



UNIVERSITY OF RAJASTHAN
JAIPUR

SYLLABUS

M.SC. Biotechnology

Semester Scheme

Ist Semester Exam December 2016

(Signature)
कुलसचिव
(विश्वविद्यालय)
राजस्थान विश्वविद्यालय
जयपुर

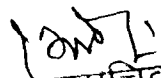
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M. Sc. Biotechnology Semester Scheme 2016-18

FIRST- SEMESTER

S. No.	SUBJECT CODE	Course Title	Course Category	Credit	Contact hours per week			EoSE duration (Hrs.)	
					L	T	P	Theory	P
1.	BTH 701	Cell Biology	CCC	4	4	0	0	3	0
2.	BTH 702	Genetics	CCC	4	4	0	0	3	0
3.	BTH 703	Microbiology	CCC	4	4	0	0	3	0
4.	BTH 711	General Biotechnology Lab.	CCC	6	0	0	9	0	6
5.	BTH A01	Biotechniques	ECC	4	4	0	0	3	3
6.	BTH B02	Enzyme Technology	ECC	4	4	0	0	3	3
7.	BTH C03	Bioprocess Engineering	ECC	4	4	0	0	3	3
8.	BTH A11	Biotechniques Lab.*	ECC	2	0	0	3	0	3
9.	BTH A12	Enzyme Technology Lab.*	ECC	2	0	0	3	0	3
10.	BTH A13	Bioprocess Engineering Lab.*	ECC	2	0	0	3	0	3

The lab courses will be allowed only in conjunction with the respective theory paper.


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BTH 701– Cell Biology

The Dynamics of cell, shape and motility: Structural organization of the plant, animal & microbial cells, Cytoskeleton, microtubules and microfilaments, motor and flagellar movements.

(3)

Cell wall, plasma membrane and plasmodesmata: Structure and functions, biogenesis, growth models and functions, ion carriers, channels and pumps, receptors. Role in movement of molecules and macromolecules across membranes, comparison with gap junctions.

(4)

Other Cellular organelles: Structure and functions of micro-bodies, Golgi apparatus, ribosomes, lysosome, endoplasmic reticulum.

Plant vacuole: Structure and function

(5)

Chloroplast and mitochondria: Fine Structure and function of the organelles, their electron transport systems, import of nuclear encoded proteins, ATP synthases, structure, organization and function of mitochondrial and chloroplast genomes, mechanism of organelle gene expression, diversity and evolution of organelle genomes.

(6)

Nucleus: Structure, nuclear envelope (karyotheca), nuclear pores, nuclear lamina, nucleolus and nuclear matrix.

(2)

Chromatin organization : Chromosome structure and packaging of DNA, nucleosome organization, molecular organization of centromere and telomere, nucleolus and ribosomal RNA genes, euchromatin and heterochromatin, specialized types of chromosomes, polytene, lampbrush, B-chromosomes , supernumerary chromosomes, molecular basis of chromosome pairing.

(6)

Cell Cycle and Mechanics of cell division: Cell cycle control mechanisms -Negative and Positive intra & extra cellular controls, Role of cyclins & cyclin depended kinases (CDKs). Cytokinesis and cell plate formation. The events of m phase, CDK & cyclin B leading to Metaphase. The spindle assembly check points leading to Anaphase. DNA damage check point controlled by P 53 protein. Map & mitogen-activated protein kinase (MAPK) : Erk1& Erk2, Ras (mitogen activated protein kinases).

(8)

Mechanism at different stages of mitosis: Cohesins and condensins in chromosome segregation, Microtubules in spindle assembly, Structure of kinetochore, centrosome and its functions, Sister Chromatid

separation. Cytokinesis actin & myosin in the generation of contractile ring, somatic metaphase.

(5)

Meiosis– Significance, Chiasma formation- Synaptonemal complex, Recombination during meiosis- Recombination nodules.

