

BIOTECHNOLOGY
B. Sc. Semester Pattern Syllabus
B. Sc. Part I
BIOTECHNOLOGY
(With effect from academic session 2017-18)

The examination shall comprise of one theory paper, one in each semester and one practical in each Semester. Each theory paper will be of 3Hrs. duration and carry 100 marks. The internal assessment will carry 20 marks. The practical examination will be of at least 4 hours duration in one day and shall carry 30 marks. The following syllabi is prescribed on the basis of six lectures per week and 6 practical periods per batch per week. Each theory paper has been divided into 6 units. There shall be one question on every unit with internal choice for each of 14 marks & one compulsory question covering all the syllabus of Semester-III (16 marks)

B. Sc. Part I – Semester I -
FUNDAMENTALS OF BIOTECHNOLOGY AND BIOMOLECULES

UNIT I

Introduction to Biotechnology

A) Definition, Historical overview of Biotechnology National & International

B) Scope of Biotechnology :

Biotechnology in Agriculture,

Biotechnology in Health & Biopharmaceuticals

Biotechnology in Industry

Biotechnology in Environment & Biodiversity

Brief introduction to generic engineering, bioinformatics and nano-biotechnology

UNIT II

Microbes in Biotechnology and microbial nutrition

A) Bacteria: general morphology of bacteria, shapes and sizes, typical bacterial cell. Cell wall of gram +ve and Gram -ve cells.

Viruses: General characteristics of viruses, structure, different shapes and symmetries with one example of each type, classification of viruses LHT system cultivation Brief idea of lytic cycle and lysogeny.

B) Nutrition: Basic nutritional requirements: Basic idea of such nutrients as water, carbon, nitrogen, sulfur and vitamins etc., natural and synthetic media, nutritional classification of bacteria. Selective and Differential media, Enrichment media.

UNIT III Microscopy and staining technique

A) Definition: Magnification, Resolution, Numerical aperture, chromatic aberration

• principle, construction, working and applications of :

Compound microscope, SEM and TEM

B) Stains: Concept, aims of staining, smear preparation, principle and procedure of staining for

Bacteria ; Simple (monochrome & negative staining); differential(Gram staining)

Hanging drop method : bacterial motility

Fungi : Lacto phenol cotton blue method•.

UNIT IV

Nucleic Acids

A) Chemical structure and base composition of nucleic acids, Chargaff's rules, Watson Crick Model (B-DNA), deviations from Watson-Crick model, other forms of DNA (A- and Z-DNA), forces stabilizing nucleic acid structures, (hydrogen bonds and hydrophobic associations, base stacking).

B) Structure of RNA(mRNA , tRNA, rRNA)

UNIT V

Chromosomes, Concept of Genes and Nucleosomes

A) Concept of prokaryotic genes and eukaryotic genes: Definition of a gene, concept of split genes, introns, exons, spacers, C-value and C-value paradox, basic idea of Cot curves.

B) Chromatin structure: Nucleosome structure (10 nm fibre, experiments leading to discovery of nucleosomal structure, types of histones, arrangement of histones in the octamer, H1 histone and its role, role and length of linker DNA), 30 nm fibers (arrangement of nucleosome in a helical structure), domain and loop structure (further compacting of 30 nm fibre, role of scaffolding proteins). Role of telomere and centromere, telomeric and centromeric repeat sequences.

UNIT VI

Amino acids and protein structure

A)Amino acids: Classification, Properties, reactions (ninhydrin), rare amino acids, and separation techniques

B) Primary structure of proteins: peptide bond, use of peptidase specificity, Fibrous proteins, globular proteins

Secondary structure of proteins: The alpha-helix, Beta -structures (parallel, antiparallel, mixed, beta-turn).

Tertiary structure of proteins: Forces that stabilize the structure (electrostatic forces, hydrogen and disulfide bonds, hydrophobic associations), myoglobin as an example of tertiary structure, concept of domains, protein denaturation.

Quaternary structure of proteins: Forces stabilizing quaternary structure, advantages of oligomeric proteins.

