

Genome Mapping

Different types of maps: physical, genetic, etc. Synteny, Human genome project, Application of genome mapping, Chromosome maps
Physical and Genetic map of Model Genomes -Lambda phage, *E. coli*, Arabidopsis, *Saccharomyces cerevisiae*, Human

Isolation and Sequencing of Gene and Protein

NA: Gene isolation by DNA shot gun method, c-DNA preparation, Chemical and Enzymatic (PCR) synthesis, Maxham-Gilbert, Sanger dideoxy method
Protein: Peptide mass spectrum with MALDI-TOF
Submitting DNA Sequences to the Databases
Analysis of Molecular markers RAPD, RFLP, SNPs, AFLP, SSCP, FISH, SSR, STMS, DNA finger printing, DNA foot printing

Gene cloning

Tools of r-DNA Technology:
Vectors: Plasmids, lambda phage, Phagemids, Cosmids, Artificial chromosomes, Shuttle vectors, Virus-based vectors, Gene libraries
Enzymes: Restriction enzymes, DNA modifying enzymes, Ligases, Polymerases
Recombinant DNA technology: Outline, Analysis and expression of cloned gene in host cell, Cloning in prokaryotes and eukaryotes, Applications

Expression Controls

Concept of Intron and Exon
Operon model, Lac negative control and Catabolite repression, Trp operon negative and attenuation control
Controls in Bacteria and Phages: Lysogeny in Lambda phage, Controls at Transcriptional, Translational and Post-translational levels
Controls in Eukaryotes: Cis and Trans regulatory elements, Dorsal protein, Role of Chromatin, DNA methylation, Imprinting, Controls at Post-transcriptional, Translational and Post-translational levels
Regulation by Modification in Sigma, Quorum sensing, Ribozyme switches, 51 RNA, Global Regulatory Mechanism
Interaction of multiple regulatory mechanism
Eukaryote vs Prokaryotic regulation

Reference

1. David Hyde (2009) Introduction to Genetic Principles, McGraw-Hill
2. Watson JD, Baker, Bell, Gall, Lavine and Losick (2006) Molecular Biology of the Gene, Pearson Education
3. Brown TA () Gene Cloning and DNA Analysis, Blackwell Science
4. Benjamin Lewin (2008) Gene IX, Jones and Bartlett
5. Benjamin Lewin (2006) Essential Genes, Pearson Education
6. Karp Gerald (2005) Cell and Molecular Biology - Concepts and Experiments, (4th Ed), Wiley
7. Mount David W (2004) Bioinformatics; Sequence and Genome Analysis, (2ndEd), CBS
8. Primrose SB, RM Twyman and RW Old (2001) Principles of Gene Manipulations, (6thEd), Blackwell Science
9. Primrose SB, R Twyman and Old RW (2001) Principles of Gene manipulation (6thEd) Blackwell Science
10. Jeremy W Dale and Simon F Park (2004) molecular Genetics of Bacteria (4th Ed) John Wiley

Bioreactors design:

Bioreactor: Material, Controls, Containments

Stirred tank reactor

Unconventional bioreactors: Air-lift, Hollow fiber, membrane, and perfusion reactor for animal and plant cell culture

Scale up and Optimization

Process control instruments

Control Parameters and its importance:

Physical (Temperature, Pressure, Agitation speed and power, Foam, Gas/Liquid flow, Volume) and Chemical (pH, DO, DCD, Redox, Specific ions, Intracellular PIAOH)

Electronic devices: Flow Microfluorometry, Multiple Internal Reflection Spectrometry

Basic Controls: On/Off Controls, PIO Controls, Cascaded Feedback Control, Supervisory Computer Control

Biosensor technology

Mass Transfer

Gas Absorption Theory and Coefficient for Oxygen transfer

Heat flow in fluids by conduction and convection, Mass transfer for heat, Heat transfer equipments

Important Rheological properties of fluid and its significance in fermentation process

Stoichiometric analysis: Overall Growth Yield Coefficient, Elemental balance, and Degree of Reduction

Down stream processing

Importance and Quality parameters in recovery process

Cell removal by Foam separation, Sedimentation, Filtration, Centrifugation

Cell Disruption by Physical, Chemical and Enzymatic methods

Concentration by Liquid-liquid extraction, Solid-phase, Precipitation, and Soubilization.

Recovery by Chromatography, Ultra filtration, RO, Liquid membranes, Crystallization and Drying.

Reference

1. Stanbury PF, Whitaker A and SJ Hall (1995) Principles of Fermentation Technology, (2ndEd), Pergamon Press
2. Alan Wiseman (1983) Principles of Biotechnology, Surrey University Press
3. Hans Peter Schmauder (1997) Methods in Biotechnology, Taylor and Francis
4. Trevan, MD (1987) Biotechnology: The Biological Principles, Toto McGraw Hill
5. Najafpour Ghasem D (2007) Biochemical Engineering and Biotechnology, Elsevier
6. Shuler Michael L and F Kargi (2002) Bioprocess Engineering: Basic concepts, (2ndEd), Pearson
7. Rosenthal Sandra J and DW Wright, Editors (2005) NanoBiotechnology Protocols, Humana Press
8. Richard H Baltz, Arnold L Demain and Julian E Davies (2010) Manual of Industrial microbiology and Biotechnology (3rd Ed) ASM Press
9. Harvey W Blanch and Douglas S Clark (1997) Biochemical Engineering, Marcel Dekker
10. John S Bailey and S C Bhatia (2009) Biochemical Engineering. CBS Pub