(2)

Apoptosis (Programmed cell death): Mechanism of apoptosis, Apoptosis triggered by internal & external signals, Apoptosis inducing factors, cancer, oncogenesis & its mutations.

(4)

Cell communication and Signal transduction: Overview of extra cellular signaling signal molecules- hormones, neurotransmitter proteins, environmental factors

Second messengers and their role in signal transduction - lipid and phosphatidyl inositol derived second messengers & Role of calcium as second messenger

(6)

Cell surface receptors in signal transduction: G-protein coupled receptor – structure and function, Ion channel receptors, Tyrosine kinase linked receptors, Receptors with intrinsic enzyme activity (RTK).

(5)

Interaction and regulation of cell signaling pathways - bacterial and plant two component signaling system, bacterial chemotaxis and quorum sensing.

(4)

Suggested readings:

1. Krishnamurthy, K.V. (2000). *Methods in Cell Wall Cytochemistry*. CRC Press, Boca Raton, Florida.
2. Reeve, ECR. (2001). *Encyclopedia of Genetics*, F. D. Publication, Chicago, USA
3. De, DN. (2000). *Plant Cell Vacuoles: An Introduction*. CSIRO Publication, Collingwood, Australia.
4. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). *Cell and Molecular Biology*. (VIII Edition). Lippincott Williams and Wilkins, Philadelphia.
5. Cooper, G.M. and Hausman, R.E. (2009). *The Cell: A Molecular Approach*. (V Edition).. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
6. Becker, W.M., Kleinsmith, L.J , Hardin. J. and Bertoni, G. P. (2009). *The World of the Cell*. (VII Edition). Pearson Benjamin Cummings Publishing, San Francisco.
7. Kleinsmith, L.J. and Kish, V.M. (1995). *Principles of Cell and Molecular Biology* (2nd Edition). Harper Collins College Publishers, New York, USA.
8. Harris, N. and Oparka, K.J. (1994). *Plant Cell Biology: A Practical Approach*. IRL Press, at Oxford University Press, Oxford, U.K.
9. Gunning, B.E.S. and Steer, M.W. (1996). *Plant Cell Biology: Structure and Function*. Jones and Bartlett Publishers. Boston, Massachusetts.
10. Karp, G. (2010). *Cell and Molecular Biology: Concepts and Experiments*. VI Edition. John Wiley & Sons. Inc.

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11. Griffiths, A.J.F. et. al.(2000). An introduction to genetic analysis, W. H. Freeman and Company, New York, USA.
12. Rana, S.V.S., (2012). Biotechniques, theory and practices (Third edition), Rastogi publications, Meerut.
13. Hall, J.L. and Moore, A.L. (1983). Isolation of Membranes and Organelles from Plant Cells. Academic Press, London, UK.
14. Roy, S.C. and De, KK. (1999). Cell Biology. New Central Book Agency (P) Ltd., Calcutta.
15. Hartl, D. L. (1994). Genetics. Jones and Bartlett Publishers International, USA.
16. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco. USA

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(BTH -702) – Genetics

Gene Structure and expression: Genetic fine structure, Operon concept, Introns and Exons, cis-trans test, fine structure analysis of eukaryotes, introns and their significance, Gene family.

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Inheritance and allelism: Mendelian and non-Mendelian inheritance, Gene interaction: Complementary genes (9:7 ratio); Supplementary genes (9:3:4 & 9:6:1 ratios), Epistasis (12:3:1, 13:3 ratios), Duplicate genes (15:1) co-dominance, Lethal Genes, Polygenic inheritance. Extra nuclear inheritance: Cytoplasmic male sterility, inheritance of mitochondrial and chromosomal plant genes, Hardy-Weinberg Law. Gene frequency and genotype frequency. Sex determination, sex linked inheritance, sex limited characters and sex reversal, multiple alleles and blood groups in man.

(9)

Genetic recombination: Homologous and non-homologous recombinations; independent assortment and crossing over; molecular mechanism of recombination, Holiday junction, site-specific recombination, FLP/FRT and cre/lox recombination, role of Rec A and Rec BCD enzymes and other recombinations.

