

## SYLLABUS FOR B.Sc. BIOCHEMISTRY

2019-2022

### SCHEME OF MARKS

Year	Paper Code	Name of Paper	Internal Assessment [CCE]	Yearly Exam	Total
I Year	BCH 101	Biomolecules	I-Three Monthly Marks 2.5 II-Half Yearly Marks 5.0 Total 7.5	42.5	50
	BCH 102	Biophysical and Biochemical Techniques		42.5	50
	BCH 103	Practical-I	-	50	50
II Year	BCH 201	Enzymology	I-Three Monthly Marks 2.5 II-Half Yearly Marks 5.0 Total 7.5	42.5	50
	BCH 202	Intermediary Metabolism		42.5	50
	BCH 203	Practical-II	-	50	50
III Year	BCH 301	Molecular Biology	I-Three Monthly Marks 2.5 II-Half Yearly Marks 5.0 Total 7.5	42.5	50
	BCH 302	Nutrition, Clinical and Environmental Biochemistry		42.5	50
	BCH 303	Practical-III	-	50	50

Scheme for Practical Examination in each year			
Total Marks	Q.No.	Experiment	Marks
50	Q.No. 1.	Major Experiment From Paper I and II	20
	Q.No. 2	Minor Experiment From Paper I From Paper II	05 05
	Q.No. 3	Spotting	10
	Q.No. 4	Viva Voce	05
	Q.No. 5	Practical Record	05

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## SYLLABUS FOR B.Sc. BIOCHEMISTRY

### B.Sc. I Year PAPER-1 (BCH-101) BIOMOLECULES

Max. Marks: 42½ [For regular students]

Max. Marks: 50 [For private students]

#### Unit I

- Introduction, applications and scope of Biochemistry
- Water as a biological solvent, weak acids, pH, buffers, Henderson-Hasselbalch equation, physiological buffers, fitness of the aqueous environment for living organisms
- Carbohydrates: Structure of monosaccharides, stereoisomerism and optical isomerism of sugars, reactions of aldehyde and ketone groups, ring structure and anomeric forms, mutarotation, reactions of sugars due to hydroxyl groups, important derivatives of monosaccharides; Disaccharides and trisaccharides (structure, occurrence and functions). Structure, occurrence and biological importance of polysaccharides (Starch, glycogen, cellulose, chitins), blood group polysaccharides; Peptidoglycans; Glycoproteins.

#### Unit II

- Lipids: Definition and classification; Fatty acids: Introduction, classification, nomenclature, structure and properties of saturated and mono-unsaturated and poly-unsaturated fatty acids,  $\omega$ -unsaturated fatty acids, essential fatty acids; prostaglandins; Triacylglycerols: nomenclature, physical properties, chemical properties and characterization of fats – hydrolysis, saponification value, rancidity of fats, Reichert-Meissl number and reaction of glycerol; Biological significance of fats; Glycerosphingolipids (lecithin, lysolecithin, cephalins, [phosphatidylserine, phosphatidylinositol, plasmalogens), Sphingomyelins; Glycolipids: cerebroside, gangliosides; properties and functions of phospholipids, isoprenoids and sterols.

#### Unit III

- Proteins: Introduction, classification based on solubility, shape, composition and functions; Amino acids: classification and structure, zwitter ions, physical and chemical properties; Peptides: peptide bond and its formation; Determination of the amino acid sequence of a

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polypeptide chain, specific chemical and enzymatic cleavage of a polypeptide chain and separation of peptides.

- Levels of structure in protein architecture: primary structure of proteins, secondary structure ( $\alpha$ -helix and  $\beta$ -pleated sheets), tertiary structure and quaternary structure; Denaturation and renaturation of proteins.
- Structure and biological functions of fibrous proteins (keratins, collagen and elastin), globular proteins (hemoglobin and myoglobin).

**Unit IV**

- Nucleic acids: Nature of genetic material; Evidence that DNA is the genetic material; Composition of DNA and RNA; generalized structural plan of nucleic acids, nomenclature used in writing structure of nucleic acids, features of DNA double helix; Denaturation and annealing of DNA; structure and roles of different types of RNA.
- Size of DNA in prokaryotic and eukaryotic cells, central dogma of molecular biology, gene, genome and chromosome.

