Andhra Pradesh State Council of Higher Education

BIOCHEMISTRY - Minor

w.e.f. 2023-24 AY onwards

COURSE STRUCTURE

Year	Semester	Course	Title	No. Hrs./ Week	No. of Credits
	II	1	Biomolecules - (T)	3	3
			Biomolecules - (P)	2	1
II	III	2	Analytical techniques- (T)	3	3
			Analytical techniques- (P)	2	1
	IV	3	Bioenergetics and Metabolism of Carbohydrates and Lipids- (T)	3	3
			Bioenergetics and Metabolism of Carbohydrates and Lipids- (P)	2	1
	IV	4	Clinical Biochemistry- (T)	3	3
			Clinical Biochemistry- (P)	2	1
III	V	5	Nutritional Biochemistry - (T)	3	3
			Nutritional Biochemistry - (P)	2	1
		6	Enzymology- (T)	3	3
			Enzymology- (P)	2	1

II -SEMESTER

BIO MOLECULES - (Course No-1)

Credits -3

COURSE OBJECTIVES

1. Provides information about classification, physico-chemical properties of amino acids and structural organization of proteins.
2. To understand the structure, properties and biological importance of carbohydrates and lipids.
3. Explore the composition and structure of nucleic acids.

UNIT-I

Fundamentals of Biochemistry: History, scope and avenues of Biochemistry. Water as a biological solvent. Measurement of PH, Buffers, Biological relevance of Buffers. Outlines of surface tension, adsorption and osmosis and their biological relevance.

UNIT-II

Carbohydrates: Classification, monosaccharides, D and L designation, open chain and cyclic structures, epimers and anomers, mutarotation. Reactions of carbohydrates (due to functional groups - hydroxyl, aldehyde and ketone. Amino sugars, Glycosides. Structure and biological importance of disaccharides (sucrose, lactose, maltose, isomaltose, trehalose), trisaccharides (raffinose, melezitose). Structural polysaccharides (cellulose, chitin, pectin) and storage polysaccharides (starch, inulin, glycogen). Glycosaminoglycans.

UNIT – III

Lipids Classification, saturated and unsaturated fatty acids, structure and properties of fats and oils (acid, saponification and iodine values, rancidity). General properties and structures of phospholipids. Prostaglandins- structure, types and biological role. Lipoproteins- types and functions.

UNIT-IV

Amino Acids and Proteins Classification, structure, stereochemistry, chemical reactions of amino acids due to carbonyl and amino groups. 2. Titration curve of glycine and pK values. Essential and nonessential amino acids, non-protein amino acids. 3. Peptide bond - nature and conformation. Naturally occurring peptides - glutathione, enkephalin. 4. Proteins: Classification based on solubility, shape, and function. Determination of amino acid composition of proteins. 5. General properties of proteins, denaturation, and renaturation of proteins. 6. Structural organization of proteins- primary, secondary, tertiary, and quaternary structures (Eg. Hemoglobin and Myoglobin).

UNIT-V

Nucleic acids and porphyrins, Types of RNA and DNA. Structure of purines and pyrimidines, nucleosides, nucleotides. Stability and formation of phosphodiester linkages. 2. Effect of acids, alkali and nucleases on DNA and RNA. 3. Structure of Nucleic acids- Watson-Crick DNA double helix structure, denaturation and renaturation of nucleic acids, Tm-values and their significance, cot curves and their significance. 4. Structure and properties of porphyrins: Heme, cytochromes and chlorophylls.

COURSE OUTCOMES

After successful completion of the practical course student should be able to

1. prepare buffers and apply the knowedge to calculate the pH values of charged biomolecules.