(5)

Mutation and types of DNA damage: Mutagens and their effects – Physical (Radiations) and Chemical (Base analogues, Intercalating agents, Alkylating agents and others), Types of mutation- Spontaneous and induced mutations, lethal, conditional, biochemical, loss and gain of function, base substitution, frame-shift mutation, germinal versus somatic mutation, Mutations induced by transposons.

(2)

Repair mechanisms of mutational DNA damages- Direct reversal of damages (Photoreactivation and Dealkylation), Excision Repair mechanisms (NER and BER), Post-replication repair mechanisms (Mismatch repair and Recombination repair), SOS repair. Inherited diseases and defects in DNA repair.

(5)

Mutagenesis: Insertional mutagenesis, site-directed mutagenesis, *in vitro* mutagenesis and deletion techniques, Ames test for mutagenesis. Ploidy and their genetic implications.

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Chromosome mapping: Linkage map, mapping with genetic markers including RAPD, QTL, construction of molecular maps, restriction mapping- concept and technique, correlation of genetic and physical maps, mapping by using somatic cell hybrids.

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Structural and numerical alterations in chromosomes : Origin, meiosis and breeding behaviour of duplication, deficiency, inversion and translocation heterozygotes. Origin, occurrence, production and meiosis of haploids, aneuploids and euploids; origin and production of autopolyploids; chromosome and chromatid segregation, allopolyploids types; genome constitution and analysis. Evolution of major crop plants, induction and characterization of trisomics and monosomics.

(8)

Molecular cytogenetics : Nuclear DNA content, C-value paradox, cot curve and its significance, multigene families and their evolution, in situ hybridization - concept and techniques, computer assisted chromosome analysis, chromosome microdissection and microcloning, flow cytometry and confocal microscopy in karyotype analysis.

(7)

Cancer: Proto- oncogenes, oncogenes and tumor suppressor genes.

(3)

Human genetics: Pedigree analyses, lod score for linkage testing, karyotypes and genetic disorders. Population genetics; General account of inherited human diseases

(5)

Suggested Readings:

1. Atherly, AG., Girton, JR. and McDonald, JF. (1999). The Science of Genetics. Saunders College Publishing, Fort Worth, USA.
2. Burnham, CR. (1962). Discussions in Cytogenetics. Burgess Publishing Co. Minnesota.
3. Busch, H. and Rothblum, L. (1982). Volume X. The Cell Nucleus rDNA Part A. Academic Press.
4. Hartl, DL. and Jones, EW. (1998). Genetics: Principles and Analysis (4th edition). Jones & Bartlett Publishers, Massachusetts, USA.
5. Khush, GS. (1973). Cytogenetics of Aneuploids. Academic Press, New York, London.
6. Lewis, R. (1997). Human Genetics: Concepts and Applications (2nd editions). WCB McGraw Hill, USA.
7. Russel, P.J. (1998). Genetics (5th edition). The Benjamin/Cummings Publishing Company INd., USA.
8. Fukui, K. and Nakayama, S. (1996). Plant Chromosomes: laboratory Methods. CRC Press, Boca ratan, Florida.
9. Sharma, AK. and Sharma, A. (1999). Plant Chromosome Analysis, Manipulation and Engineering. Hoarwood Academic Publisher, Australia.
10. Gardner, EJ., Simmons, MJ., Snustad, DP. (2008). Principles of Genetics (VIII ed). John Wiley & Sons.

11. Snustad, D.P. and Simmons, M.J. (2009). Principles of Genetics (V Edition). John Wiley and Sons Inc. USA.
12. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics (XI Edition). Benjamin Cummings Publishing Company INd., USA.
13. Russell, P. J. (2009). Genetics - A Molecular Approach.(III Edition). Benjamin Cummings Publishing Company INd., USA.
14. Pevsner, J. (2009). Bioinformatics and Functional Genomics (II Edition). John Wiley & Sons.
15. Griffiths, AJF. Wessler, SR., Lewontin, RC. and Carroll, SB. (2008). Introduction to Genetic Analysis (IX Edition). W. H. Freeman & Co.
16. Arora, MP. Gurdarshan and Sandhu, S. (2004). Genetics. Himalaya Pub. House, New Delhi.

