

UNIVERSITY OF RAJASTHAN

JAIPUR

M. Sc. BIOTECHNOLOGY

SEMESTER-II

SYLLABUS SEMESTER SCHEME

2017-18


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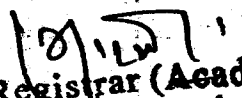
M. Sc. Biotechnology Semester Scheme 2017-18

SECOND SEMESTER

S. No.	SUBJECT CODE	Course Title	Course Category	Credit	Contact hours per week			EaSE duration (Hrs.)	
					L	T	P	Theory	P
1.	BTH 801	Molecular Biology	CCC	4	4	0	0	3	0
2.	BTH 802	Virology & Immunology	CCC	4	4	0	0	3	0
3.	BTH 803	Biological Macromolecules & Enzymology	CCC	4	4	0	0	3	0
4.		Theory Elective-1	BCC	4	4	0	0	3	0
5.		Theory Elective-2	BCC	4	4	0	0	3	0
6.		Theory Elective-3	BCC	4	4	0	0	3	0
7.	BTH 811	General Practical Lab. (Based on BTH 801, BTH 802 & BTH 803)	CCC	6	0	0	9	0	6
8.		Elective Practical Lab-1	BCC	2	0	0	3	0	4
9.		Elective Practical Lab-2	BCC	2	0	0	3	0	4
10.		Elective Practical Lab-3	BCC	2	0	0	3	0	4

Note:-

1. Elective lab. can be opted only if the respective Elective theory has been opted by the student.
2. Department will offer minimum three and maximum five theory elective courses for the semester based on options submitted by students and availability of Faculty to teach the course.


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Theory Elective Courses:-

Specialization Clusters:-

A-GEN: General

B-IB : Industrial Biotechnology

C-EB: Environmental Biotechnology

D-PE: Protein Engineering

Theory Elective Courses

Elective Course Code	Specialization	Course Title	Prerequisite	Semester in which course will be available
BTH A01	GEN	Analytical Techniques		I
BTH A02	GEN	Bioinformatics & Biostatistics		II
BTH A03	GEN	Entrepreneurship & Ethics		III
BTH A04	GEN	Virology		IV
BTH B01	IB	Enzyme Technology		I
BTH B02	IB	Bioprocess Engineering		I
BTH B03	IB	Industrial Biotechnology & Biosafety		II
BTH B04	IB	Nanobiotechnology		IV
BTH C01	EB	Biodiversity, Ecology and Evolution		II
BTH C02	EB	Applied Environmental Biotechnology		IV
BTH D01	PE	Protein Engineering		III
BTH D02	PE	Proteomics & Genomics		III

Laboratory Elective Courses

Elective Course Code	Specialization	Course Title	Prerequisite	Semester in which course will be available
BTH A11	GEN	Analytical Techniques		I
BTH A12	GEN	Bioinformatics & Biostatistics		II
BTH A13	GEN	Entrepreneurship & Ethics		III

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BTH A14	GEN	Virology	IV
BTH B11	IB	Enzyme Technology	I
BTH B12	IB	Bioprocess Engineering	I
BTH B13	IB	Industrial Biotechnology & Biosafety	II
BTH B14	IB	Nanobiotechnology	IV
BTH C11	EB	Biodiversity, Ecology and Evolution	II
BTH C12	EB	Applied Environmental Biotechnology	IV
BTH D11	PE	Protein Engineering	III
BTH D12	PE	Proteomics & Genomics	III

BTH 801- Molecular Biology

Genetic material: The Structures of DNA and RNA / Genetic Material, Types of DNA, Types of genetic material, DNA topology - linking number, topoisomerases, Organization of DNA in Prokaryotes, Viruses, Eukaryotes. 6

DNA Replication: Genome and its organization; Prokaryotic and eukaryotic DNA replication. Unit of replicon, enzymes involved, mechanisms of DNA replication, origin and replication fork, fidelity of replication, accessory proteins involved in DNA replication. 6

