M.Sc. BIOCHEMISTRY

III SEMESTER

BC 3.1: PLANT BIOCHEMISTRY AND HUMAN NUTRITION

Course Outcome

CO1: To offer basic concepts of carbon dioxide fixation in plants and biochemistry of nitrogen fixation
CO2: To acquire knowledge on factors effecting seed germination and secondary metabolites in plants
CO3: To learn biological values of proteins, dietary needs of lipids, Physiological roles and deficiency disorders of vitamins and minerals
CO4: To understand the need for specialized food for people with special needs - Pregnancy and lactating women, atherosclerosis, cardiovascular disorders and Obesity
CO5: To gain knowledge on biological effects of non-nutrients

Course Specific Outcome

CSO1: To offer detailed knowledge on Nitrogenase enzyme complex and its function
CSO2: To provide concept of role of leptin in regulation of body mass
CSO3: To gain knowledge on food contaminants and food additives

Course Learning Outcome:

LO1: Learning outcomes for this course include detailed understanding of metabolic processes specific for plants such as nitrate assimilation, photorespiration, nitrogen fixation and the role of different phytohormones in plant growth and development
LO2: Students will also gain insight into secondary metabolites and their functions in plants
LO3: Students will learn the basic concept of nutrition for maintaining normal health, role of nutrients for the body, dietary requirements of carbohydrates, proteins and fats
LO4: Students will understand the importance of essential fatty acids, vitamins and minerals for the body

Unit – 1

Carbon dioxide fixation in plants – Calvin cycle & its regulation, C-4 and CAM pathways, Photorespiration, RUBISCO

Nitrogen metabolism: Biochemistry of Nitrogen fixation, Nitrogenase enzyme complex & its function, Nitrogen fixation genes, Formation of root nodules in Legumes, Assimilation of Nitrate and Ammonia

Unit – 2

Seed germination: Biochemical changes during Seed germination, Factors effecting Seed germination; Seed Dormancy: Types of Dormancy, Methods to break Seed Dormancy. Structure, physiological function and mechanism of action of phytohormones – Auxins, Gibberellins, Cytokinin's, Ethylene and Abscisic acid

Secondary metabolites in plants – Nature, distribution, biosynthesis and function of plant Terpenes Phenolics and Nitrogen containing compounds

Unit – 3

Animal and vegetative foods – chemical composition. Nutrients – Essential Nutrients and their classification. Digestibility, absorption and biochemical functions of macro nutrients, Carbohydrates – dietary requirements. Proteins – Nitrogen balance studies, Determination of Biological values of proteins, Specific Dynamic Action, improvement of protein quality by supplementation and fortification. Lipids – Dietary needs of lipids, essential fatty acids. Calorific values of foods, Basal metabolic rate and its determination, factors influencing BMR
Vitamins: sources, physiological role and deficiency disorders of vitamins A, D, E, K, Vitamin C and B complex vitamins–Thiamine, riboflavin, niacin, pantothenic acid, lipoic acid, pyridoxine, biotin, folic acid and Vitamin B_{12}

Unit – 4

Biological effects of non-nutrients, dietary fibre, physiological actions. Antinutrients – Protease inhibitors, hemeagglutinins, hepatotoxin, goitrogens, cyanogenic glucosides, methyl xanthines, oxalates. Toxins from mushrooms. Biological effects of food contaminants – Hexachlorobenzene, arsenic, DDT, cadmium, mercury, lead, aflatoxins, food additives – saccharin and sodium nitrite. Animal foods and seafoods. Food allergy – role of allergens, diagnosis and management of food allergy. Food processing and loss of nutrients during processing and cooking

Unit -5

Clinical nutrition – role of diet and nutrition in prevention of atherosclerosis, cardiovascular disorders and obesity, role of leptin in regulation of body mass. Starvation – Protein sparing treatment during fasting, Protein calorie malnutrition – Kwashiorkar and Marasmus, Nutritional requirements for pregnant and lactating women and agedpeople.Functions and deficiency disorders of minerals

Reference books:

1. Plant Biochemistry-Hans-Walter Heldt, BirgitPiechulla, 4th ed
2. Plant Biochemistry - Dr. V.Arunkumar, Dr.K.Siva Kumar, Dr. N. Senthil Kumar
3. Plant Biochemistry-James Bonner,J.R.Varner
4. Introduction to plant Biochemistry-Goodwin, Mercer, 2nd ed
5. Handbook of photosynthesis-Mohammad Pessarakli et al., 3rd ed
6. Seed: Physiology of development and germination –J. D. Bewley, M. Black, 2nd
7. Nutritional Elements and Clinical Biochemistry- M.A. Brewster, H.K.Naito
8. Nutritional Biochemistry and Metabolism: With Clinical Applications- Maria C. Linder, 2nd ed
9. Advanced textbookon Food and Nutrition-M.S.Swaminathan, Vol. I & II
10. Handbook of Nutritional Biochemistry: Genomics, Metabolomics and Food Supply - Sondre Haugen, Simen Meijer

M.Sc. BIOCHEMISTRY
III SEMESTER
BC 3.2: IMMUNOLOGY

Course Outcomes:

CO1: The course is designed to make the students to understand the principles of immunology which will empower them to gain a broad foundation on the molecular defense mechanisms of the human body
CO2: Foundation in immunology course will enable the student to pursue doctoral program and carry out advanced research
CO3: The course enables the student to get acquainted with the importance of antigen-antibody interaction in disease diagnosis
CO4: The course will enlighten the student about the importance of immunization and the significance of conventional vs. recombinant vaccines
CO5: To acquire expertise in immunological diagnostics approaches and their use

Course Specific Outcomes:

CSO1: The specific outcome of this course is to apprise the students about the components associated with immune system, molecular mechanisms, and their working, which will develop an awareness of key concepts from a vast amount of experimental data that is rapidly emerging in this field
CSO2: The course also deals with implications of deregulation of basic regulatory networks that lead to immune system related disorders
CSO3: The students will be able to describe the roles of the immune system in both maintaining health and contributing to disease
CSO4: To understand the genetic basis of antibody diversity and the importance of humoral, cell-mediated, and innate immune responses in combating pathogens
CSO5: To understand the principles of tolerance, autoimmunity, and the role of immunity in protection against pathogens

Learning Outcomes:

Upon completion of this course, the student will be able to

LO1: Compare and contrast innate and adaptive immunity, describe which cell types and organs present in the immune system and distinguish T and B cells in regarding to their cell surface receptors
LO2: Able compare humoral versus cell-mediated immune responses, distinguish and characterize antibody isotypes, development, and functions
LO3: Understand various mechanisms that regulate immune response and role of MHCs
LO4: Exemplify the adverse effects of immune system including Allergy, Hypersensitivity, Transplantation, Autoimmunity and Cancer
LO5: Apply basic immunological techniques in identifying and quantifying antigen and antibody for disease diagnosis

Unit-1

Immune response–Innate and adaptive, Antigens, Superantigens, Adjuvants:Cells and organs of the immune system -Thymus, bone-marrow, spleen, lymph node, T and B Cells – Origin, characteristics, and functions; T and B cells activation, differentiation, T and B cell surface receptors

Unit-2

Immunoglobulins - Structure, classes, and biological activities. Isotypes, Allotypes, Idiotypes: Humoral immune response and Cell-mediated immune responses: Immunoglobulin genes and Antibody diversity, Class switching; Cytokines-Interleukins (ILs) and Interferons(IFNs)

Unit-3

The Complement system- pathways activate the complement system - the Classical complement pathway, the Alternative complement pathway and the lectin pathway, Biological consequences of complementactivation, Regulation
Major Histocompatibility Complex-HLA, Polymorphism of MHC molecules. MHC restriction and its role in immune response: Antigen presenting cells, Processing, andpresentationofantigens

Unit-4

Immune effector mechanisms – Hypersensitivity: immediate (type I, type II, type III) and delayedhypersensitivityreactions: Immunedeficiencies diseases-SCIDandAIDS Autoimmunity-organ specific(Hashimoto's thyroiditis)andsystemic diseases (Rheumatoid arthritis). Tissue transplantation - auto, allo, iso and xenografts, tissue matching, transplantation rejection, mechanism and control, immunosuppressive agents: Cancer immunology– Tumor associated antigens, Immunological surveillance of cancer

Unit-5

Antigen-antibody interactions and quantification: Antibody affinity and avidity, Precipitation reactions Immunodiffusion, Radial immunodiffusion, double immunodiffusion; Immunoelectrophoresis, Rocket Immunoelectrophoresis: Agglutination reactions: hemagglutination and Complement fixation: Immunofluorescence, FACS, RIA, ELISA, Immunoblotting, Hybridoma technology- production of monoclonal antibodies and their applications, humanized antibodies