2. Identify various carbohydrates, aminoacids and lipids present in the nature by performing qualitative analysis.

II -SEMESTER

BIO MOLECULES - (Course No-1)

Credits -1

1. Preparation of buffers (acidic, neutral, and alkaline) and determination of pH.
2. Qualitative identification of carbohydrates- glucose, fructose, ribose/xylose, maltose, sucrose, lactose, starch/glycogen.
3. Qualitative identification of amino acids- histidine, tyrosine, tryptophan, cysteine, arginine.
4. Qualitative identification of lipids- solubility, saponification, acrolein test, Salkowski test, Lieberman-Burchardtest.
5. Preparation of Osazones and their identification
6. Estimation of proteins in biological samples:
   a. Biuret method.
   b. Folin-Lowry method.
   c. UV method.
   d. Bradford's dye binding method
7. Estimation of amino acid by Ninhydrin method.
8. Estimation of tyrosine by Million's –reaction

Recommended Books

1. Fundamentals of Biochemistry –Jain, J.L., Jain, S., Jain, N. S. Chand & Co.

2. Biochemistry – Satyanarayana. U and Chakrapani. U, Books & Allied Pvt. Lt

3. Nelson.D.L. and Cox.M..M -Lehninger's Principles of Biochemistry- Freeman & Co.- 7 th Edition

III - SEMESTER

ANALYTICAL TECHNIQUES – (Course No-2

Credits -3

COURSE OBJETIVES

1. To understand the basic concepts of analytical techniques.
2. To gain knowledge about the latest advances in analytical techniques.
3. To apply these techniques in research.

UNIT-I

Methods of tissue homogenization. Salt and organic solvent extraction and fractionation. Dialysis, Reverse dialysis, ultra filtration, lyophilization.

Chromatography: principle, procedure and application of partition chromatography, adsorption chromatography, ion exchange chromatography, gel chromatography, affinity chromatography, GLC and HPLC.

UNIT-II

Electrophoresis: Principle, procedure and application of free flow, zone electrophoresis (Paper electrophoresis, Gel electrophoresis, PAGE, SDS-PAGE and Disc PAGE). Isoelectric focusing, High voltage electrophoresis, Pulse field electrophoresis, Immunoelectrophoretic.

UNIT-III

Centrifugation: Principle of sedimentation technique. Different types of centrifuge and rotors. Principle, procedure and application of differential centrifugation, density gradient centrifugation, ultra centrifugation, rate zonal centrifugation, isopycnic centrifugation.

UNIT-IV

Colorimetry and spectrophotometry: Laws of light absorption -Beer - Lambert's law. UV and visible absorption spectra, molar extinction coefficient and quantitation. Principle and instrumentation of colorimetry and spectrophotometry. Principle of nephelometry, fluoromentry, Atomic absoption and emission spectrophotometer

UNIT-V

Important stable radioisotopes used in biochemical research. P 32, I 125,I131, Co 60. C 14 etc. Radiation hazards and precautions taken while handling radioisotopes. Principle and application of RIA. Measurement of radioactivity by GM counter and Scintillation counter.

III - SEMESTER

ANALYTICAL TECHNIQUES – (Course No-2)

Credits -1

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1. Estimation of ascorbic acid
2. Separation and estimation of total carotenoids and β-carotene
3. Extraction and estimation of vitamin A, vitamin E, niacin and free amino
4. Estimation of phosphorus by Fiske and Subbarow method Characterization of fats – estimation of saponification number, iodine number, acid number and R.M.Number
5. Extraction of Phytoconstitutents by Soxhlet and quantification

COURSE OUTCOMES

1. After completing this course, the student will
2. Understand the basic concepts and principles of biochemical techniques namely Spectrophotometry, Fluorimetry, Chromatography and Centrifugation.
3. Analyse biochemical compounds such as Carotenoids, Vitamins, Alkaloids and Flavonoids.
4. Identify the compounds by various biochemical techniques and interpret the results
5. Apply the laboratory skills and concepts in carrying out experiments using sophisticated instruments.