Transcription-Prokaryotic, Eukaryotic transcription, transcriptional factors and machinery, RNA polymerases, Regulatory elements and mechanisms of transcription regulation- formation of initiation complex, transcription activators and repressors, capping, elongation and termination, RNA processing, RNA editing, structure and function of snRNA & snprotein, spliceosome, type III intron, splicing of eukaryotic RNA, polyadenylation, structure and function of mRNA; RNA transport, nuclear export of m- RNA, m-RNA stability. catabolite repression, attenuation and antitermination. 11

Regulation at transcriptional level : Signal transduction- Environmental signals to Cell surface, intracellular communication; Protein DNA interaction, Transcriptional complex and activation of smart gene; Activation of transcription by Gene battery; Processing regulation

i.e. splicing in different manner e.g. Troponin gene; Repression of transcription- Gene silencing.

5

Translation - Prokaryotic and eukaryotic translation, the translation machinery, tRNA structure and function, Genetic code (nuclear and orgenell). Ribosome subunits its molecular structure and function; Formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, aminoacylation of t-RNA, aminoacyl tRNA synthetase, termination of translation, proof-reading; translational inhibitors; Co- and Post- translational modification of proteins.

12

Regulation at translational level : Activation and Repression of translation through mRNA binding protein, Phosphorylation of eukaryotic initiation factors of translation; Repressor protein, Cytoplasmic control of mRNA stability.

4

Regulation of gene expression in prokaryotes and eukaryotes - Panoply of operon; Spatial (Tubulin gene in plants) & temporal (Globin gene in animals) regulation; Tissue specific gene regulation.

4

Protein Localization: Synthesis of Secretory and membrane proteins, intracellular protein traffic-import into nucleus, mitochondria, chloroplast and peroxisomes, Receptor mediated endocytosis.

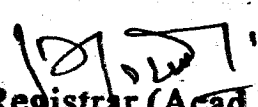
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Antisense and Ribozyme Technology: Molecular mechanism of antisense molecules, Biochemistry of Ribozymes -Hammerhead, hairpin, RNase P and other ribozymes, applications of antisense and ribozyme technology.

6

Suggested Laboratory Exercises:

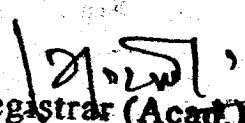
1. Preparation of culture medium (LB) for *E.coli* (both solid and liquid) and raise culture of *E.coli*.
2. Isolation of genomic DNA and its quantification
3. Perform DNA amplification by PCR.
4. Isolation of RNA.
5. Demonstration of antibiotic resistance
6. Metabolic labelling of proteins and immunoprecipitation.
7. Any other practical based on theory syllabus.


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Suggested Readings:

