Telangana State Council of Higher Education, Govt. of Telangana
B.Sc., CBCS Common Core Syllabi for all Universities in Telangana
(w.e.f 2016-17)

PROPOSED SCHEME FOR CHOICE BASED CREDIT SYSTEM IN B.Sc., BIOCHEMISTRY

Approved Syllabus for the III year
(SEMESTER V & VI)

To be implemented from the academic year 2018-19

SEC - 3

Semester – V: Paper- BS 501: APPLIED BIOCHEMISTRY
(2 Credits; 2 Hr/week)

Credit – I: Enzyme and Protein purification methods

1. Homogenization techniques
2. Centrifugation methods
3. Ammonium sulfate precipitation and Dialysis
4. Column chromatography and determination of molecular weight
5. UV Spectra, SDS-PAGE and Native PAGE

Credit – II: Nucleic acid analysis and Cell Cultures

1. Agarose gel electrophoresis
2. PCR
3. Blotting Techniques
4. Plant cell and Animal cell cultures
5. Microbial cell cultures for production valuable enzymes (Amylase, Protease, Cellulase)

References

1. Applied Biochemistry and Bioengineering by Lemuel Wingard, JR., Ephraim Katchalski-Katzir and Leon Goldstein, Academic Press Inc.
2. Protein purification – Principles and practice by Robert K. Scopes, Springer-verlag
3. Protein purification – Principles, High resolution methods and applications by Jan-Christer Janson, Wiley
4. Enzyme purification and related techniques, Vol 22, Nathan Kaplan Nathan Colowick, Elsevier
5. Plant Cell cultures: Essential methods by Michael R. Davrey and Paul Anthony, Wiley-Blackwell
6. Animal Cell cultures: Essential methods by John M. Davis, Wiley-Blackwell
7. Handbook of industrial cell culture – Mammalian, microbial and plant cell cultures by Victor A. Vinci and Sarad R. Parekh, Springer Science+Business Media LLC.

GE - 1
Semester – V: Paper – BS 502: Physiology and Biochemistry
(2 Credits; 2 Hr/week)

Credit – I: Physiology

1. Physiology of digestion
2. Physiology of vision
3. Physiology of muscle and nerve
4. Composition of blood and blood coagulation
5. Hormones secreted by Pituitary
6. Hormones of Thyroid and Clinical Relevance
7. Hormones of Pancreas and Clinical Relevance

Credit – II: Biomolecules and Metabolism

1. Water properties, pH and Buffers
2. Amino acids – Classification, properties and importance. Structure of proteins. Carbohydrates – Classification (mono, di, oligo and poly), properties and importance. Lipids – Classification, properties and importance. Nucleic acids – Purines, Pyrimidines, Nucleosides, Nucleotides. Structure and types of DNA and RNA and denaturation
3. Enzymes – Classification, Factors affecting enzyme activity, Clinically important enzymes (SGOT, SGPT, LDH and CPK)
4. Amino acid metabolism – General reactions, metabolism of aromatic amino acids
5. Carbohydrate metabolism – Glycolysis, TCA cycle and Gluconeogenesis
6. Lipid metabolism - β-oxidation of fatty acids, de novo synthesis of fatty acids
7. Nucleic acid metabolism – Synthesis and degradation of purines and pyrimidines

References

1. Textbook of Biochemistry and Human Biology – Talwar, G.P. and Srivastava. L.M., Printice Hall of India
2. Human Physiology – Chatterjee.C.C, Medical Allied Agency
3. William's Textbook of Endocrinology – Larsen, R. P. Korenberg, H. N. Melmed, S. and Polensky, K. S. Saunders
4. Lehninger's Principles of Biochemistry – Nelson.D.L. and Cox.M.M., Freeman & Co.
5. Biochemistry – Berg.J.M., Tymoczko.J.L. and Stryer.L., Freeman & Co
6. Fundamentals of Biochemistry –Jain, J.L., Jain, S., Jain, N. S. Chand & Co.