**Unit V**

- Porphyrins: Porphyrin nucleus and classification of porphyrins; Important metalloporphyrins occurring in nature. Detection of porphyrins spectrophotometrically and by fluorescence.
- Bile pigments: chemical nature and their physiological significance.
- Hormones: Structure, biological functions and cellular signaling of peptide (Insulin, epinephrine) and steroids (Glucocorticoid, Androgens) hormones.

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**PAPER-II (BCH-102)**  
**BIOPHYSICAL AND BIOCHEMICAL TECHNIQUES**

Max. Marks: 42½ [For regular students]

Max. Marks: 50 [For private students]

**Unit I**

- Concept of Bioenergetics: Principles of thermodynamics and their application in biochemistry- introduction, thermodynamic system, thermodynamic state functions, first and second laws of thermodynamics, concept of free energy, standard free energy, determination of  $\Delta G$  for a reaction, relation between equilibrium constant and standard free energy change in coupled reactions.
- Biological oxidation-reduction reactions: introduction, redox potential, relation between standard reduction potentials and free energy change.
- High energy phosphate compounds: introduction, phosphate group transfers- free energy of hydrolysis of ATP and sugar phosphate along with reasons for high  $\Delta G$ .

**Unit II**

- Hydrodynamic methods: Sedimentation- sedimentation velocity, preparative and analytical ultracentrifugation techniques, determination of molecular weight by hydrodynamic methods.
- Measurement of pH: Principle of glass and reference electrodes, types of electrodes, complications of pH measurement (dependence of pH on ionic strength, electrode contamination and sodium error) and use of pH paper.

**Unit III**

- Chromatography: General principles and applications of paper chromatography, thin layer chromatography, ion exchange chromatography, molecular sieve chromatography, hydrophobic chromatography, gas liquid chromatography and HPLC.
- Electrophoresis: Basic principles of agarose electrophoresis, PAGE and SDS PAGE, isoelectrofocussing; Two dimensional gel electrophoresis and its importance.

**Unit IV**

- Spectroscopic techniques: Beer-Lambert's law, light absorption and its transmittance, determination and application of extinction coefficient, application of visible and UV

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spectroscopic technique (structure elucidation and numerical excluded). Principle and application of NMR, ESR Mass spectroscopy, Fluorescence and emission spectroscopy.

- Immunological Techniques: Immunodiffusion, Immuno-electrophoresis. Radioimmunoassay, ELISA, Immunofluorescence.

#### Unit V

- Radioisotopic Techniques: Types of radioisotopes; Units of radioactivity measurements: Techniques used to measure radioactivity (gas ionization and liquid scintillation counting); Nuclear emulsions used in biological studies (pre-mounted, liquid and stripping).
- Isotopes commonly used in biochemical studies:  $^{32}\text{P}$ ,  $^{35}\text{S}$ ,  $^{14}\text{C}$  and  $^3\text{H}$ ; Autoradiography.
- Biological hazards of radiation and safety measures in handling radioisotopes. Biological applications.

#### PRACTICAL-I (BCH 103)

(Based on BCH-101 and 102)

Max. Marks: 50

1. Preparation of standard buffer and determination of pH of a solution.
2. Qualitative tests for carbohydrates, proteins, amino acids and lipids.
3. Determination of saponification value and iodine number of fats.
4. Estimation of ascorbic acid.
5. Titration curve for amino acids and determination of pK value.
6. Verification of Beer-Lambert's law.
7. Estimation of i. Carbohydrates by anthrone method ii. Blood glucose by the methods (a) Folin-Wu (b) Nelson-Somogyi.
8. Estimation of amino acids by ninhydrin method.
9. Extraction of total lipids by Folch method
10. Separation of sugars using paper chromatography

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## List of Recommended Books for 1st Year of Biochemistry (Theory and Practical)