1. Voet, D. and Voet, JG. (2013). **Biochemistry (4th edition)**, John Wiley & Sons.
2. Segel, IH. (1976). **Biochemical Calculations (2nd ed.)**, John Wiley & Sons Inc.
3. Voet, D. and Voet, JG. (2004). **Biochemistry (4th ed.)**, J Wiley and Sons.
4. Berg J.M., Tymoczko J.L. and Stryer L. (2002), **Biochemistry**, W.H. Freeman
5. Frefilider, D. (). **Physical biochemistry**, W.H. Freeman & company.
6. Work, TS. and Work, E. (1980). **Laboratory Techniques in Biochemistry and Molecular Biology**, online version;
www.sciencedirect.com/science/bookseries/00757535
7. Rao, CNR. (1999). **Understanding Chemistry**, Universities press, Hyderabad.
8. Wilson, K. & Goulding, KH. (1986). **A Biologist's Guide to principles and Techniques of practical biochemistry**, ELBS Edition.
9. Cooper, TG. (1994). **Tools of Biochemistry**,
10. Malacinski, GM. (2005). **Essentials of Molecular Biology**, Jones and Barlett publications.
11. Creighton, TE. (1993). **Proteins-Structure and Molecular properties**, WH freeman and company.
12. Branden, C. and Tooze, J. (1991). **Introduction to protein structure**, Garland publishing, New York.
13. Kendrew, J. (1994). **Encyclopaedia of Molecular Biology**, Blackwell scientific publications, oxford.
14. Tafor, C. (). **Physical chemistry of Macromolecules**, John Wiley and Sons.
15. Cantor, CR. and Schimmel, PR. (1980). **Biophysical chemistry**, WH Freeman.
16. Marie-Claire Bellissent-Funcl (ed) (1992). **Protein Structure by Max Perut Perutz**. In: **Hydration Processes in Biology: Theoretical and Experimental Approaches**.
17. Gelvin, S.B. and Schilperoort, R.A. (eds.) (1994). **Plant Molecular Biology Manual**. 2nd edition, Kluwer Academic Publishers, Dordrecht, The Netherlands.
18. Glick B.R. and Thompson, J.E. (1993). **Methods in Plant Molecular Biology and Biotechnology**. CRC Press, Boca Raton, Florida.
19. Glover, D.M. and Hames, B.D. (Eds.) (1995). **DNA Cloning 1 : A Practical Approach, Core Techniques**, 2nd edition. PAS, IRL Press at Oxford University Press, Oxford.
20. Shaw, C.H. (Ed.) (1988). **Plant Molecular Biology: A Practical Approach**, IRL Press, Oxford.
21. Rana, S.V.S., 2012. **Biotechniques, theory and practices (Third edition)**, Rastogi publications, Meerut.
22. Glick, BR. And Pasternak, JJ. (1994). **Molecular Biotechnology Principles and Applications of Recombinant DNA**. Panima Publishing Corp, New Delhi.
23. Watson, JD., Gilman, M., Witkowski, J and Zollar, M. (1992). **Recombinant DNA (Sec. Ed.)**. Scientific American Books, New York.


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BTH 802- Virology and Immunology

Disease development: Introduction and history, Host parasite relationship, Host colonization and factors predisposing to infection. Types of toxins (exotoxins, endotoxins, entotoxins) and their structures; mode of action (biochemical, physiological); nonspecific and specific defense mechanisms.

5

Viruses: Nomenclature and classification; morphology and ultra-structure; Capsid and their arrangements; Genetics of viruses; distinctive properties of viruses.

10

Animal and human viruses: Epidemiology, life cycle, pathogenicity and diagnosis. Prevention and treatment of RNA viruses: Enteroviruses, Orthomyxoviruses, Paramyxoviruses and Rhabdoviridae. DNA viruses: Poxviridae. Herpesviridae, Adenoviridae, Hepadna virus. Viral vaccines, interferons, and antiviral drugs.

10

Effect of viruses on plants: Symptomatology, histopathology, physiology and pathogenicity. Common viral diseases of plants (TMV, Cauliflower mosaic virus and Potato virus X). Transmission of plant viruses through vectors (insects, nematodes, fungi) and without vectors (contact, seed, pollen transmission). Brief account of diagnostic techniques in plants; infectivity assay of plant viruses, indicator plants, histochemical tests and vector control.

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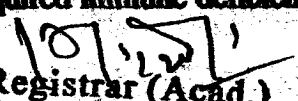
Immunology: Brief history, innate responses, innate and acquired immunity, organization and structure of lymphoid organs. Nature, biology and types of antigens and super antigens. Antibody structure and types; theories of antibody production; Antigen antibody interaction.

10

Cells of immune system: Lymphocyte (B-cells, T-cells and natural killer cells); Antigen Presenting cells (Macrophages, B cells, dendritic cells), killer T cells, also called cytotoxic T lymphocytes (CTLs).