References books:

1. Kuby Immunology- Owen, Punt, 10th ed
2. Parham, The immune System, 3rd ed
3. Wiley: Roitt's Essential Immunology - Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt , 13th ed
4. Cellular and Molecular Immunology -Abul Abbas, Andrew H. Lichtman, Shiv Pillai , 9th ed
5. Fundamental Immunology - WilliumE.Paul, 7th ed
6. Janeway's Immunobiology - Kenneth Murphy and Casey Weaver, 9th ed
7. Introduction to Immunology – JohnW.Kinball , 3rd ed
8. Immunology – D.M.Weir, John Stewart, 8th ed
9. Veterinary Immunology - Ian R. Tizard, 9th ed
10. Fundamental of Immunology – Otto Bier, 2nd ed
11. Fundamentals of Immunology – William C. Boyd
12. Cellular and Molecular Immunology - Abbas, Saunders, 3rd ed

M.Sc. BIOCHEMISTRY
III SEMESTER
BC 3.3: REGULATION OF GENE EXPRESSION AND GENETIC ENGINEERING

Course Outcomes:

CO1: To understand the basic aspects of gene regulation in prokaryotes
CO2: To gain the knowledge about various regulatory molecules and proteins involved in eukaryotic gene regulation
CO3: To know the importance of various enzymes of rDNA technology and cloning vectors used
CO4: To gain knowledge about gene transfer techniques and expression of foreign gene
CO5: To understand the construction of DNA libraries and applications of genetic engineering

Course Specific Outcomes:

CSO1: The course highlights the importance of operons in prokaryotic gene regulation and regulation of bacteriophage λ
CSO2: The course covers broad range of regulatory elements in eukaryotes and various levels of gene regulation
CSO3: Major emphasis was on restriction endonucleases and other modifying enzymes, and different types of cloning vectors used in rDNA technology
CSO4: Particular emphasis on introduction of DNA in to living cells like bacteria and other eukaryotes like yeast, mammals and expression of foreign gene
CSO5: The course covers different aspects of identification of recombinants and their applications

Learning Outcomes:

LO1: Students will understand the role of various operons in regulating gene expression in prokaryotes and phage variation in *Salmonella*
LO2: Students will acquire a good knowledge in regulation of eukaryotic gene expression at transcription and translational levels and various transcription factors involved
LO3: Students will gain knowledge about the machinery required for manipulating gene and methods of cloning
LO4: Students will be able to understand the difference between cloning and expression vectors and to identify the recombinant clones
LO5: Students will acquire knowledge about different types of DNA libraries and their uses and also about various types of hybridization techniques

Unit-1

Lac operon: Structure and function, Induction of *lac* operon – a negative control system, Catabolite repression – a positive control system; Function and regulation of *trp* operon, Attenuation of *trp* operon, *Ara* operon - Dual functions of the repressor
Diversity of sigma factor - Bacterial sporulation and Phage infection in *Bacillus subtilis,* Heat-shock response in *E.coli,* Regulation of phage variation in *Salmonella*
Regulation of lytic phase and lysogenic phase of Bacteriophage λ

Unit-2

Chromatin and Gene regulation: Hypersensitive sites, DNA methylation, Histone acetylation, Histone code, Chromatin remodeling; Heterochromatin and Silencing
Different levels of Eukaryotic gene control: Transcriptional Control – Eukaryote promoter and enhancer sequence organization, Transcription activators and silencers, DNA binding protein motifs - Zinc-Fingers, Homeodomains, Helix-Loop-Helix, Leucine Zipper; Post-transcriptional control – Alternate splicing, Trans splicing, RNA editing, RNA transport, RNA stability
Regulation of Gene Expression by Small RNAs (RNA Interference, RNAi) Translational control; Regulation of galactose metabolism in Yeast; Steroid hormone mediated gene expression and regulation

Unit-3

Discovery and Properties of Restriction endonucleases: Restriction modification system, Restriction maps, DNA modifying enzymes
Cloning vectors: Vectors for *E. coli*: Plasmids, M 13 bacteriophage vectors, λ bacteriophage, Cosmids, Phagemids; Eukaryotic cloning vectors: Cloning vectors for Yeast, YAC, Cloning vectors for higher Plants - Ti plasmid, Ri plasmid,
Cloning vectors for Insects, Viruses as cloning vectors for Mammals
Ligation of fragments - Cohesive and Blunt ends, Linkers, Adaptors, Homopolymer tailing