- Gupta S.N. **Concepts of Biochemistry**. Rastogi Publications.
- Deb A.C. **Fundamentals of Biochemistry**. New Central Book Agency.
- Vasudevan D.M. and Sreekumari S. **Fundamentals of Biochemistry**. Jaypee Brothers, Medical Publishers.
- Lehninger, Nelson and Cox. **Principles of Biochemistry**. Macmillan Worth Publishers.
- Voet and Voet. **Principles of Biochemistry**. John Wiley.
- D. Freifelder. **Biophysical Chemistry**. W.H. Freeman and Publishers.
- Wilson and Walker. **Practical Biochemistry**. Cambridge Publishers.
- Talwar, Hasnain and Sarin. **Textbook of Biochemistry, Biotechnology,, Allied and Molecular Biology**. PHI Learning.
- Powar C.B. and Chatwal. **Biochemistry**. Himalaya Publishing House.
- Swarup, Pathak and Arora. **Laboratory Techniques in Modern Biology**. Kalyani Publishers.
- Sadasivam S. and Manickam A. **Biochemical Methods**. New Age International Publishers.
- RC Gupta and S. Bhargava. **Practical Biochemistry**. CBS Publishers and Distributors.
- Plummer D.T. **An Introduction to Practical Biochemistry**. Tata McGraw Hill Hills Publishing Company.
- Jain J.L. **Fundamentals of Biochemistry**. S.Chand Publications.
- Upadhyay and Nath. **Biophysical Chemistry**. Himalaya Publishers.
- Shanmugam. **Laboratory Handbook of Biochemistry**. PHI Learning.

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**B.Sc. II Year (Biochemistry)**

**PAPER-III (BCH 201)**

**ENZYMOLGY**

Max. Marks: 42½ [For regular students]

Max. Marks: 50 [For private students]

**Unit I**

- Introduction: Definition, general characteristics, nomenclature, IUB enzyme classification (rationale, overview and specific examples), significance of numbering system.
- Definitions and examples of holoenzymes, apoenzymes, coenzymes, cofactors, activators, inhibitors, active site (identification of group excluded), metallo-enzymes, units of enzyme activity, specific enzymes, isoenzymes, monomeric enzymes, oligomeric enzymes and multi-enzyme complexes.
- Enzyme specificity.

**Unit II**

- Nature of non-enzymatic and enzymatic catalysis; Measurements and expression of enzyme activity – enzyme assays; Definition of IU, Katal, enzyme turn over number and specific activity.
- Role of non-protein organic molecules and inorganic ions-coenzymes, prosthetic groups. Role of vitamins as coenzyme precursors (general treatment).
- Enzyme purification: Methods for isolation, purification and characterization of enzymes.

**Unit III**

- Enzyme catalysis: Role of cofactors in enzyme catalysis: NAD/ NADP<sup>+</sup>, FMN/ FAD, coenzyme A, biocytin, cobamide, lipoamide, TPP, pyridoxal phosphate, tetrahydrofolate and metal ions with special emphasis on coenzyme functions.
- Acid-base catalysis, covalent catalysis, proximity and orientation effects, strain and distortion theory. Mechanism of action of chymotrypsin, carboxypeptidase, ribonuclease and lysozyme.

**Unit IV**

- Enzyme kinetics: Factors affecting enzyme activity- enzyme concentration, substrate concentration, pH and temperature.

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- Derivation of Michaelis-Menten equation for uni-substrate reactions.  $K_m$  and its significance.
- Kinetics of zero and first order reactions.
- Reversible and irreversible inhibition, competitive, non-competitive and uncompetitive inhibition, determination of  $K_m$  and  $V_{max}$  in presence and absence of inhibitor; Allosteric enzymes.

#### Unit V

- Industrial and clinical applications of enzymes.
- Immobilization of enzymes and their industrial applications.
- Production of glucose from starch, cellulose and dextran; Use of lactase in dairy industry; Production of glucose-fructose syrup from sucrose; Use of proteases in food, detergent and leather industry; Medical applications of enzymes; Use of glucose oxidase in enzyme electrodes.