5

Hybridoma technology & monoclonal antibodies and its applications, regulation of immune responses- Hypersensitivity, Autoimmunity, Immune response during bacterial (tuberculosis), parasitic (malaria), and viral (HIV) infections, congenital and acquired immune deficiencies,


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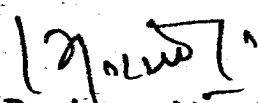
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Suggested Laboratory Exercises:

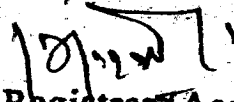
1. Study of various symptoms produced in plants due to virus infection.
2. Study of viral diseases of plants/ animals/ human (Specimen/ photographs)
3. Different type of viruses (Photographs/ sketches).
4. Raising virus free plants through apical meristem culture.
5. Blood film preparation and identification of cells.
6. Immunization, Collection of Serum.
7. Double diffusion and Immuno-electrophoresis.
8. Radial Immuno diffusion.
9. Purification of IgG from serum.
10. Separation of mononuclear cells by Ficoll-Hypaque.
11. Con-A induced proliferation of thymocytes (by MTT method).
12. ELISA.
13. Immunodiagnostics (demonstration using commercial kits).
14. Any other practical based on theory syllabus.

Suggested Readings:

1. Morag C and Timbury M.C. 1994. Medical virology-X Edition. Churchill Livingstone, London.
2. Dimmock NJ, Primrose SB. 1994. Introduction to Modern Virology, IV Edition, Blackwell Scientific Publications, Oxford.
3. Conrat HF, Kimball PC and Levy JA. 1994. Virology (III Edition), Prentice Hall, Englewood cliff, New jersey. USA.
4. Matews, RE. 1992. Functionals of plant virology, Academic press, San Diego.
5. Topley and Wilson's 1995. Text Book on principles of Bacteriology, virology and Immunology, Edward Arnold, London.
6. Lennetter, 1984. Diagnostic procedures for viral and Rickettsial diseases. American public Health association, NY.
7. William Hayes, 1985. The genetics of Bacteria and their viruses. Blackwell Scientific Publishers, London.


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8. Ronald M. Atlas. 1995. **Principles of microbiology.** Mosby Year Book Inc. Missouri 63146.
9. Kenneth M. Smith, 1996. **Plant viruses.** Universal Book Stall, New Delhi.
10. Walkey D.G.A. 1985. **Applied Virology.** International Books & Periodicals supply service. New Delhi.
11. Maramarosch Karl, 1992. **Plant Diseases of viral, viroid, Mycoplasma & uncertain etiology.** Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi, Bombay, Calcutta.
12. Powar, C.B. and Daginawala, H.F. 2003. **General Microbiology Vol. II.** Himalaya Publishing House. Mumbai.
13. Biswas, A. Biswas, SK. 2006. **An Introduction to Viruses.** Vikas Publishing House Pvt. Ltd., New Delhi.
14. Agrios, G.N. 1997. **Plant Pathology,** Academic Press. NY. USA.
15. Kuby Immunology, (4th Edition) R.A. Goldsby, Thomas J. Kindr Barbara, A. Osbarne, (Freeman) & Co. New York.
16. Bloom, BR. Lambert, PH. 2000. **Immunology. A short course (4th Edition),** John Wiley & Sons
17. Roitt, M. 1998. **Essentials of Immunology,** ELBS, Blackwell Scientific publishers, London.
18. Gerhardt. P. Murray, R. Ce., Wood W.A., and Krieg NR.(eds.) 1994. **Methods for General and Molecular Bacteriology .** American Society for Microbiology, Wasington D.C.
19. Pelczar MJ. Chan ECS. Krieg NR. **Microbiology (5th Edition)** Tata McGraw Hill, Delhi.
20. Kumar, S. 2012. **Textbook of Microbiology,** Jaypee Brothers Medical Publishers Pvt. Ltd., New Delhi.