The oceans

Oceans of the world, Physical and Chemical Properties
Biological productivity in the ocean
Composition of seawater, estuarine and brackish waters
Marine environment: Flora, seaweeds, sea grasses and mangroves

Marine Resources

Chemical resource: Metals, minerals and trace elements
Ocean habitat and biota
Planktons, Crustaceans, Molluscs and Fishes, Vertebrates and Mammals
Live resource: Assessment of live resources assessment

Marine Biotechnology

Bioactive compounds from marine life
Commercial bio-products from marine organisms: Polysaccharide, Protein, Enzymes and Lipids
from marine sources and their applications
Novel genes: Anti-freeze protein, GFP

Commercial Potential

Aquaculture: Economics, Fish farming, Improvements, Barriers
Environment Remediation and Biosensors
Control of Bio-fouling and Bio-corrosion
Sea farming, Algal Single Cell Protein

Reference

1. Pinet Paul R (2009) Invitation to Oceanography (5thEd), Jones and Bartlett
2. Morrissey John F and JL Sumich (2009) Introduction to the Biology of Marine Life (9thEd), Jones and Bartlett
3. Castro Peter and ME Huber (2003) Marine Biology, (4thEd), McGraw Hill
4. ThiemanWilliam J and MA Palladino (2009) Introduction to Biotechnology, (2ndEd), Pearson Education
5. Attaway David H (2001) Marine Biotechnology, Vol 1 Pharmaceutical and Bioactive Natural Products
6. Colwell Rita R (1984) Biotechnology in the Marine Sciences (Adv. in Marine Science and Biotechnol) Wiley Interscience.
7. Boand Carl E (1996) Biology of Fishes, (2ndEd), WB Saunders Company
8. Italy E (1998) (Eds) New Developments in Marine Biotechnology, Plenum Pub
9. Gal Y Le and HOHalvorson (1998) New Developments in MarineBiotechnology, Springer

Enzymes

- (A) Enzyme: Structure, Properties, Nomenclature and Classification
- (B) Specificity, Enzyme Activity Unit, Specific activity and Turnover number
- (C) Factors influencing Enzyme activity, Michaelis-Menten Equation
- (D) Method for determination of Mole weight, Amino acid composition and foldings
- (E) Activation energy, Mechanism of catalysis, Lock and Key model, Induced-fit model, Methods to determine enzyme mechanism

Enzyme controls

Mechanism of action: Enzyme, Activators, Inhibitors and Allosteric regulators
Multi – enzyme complex; single and multi-substrate systems;
Isoenzymes - Lactate dehydrogenase.
Coenzymes - NAD, NADP, FAD, PLP, TPP.
Abzymes, Ribozymes

Production of Proteins

Homogenization, Extraction, Assay of proteins
Purification by Size, Mass, Polarity, Solubility and Specificity-based separation
Industrial use and market for enzymes
Culture, Medium, Process and Recovery for fungal Amylase, Glucose isomerase, Taq polymerase, T₄ DNA ligase
Recombinant Molecules: Heterologous bioproduction of Insulin, HGH, Erythropoetin, Somatostatin, Blood clotting factor VIII, Granulocyte colony stimulating factor

Enzyme Manipulation

Techniques of Enzyme and Microbial cells immobilization, Reaction in organics, Solid phase and supercritical fluid
Biosensors: Enzyme and cell based system, Principle, working, Advantages, success case
Protein engineering: Modification of protein, Methods and examples of enzyme engineering

Reference:

1. Price Nicholas C and L Stevens (1999) Fundamentals of Enzymology: The cell and molecular biology of catalytic proteins, (3rdEd), OUP.
2. Palmer Trevor (2004) Enzymes: Biochemistry, Biotechnology and clinical chemistry, Horwood
3. Copeland Robert A (2000) Enzymes: A practical introduction to structure, mechanism and data analysis, (2ndEd), Wiley
4. Boyer, P.D () The enzymes Vols. 1&2. A.P. Freeman
5. Fersht, A.R () Enzyme structure & Mechanism A.P Freeman

Practical I, II Molecular Biology, Biochemical Engineering, Marine Biotechnology, Enzyme Technol (301-304)

1. Separation of Analyte by DEAE-cellulose ion-exchange column chromatography
2. Separation of proteins by Dextran Gel-permeation column chromatography
3. Isolation of Amylase from germinating seeds
4. Colorimetric Estimation of Amylase
5. Determination of Michaelis-Menten constants for Amylase
6. Isolation of Genomic DNA from *E. coli*
7. Isolation of Plasmid DNA from Bacterial cells
8. Bacterial Transformation and expression of marker gene
9. Detection of Bt (Cotton) / Lac (*E. coli*) gene using PCR
10. Analysis of plasmid restriction digest on agarose gel with molecular markers
11. Effect of aeration parameters over OTR in Shake-flask study by Sulphite oxidation
12. Stabilization of protein for development of formulation
13. Prediction Of 3D protein Structure from the sequence
14. Homology searching for known sequence from Genome database