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**PAPER-IV (BCH 202)**

**INTERMEDIARY METABOLISM**

Max. Marks: 42½ [For regular students]

Max. Marks: 50 [For private students]

**Unit I**

- Introduction to Metabolism: General features of metabolism. Experimental approaches to study metabolism: use of intact organism, bacterial mutants, tissue slices, stable and radioactive isotopes.
- Carbohydrate metabolism: Reactions and energetics of glycolysis; Alcoholic and lactic acid fermentation; Reaction and energetics of TCA cycle; Regulation of glycolysis and TCA cycle.
- Gluconeogenesis, glycogenesis and glycogenolysis. Reaction and physiological significance of pentose phosphate pathway.

**Unit II**

- Electron transport chain and oxidative phosphorylation: Structure of mitochondria, sequence of electron carriers, sites of ATP production, inhibitors of electron transport chain.
- Hypothesis of mitochondrial oxidative phosphorylation (Basic concepts): Inhibitors and uncouplers of oxidative phosphorylation.
- Transport of reducing potentials into mitochondria.

**Unit III**

- Lipid metabolism: Introduction, hydrolysis of triacylglycerols, transport of fatty acid into mitochondria,  $\beta$ -oxidation of saturated fatty acids, ATP yield from fatty acids oxidation.
- Biosynthesis of saturated and unsaturated fatty acids. Metabolism of ketone bodies, oxidation of unsaturated and odd chain fatty acids.
- Outlines of biosynthesis of triglycerides and important phospholipids, glycolipids, sphingolipids and cholesterol.
- Regulation of cholesterol biosynthesis.

**Unit IV**

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- Amin acid Metabolism: General reaction of amino acids metabolism: Transamination, oxidative deamination and decarboxylation.
- Urea cycle
- Degradation and biosynthesis of amino acids. Glycogenic and ketogenic amino acids.

### Unit V

- Nucleotide Metabolism: Sources of the atoms in the purine and pyrimidine molecules. Biosynthesis and degradation of purines and pyrimidines.
- Regulation of purine and pyrimidine biosynthesis.
- Porphyrin Metabolism: Biosynthesis and degradation of popyhrins.
- Production of bile pigments.

### PRACTICAL-I (BCH 203)

(Based on BCH-201 and 202)

Max. Marks: 50

1. Separation of blood plasma and serum.
2. (a) Estimation of protein from serum by Biuret and Lowry methods (b) Determination of albumin and A/G ratio in serum.
3. Estimation of bilirubin conjugated and unconjugated in serum.
4. (a) Estimation of lipids in serum by Vanillin method (b) Estimation of cholesterol in serum.
5. Estimation of lipoproteins in plasma.
6. Estimation of blood urea nitrogen from plasma.
7. Separation and identification of amino acids by (a) paper chromatography and (b) thin layer chromatography
8. Separation of polar and non-polar lipids by thin layer chromatography.
9. (a) Assay of serum alkaline phosphatase activity (b) Inhibition of alkaline phosphatase activity by EDTA (c) Effect of substrate concentration on alkaline phosphatase activity and determination of its  $K_m$  value.
10. (a) Effect of temperature on enzyme activity and determination of activation energy (b) Effect of pH on enzyme activity and determination of optimum pH (c) Effect of enzyme concentration on enzyme activity.
11. (a) Preparation of starch from potato and its hydrolysis by salivary amylase (b) Determination of achromatic point in salivary amylase (c) Effect of sodium chloride on amylases.

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## List of Recommended Books for 1st Year of Biochemistry (Theory and Practical)