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BTH 803- Biological Macromolecules & Enzymology

Amino acids and peptides:

Classification, chemical reactions and physical properties. Biosynthesis of amino acid (Reductive amination Transamination, GS-GOGAT system). Protein structure (primary, secondary, tertiary & quaternary), Protein folding, Glyco and lipoproteins -structure and function, Globular, Fibrous proteins; Hydrophobic and hydrophilic interactions, Ramachandran plot, DNA-protein interactions (Yeast hybrid system); Protein sequencing. Biological importance of proteins. 15

Nucleotides: Biosynthesis of purines & pyrimidene (De-novo synthesis and Salvage pathway) 5

Carbohydrate: Classification and reactions, structure and function of mono, disaccharides, and polysaccharides. Methods for compositional analysis of polysaccharides 5

Lipids: Classification, structure, biosynthesis and functions of glycerol phospholipids, sphingolipids and cholesterol. 5

Secondary metabolites: General introduction and significance, difference from primary metabolites, types of secondary metabolites (*alkaloids, flavonoids & steroids*). Polypeptides, Non- ribosomal peptides. 5

Principles of thermodynamics: First and second law, concept of free energy, isothermal process, reversibal & irreversible process, high energy compounds. Maxwell equation, Joule-Thomson co- efficient, Kelvin- Plank Statement. Thermodynamic properties of pure substances in solid, liquid & vapour phases. 8

Enzymes: classification, nomenclature, Structure: concept of holoenzymes, coenzyme, apoenzyme, isozymes and prosthetic groups, Allosteric enzymes.

Physiochemical and biological properties, role of enzymes as catalysts, substrate specificity, Mechanism of enzyme action (active site, chemical modification) and regulation (Zymogens, Isozymes)

Enzyme kinetics and regulation: Michaelis-Menten equation, Km value, Kinetics of bi substrate reaction.

Enzyme inhibition- irreversible, reversible, competitive, non-competitive and uncompetitive inhibition. Regulation of enzyme activity- feedback inhibition.

Enzyme catalysis-effect of organic solvents on enzyme catalysis, Immobilization of enzymes and its application. Determination of active sites. Functional proteins- structure and drug target (enzyme and receptors). Effects of substrate, temperature, pH and inhibitors on enzyme activity and stability, Enzyme engineering. Importance and applications of enzymes. Industrial aspects of enzymology

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Suggested Laboratory Exercises:

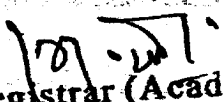
Separation and Characterization of macromolecules: molecular shape and size; molecular weight; by liquid chromatography, electrophoresis and spectroscopy

- 1. Reactions of amino acids, sugars and lipids.**
- 2. Isolation, purity determination and quantitation of cholesterol.**
- 3. Electrophoresis of proteins.**
- 4. Quantification of proteins and sugars.**
- 5. Analysis of oils-iodine number, saponification value, acid number.**
- 6. UV- Visible and IR Spectroscopy- absorption spectra.**
- 7. Separation techniques- Centrifugation, Chromatography (ion exchange-TLC etc.)**
- 8. Electrophoresis of DNA-linear, circular**
- 9. Demonstration of HPLC.**
- 10. Enzyme: Purification and Kinetic analysis.**
- 11. Hybridoma technology**
- 12. Any other practical based on theory syllabus**

Text Book:

1. Murray. R.K, Granter.D.K, Mayes. P. A, Rodwell. V. W, Harper's Biochemistry. 27th ed. McGraw Hill, 2006.

2. Berg.J.M, Tymoczko.J.I, Stryer, I. Biochemistry. 6 th ed. Freeman, 2006.

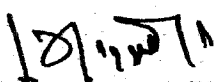

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3. Nelson D.L, Cox M. M. Lehninger's Principle of Biochemistry. 4th ed. Freeman, 2004

4. Biochemistry, Voet and Voet, 2nd edition, 2004

Suggested Reading:

1. Principles of Biochemistry, Voet, Voet, and Pratt, Fourth addition, 2012.
2. Fundamentals of Biochemistry: Life at the Molecular Level, Voet, Voet, and Pratt, 2008
3. Principles and Techniques of Biochemistry and Molecular Biology, Wilson and Walker, 2010.
4. Adams R.L, Knowler J, Leader D.P. Biochemistry of Nucleic Acids. Cambridge Univ. Press, 1998.
5. Dixon & Webb. Enzymes. 3rd ed. Longmans, 1979.