Reference Books

1. Physical Biochemistry- Application to Biochemistry and Molecular Biology: Friefelder D. WH Freeman and Company 1. Principles and Techniques of Biochemistry and Molecular Biology: - Ed. K. Wilson and J. Walker, Cambridge Univerity Press.
2. The Tools of Biochemistry: Cooper T.G., John Wiley and Sons Publication.
3. Biophysical chemistry. Principles and Techniques: Upadhayay A, Upadhayay K and Nath N., Himalaya publishing house.
4. Experimental Biochemistry. Cark Jr J. M. and Switzer R.L, W.H. Freeman and Company.
5. Research Methodology for Biological Sciences: Gurumani.N. M.J.P. Publishers., Chennai, India.
6. Instrumental Methods of Chemical Analysis: Chatwal. G and Anand.S., Himalaya Publishing House, Mumbai, India.
7. A Biologist's Guide to Principles and Techniques of Practical Biochemistry: Williams. B.L. and Wilson. K. (ed.) Edward Arnold Ltd. London
8. Jayaraman, J. (2011). Laboratory Manual in Biochemistry, New Age International (P) Ltd.
9. Sadasivam, S. and Manickam, A. (2005). Biochemical Methods, Second edition, New Age International (P) Ltd.

IV - SEMESTER
BIOENERGETICS AND METABOLISM OF CARBOHYDRATES AND LIPIDS- (Course No-3)

Credits -3

COURSE OBJECTIVES

1. To acquire knowledge related to the intermediary metabolism and the role of TCA cycle in central carbon metabolism.
2. To learn basic concepts of Bioenergetics, the importance of high energy compounds, electron transport chain, synthesis of ATP, mechanisms of oxidative phosphorylation and photophosphorylation.
3. To understand the fundamentals of cellular metabolism of carbohydrates their association with various metabolic diseases.
4. To learn biosynthesis and degradation of Lipids, fatty acids and cholesterol, Metabolism of lipoproteins and Ketone bodies.

UNIT-I

Principles of thermodynamics, free energy, enthalpy and entropy, Free energy changes in biological transformations in living systems. Redox potential, phosphate group transfer potential and ATP, High-energy compounds, oxidation and reduction reactions.

UNIT-II

Oxidative phosphorylation, Mitochondria ultrastructure, Energy harnessing cascade from nutrients, Reducing equivalents, Electron transport and its carriers-Complex I, II, III, IV; Mitchell's Hypothesis—experimental verification, Determination of P:O ratio, ATP synthesis by F1-FO ATP synthase, E. Racker's experiment. Relation of proton movement and ATP synthesis. Experimental demonstration of the movement of ATP synthase.

Oxidation and reduction enzymes, utilization of oxygen aby oxygenase's, superoxide dismutase and catalase. respiratory control, Mechanism, and theories of oxidative phosphorylation. Respiratory chain inhibitors and unvouplers of oxidative phosphorylation. Microsomal electron transport system. Bioluminescence.

UNIT-III

Approaches for studying intermediary metabolism. Glucose as fuel, glucose transporters, Glycolysis, and its regulation. Substrate cycling, TCA cycle – function and regulation, Glyoxylate cycle, Gluconeogenesis, and its regulation, HMP shunt and its significance, Uronic acid pathway, Glycogen metabolism and its regulation with special reference to phosphorylase and glycogen synthase, Metabolism of fructose, galactose and lactose, Biogenesis of amino sugars, peptidoglycans, glycosyl aminoglycans and glycoproteins. In born errors of carbohydrate metabolism.

UNIT-IV

Lipid metabolism – Oxidation of fatty acids, Biosynthesis of fatty acids and regulation; Metabolism of arachidonic acid; formation of prostaglandins, thromboxanes, leukotrienes, Biosynthesis of triglycerides.

UNIT-V

Metabolism of phospholipids, sphingolipids. Biosynthesis of cholesterol and its regulation, Formation of bile acids. Role of liver and adipose tissue in lipid metabolism. In born errors of lipid metabolism

IV - SEMESTER
BIOENERGETICS AND METABOLISM OF CARBOHYDRATES AND LIPIDS- (Course No-3)

Credits -1

PRACTICAL SYLLABUS

1. Isolation of casein from milk
2. Preparation of lactalbumin from milk
3. Estimation of reducing sugar by DNSA (dinitrosalicylic acid) method
4. Titration of glucose by Benedict's method
5. Estimation of urea by Diacetylmonoxime method
6. Estimation of creatinine in serum
7. Estimation of cholesterol by ZAK's method

COURSE OUTCOMES

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

1. Explain the broad outlines of intermediary metabolism and importance of carbohydrate metabolism in life.
2. Describe the importance of Electron transport and ATP production mechanism.
3. Gain in knowledge in Carbohydrate metabolism and their associated with disorders.
4. Describe the details of lipid metabolism.