- West E.S. Todd W.R., Mason H.S. and Bruggen J.T.V. **Textbook of Biochemistry**. Oxford and IBH Publishing House.
- U.Satyanarayana. **Biochemistry**.
- Gupta S.N. **Biochemistry**. Rastogi Publications.
- Voet and Voet. **Biochemistry**. Wiley Interscience Publishers.
- Conn E.E., stumpf P.K., Bruening G., and Doi R.H. **Outlines of Biochemistry**. John Wiley and Sons.
- Murray R.K., Mayes PA., Granner D.K., Rodwell V.W. **Harper's Biochemistry**. Tata McGraw Hill.
- Mathews von Holde. **Biochemistry**. Pearson Education Publishers
- Talwar, Hasnain and Sarin. **Text Book of Biochemistry, Biotechnology, Allied and Molecular Biology**. PHI Learning.
- Powar C.B. and Chatwal. **Biochemistry**. Himalaya Publishing House,
- Swarup, Pathak and Arora. **Laboratory Techniques in Modern Biology**. Kalyani Publishers.
- Sadasivam S. and Manickam A. **Biochemical Methods**. New Age International Publishers.
- Gupta R.C. and Bhargava S. **Practical Biochemistry**. CBS Publishers and Distributors.
- Plummer D.T. **An Introduction to Practical Biochemistry**. Tata McGraw Hill Publishing Company.

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**B.Sc. III Year (Biochemistry)**

**PAPER-V (BCH 301)**

**MOLECULAR BIOLOGY**

Max. Marks: 42½ [For regular students]

Max. Marks: 50 [For private students]

**Unit I**

- Basic Concepts of Genetic Information: Nucleic acids as genetic information carriers, experimental evidences; Central Dogma: current version and reverse transcription.
- Primary structure of nucleic acids and their properties, salient features of eukaryotic, prokaryotic and viral genome. Basic concept about the secondary structure of nucleic acid, 5'-3' direction antiparallel strands, base composition, base equivalence, base pairing and base-stacking in DNA.
- Structural Levels of DNA: Watson and Crick model, A, B and Z types of DNA, major and minor grooves, chirality of DNA, tertiary structure of DNA.
- Structure and properties of RNA: Classes of RNA, secondary and tertiary structure.

**Unit II**

- DNA replication in prokaryotes; conservative, semi-conservative and dispersive types experimental evidence for semi-conservative replication.
- DNA polymerases, other enzymes and protein factors involved in replication.
- Mechanism of replication.
- Inhibitors of DNA replication.

**Unit III**

- Transcription in prokaryotes and eukaryotes: RNA polymerase, promoters, initiation, elongation and termination of RNA synthesis, inhibitors of transcription; Reverse transcriptase.
- Post-transcriptional processing of RNA in eukaryotes.

**Unit IV**

- Genetic code: basic features of genetic code, biological significance of degeneracy. Wobble hypothesis.

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- Mechanisms of translation in prokaryotes: Ribosome structure, A and P sites, charged tRNA, f-met-tRNA, initiation codon, Shine-Dalgarno consensus sequence, formation of 70S initiation complex, role of EF-Tu, EF-Ts, EF-G and GTP, non-sense codons and release factors.
- Regulation of gene expression in prokaryotes: Enzyme induction and repression, operon concept (*lac* operon, *trp* operon).

Unit-V

- Mutation: Molecular basis of mutation, types of mutation (insertion, deletion, transition, transversion, frame shift, suppressor sensitive germinal and somatic, backward and forward mutations, dominant and recessive mutations, spontaneous and induced mutations).
- Mutagenicity testing: Correlation of mutagenicity and carcinogenicity: Ames test, Random and site directed mutagenesis.
- DNA damage and repair mechanisms.
- Recombinant DNA Technology: Restriction endonucleases, brief discussion of steps in DNA cloning. Applications of Recombinant DNA Technology.

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**PAPER-VI (BCH 302)****NUTRITIONAL, CLINICAL & ENVIRONMENTAL BIOCHEMISTRY**

Max. Marks: 42½ [For regular students]

Max. Marks: 50 [For private students]

**Unit I**

- Nutrition and dietary habits: Introduction and definition of food and nutrition.
- Fat soluble vitamins (A, D, E and K), water soluble vitamins (B and C); Minerals (Ca, Fe and iodine) and their biological functions.
- Basic food groups: energy giving foods, body building foods and protective foods.
- Composition of balanced diet, recommended dietary allowances (RDA) for average Indian, locally available foods, inexpensive quality foods and food stuffs rich in more than one nutrients. Balance vegetarian and non-vegetarian diets, emphasis on nutritional adequacy.