Unit-4

Introduction of DNA in living cells: Transformation, Identification of recombinants, Introduction of Phage DNA into bacterial Cells (Transfection), Identification of recombinant phage
Expression of foreign gene: Gene expression in E coli, Production of recombinant proteins in Eukaryotes, Fungi, Yeast, Mammalian and Insect cell systems; Gene transfer techniques - Biological and Artificial

Unit-5

DNA libraries: Methods used for construction of Genomic and c DNA libraries, Identification of recombinant clones - Colony and Plaque hybridization, Probing, Southern blotting, Northern blotting, South-Western blotting

Polymerase chain reaction: concept, types, methods and applications; Biological, Medical and Industrial applications of recombinant DNA technology

Refernce books:

1. Genes V - Benjamin Lewin
2. Recombinant DNA: A Short course - J.D.Watson et al., 3rd ed
3. Gene cloning and DNA Analysis – T.A.Brown, 6th ed
4. Principles of Gene Manipulation: An Introduction to Genetic Engineering - Sandy B. Primrose, Richard Twyman, Bob Old, 6th ed
5. Genetic Engineering by Sandhya Mitra.
6. Molecular Biotechnology: Principles and Applications of Recombinant DNA - Bernard R. Glick, Jack. J. Pasternak

M.Sc. BIOCHEMISTRY
III SEMESTER
BC 3.4: INDUSTRIAL BIOTECHNOLOGY

Course Outcomes:

CO1: To learn the principle of fermentation and its types such as surface, submerged and solid state fermentations, different types of culture techniques for bacteria and fungi, design and operation of fermentors and types of fermentors such as continuous stirred tank fermentor and air-liftfermentor

CO2: To understand types of reactions in fermentations, criteria of selection and characteristics of industrial microorganisms, role of primary and secondary metabolites, different strategies for strain improvement and maintenance of the industrial strains

CO3: To understand the need for using raw materials, different types of fermentation media, recovery of products, steps involved in downstream processing and applications of bioreactors

CO4: To learn the production of ethyl alcohol, n-butanol, wine, beer; fermentative production of organic acids, antibiotics, enzymes, amino acids, vitamins and production of biogas from agricultural waste

CO5: To understand the advantages for preparing immobilized enzymes and cells, methods of immobilization, immobilization of multienzyme systems, effect of partition on kinetic properties of enzymes, types of enzyme reactors, what are the problems in using immobilized biocatalysts, industrial and medical applications of immobilized enzymes, principle, types and applications of biosensors, principle and applications of protein engineering

CO6: To learn the production and applications of single cell protein, importance of microbial transformations, types (steroidal transformations), applications, bioleaching, biosorption, biodegradation, bioremediation, Biofertilizers – Blue-green algal fertilizers (*Azolla, Aneabena*), seaweed fertilizers, *Mycorrhiza*, Biocontrol agents- Siderophores, biopesticides – Insecticidal toxin of *Bacillus thuringiensis*, mode of action and control, Bacculoviruses

Course Specific Outcomes:

CSO1: The objectives of this course are to introduce students to developments/advances made in field of microbial technology for use in human welfare and solving problems of the society

CSO2: Students should be able to appreciate relevance of microorganisms from industrial context

CSO3: Students should be able to carry out stoichiometric calculations and specify models of their growth

CSO4: To understand the basics of process of fermentation technology and learnt the concept of Screening, optimization and maintenance of industrially important microbial cultures and further in production of biodiesel

CSO5: Students should be able to give an account of design, development and operations of various bioreactors and production optimization, and preparation of sterile base materials for downstream processing

CSO6: Students should be able to calculate yield and production rates in a biological production process, and also interpret data

CSO7: Students should be able to give an account of important microbial/enzymatic industrial processes

CSO8: The course will introduce major groups of microorganisms tools in biotechnology and their most important environmental applications

Learning outcomes:

LO1: The students will be able to understand the principles of fermentation culture techniques, design and operation of fermentors
LO2: The students will be able to know fermentation reactions, characteristics of industrial Microorganisms, role of metabolites, strategies for strain improvement and maintenance of the industrial strains
LO3: The students will be able to understand the use of raw materials, fermentation mediaand bioreactors, recovery of products, anddownstream processing
LO4: The students will learn the fermentative production of alcohols, organic acids, antibiotics, enzymes, amino acids, vitamins and biogas
LO5: The students will be able to understand the concept of preparing immobilized enzymes and cells, immobilization and its effect on kinetic properties of enzymes, applications of immobilized enzymes, biosensors, protein engineering
LO6: The students will learn the production and applications of single cell protein, microbial transformations,bioleaching, biosorption, biodegradation, bioremediation, biofertilizers, biocontrol agents, biopesticides
LO7: On completion of this course, students would develop deeper understanding of the industrial biotechnology and its applications