B.Sc. I SEMESTER I
PRACTICALS BIOTECHNOLOGY
FOUNDATION OF BIOTECHNOLOGY & BIOMOLECULES

- 1 Introduction to Biotechnology Laboratory
- 2 Demonstration, use and care of biotechnology equipment's.
- 3 Preparation of media, sterilization and isolation of bacteria and fungi
- 4 Isolation of Fungi from plant
- 5 Isolation of Bacteriophage from sewage / other sources.
- 6 Demonstration of motility of Bacteria.
- 7 Simple staining of bacteria
- 8 Gram's staining of Bacteria
- 9 Endospore staining.
- 10 Demonstration of starch hydrolysis by bacterial cultures
- 11 Growth of fecal coliforms on selective media.
- 12 Estimation of DNA by Diphenylamine method
- 13 Estimation of RNA by Orcinol method
- 14 Formol titration of glycine.
- 15 Detection of Amino Acid by paper chromatography
- 16 Quantitative Estimation of proteins by Biuret method

Note: - Mandatory to perform atleast 6 practical

Recommended readings:

Modern Concept of Biotechnology.H.D.Kumar (Vikas Pub.)

Fundamentals of Biotechnology - Purohit&Mathur (Agro Bot. Pub.)

General Microbiology, Stainer, R.Y., Ingraham, J.L., Wheelis, M.L.and Painter, P.R. The MacMillan Press Ltd..

Brock Biology of Microorganisms, Madigan, M.T., Martinko, J.M. and Parker, J. Prentice-Hall.

Microbiology, Pelczar, M.J. Jr., Chan, E.C.S. and Kreig, N.R., Tata McGraw Hill..

Elements of Biotechnology P.K.Gupta

Biotechnology by Lalji Singh

Biotechnology by B.D. Singh

Biotechnology ByU.Sathynarayan

Biotechnology by Dube&Maheshwari

Lehninger's Principles of Biochemistry (5th edition) by Nelson DL and Cox MM, CBS Publications, 2008.

Biochemistry by Stryer L. (5th edition) W.H. Freeman & Co., New York, USA,

Fundamentals of Biochemistry. 3rd Edition, (2008), Donald Voet& Judith Voet , John Wiley and Sons, Inc. USA

Laboratory Manual for Biotechnology, VermaAshish, Das Sujit, and Singh Anchal, S Chand & Company, New Delhi

An Introduction to Practical Biochemistry, 3rd Edition, Plummer D.T., Tata McGraw Hill Publishing Company Limited, New Delhi

Experiments in Microbiology, 4th Ed., Aneja K.R.New Age International Pub.N.Delhi.

Experimental Biochemistryby B. SashidharRao and Vijay M. Deshpande

Karwa A. S., Rai, MK and Singh HB (2008) Handbook of Technique in Microbiology, Scientific publisher, Jodhpur

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B. Sc. Part I – Semester II
MICROBIOLOGY, CELL BIOLOGY& ENZYMOLOGY

UNIT I

Microbial Growth

Growth: Growth rate and generation time, details of growth curve and its various phases.

Concept of synchronous cultures, continuous and batch cultures (chemostat and turbidostat).

Measurement of growth.

Physical conditions required for growth: Temperature (classification of microorganisms on the basis of temperature requirements), P^H etc. Pure cultures and Axenic culture. Maintenance of pure culture.

UNIT II:

Microbial Control

Terminologies - Sterilization, disinfection, antiseptic, sanitization, germicide, microbistasis, preservative and antimicrobial agents.

Mechanism of cell injury: Damage to cell wall, cell membrane, denaturation of proteins, inhibition of protein synthesis, replication, Physical control: Temperature (moist heat, autoclave, dry heat, hot air oven and incinerators), dessication, surface tension, osmotic pressure, radiation, UV light, electricity, ultrasonic sound waves, filtration.

Chemical control: Antiseptics and disinfectants (halogens, alcohol, gaseous sterilization. Antibiotics and chemotherapeutics agents .Concept of biological control.

UNIT III

Eukaryotic cell

A) Eukaryotic Cell –difference between plant and animal cell Structure and function of the following: nucleus, mitochondria, ribosomes, Golgi complex, endoplasmic reticulum, plastids lysosomes, peroxisomes, glyoxisomes and vacuoles.

B) Plant cell wall.

Cytoskeleton (microtubules, intermediate filaments (IF) and microfilaments) and cell locomotion.

Mitosis and meiosis. Brief idea of cell cycle.

Muscle and nerve cell structure, synaptic transmission and neuromuscular junctions.