DSC – 1 E

Semester – V: Paper-BS 503 (Theory) : Physiology and Clinical Biochemistry

(3 Credits; 3 Hr/week)

Credit-I: Physiology

1. Digestion and absorption of carbohydrates, lipids and proteins
2. Composition of blood and coagulation of blood
3. Hemoglobin and transport of gases in blood (oxygen and CO_2)
4. Heart- structure of the heart, Cardiac cycle, cardiac factors controlling blood pressure
5. Physiology of Vision
6. Muscle- kinds of muscles, structure of myofibril, organization of contractile proteins and mechanism of muscle contraction.
7. Structure of Neuron and propagation of nerve impulse

Credit-II: Endocrinology

1. Endocrinology- organization of endocrine system. Classification of hormones.
2. Mechanism of hormonal action- Steroid and peptide hormones such as adrenaline, glucocorticoids and insulin.
3. Chemistry, physiological role and disorders of hormones of Pituitary, Hypothalamus and Thyroid
4. Chemistry, physiological role and disorders of hormones of Pancreas
5. Chemistry, physiological role and disorders of hormones of Parathyroid
6. Chemistry, physiological role and disorders of hormones of Gonads, Placenta and Adrenals
7. Gastrointestinal hormones and their physiological role

Credit-III: Organs and Organ Function tests

1. Structure and functions of the liver.
2. Liver function tests- conjugated and total bilurubin in serum, albumin: globulin ratio, hippuric acid and bromsulphthalein tests. Serum enzymes in liver diseases- SGPT, GGT and alkaline phosphatase.
3. Kidneys-structure of nephron and Mechanism of urine formation
4. Normal and abnormal constituents of urine.
5. Biological buffers. Role of kidneys in maintaining acid-base and electrolyte balance in the body.
6. Renal function tests- creatinine and urea clearance tests, phenol red test.
7. Biochemical tests for the diagnosis of heart diseases- HDL/LDL cholesterol, SGOT, LDH, CK, C-reactive protein, cardiac troponins.

References

1. Textbook of Biochemistry and Human Biology – Talwar, G.P. and Srivastava. L.M., Printice Hall of India
2. Review of Medical Physiology-Ganong. McGraw-Hill.
3. Human Physiology – Chatterjee.C.C, Medical Allied Agency
4. Textbook of Medical Physiology – Guyton.A.G and Hall.J.E., Saunders
5. William's Textbook of Endocrinology – Larsen, R. P. Korenberg, H. N. Melmed, S. and Polensky, K. S. Saunders
6. Mammalian Biochemistry- White, A. Handler, P. and Smith, E. L. McGraw-Hill.

7. Textbook of Human Nutrition- Bamji, Pralhad Rao and Reddy V. Oxford & IBH Publishers.
8. Foods: Facts & Principle- Shakuntala and Shadaksharaswamy. Wiley Ester Press.
9. Essentials of Food and Nutrition – Swaminathan.M. Bangalore Press.
10. Human Nutrition and Dietetics. Davidson, S. and Passmore, J. R. ELBS.
11. A Textbook of Biochemistry: Molecular and Clinical Aspects. Nagini, S. Scitech Publishers.
12. *Tietz* Fundamentals of Clinical Chemistry- Burtis, A. A. and Ashwood, E. R. Saunders-imprint Elsevier Pub.
13. Textbook of Biochemistry with Clinical Correlations – Devlin.T.M.,Wiley – Liss
14. Textbook of Medical Biochemistry – Chatterjea.M.N. and Shinde.R, Jaypee Brothers Medical Publishers.
15. Textbook of Medical Biochemistry- Ramakrishnan, S., Prasannan, K. G. and Rajan, R. Orient Longman

DSC – 1E

Semester – V: Paper - BS 503 (Practicals): Physiology and Clinical Biochemistry

(1 Credits; 2 Hr/week)

1. Estimation of hemoglobin in blood.
2. Total count - RBC and WBC. Differential count.
3. Urine analysis for albumin, sugars and ketone bodies.
4. Estimation of urinary creatinine.
5. Estimation of blood urea.
6. Estimation of serum total cholesterol.
7. Determination of serum alkaline phosphatase activity.
8. Determination of SGOT and SGPT activity

References

1. Experimental Biochemistry-A student companion-Beedu Sashidhar Rao and VijayDeshpande.
2. Laboratory Manual in Biochemistry- Jayaraman, J. Wiley Eastern
3. Biochemical Methods- Sadasivam,S and Manickyam,A. New Age International Publishers

DSE – 1 E
Semester – V: Paper-BS 506 A (Theory): Molecular Biology
(3 Credits; 3 Hr/week)

Credit- I : DNA Replication

1. Organization of genome in prokaryotes and eukaryotes.
2. Experimental evidences to prove nucleic acids as genetic material.
3. Nature and structure of the gene.
4. DNA replication- models of replication, Meselson-Stahl's experimental proof for semi-conservative model.
5. DNA polymerases I, II and III of *E.coli*, helicase, topoisomerases, primase, ligase.
6. Bidirectional replication model. Okazaki fragments, leading and lagging strands of DNA synthesis.
7. Inhibitors of DNA replication.