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जयपुर ०२

(BTH- 703)– Microbiology

History and Development: Microbial evolution, systematic and taxonomy; primitive organisms and their metabolic strategies and molecular coding; New approaches to bacterial taxonomy classification including rBTHyping, Ribosomal RNA sequencing. (7)

Prokaryotic and eukaryotic diversity: Nomenclature and Bergey's Manual; Prokaryotic Cells: Structure and Function-Cell wall composition of Gram+ve & -ve bacteria; Cell wall and cell membrane synthesis; Flagella and motility; cell inclusions like endospores, gas vesicles. Bacteria: Purple and green bacteria, budding bacteria, Spirochaetes; Sheathed bacteria, Endospore forming rods and cocci; Mycobacteria; Mycoplasma, Archaea: Archaea as earliest life forms; Halophiles, Methanogens; Hyperthermophilic archaea and Thermoplasma.

Eukarya: Algae, Fungi, Slime molds and Protozoa- General characteristics and types (15)

Pathogenic bacteria of medical importance: Nomenclature and Classification; Gram Positive cocci of Medical Importance - Pneumococcus, Staphylococcus, Micrococcus, Streptococcus; Gram negative cocci - Neisseria, Branhamella; Gram positive bacilli - Coryneform organisms, Actinomyces, Clostridium; Gram negative bacilli- Vibrios, Aeromonas, Haemophilus, Bordetella, Enterobacteriaceae, mycobacteria, spirochetes, Chlamydiae, Rickettsiae. Establishment, spread, tissue damage and anti- phagocytic factors. (10)

Microbial Growth: Pure culture technique; Microbial Growth- definition, mathematical expression of growth, growth curve, measurement of growth and growth yields, Synchronous growth, Continuous, Batch and Fed Batch Culture; Factors affecting growth: temperature, acidity, alkalinity, water availability and oxygen; Culture collection maintenance and preservation. (6)

Bacterial genetic system: Recombination - transformation, conjugation, transduction; Bacterial genetic map with reference to *E. coli*.

Genetic system of yeast and *Neurospora* (5)

Physiology and Metabolic Diversity among Microorganisms: Nutritional classification of microorganisms- chemoautotrophs, chemoheterotrophs and photosynthetic microorganisms. Photosynthesis in microorganisms; Chemolithotrophy; Hydrogen, Iron, Nitrate and oxidizing bacteria; Nitrate and sulfate reduction; Nitrogen metabolism; Nitrogen fixation. (12)

Chemotherapy and Antimicrobial agents: Sulfa drugs; Antibiotics; Pencillin and Cephalosporin; Antibiotics from prokaryotes and eukaryotes; Mode of action; Resistance to antibiotics.

(5)

Suggested Readings:

1. Pelczar, M.J. Jr., Chan, E.C.S. and Kreig, N.R. (2004). *Microbiology* (5th Ed). Tata McGraw Hill.
2. Maloy, S.R., Cronan, J.E. Jr. and Freifelder, D. Jones, *Microbial Genetics* Bartlett Publishers.
3. Benson, H.J. *Microbiological Applications, (A Laboratory Manual in General Microbiology)*. WCG; Wm C. Brown Publishers.
4. Purohit, S.S. *Microbiology: Fundamentals and Applications* Published by Agrobios, India.
5. Salle, A.J. (1999). *Fundamental Principles of Bacteriology*, (7th ed.) Tata- McGraw Hill
6. Prescott, L.M., (2005). *Microbiology*, (6th ed.) McGraw-Hill.
7. Kathleen Park Talaro & Arthur Talaro (2002) *Foundations in Microbiology* International edition. McGraw Hill.
8. Alexopoulos CJ, Mims CW, and Blackwell M. (1996). *Introductory Mycology*. 4th edition. John and Sons, Inc.
9. Atlas RM. (1997). *Principles of Microbiology*. 2nd edition. W.M.T. Brown Publishers.
10. Cappucino J and Sherman N. (2010). *Microbiology: A Laboratory Manual*. 9th edition. Pearson Education limited.
11. Madigan MT, Martinko JM and Parker J. (2009). *Brock Biology of Microorganisms*. 12th edition. Pearson/Benjamin Cummings.
12. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). *General Microbiology*. 5th edition. McMillan.
13. Tortora GJ, Funke BR, and Case CL. (2008). *Microbiology: An Introduction*. 9th edition. Pearson Education.
14. Vashishta BR and Sinha AK. (2008). *Fungl*. S. Chand and Company Ltd.
15. Black JG. (2008). *Microbiology: Principles and Explorations*. 7th edition. Prentice Hall
16. Srivastava S and Srivastava PS. (2003). *Understanding Bacteria*. Kluwer Academic publishers, Dordrecht
17. Tortora GJ, Funke BR, and Case CL. (2008). *Microbiology: An Introduction*. 9th edition Pearson Education.
18. Willey JM, Sherwood LM, and Woolverton CJ. (2008). *Prescott, Harley and Klein's Microbiology*.

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BTH-711 (General Biotechnology Lab.)

Laboratory Exercises:-

BTH 701 (Cell Biology) :-

1. EM study of cell organelles
2. Fluorescence staining with FDA for cell viability.
3. Cell wall staining with calcofluor
4. Study of stages in cell cycle
5. Mitosis and Meiosis
6. Histochemical localization of protein, carbohydrate, fats, starch, lignin, nucleic acids
7. Isolation of mitochondria and the activity of its marker enzyme, succinate dehydrogenase (SDH).
8. Demonstration of SEM and TEM.
9. Karyotype analysis, banding patterns.
10. Polytene, lampbrush, B-chromosomes and sex chromosomes,
11. Preparation of Polytene chromosome from *Chironomous larva/Drosophila larva*
12. Silver banding for staining nucleolus-organizing region, where 18S and 28S rDNA are transcribed.
13. Orcein and Feulgen staining of the salivary gland chromosomes of Chironomas and Drosophila.
14. Characteristics and behavior of B chromosomes using maize or any other appropriate material.
15. Any other practical based on theory syllabus.

BTH 702 (Genetics):-

1. Study of Hardy-Weinberg Law using simulations (seeds).
2. Linear differentiation of chromosomes through banding techniques, such as G-banding, C-banding and Q-banding.
3. Working out the effect of mono- and trisomy on plant phenotype.
4. Induction of polyploidy using colchicine,
5. Different applications of Colchicine.
6. Study of variations in plants due to numerical alterations in chromosomes.
7. Isolation of chlorophyll mutants following irradiation and treatment with chemical mutagens.
8. Numericals based on inheritance and gene interactions.
9. Flow cytometry and confocal microscopy.
10. Any other practical based on theory syllabus.

BTH 703 (Microbiology):-

1. Preparation of liquid and solid media for growth of microorganisms.
2. Isolation and maintenance of organisms by plating, streaking and serial dilution methods, slants and stab cultures, storage of microorganisms.

3. Isolation of pure cultures of bacteria from soil and water.
4. Growth; Growth curve, Measurement of bacterial population by turbidometry and serial dilution methods.
5. Effect of temperature, pH and carbon and nitrogen source on growth.
6. Microscopic examination of bacteria, yeast and molds.
7. Staining techniques to observe bacterial structure: Simple staining, Gram staining, Negative staining, Endospore staining, Capsule staining
8. Study of mutations by Ames test.
9. Biochemical characterization of selected bacterial strains.
10. Isolation and identification of pathogenic fungi from plants.
11. Isolation and identification of nonpathogenic fungi from soil.
12. Raising fungal pure cultures by hyphal tip culture & single spore culture.
13. Microbiological examination of milk: By Methylene-blue dye reduction test
14. Other practical based on theory syllabus.