Unit-1

Introduction to Fermentation technology – Bacterial growth and factors effecting growth.Principles of fermentation, surface, submerged and solid state fermentations. Batch, fed batch, semi-continuous and continuous culture techniques. Design and operation of fermentors, Agitation and aeration, Types of fermentors- continuous stirred tank fermentor (CSTF), air-liftfermentor

Unit-2

Types of reactions in fermentations, selection and characteristics of industrial microorganisms, Primary and secondary metabolites, Strategies for strain improvement and maintenance of the industrial strains. Raw materials, different types of fermentation media, Recovery of products, steps in downstream processing, Bioreactors

Unit-3

Production of ethyl alcohol, n-butanol, beer and wine. Fermentative production of Organic acids - citric acid, lactic acid, acetic acid; Antibiotics - penicillin, streptomycin, tetracycline;Amino acids - glutamic acid, lysine; Enzymes - amylase, proteases, streptokinase, and Vitamins - $B_{12,}$ $B_{2,}$ and vitamin C. Production of biogas from agricultural waste

Unit-4

Introduction to Immobilization of enzymes and cells – methods of immobilization, effect of partition on kinetic properties of enzymes, immobilization of multienzyme systems. Enzyme reactors - packed bed reactors, fluidized bed reactors, problems in using immobilized biocatalysts, Industrial and medical applications of immobilized enzymes and cells. Principle, types and applications of Biosensors. Principle and applications of Protein engineering

Unit – 5

Production and applications of single cell protein, Microbial transformations (bioconversions)-: Types and applications, steroidal transformations. Bioleaching, biosorption, biodegradation, bioremediation. Biofertilizers – Blue-green algal fertilizers (*Azolla, Anabaena*), seaweed fertilizers, *Mycorrhiza*. Biocontrol agents- Siderophores, biopesticides – Insecticidal toxin of *Bacillus thuringiensis*, mode of action and control, Bacculoviruses

Reference books:

1. Biotechnology-A text book of Industrial Microbiology-W.Crueger, A.Crueger, 3rd ed
2. Industrial Microbiology-L.E.Casida, 2nd ed
3. Molecular Biology and Biotechnology-J.M.Walker, E.B.Gingold, 4th ed
4. Concepts in Biotechnology-D.Balasubramanian et al.,
5. Text book of Biotechnology-T.T.Pandian, D.Kandavel
6. Essentials of Biotechnology-U.K.Patil, K.Muskhan
7. Molecular Biotechnology-S.Ramreddy, K.Venkateswarlu et al.,
8. Biotechnology - U.Satyanarayana
9. Principles of fermentation technology - Stanbury, P. F., & Whitaker, A Press.

M.Sc. BIOCHEMISTRY
III SEMESTER
PRACTICAL -I
BC 3.5: IMMUNOLOGY AND FOOD ANALYSIS

Course Outcomes:

CO1: To offer hands on experience on various immunology techniques such as Radial Immunodiffusion, Immunoelectrophoresis, Rocket Immunoelectrophoresis and Western blotting.
CO2: To provide skills in performing purification of bovine serum immunoglobulin and ELISA.
CO3: To learn to extract and estimate total lipids from oil seeds.
CO4: To provide hands on experience in the preparation of carotene, chloroplasts and haemoglobin and isolation of glycogen and glutamic acid from foods.
CO5: To learn to analyse minerals from foods.

C**ourse Specific Outcomes:**

CSO1: To offer hands on experience on various advanced immunology techniques.
CSO2: To provide skills in performing various diagnostic tests-typhoid, VDRL and pregnancy tests.
CSO3: To provide hands on experience in the preparation of glycogen, carotenes, chloroplasts and glutamic acid from various foods.

Course Learning Outcomes:

LO1: Students will develop skills to perform various immunoassays such as Ouchterlony immunodiffusion, Western Blotting, ELISA for diagnosis of various diseases.
LO2: Students will also learn techniques to purify immunoglobulins and the principles of blood typing.
LO3: Students will acquire expertise in the determination of moisture in food, and determination of minerals, amino acids in various foods.
LO4: Students will learn to isolate glycogen from sheep liver and preparation of haemoglobin from blood.