Credit- II : Transcription

1. Transcription - RNA synthesis, RNA polymerases of prokaryotes.
2. Promoters, Initiation- sigma factors and their recognition sites.
3. Elongation- role of core enzyme.
4. Termination- rho dependent and rho independent. RNA polymerase I, II and III of eukaryotes.
5. Transcriptional events in eukaryotic m-RNA synthesis
6. Post-transcriptional modifications of eukaryotic m-RNA
7. Inhibitors of RNA synthesis.

Credit- III : Translation and Regulation of Gene Expression

1. Introduction to protein synthesis- Genetic code, structure of t-RNA
2. Deciphering of genetic code, Nirenberg's and Khorana's experiments, wobble hypothesis, degeneracy of genetic code.
3. Protein synthesis- activation of amino acids (aminoacyl t-RNA synthetases).
4. Ribosome structure. Initiation, elongation and termination of protein synthesis.
5. Post- translational modifications- signal hypothesis.
6. Inhibitors of protein synthesis.
7. Regulation of prokaryotic gene expression- induction and repression. Lac operon, catabolite repression. Tryptophan operon and attenuation.

References

1. Molecular Biology of Cell- Alberts, B. Bray, D. Lewis, J. Raff, M. Roberts, K. and Watson, J. D. Garland Publishing.
2. Recombinant DNA and Biotechnology: A Guide for teachers- Helen and Massey. ASM Press.
3. Genes VIII – Lewin. B, Oxford University Press .
4. Molecular Biology- Freifelder. D. Naroasa Pub. House
5. Molecular Biology of the Gene- Watson. J.D., Baker, T.A, Bell, S.P.,Gann.A, Levine, M and Losick.R, Pearson Education.
6. Molecular Biotechnology- Glick, B. R. and Pasternak, J. J. ASM Press
7. Principles of Gene Manipulation: An Introduction to GE- Old, R. V. and Primrose, S. B. Blackwell Sci. Pub.
8. Molecular Cell Biology- Lodish, H., Berk, A., Matsudaira, P., Kaiser, C. A., Krieger, M. Scott M P., Zipursky, S. L. and Darnell, J. Freeman & Co.

DSE – 1 E
Semester – V: Paper - BS 506 A (Practicals) : Molecular Biology
(1 Credits; 2 Hr/week)

1. Isolation of DNA from onion/liver/coconut endosperm.
2. Isolation of plasmid DNA
3. Isolation of RNA
4. Determination of purity of nucleic acids by UV-spectrophotometric method.
5. Estimation of DNA by diphenylamine method.
6. Estimation of RNA by orcinol method.
7. Electrophoresis of nucleic acids and visualization by methylene blue staining.
8. Restriction mapping: λ- DNA with any two restriction enzymes.

References

1. Experimental Biochemistry-A student companion-Beedu Sashidhar Rao and VijayDeshpande.
2. Laboratory Manual in Biochemistry- Jayaraman, J. Wiley Eastern
3. Biochemical Methods- Sadasivam,S and Manickyam,A. New Age International Publishers

DSE – 1 E

Semester – V: Paper-BS 506 B (Theory): Cell Biology and Genetics

(3 Credits; 3 Hr/week)

Credit – I: Cell Biology

1. Cells as basic units of living organisms
2. Composition & functions of cell organelles
3. Cytoskeleton- Microfilaments, Microtubules & Intermediate filaments
4. Ultra-structure of prokaryotic cell and eukaryotic cells
5. Chromosome organization in Prokaryotes and Eukaryotes and structure of chromosomes (Polytene and Lamp Brush)
6. Mitosis and Meiosis and their significance
7. Cell Cycle and cell death; Apoptosis