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Theory Elective Courses Specialization Clusters

Cluster: GEN- General

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: CLUSTALW; Detecting functional sites in DNA; Motif and domain prediction and analysis; Identification of open reading frames (ORF); Gene annotation technology.

11

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

09

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

10

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.

13

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.

13

Laws of probability, theorem of total probability

4

Elective Practical Lab BTH A12: Bioinformatics & Biostatistics

Suggested Laboratory Exercises:-

1. Introduction to bioinformatics databases (any three): NCBI/PDB/DDBJ, Uniprot, PDB etc.


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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
11. 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.
3. A Textbook of Systems Biology, E. Klipp, W. Liebermeister, C. Wierling, Axel Kowald, H. Lehrach, R. Herwig (2009), Wiley-VCH Verlag GmbH & Co.
4. Bioinformatics: Sequence and Genome Analysis, David W. Mount (2001), Cold Spring Harbor (CSH) Laboratory Press.
5. Plant System Biology, Coruzzi, G.M. (2009), Wiley Publishing House.
6. Bioinformatics - A Practical Guide to the Analysis of Genes and Proteins. 2nd Edition by Baxevanis.
7. Bioinformatics: Sequence, structure and Data Bank: A Practical Approach by Higgins.
8. Bioinformatics - from Genomes to drug. 2 volumes by Lenganer.
9. Bioinformatic Methods and Protocols - Misener.
10. Bioinformatics: Sequence and Genome analysis.
11. Introduction to Bioinformatics by Altwood.
12. Proteome Research: New Frontiers in Functional Genomics: Principles and Practices.
13. Genomics: The Science and Technology behind the human project.
14. Protein Biotechnology. Edited by Felix Franks. Humana Press, Totowa, New Jersey.
15. Practical Statistics for experimental biologist by Wardlaw, A.C. (1985).
16. Statistical Methods in Biology - 2000 by Bailey, N.T. J. English Univ. Press.
17. Biostatistics - 7th Edition by Daniel & Fundamental of Biostatistics by Khan
18. Statistics for Biologist by Campbell R.C. (1974) Cambridge University Press
19. Introduction to Biostatistics, Le and Chap (2009), Wiley and Sons.
20. Fundamentals of Biostatistics, B. Rosner (2005), Duxbury Press.
21. Medical Statistics from Scratch, Bowers (2008), Wiley and Sons.

Cluster: IB- Industrial Biotechnology

BTH B03:IB: Industrial Biotechnology and Biosafety

Selection of industrial microorganisms: industrial cultures- bacteria, algae, fungi and actinomycetes. Primary and secondary screening, Isolation and preservation of microorganisms for industrial products. Strain development- mutation, selection and recombination. Immobilisation of microbial cells and their application. 8

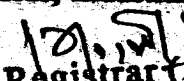
Microorganism as bio-resource for human needs: Mushroom cultivation technology. Biofertilizers and their application, biopesticide in disease management; Rhizobacteria for plant growth promotion and disease management including parasitic nematodes; Bacteria and soil fungi in plant disease management; Reclamation of mining wastelands, Application of fungi for biodegradation of cellulosic waste and ethanol production. Bioplastics and biopolymers. Biosensors- application in industry. 10