RECOMMENDED BOOKS

1. Principles of Biochemistry, White. A, Handler, P and Smith.
2. Biochemistry, Lehninger A.L.
3. Biochemistry, David E. Metzler.
4. Biochemistry, LubertStryer.
5. Text of Biochemistry, West and Todd.

IV - SEMESTER

Clinical Biochemistry-(Course No-4)

Credits -3

COURSE OBJECTIVES

1. To understand the basic concepts of laboratory techniques.
2. To understand the basic concepts of organ functions.
3. To gain knowledge about various investigations and their interpretations.

UNIT-I

Clinical Biochemistry Laboratory and Investigation of Homeostasis. The use of biochemical tests- Specimen collection and types, Automation and Computerization Water and electrolyte homeostasis - renin angiotensin – aldosterone system Pathological variations of water and electrolytes- diagnosis and Interpretations Self Study: Acid base balance and imbalance - Mechanism of regulations, Anion gap, Acidosis and Alkalosis.

UNIT-II

Abnormal Hemoglobin and Inherited Disorders 9hrs Inborn errors of Metabolism: Patterns of inheritance - alkaptonuria, phenyl ketonuria, albinism, glycogen storage diseases and inherited disorders associated with urea cycle. Abnormal hemoglobin and' hemoglobinopathies- Sickle cell anemia and thalassemias, porphyrias and porphyrinurias. Self-study: Plasma proteins in health and diseases

UNIT-III

Investigation of Renal and Gastric Functions. Renal functions tests: Preliminary investigations, tests based on GFR, RPF and tubular function. Diseases related to kidney - nephritis, nephrosis, uremia, renal failure, renal calculi, renal hypertension, renal tubular acidosis, diabetes insipidus.. Dialysis - hemodialyis and peritoneal dialysis. Gastric function tests: Examination of resting content, Fractional gastric analysis, stimulation tests, Tubeless gastric analysis. Malabsorption syndrome, acidity, ulcers - gastric, duodenal and peptic, colon cancer, pancreatitis, gastric and pancreatic 'function tests. Self study: Gout, Leschnyhan syndrome and oroticaciduria.

UNIT-IV

Liver Function Tests and Lipid Disorder Liver function tests: Tests based on abnormalities of bile pigment metabolism, detoxification and excretory functions. Diagnosis of different types of jaundice. Pancreatic function tests. Diseases relating to liver - jaundice, cirrhosis, hepatitis, cholestasis, cholelithiasis, hepatic coma, hepatic carcinoma, inherited diseases of bilirubin metabolism Lipid: Lipoprotinemias and atherosclerosis coronary heart diseases and hypertension. Self study: Biochemical changes in cancer - detection of tumor markers

UNIT- V

Blood Glucose Regulation and Enzymes of Diagnostic Importance 9 hrs Carbohydrates: Blood glucose level - regulation and its clinical significance, Diabetes mellitus, Glycosuria and GTT. Enzymes and Isoenzymes of clinical importance - general principles of assay - Clinical significance of enzymes and isoenzymes (LDH, CK, phosphatase, 5' nucleosidase,

amylase, lipase, acetyl cholinesterase, transaminase and gamma glutamyl transferase) Self study: meningitis, encephalities, epilepsy, Parkinson's, Alzheimer's, cerebral palsy.

IV - SEMESTER

Clinical Biochemistry-(Course No-4)

Credits -1

PRACTICAL SYLLABUS

1. Blood analysis:
   Iron and Hemoglobin, Glucose, GTT. 10hrs
2. Serum and Urine analysis:
   Creatine, chloride, phosphorus, calcium. 10 hrs
3. Lipid profiles (Serum) –
   Total cholesterol, triglycerides, HDL, LDL 5 hrs
4. Liver function tests –
   Total Bilirubin, total protein, albumin, globulin, albumin/globulin ratio, AST, ALT, ALP 10 hrs
5. Kidney function tests
   Urea, creatinine, uric acid.