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(BTH –A01) Biotechniques

General techniques: Preparation of buffers, Evaluation of PKa's, Enzyme immobilization technique.

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Chromatography and Spectroscopy: Paper chromatography, TLC, GC/GLC, HPLC, Ion Exchange chromatography, Affinity chromatography, Adsorption chromatography, Spectrophotometry, Spectroscopy, GCMS, NMR.

(13)

Microscopy- SEM, TEM, Confocal microscopy. Staining techniques. Micrometry, measurement of dimensions, counting of cells by haemocytometer. Histochemical techniques-Localization of nucleic acids, proteins, lipids, carbohydrates and enzymes.

(6)

Proteins: Isolation of proteins, Estimation of proteins by Lowry and Bradford's methods. Thermal unfolding and stability of proteins, Reduction of disulphide bonds of proteins.

(6)

Carbohydrates: Estimation of glucose by Glucose oxidase (Trinder's reagent), Estimation of reducing sugars by Nelson Somogi's method, Effect of temperature, time and substrate concentration on α -amylase activity.

(3)

DNA and RNA: Isolation of DNA and RNA, Estimation of DNA and RNA by chemical means, wavelength scan of DNA and RNA, Melting studies of Calf thymus DNA. Electrophoresis (Paper, Gel, Immunodiffusion etc.);

(4)

Genetics and Molecular Biology: Genetic recombination, Techniques and screening of recombinants, Insertion mutation of a cloned gene, Isolation of plasmids and their curing, Restriction analysis of plasmids to locate position of inserts, Restriction mapping of the plasmid, Cloning of restriction fragment containing neomycin phosphotransferase gene, Expression of β -gal under different promoters, with wild type *E.coli* as control.

(13)

Immunology: Purification of Immunoglobulin from serum, Double diffusion, Generation of antibody in mouse, Conjugation of antibody in mouse, Conjugation of antibody with enzyme, ELISA (i) Capture ELISA, (ii) Direct ELISA, Western blot, Affinity column and purification of antigen, Cell fusion for generation of Hybridoma.

BTH A11 - Biotechniques Lab.

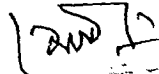
Laboratory Exercises:

Practicals based on theory syllabus.

उप-कुलसचिव (12)
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लुधियाना

Suggested Reading (for Laboratory Exercises)

1. Butenko, R.G. (2000). Plant Cell Culture, University Press of Pacific.
2. Collin, H.A. and Edwards, S. (1998). Plant Cell Culture. Bios Scientific Publishers, Oxford, UK.
3. Dixon, R.A. (Ed.) (1987). Plant Cell Culture : Practical Approach. IRL Press, Oxford.
4. Gelvin, S.B. and Schilperoort, R.A. (eds.) (1994). Plant Molecular Biology Manual. 2nd edition, Kluwer Academic Publishers, Dordrecht. The Netherlands.
5. George, E.F. (1993). Plant Propagation by Tissue Culture. Part 1. The Technology, 2nd edition. Exegetics Ltd., Edington, UK.
6. George, E.F. (1993). Plant Propagation by Tissue Culture. Part 2. In Practice 2nd edition. Exegetics Ltd., Edington, UK.
7. Glick B.R. and Thompson, J.E. (1993). Methods in Plant Molecular Biology and Biotechnology. CRC Press, Boca Raton, Florida.
8. 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.
9. Hackett, P.B., Fuchs, J.A. and Meesing, J.W. (1988). An Introduction to Recombinant DNA Techniques : Basic Experiments in Gene Manipulation. The Benjamin/Cummings Publishing Co., Inc. Menlo Park, California.
10. Hall, R.D. (Ed.) (1999). Plant Cell Culture Protocols. Humana Press, Inc., New Jersey, USA.
11. Shaw, C.H. (Ed.) (1988). Plant Molecular Biology: A Practical Approach, IRL Press, Oxford.
12. Smith, R.H. (2000). Plant Tissue Culture: Techniques and Experiments. Academic press, New York.
13. Rana, S.V.S., 2012. Biotechniques, theory and practices (Third edition), Rastogi publications, Meerut.
14. Glick, BR. And Pasternak, JJ. (1994). Molecular Biotechnology Principles and Applications of Recombinant DNA. Panima Publishing Corp, New Delhi.
15. Watson, JD., Gilman, M., Witkowski, J and Zollar, M. (1992). Recombinant DNA (Sec. Ed.). Scientific American Books, New York.