Credit – II: Genetics

1. Basic concepts of Mendel's experiments – Law of segregation and Law of Independent assortment
2. Partial or incomplete dominance and Co-dominance
3. Non-Mendelian inheritance: Extra chromosomal inheritance (*Paramoecium* & *Drosophila*).
4. Maternal inheritance (Coiling in snails, Leber's hereditary optic neuropathy (LHON)).
5. Linkage and recombination
6. Polygenic inheritance (Introduction to quantitative traits).
7. Sex linked inheritance. X-linked recessive inheritance (colour blindness & Hemophilia). Concept of Autosomal recessive and dominant inheritance

Credit – III: Mutations and Mutagens

1. Mutations (spontaneous / induced, somatic / germinal, forward / reverse, transition / transversions)
2. Mutations (Silent, missense, nonsense, and frame shift mutations, conditional, leaky)
3. Detection, selection & isolation of microbial mutants
4. Estimation of mutation rates
5. Reversion and suppression of mutations
6. Mutagens – physical, chemical
7. Transposon mutagenesis, site-directed mutagenesis

References

1. Principles of Genetics by Eldon John Gardner, Michael J. Simmons, D. Peter Snustad; John Wiley
2. Modern Genetic Analysis Anthony JF Griffiths, William M Gilbert, Jeffrey H Miller, and Richard
   C Lewontin. Pub. W. H. Freeman
3. Lewin B. (Ed)(1996) Genes, VII edition, John Wiley and Sons, New York.
4. Cell and Molecular Biology, De Robertis and De Robertis , Lippincott & Wilkins
5. Cell Biology by C. B. Pawar
6. Principles of Genetics by R.H. Tamarin McGrawhill
7. Theory & problems in Genetics by Stansfield, Schaum out line series McGrawhill

DSE – 1 E

Semester – V: Paper-BS 506 B (Practicals) : Cell Biology and Genetics

(1 Credits; 2 Hr/week)

1. Preparation of different stages of Mitosis
2. Preparation of different stages of Meiosis
3. Types of chromosomes
4. Karyotyping
5. Problems on Monohybrid cross
6. Problems on dihybrid ratio in *Drosophila*/maize
7. Problems on Linkage and Recombination
8. Studies on Sex linked inheritance and X-linked recessive inheritance

References

1. Essential practical handbook of Cell Biology & Genetics, Biometry and Microbiology: A Laboratory Manual by Debarati Das, Academic Publishers

SEC – 4

Semester – VI: Paper-BS 601 : Mini Project
(2 Credits; 2 Hr/week)

The mini project can be either live or review based and is of **4 weeks duration**. Suitable project work to be carried out by the student under the mentorship of departmental staff within the department. The assessment would be carried out based the dissertation and project viva-voce.

The distribution of marks for the project is as follows.

Dissertation – 25 Marks

Project presentation – 15 Marks

Response to queries – 10 Marks

GE - 2

Semester – VI: Paper – BS 602 (Theory): Nutrition in health and disease

(2 Credits; 2 Hr/week)

Credit – I: Nutrition

1. Balanced Diet
2. Calorific value of foods
3. SDA of foods
4. BMR and factors affecting it
5. BMI and its determination
6. Recommended dietary allowance (RDA) for children, adults and lactating women
7. Foods and their Nutrient content – cereals, pulses, nuts and fibre

Credit – II: Nutritional disorders

1. Malnutrition - Kwashiorkar,
2. Malnutrition - Marasmus
3. Vitamins – Classification, dietary sources, biochemical role, deficiency disorders
4. Trace elements (Ca, Mg, Fe, I and Zn)
5. Obesity and diabetes
6. Probiotics in human health
7. Functional foods

References

1. Essentials of Food and Nutrition –Swaminathan M. Bangalore Press
2. Manual of Nutritional Therapeutics, 2nd edition, Alpers (1991), Little Brown Publications, Washington.