COURSE OUTCOMES

1. After completing this course, the student will:
2. Obtain basic knowledge about specimen collections, pathological variations of water, electrolytes
3. Interpret the results to diagnose the abnormal functions of organs.
4. Understand the antinutrient factors and its implication on other nutrients in food.Understand the, patterns of inherited disorders and disorders of hemoglobin metabolism
5. Correlate the tests used for renal and gastric functions and their interpretations
6. Impart the diagnostic tests for liver function and lipoprotein metabolic disorders
7. Evaluate the alterations in blood glucose regulation and enzymes of clinical importance

REFERENCE BOOKS

1. Gowenlock, A.H. and Donald, J(2002). Varley's practical clinical Biochemistry, sixth edition, CBS publications and Distributors, New Delhi.
2. Sembulingam, K and Sembulingam, P(2010). Essentials of Medical Physiology, fifth edition. Jaypae Brothers (p) ltd, New Delhi.
3. Burtis and Ashwood (2007) Tietz Fundamentals of Clinical chemistry, 6th edition, WB Saunders Company, Oxford Science Publications USA.
4. Chatterjee and Shindae(2012). Text book of medical biochemistry, 8th edition.

5. Devlin, T.M(2010). Text Book of Biochemistry with clinical correlations, 7th edition. NewYork.
6. Gans, G and Murphy, J.M. (2008). Clinical Biochemistry, fourth edition, Churchill Livingstone, Elsevier

V - SEMESTER
NUTRITIONAL BIOCHEMISTRY-(Course No-5)

Credits -3

Course Objectives:

1. To compile various Nutrition and balanced diet,various dietary requirements of nutrients.
2. To acquire knowledge about protein calorie malnutrition
3. To revise the facts about Fat- and Water-soluble vitamins and their importance. 5. To extract facts about Obesity and various lifestyle associated diseases

UNIT- I

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.

UNIT-II

Clinical nutrition – role of diet and nutrition in prevention of atherosclerosis 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 aged people.

UNIT-III

Biological effects of non-nutrients, dietary fibre, physiological actions. Antinutrients – Protease inhibitors, hemagglutinins, 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-IV

Vitamins – Fat soluble vitamins (A,D,E,K) and Water soluble vitamins (B complex and C) (Sources, biological functions and RDA), Disorders of vitamins A, D, E, K , Vitamin C and B-complex vitamins : Thiamin, Riboflavin, Niacin, Pantothenic acid, Lipoic acid, Pyridoxine, Biotin, folic acid and vitamin B12.Minerals- iron, calcium, iodine, selenium (Sources, biological functions and RDA). Deficiency disorders of minerals Nutritional requirements in infancy, childhood, pregnancy and lactation and old age.

UNIT- V

Obesity – Causes, Anthropometric measurements and Diet management. Dietary management in – Infection, Fever, Constipation, Diabetes mellitus, Peptic Ulcer, PCOS, Hypertension, Cardiovascular diseases, Pancreatitis, Cirrhosis and Cancer.

V - SEMESTER
NUTRITIONAL BIOCHEMISTRY-(Course No-5)

Credits -1

PRACTICALS

1. Determination of reduced Ascorbic acid by DCPIP method
2. Determination of total Ascorbic acid by DNPH method
3. Determination of calcium in the food
4. Isolation of casein from milk and determination of its protein by any method
5. Determination of cholesterol of edible oil
6. Determination of ash content
7. Determination of moisture content of foods/food grains/ powders
8. Determination of fructose from honey/fruit pulp
9. Determination of pyridoxine of fruits/leaves
10. Isolation of lactose from skimmed milk and the estimation of lactose
11. Determination of iodine value of edible oil by titrimetry
12. Determination of acid value by titrimetry

COURSE OUTCOME

1. Analyse the role of various nutrients, their dietary allowances and relate in day-to-day life.
2. Revise the Knowledge about the water- and fat-soluble vitamins and its significance and its functions
3. Outline the Knowledge about Obesity and obtaining better results

REFERENCE BOOKS:

1. Smith EL (1983) Principles of biochemistry: mammalian biochemistry: McGraw-Hill Companies.
2. Chatterjee CC (1951) Human physiology: Medical Allied Agency.
3. Murray R, Granner D, Mayes P, Rodwell V (2003) Harper's illustrated biochemistry (LANGE basic science): McGraw-Hill Medical.
4. Guyton Aurcher C, Hall John E (2006) Text book of Medical Physiology. Elsevier India Pvt. Ltd. New Delhi.
5. Dixon M, Webb E (1979) Enzyme inhibition and activation. Enzymes 3: 126-136.
6. Rao C (1973) University General Chemistry: An Introduction to Chemical Science: MacMillan India.
7. Price NC, Frey PA (2001) Fundamentals of enzymology. Biochemistry andMolecular Biology Education 29: 34-35.
8. Palmer T, Bonner PL (2007) Enzymes: biochemistry, biotechnology, clinical chemistry: Elsevier.

V -SEMESTER

ENZYMOLOGY- (Course No-6)

Credits -3

COURSE OBJECTIVES

1. To enlighten the students about enzyme kinetics.
2. To help the students to understand the mechanism of action of enzymes.
3. To help the students to learn the applications of enzymes.

UNIT-I

Introduction to enzymes: Holoenzyme, apoenzyme, prosthetic group. Interaction between enzyme and substrate- lock and key model, induced fit model., enzyme specificity and types. IUB system of classification and nomenclature of enzymes (Class and subclass with one example) Ribozymes, Abzymes.

UNIT-II

Enzyme kinetics: Importance, order of reaction, study of the factors affecting the velocity of enzyme catalyzed reaction- enzyme concentration, temperature, pH, substrate concentration, inhibitors and Derivation of Michaelis -Menten equation and Km value determination and its significance. Definition of Vmax value of enzyme and its significance. Lineweaver- Burk plot (Only for single substrate enzyme catalyzed reaction).

UNIT-III

Methods of measurements and expression of enzyme activity. Unit of enzyme activity - definition and importance. Enzyme inhibition: Reversible and irreversible – examples. Reversible- competitive, noncompetitive and uncompetitive inhibition- explanation of double reciprocal plot with examples.

UNIT-IV

Enzyme regulation – covalently modulated enzymes with examples of adenylation and phosphorylation and allosteric regulation- example Aspartate tras carbamoylase. Isoenzymes- Lactate dehydrogenase and creatine phosphokinase. Zymogens

UNIT-V

Immobilization of enzymes, methods of immobilization. Industrial uses of enzymes: Detergent enzymes, thermo stable alpha amylase, papain, chymotrypsin

V - SEMESTER

ENZYMOLOGY- (Course No-6)

Credits -1

PRACTICAL SYLLABUS

1. Assay of α- amylase activity in saliva
2. Determination of optimum pH of a plant/animal or microbial enzyme.
3. Studying the effect of different temperatures during enzyme activity measurements.
4. Studying the effect of different pH during enzyme activity measurements.
5. Substrate saturation and determination of Km value from Michaelis Menten curve.

COURSE OUTCOMES

After completing this course, the student will:

1. Acquire the knowledge of structure and organization of protein
2. Identify the different classes of enzymes, the methods used for purification of enzymes and describe enzyme kinetics for bisubstrate and multisubstrate reactions.
3. Do research in a contemporary action of enzyme and enzyme inhibition.
4. Explain the enzyme regulation and multienzyme complex.
5. Explore the applications of enzymes in clinical and various industrial sectors.

REFERENCE BOOKS

1. Enzymes: M. Dixon and E. C. Webb. Longman Publication.
2. Enzymology: Nicholas and Price
3. Biochemistry: D.Voet and J. G. Voet, John Wiley & sons Inc. New York ChischesterBrisbane,Toronto, singapore ISBN 0-471-58651-X
4. Biochemistry: L. Stryer. and Hall, J.E., Library of congress cataloguing-in publication Data, Bery, Jeremy mark ISBN -0-7167-4684-0.
5. Enzymes: Trevor Palmer Affiliated East- West Press Pvt. Ltd, New Delhi ISBN 81-7671-04