

BTH D02:PE: Proteomics and Genomics

Genomics: Genome sequencing strategies and programs, new technologies for highthroughput sequencing, methods for sequence alignment and gene annotation. Approaches to analyze differential expression of genes - ESTs, SAGE, microarrays and their applications, gene tagging, gene and promoter trapping, knockout and knock-down mutants, dynamic modulation of protein structure and function, chip in chip.

Genome and Gene databases, Brief Outlook of Various Plant Genome Projects and their Outcome (Arabidopsis, Tomato, Potato, Rice), Non-coding RNAs, Transcriptomics, RNA interference and gene silencing, genome imprinting, small RNAs-biogenesis and functions, role of small RNAs in heterochromatin formation and gene silencing, tools to study methylome and histone modifications Humane and Mouse
Proteomics: Analysis of proteins by different biochemical and biophysical procedures like CD (Circular Dichroism), NMR, UV/Visible and fluorescent spectroscopy, protein identification and analysis on ExPASy server, other protein related databases, 1-D and 2-D gel electrophoresis for proteome analysis, Sample preparation, gel resolution and staining.

Mass spectrometry based method for protein identification like PMF (protein mass fingerprinting) and LCMS (Image analysis of 2D gels) Data acquisition, spot detection & quantitation, gel matching, data analysis, presentation, databases, conclusions: DIGE (Differential In Gel Electrophoresis), alternatives to 2-DE for protein expression analysis. Analysis of post-translational modifications and protein-protein interactions. Protein chips and arrays, future directions in proteomics, scope of functional proteomics, and Protein databases, Protein- protein interaction, Interactome.

Elective Practical Lab BTH D12: Proteomics & Genomics

Suggested Laboratory Exercises:
1. Demonstration and listing of sequence retrieval online tools.
2. Demonstration and listing of sequence submission online tools.
3. Listing and demonstration of Protein and DNA Sequence Databases and their utilities.
4. Demonstration of DNA and Protein Array Technology and applications.
5. Reverse transcription-PCR to examine gene expression.
6. Real-time PCR to quantify gene expression.
7. Northern and Western Blotting analysis.
8. Demonstration of Instrumentation (MALDI/TOF, LC-MS-MS, 2DGE) by visit or audio-visual medium.
9. Protein separation techniques (Chromatography-ion-Exchange, Gel Filtration, Affinity, Ultrafiltration, Recombinant protein separation techniques).
10. Comparison of Next-generation sequencing methods (by Chart, poster preparation).
11. Any other exercises designed by course teacher as per the syllabus.

SUGGESTED READINGS:

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