UNIT IV

Carbohydrates and Lipids

Definition, classification, nomenclature of carbohydrates, structures of monosaccharides (glucose and fructose), disaccharides (sucrose, lactose, maltose), trisaccharide (raffinose) and polysaccharides (structures of cellulose, starch and glycogen as examples of homopolysaccharides). Concept and examples of heteropolysaccharides.

Types of lipids, structures of saturated and unsaturated fatty acids, triglycerides, simple and mixed triglycerides, phospholipids, glycolipids (ganglioside and cerebroside) and sphingolipids. Concept of acid value, saponification value and iodine value. Terpenoids and isoprenoids - definition and representative structures, steroids. Definition, Classification and representative structures (Cholesterol).

UNIT V

Introduction to Enzymes

Terminology: Active site, allosteric site, Holoenzyme, apoenzyme, coenzyme, substrate, inhibitor, activator, modulator etc. Enzyme nomenclature and classification (IUBMB) with example

Concept of isoenzymes (example Lactate Dehydrogenase) and multienzymes (example pyruvate dehydrogenase)

Substrate Specificity (bond specificity, group specificity, absolute specificity, stereo-specificity, lock and key and induced fit models).

Concept of allosteric enzymes (brief idea of AT Case as an example)

Mechanisms of catalysis: Acid-base, covalent and metal ion catalysis.

UNIT VI

Enzymes Kinetic

Assay of Enzymes: Concept of activity, specific activity, turnover number, units of enzyme activity (katal, international unit), spectrophotometric methods of assay of enzymes (simple and coupled assay),.

Enzyme kinetics: Michaelis-Menten equation and its modification (Lineweaver-Burke plots)

Factors affecting enzyme activity: Enzyme concentration, Substrate concentration, pH, Temperature, Activators and Inhibitors,

enzyme inhibition kinetics (reversible inhibition types – competitive, uncompetitive and non-competitive), kinetics of allosteric enzymes

Industrially significant enzymes: amylase, protease, and lipase

Immobilization techniques.

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B.Sc. Part -I
SEMESTER II PRACTICALS
Biotechnology
Microbiology, Cell constituents & Enzymology

1. Qualitative Analysis of sugars and proteins.
2. Quantitative estimation of sugars (Dinitrosalicylic acid method).
3. Estimation of glucose by Benedict's quantitative method
4. Quantitative estimation of proteins by Lowry's method.
5. Determination of saponification value of Fats
6. Determination of Acid Value of Fats
7. Isolation of urease and demonstration of its activity
8. Assay of protease activity.
9. Preparation of starch from Potato and its hydrolysis by salivary amylase.
10. Assay of alkaline phosphatase
11. Immobilization of enzymes / cells by entrapment in alginate gel
12. Effect of temperature / pH on enzyme activity
13. Isolation of pure culture by pour plate method
14. Isolation of pure culture by streak plate method.
15. Anaerobic cultivation of microorganisms.
16. Cultivation of yeast and moulds.
17. Antibiotic sensitivity assay.
18. Oligodynamic action of metals.
19. To study germicidal effect of UV light on bacterial growth.
20. Stages of mitosis.

Note: - Mandatory to perform atleast 6 practical.

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Recommended readings:

General Microbiology - Stanier R.Y., 5th edition, (1987)Macmillan Publication, UK.

Presscott's Microbiology, 8th edition (2010), Joanne M Willey, Joanne Willey, Linda Sherwood, McGrawHil Science Engineering, USA

Cell biology by E.D.P .De Robertis and E.M.F. De Robertis Jr. &Febiger

Molecular Biology Of The Cell, 4th Edition. Bruce Alberts, Alexander Johnson, Julian Lewis, Martinraff, Keith Roberts, And Peter Walter. New York: Garland.

Animal Physiology.by N.Arumugam , A.Mariakuttikan

Animal physiology by P. S verma S. chand publications

Price.N.C.,Stewens Levis," Fundamentals of Enzymology", 3rd edition

Modi.H.A; "Elementory Microbiology", Vol I; Akta Publication, Nadiad

Nelson D.L,Cox M.M, "Lehninger's Principles of Biochemistry" CBS Publications,2000.

Pawar.C.B; (1989) "Cell Biology"; Himalaya Pub. House, Mumbai

Satyanarayan U, " Biochemistry",Books and Allied (P) ltd,Kolkata.

Rastogi S.C, "Cell Biology" ,3rd edition,New Age International (P) Ltd.

Stryer L,"Biochemistry",4th edition,W.H.Freeman and Co,New York,USA.