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(BTH-B02) Enzyme Technology

- 1. 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.
- 2. 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 V_{max} and K_m values.
- 3. 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.
- 4. Large scale use of enzymes in solution:** 8 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
- 5. Preparation and kinetics of immobilised enzymes:** -- Methods of immobilization of enzymes, Physical adsorption, covalent binding, entrapment and micro encapsulation, kinetics of immobilised enzymes, effect of solute partition and diffusion on the kinetics of immobilised enzymes
- 6. 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 immobilised invertase, lactase, raffinase.
- 7. Biosensors:** -Use of enzymes in analysis, biosensors- calorimetric, potentiometric, amperometric, optical piezoelectric biosensors and immunosensors.
- 8. Advanced topics in enzyme technology:** -- Enzyme reactions in biphasic liquid systems; proteases, glycosidases and lipases in synthetic reactions, interesterification of lipids, artificial enzymes, un-natural substrates, enzyme engineering, extremophilic enzymes.

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. Gerhartz
5. Plant enzymology and plant histoenzymology ---Mallick CP and Singh MB., Kalyani Publishers., New Delhi., (1980).

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BTH A12 -Enzyme Technology Lab.

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 V_{max} and K_m values.
4. Effect of temperature, pH, ionic strength and inhibitors.
5. Immobilization of enzymes/whole cells by adsorption, covalent linkage, entrapment methods.
6. Enzyme reactions in biphasic aqueous - organic solvent.
7. Application of enzymes in detergents, chemical production, juice clarification and bioprocessing.

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(BTH-C03) Bioprocess Engineering

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

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

(8)

Metabolic engineering: control mechanisms and manipulation of shikimic acid pathway. Isolation, maintenance and preservation of industrial microorganisms, microbial growth and death kinetics. Media for industrial fermentation. Air and media sterilization.

(12)

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

(18)

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.

(14)

BTH A13- Bioprocess Engineering Lab.

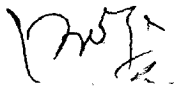
Laboratory Exercises:

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.
4. Production and estimation of Alkaline Protease.
5. Use of alginate for cell immobilization.
6. Microbial production of single cell protein.
7. Any other practical based on theory syllabus

Suggested Readings:

1. Aiba, S., Humphrey AE. and Millis, N.F. (1973). Biochemical Engineering(2nd Edition), Univ. of Tokyo Press, Tokyo.
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5. Enfors, S-O. and Haggström, L. (2000). Bioprocess Technology: Fundamentals and Applications, KTH, Stockholm.
6. Jackson, AT., (1991). Process Engineering in Biotechnology, Prentice Hall, Engelwood cliffs, NJ, USA.
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8. Stanbury, PF., Whitaker, A. and S. J. Hall, SJ. (1995). Principles of Fermentation Technology, Pergamon Press, Oxford.
9. Nielson, J. and Vissadsen, J., (). Bioreaction Engineering Principles, Plenum Press.
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11. Shuler, ML.(Ed.), (1989). Chemical Engineering Problems in Biotechnology, AIChE, New York.
12. Lee, JM. (2009). Biochemical Engineering, Prentice Hall Inc.
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