**Unit II**

- Nutritive and calorific value of foods: Basic concept of energy expenditure, units of energy. Measurements of energy expenditure by direct and indirect calorimetry, calculation of non-protein RQ with respect to carbohydrates and lipids. Determination of the heat production of the diet.
- The basal metabolism and methods of measuring basal metabolic rate (BMR); energy requirements during growth, pregnancy, lactation and various physical activities. Calculation of energy expenditure of average man and woman.
- Specific dynamic action (SDA) of foods, nutrition value of various kinds foods generally used by Indian population. Planning of dietary regimens for infants, during pregnancy and old age. Protein calorie malnutrition (Kwashiorkar and Marasmus). Human milk and its virtues, breast versus formulated milk feeding.

**Unit III**

- Clinical biochemistry: Basic concepts, definition and its scope in diagnosis; a brief review of units and abbreviations used in expressing concentrations and standard solution.
- Quality control: Manual vs automation in clinical laboratory.
- Collection and preparation of biological fluids (blood, serum, plasma, urine and CSF).

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- Importance of biochemical analysis of blood, urine and CSF: Normal values for important constituents (in SI unit) in blood (plasma/ serum). CSF and urine.

#### Unit IV

- Clinical enzymology: Definition of functional and non-functional plasma enzymes.
- Isoenzymes and diagnostic tests.
- Enzyme pattern in health and diseases with special mention of plasma lipase, amylase, cholinesterase, alkaline and acid phosphatases, SGOT, SGPT, LDH and CPK; Functional tests of liver and kidney.
- Disease related to metabolism: Hypo- and hyper-glycemia, lipid malabsorption and steatorrhea, sphingolipidosis; role of lipoproteins.
- Inborn errors of amino acid metabolism-alkaptonuria, phenylketonuria, albinism, gout and hyperuricemia.

#### Unit V

- Air pollution: Suspended particulate matter, compounds of carbon, sulfur, nitrogen and their interactions, methods of estimation of biotic and abiotic pollutants, their effects on human health.
- Water pollution: Major pollutants from domestic, agricultural and industrial wastes, effects of pollutants on plants and animals, treatment of domestic and industrial wastes, solid-wastes and their treatment.
- Soil pollution: Types and causes.

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**PRACTICAL-III (BCH 303)**  
**(Based on BCH 301 and 302)**

Max. Marks: 50

1. Extraction of DNA and its estimation by diphenylamine method
2. Effect of temperature on the viscosity of DNA using Ostwald's viscometer.
3. Extraction of RNA and its estimation by Orcinol method.
4. Estimation of hemoglobin.
5. Estimation of calcium in serum and urine.
6. Estimation of phosphorus in serum and urine.
7. Estimation of creatine in plasma and urine.
8. Estimation of immunoglobulins by precipitation with saturated ammonium sulfate.
9. Estimation of SGOT and SGPT.
10. Enumeration of bacteria from air, water and soil.

**List of Recommended Books or III year Biochemistry (Theory and Practical)**

- Chatterjee M.N. and Shinde R. *Textbook of Medical Biochemistry*, Jaypee Brothers, Medical Publishers.
- Zybay, Pearson and Vance. *Principles of Biochemistry*. W.M.H. Brown Publishers.
- Gupta S.N. *Biochemistry*. Rastogi Publications.
- Berg, Tymoczko and Stryer. *Biochemistry*. Freeman Publishers.
- Powar C.B. and Chatwal. *Biochemistry*. Himalaya Publishing House.
- Swarup, Pathak and Arora. *Laboratory Techniques in Modern Biology*. Kalyani Publishers.
- Sadasivam S. and Manickam A. *Biochemical Methods*. New Age International Publishers.
- Gupta R.C. and Bhargava S. *Practical Biochemistry*. CBS Publishers and Distributors.
- Plummer D.T. *An Introduction to Practical Biochemistry*. Tata McGraw Hill Publishing Company.
- Tilak S.T. *Aerobiology*. Vaijanti rakashan, Aurangabad.
- Mahapatra P.K. *Textbook of Environmental Microbiology: A Laboratory Manual*.

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