Fundamentals of Biochemistry. 3rd Edition, (2008), Donald Voet& Judith Voet , John Wiley and Sons, Inc. USA

Principles of Biochemistry, 4th edition (1997), JefforyZubey, McGraw-Hill College, USA

Bacteriology by Salle

Organic Chemistry (Vol.1, Vol. 2) by O.P. Agrawal.

Practical Biochemistry by David Plummer

Experimental Biochemistryby B. SashidharRao and Vijay M. Deshpande

B. Sc. Semester Pattern Syllabus
B. Sc. Part II
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B. Sc. Part II – Semester III

METABOLISM AND BIOPHYSICAL TECHNIQUES I

UNIT I

Bioenergetics and carbohydrate metabolism

- A) Concept of free energy, Entropy, Enthalpy & Redox Potential. Concept of high energy bonds as related to the structure of ATP, Phosphoenolpyruvate.
- B) Glycolysis (pathway, entry of other monosachharides and disaccharides, regulation, inhibitors) Gluconeogenesis: Bypass reactions.
- C) TCA cycle: Detailed account, regulation, amphibolic nature and anaplerosis.
Electron Transport Chain: Components of the chain, sites of ATP synthesis,

UNIT II

Lipid Metabolism

- A) β -oxidation of fatty acids, role of carnitine, oxidation of unsaturated fatty acids & odd carbon fatty acids.
Regulation. Ketogenesis, Ketosis & ketoacidosis in physiology & pathology.
- B) Biosynthesis of fatty acids, fatty acid synthase complex, regulation, Microsomal & Mitochondrial system of chain elongation & synthesis of unsaturated fatty acids.

UNIT III

Metabolism of Nitrogenous Compounds

- A) Transamination (mechanism). Oxidative & Non-oxidative deamination.
Urea cycle: Detailed account, linkage of urea & TCA cycle, compartmentation of urea cycle, regulation, metabolic disorders of urea cycle.

B) Transmethylation& Decarboxylation, physiologically important products of decarboxylation. Biosynthesis of purines and pyrimidines: Salvage pathways.

UNIT – IV:

A) Spectrophotometry: Concept of electromagnetic radiation, spectrum of light, absorption of electromagnetic radiations, Concept of chromophores and auxochromes, Absorption spectrum and its uses, Beer's law - derivation and deviations, extinction coefficient.

B)

Difference between spectrophotometer and colorimeter.

Instrumentation and Applications of UV and visible spectrophotometry Double beam spectrometer; dual-wavelength spectrometer.

UNIT V:

A) Principle instrumentation and application of IR and Mass spectrometry

B) Spectrofluorometry: principle, instrumentation and applications. Absorption & emission flame photometry: principle, instrumentation and application.

UNIT VI:

A) Chromatography: Partition principle, partition coefficient, nature of partition forces, brief account of paper chromatography. Thin layer chromatography and column chromatography.

Gel filtration: Concept of distribution coefficient, types of gels and glass beads, applications.

B) Ion-exchange chromatography: Principle, types of resins, choice of buffers, applications including amino acid analyzer. Affinity chromatography: Principle, selection of ligand, brief idea of ligand attachment, specific and non-specific elution, applications. Elements of high pressure liquid chromatography.

B.Sc. Part -II
SEMESTER III PRACTICALS
Biotechnology
Metabolism & Biophysical Techniques

1. Spectrophotometric analysis of DNA denaturation.
2. Determination of absorption spectrum of oxy- and deoxyhemoglobin and methemoglobin.
3. Protein estimation by E280/E260 method.
4. Paper chromatography of amino acids/sugars/lipids.
5. TLC of sugars/amino acids.
6. Cellular fractionation and separation of cell organelles using centrifuge.
7. Isolation of mitochondria and assay of marker enzyme.
8. Estimation of Urea by diacetylenoxime method
9. Estimation of Sugars by Folin Wu method
10. Validity of Beer's law for colorimetric estimation of creatinine.
11. Absorption spectrum of NAD & NADH
12. Preparation of standard buffers and determination of pH of a solution
13. Titration of a mixture of strong & weak acid

Note: - Mandatory to perform atleast 6 practical

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Lehninger's Principles of Biochemistry (5th edition) by Nelson DL and Cox MM, CBS Publications, 2008.