IMMUNOLOGY (A)

Determination of A, B, O and Rh blood groups in human beings
Dissection and Identification of thymus, spleen and lymph nodes
Techniques of Immunization and Bleeding
Ouchterlony immunodiffusion for detection of Antigens
Radial Immunodiffusion
Immunoprecitation and precipitin curve
Immunoelectrophoresis
Rocket immunoelectrophoresis

Purification of bovine serum IgG by ammonium sulphate precipitation
Enzyme Linked Immuno Sorbent Assay (ELISA)
Western blotting
Diagnostic test for typhoid fever
VDRL Test
Pregnancy Test

FOOD ANALYSIS (B)

Isolation of Glycogen from Sheep Liver Preparation
of Carotenes from Carrots Preparation of
Haemoglobin from Blood Preparation of
Chloroplasts from green leaves Isolation of Glutamic
acid from Gluten of Wheat
Extraction and estimation of total lipids from oil seeds (solvent extraction)
Quantitative analysis of foods for -

Moisture
Ash
Iron
Calcium
Copper

Reference books:

1. Keith Wilson and John Walker, Principles and techniques of Practical Biochemistry, 2010, Seventh edition, Cambridge University Press
2. Holme. D. J. and Peck. H., Longman Analytical Biochemistry, 1998, 3rd edition.
3. Chatwal, G & Anand, S, Instrumental methods of chemical analysis, 2005, Himalaya Publishing House
4. S. K. Sawhney & Randhir Singh, Introductory Practical Biochemistry, 2014, Narosa Publications House

M.Sc. BIOCHEMISTRY
III SEMESTER
PRACTICAL -II
BC 3.6: INDUSTRIAL BIOTECHNOLOGY AND GENETIC ENGINEERING

Course Outcomes:

CO1: To provide the laboratory skills for fermentative production of industrially important products
CO2: To gain hands on experience for preparation of immobilized enzymes and microbial cells
CO3: To offer basic skills on use of UV spectrophotometer for quantification of DNA
CO4: To provide hands on experience on use of restriction enzymes and other ligation methods
CO5: To offer hands on experience on separation of nucleic acids and their recovery from gels
CO6: To provide practical knowledge about different DNA markers

C**ourse Specific Outcomes:**

CSO1: Development of laboratory skills for the production of antibiotics, organic acids, enzymes, amino acids, vitamins etc.
CSO2: Gain basic knowledge for preparation of immobilized enzymes and cells
CSO3: Gain thorough knowledge on use of instruments required to carry out genetic engineering practicals

Course Learning Outcomes:

LO1: Students will be able to get hands on experience on fermentative production of industrially important products.
LO2: After completion of practicals students will be familiar in quantification of Nucleic acids using UV spectrophotometer.
LO3: Students will be able to get hands on experience on Immobilization enzymes and cells by entrapment method.
LO4: Students will acquire the hands on experience on experiments related to genetic engineering.
LO5: After completion of the course students will be familiar in RFLP, PCR and southern blotting techniques

INDUSTRIAL BIOTECHNOLOGY (A)

Fermentative production and quantification of:

Antibiotics - penicillin/ streptomycin/tetracycline
Organic acid: citric acid/ lactic acid/ acetic acid
Enzymes: amylase/ protease/urease
Amino acid: glutamic acid/ lysine
Vitamins: B_{12}/ B_2/vitamin C
Ethyl alcohol/ fruit wine and calculation of fermentation efficiency

Methods of immobilization of protein/enzyme and microbial cells

GENETIC ENGINEERING (B)

Isolation of plasmids and estimation of plasmid DNA by UV method
Restriction digestion of λ DNA, Ligation of RE fragments
Agarose and Polyacrylamide gel electrophoresis of nucleic acids
Recovery of DNA/RNA fragments from agarose gels Preparation of competitive *E.coli* cells and transformation Expression of cloned gene (GFP)
DNA finger printing (RFLP or RAPD)
PCR
Southern blotting

Reference books

1. Genome Mapping: A practical approach. Dear P (Editor). 1st Ed. 2000. Oxford University Press: Oxford
2. Molecular Cloning – A Laboratory Mannual, Sambrook.
3. Manual of Industrial Microbiology and Biotechnology - Richard H. Balt et al., 3rd ed