Fermentation process: design- overview of aerobic and anaerobic fermentation process. Fermentor systems- types. *Fermentation process* and factors affecting fermentation process. Batch Fermentation, Continuous Fermentation & Semi- Continuous Fermentation. Design of fermentation media, Substrates used as carbon and nitrogen sources. 8

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. 8

Health care products and food additives: Antibiotics- penicillin, streptomycin and erythromycin. Vaccines- BCG, hepatitis- B & recombinant vaccines; Vitamins- B₁₂, D & C; dairy products- cheese, yoghurt and other products., health care and environment. 10

Metabolic Engineering and industrial Products: Plant secondary metabolites, control mechanisms and manipulation of phenylpropanoid pathway, alkaloids, Industrial enzymes,


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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.

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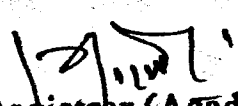
Elective Practical Lab BTH B13: Industrial Biotechnology & Biosafety

Suggested Laboratory Exercises:


1. Isolation of industrially important microorganisms for microbial processes.
2. Comparative studies of Ethanol production using different substrates.
3. 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 chemicals and their biosafety measures.
8. Any other practical based on theory syllabus

Suggested Readings:

1. Aiba, S., Humphrey AE. and Millis, N.F. 1973. **Biochemical Engineering**, Univ.of Tokyo Press, Tokyo.
2. Atkinson, B. (1974). **Biochemical Reactors**, Pion Ltd. London.
3. Baily, J.E. and Oils, D.F., (1986). **Biochemical Engineering fundamentals**, McGraw Hill Book Co., New York.
4. Enfors S.O. & Haggstrom L. 2000. **Bioprocess Technology: Fundamentals and Applications**, KTH, Stockholm.
5. Jackson, AT., (1991) **Process Engineering in Biotechnology**, Prentice Hall, Engelwood cliffs.


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6. Shuler, ML. and Kargi, F., (1992). **Bioprocess Engineering: Basic Concepts**, Prentice Hall, Engelwood Cliffs.
7. Stanbury, PF. and Whitaker, A., (1995). **Principles of Fermentation Technology**, Pergamon Press, Oxford. London.
8. Nielson, J. and Vissadsen, J., **Bioreaction Engineering Principles**, Plenum Press.
9. Shuler, ML.(Ed.), (1989). **Chemical Engineering Problems in Biotechnology**, AICHE.
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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). 12

Microbial diversity & Ecology:- Prokaryotic & Eukaryotic microbes, Physiological diversity. Phylogeny of Archaea, extremophils.

Microbes in habitats like soil, oceans, human gut. Association of microbes with eukaryotes. key nutrient cycles- C, N and S. Microbial bioremediation, biodegradation, biomining 12

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. 12

Conservation biodiversity, Sustainable uses of plant genetic resources and biotechnology assisted plant conservation - In situ and ex situ methods. Molecular markers and their application in plant conservation. 12

Concept and dynamics of ecosystem, Components of Ecosystem- Biotic and Abiotic, Food chain, Food web, and energy flow. Trophic levels and ecological pyramids. Biogeochemical cycles. UNIT-5 Theories of Evolution (Lamarckism, Neo-Lamarckism, Darwinism, Neo-Darwinism and De Vries theory of mutation), Molecular evolution. Theory of natural selection. Gene pool and gene frequencies. Mechanism of Isolation. Genetic basis of evolution. 12

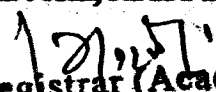
Elective Practical Lab BTH C11: Biodiversity, Ecology and Evolution

Suggested Laboratory Exercises:-

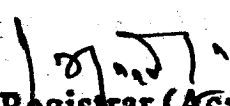
1. Vegetation Maps of India
2. Identification of locally available Medicinal Plants and their use.
3. Evaluating Diversity in fruits and vegetables and their Morphological differences
4. Study and simple tests for gums, resins, dyes, fibres from plants
5. Any other practical according to theory syllabus.

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