Biochemistry by Stryer L. (5th edition) W.H. Freeman & Co., New York, USA, Fundamentals of Biochemistry. 3rd Edition, (2008), Donald Voet & Judith Voet, John Wiley and Sons, Inc. USA

Satyanarayan U, "Biochemistry", Books and Allied (P) Ltd, Kolkata.

Fundamentals of Biochemistry by Dr. J. L. Jain

Physical Biochemistry by D. Freifelder IInd Edition (1982)

Biophysical Chemistry by Upadhyay Upadhyay and Nath.

Principles and Techniques of Biochemistry and Molecular Biology by Keith Wilson and John Walker.

Experimental Biochemistry by B. Sashidhar Rao and Vijay M. Deshpande.

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B. Sc. Part II – Semester IV
BIOTECHNOLOGY

IMMUNOLOGY AND BIOPHYSICAL TECHNIQUES II

UNIT I

Immune system, Organs and cells of immune system
Immunity, innate immune mechanism
Acquired immune mechanism, Antigen, Antigenicity (factors affecting antigenicity)
Humoral immunity, main pathways of complement system.
Vaccination: Discovery, principles, significance. Concept of autoimmunity.

UNIT II

Antibody structure and classes.
Cell mediated immunity: T cell mediated immunity, NK cell mediated immunity, ADCC, delayed type hypersensitivity, cytokines and brief idea of MHC.
Hypersensitivity and vaccination : General features of hypersensitivity, various types of hypersensitivity,.

UNIT III

Immunological Techniques: Antigen-antibody reactions: Precipitation, agglutination, complement fixation, immunodiffusion, ELISA.
Hybridoma technology: Monoclonal antibodies and their applications in immunodiagnosis.

UNIT – IV:

Migration of ions in electric field, Factors affecting electrophoretic mobility.
Paper electrophoresis: - Electrophoretic run, Detection techniques, Cellulose acetate electrophoresis, High voltage electrophoresis.
Gel electrophoresis: - Types of gels, Solubilizers, Procedure, Column & slab gels, Detection, Recovery & Estimation of macromolecules.

UNIT V

SDS-PAGE Electrophoresis: - applications (determination of molecular weight of proteins, determination of subunit stoichiometry, molecular biology applications).

Isoelectric focussing, Principle, Establishing pH and density gradients, Procedures & applications. Pulsed-field gel electrophoresis.

Centrifugation:

Basic principles, concept of RCF, types of centrifuges (clinical, high speed and ultracentrifuges).

Preparative centrifugation: Differential and density gradient centrifugation, applications (Isolation of cell components).

Analytical centrifugation: Sedimentation coefficient, determination of molecular weight by sedimentation velocity and sedimentation equilibrium methods

UNIT –VI:

Isotopic tracer technique: -

Radioactive & stable isotopes, rate of radioactive decay. Units of radioactivity.

Measurement of radioactivity: - Ionization chambers, proportional counters, Geiger- Muller counter, Solid and liquid scintillation counters (basic principle, instrumentation and technique), Cerenkov radiation. **Measurement of Stable isotopes:** Falling drop method for deuterium measurement, Mass spectrometry.

Principles of tracer technique, advantages and limitations, applications of isotopes in biotechnology (distribution studies, metabolic studies, isotope dilution technique, metabolic studies, clinical applications, autoradiography).

Immunology & Biophysical techniques

1. Antigen – antibody reaction – determination of Blood group

2. Pregnancy test

3. Widal test

4. Ouchterloney immunodiffusion

5. Radial immunodiffusion

6. ELISA

7. Isolation of casein by isoelectric precipitation

8. Paper electrophoresis of proteins

9. Gel electrophoresis of proteins.

10. SDS-PAGE of an oligomeric protein.

Note: - Mandatory to perform atleast 6 practical

Recommended readings:

R. A. Goldsby, T.J. Kindt, B.A. Osborne, "Kuby - Immunology", 4th Edition.

Kuby immunology, Judy Owen , Jenni Punt , Sharon Stranford., 7th edition (2012), Freeman and Co., NY

Roitt Evan, Brostoff J. Male D. (1993) Immunology 6th Ed., Mosby & Co. London.

Fundamentals of Immunology: Paul W.E. (Eds.) Raven Press, New York, 1988

Physical Biochemistry by D. Freifelder IInd Edition
Freeman publication (1982)

Biochemical techniques by Wilson and Walker.

Biophysical techniques by Upadhye and Upadhye.