DSC – 1 F

Semester – VI: Paper-BS 603 (Theory): Nutrition and Immunology

(3 Credits; 3 Hr/week)

Credit – I: Nutrition

1. Balanced diet. Calorific values of foods and their determination by bomb calorimeter.
2. BMR and factors affecting BMR. Specific dynamic action of foods.
3. Energy requirements and recommended dietary allowance (RDA) for children, adults, pregnant and lactating women.
4. Sources of complete and incomplete proteins. Biological value of proteins. Role of essential fatty acids in human nutrition.
5. Malnutrition- Kwashiorkar, Marasmus and PEM.
6. Vitamins- sources, structure, biochemical roles, deficiency disorders of water and fat soluble vitamins; Bulk and trace elements-Ca, Mg, Fe, I, Cu, Mo, Zn, Se and F.
7. Nutraceuticals; Obesity and starvation.

Credit – II: Immunology

1. Organization of immune system.
2. Organs and cells of immune system.
3. Innate and acquired immunity.
4. Cell mediated and humoral immunity (T- and B- cells).
5. Classification of immunoglobulins, structure of IgG. Theories of antibody formation- clonal selection theory.
6. Epitopes / antigenic determinants. Concept of haptens. Adjuvants.
7. Monoclonal antibodies and their applications

Credit – III: Immunotechnology

1. Antigen-antibody reactions- agglutination, immunoprecipitation, immunodiffusion.
2. Blood group antigens.
3. Immunodiagnostics-RIA, ELISA.
4. Vaccines and their classification. Traditional vaccines-live and attenuated, toxoids.
5. Modern vaccines- recombinant and peptide vaccines.
6. Outlines of hypersensitivity reactions.
7. Fundamentals of graft rejection and MHC proteins.

References

1. Essentials of Food and Nutrition –Swaminathan M. Bangalore Press
2. Immunology. Tizard, I. R. Thomson Press.
3. Kuby Immunology – Kindt.T.J., Goldsby.R.A. and Osborne.B.A., Freeman & Co.
4. Roitt's Essential Immunology – Roitt.I.M. and Delves.P.J., Blackwell Science.

DSC – 1 F

Semester – VI: Paper-BS 603 (Practicals): Nutrition and Immunology

(1 Credits; 2 Hr/week)

1. Estimation of calcium by titrimetry
2. Estimation of iron in apple juice by phenanthroline method.
3. Estimation of vitamin C by 2, 6 -dichlorophenol indophenol method.
4. Isolation of total lipids by gravimetric method.
5. Determination of iodine value of an oil.
6. Determination of acid value of an oil.
7. Agglutination: ABO and D Ag typing
8. ODD and ELISA - sandwich ELISA

References

1. Experimental Biochemistry-A student companion-Beedu Sashidhar Rao and VijayDeshpande.
2. Laboratory Manual in Biochemistry- Jayaraman, J. Wiley Eastern
3. Biochemical Methods- Sadasivam,S and Manickyam,A. New Age International Publishers

DSE – 1 F

Semester – VI: Paper-BS 606 A (Theory): Microbiology and r-DNA Technology

(3 Credits; 3 Hr/week)

Credit – I : Microbiology

1. Introduction to brief history of microbiology. Classification of microorganisms, Mycoplasma.
2. Isolation and cultivation of bacteria. Selective media and enriched media.
3. Bacterial growth curve and kinetics of growth. Batch, continuous and synchronous cultures.
4. Gram's staining- Gram positive and Gram negative bacteria, motility and sporulation.
5. Industrial uses of *Aspergillus niger*, yeast and Spirulina.
6. Structure and composition of viruses. One-step growth and determination of plaque forming units (PFU).
7. Viral life cycles – T4 (Lytic), λ phage (lytic and lysogenic), TMV, Retro viruses- HIV.

Credit – II: r-DNA technology I

1. Outlines of cloning strategies.
2. DNA sequencing- Maxam Gilbert and Sanger's methods.
3. Tools of r-DNA technology: Enzymes- Restriction endonucleases and ligases
4. Restriction mapping.
5. Cloning vectors- Plasmids, Cosmids, and λ phages
6. Hosts- *E.coli*
7. Molecular markers–RFLP, AFLP and RAPD

Credit – III: r-DNA technology II

1. Construction of c-DNA libraries.
2. Polymerase chain reaction- principle and applications.
3. Outlines of blotting techniques-Southern, Northern and Western.
4. Applications of gene cloning- production of insulin
5. Production of human growth hormone
6. Production of Bt cotton
7. Edible vaccines.

References

1. Textbook of Microbiology – Ananthanarayan, R and Jayaram Paniker, C.K., Orient Longman.
2. Microbiology – Prescott.L.M.,Harley.J.P. & Klein.D.A, McGraw-Hill.
3. Microbiology – Pelczar Jr,.M.J., Chan.E.C.S. and Krieg.N.R., Tata McGraw-Hill.
4. Textbook of Microbiology- Dubey, R. C. and Maheshwari, D. K. S. Chand & Co.
5. Principles of Gene Manipulation: An introduction to GE – Old, R. and Primrose, S.B. Blackwell Sci. Pub
6. Molecular Biotechnology Glick, BR and Paternak, JJ. Publish ASM Press

DSE – 1 F

Semester – VI: Paper-BS 606 A (Practicals): Microbiology and r-DNA Technology

(1 Credits; 2 Hr/week)

1. Preparation of culture media and sterilization methods.
2. Isolation of pure cultures: (i) Streak plate method (ii) Serial dilution method.
3. Gram staining.
4. Motility of bacteria by hanging drop method.
5. Bacterial growth curve.
6. Antibiotic sensitivity by paper disc method.
7. Gene cloning (Demonstration only)
8. Preparation and transformation of competent cells

References

1. Molecular Cloning (Lab manual) by Maniatis T, Fritsch EF, Sambrook J, Volume –I, CSH
2. Microbiology – A Laboratory manual by Cappuccino and Sherman, Pearson Publications LPE.
3. Experiments in Microbiology, Plant Pathology and Biotechnology by Aneja A. R., New Age Publications

DSE – 1 F
Semester – VI: Paper-BS 606 B (Theory): Biotechnology
(3 Credits; 3 Hr/week)

Credit – I: Plant Biotechnology

1. Plant tissue culture and its applications
2. Plants as bioreactors and valuable chemical factories (production of bioactive compounds)
3. Crop improvement, Production of herbicide and insect resistant plants
4. Plant metabolic engineering
5. Genetic engineering for quality improvement of Protein, lipids, carbohydrates, vitamins & mineral nutrients
6. Marker-assisted selection of qualitative and quantitative traits.
7. Genetically modified crops – Arabidopsis, Golden rice, soybeans, Bt cotton, tobacco, potato, papaya, jatropha,

Credit – II: Animal and Microbial Biotechnology

1. Animal cell cultures as bioreactors
2. Usage of animal cell culture for *in vitro* drug testing
3. Molecular pharming; Production of vaccines, pharmaceutical proteins, recombinant hemoglobin and blood substituents
4. Microbes as biocontrol agents
5. Overview of Microbial insecticides (Baculoviruses, *Bacillus thurinigiensis* and *Bacillus sphaericus*)
6. Bioremediation, Biodegradation of cellulose and lignocellulose, biosurfactants and bioemulsifiers
7. Microbial ore leaching and production of microbial fuels (hydrogen, methane)

Credit – III: Environmental Biotechnology

1. Renewable and Non-renewable energy sources
2. Strategies involved in Municipal solid waste treatment
3. Treatment of industrial and domestic effluent (aerobic and anaerobic)
4. Biomaterials as an alternative to non-degradable materials
5. Microorganisms for Heavy Metal Accumulation
6. Biosorption
7. Heavy metal tolerance (including mechanism) and its impact on environment

References:

1. Introduction to Biotechnology, William J. Thieman, Michael A. Palladino, Benjamin Cummings Publ
2. Biotechnology- Arora, Himalaya pub. House
3. Introduction to Environmental Biotechnology by A. K. Chatterji, PHI Learning Pvt. Ltd.
4. Animal Cells as Bioreactors - By Terence Gartoright, Cambridge Univ Press
5. Text Book of Biotechnology - By H.K. Das (Wiley Publications)
6. Introduction to Plant Tissue Culture - By M.K. Razdan (Oxford and IBH Publishing Company, New Delhi)
7. Industrial Microbiology by L.E. Casida

DSE – 1 F

Semester – VI: Paper-BS 606 B (Practicals): Biotechnology

(1 Credits; 2 Hr/week)

1. Preparation of MS medium and initiation of callus
2. Micropropagation of plants
3. Preparation of animal cell culture media, Cell disaggregation and cell counting
4. Isolation of microbes from environment (soil, water, skin, bread, milk)
5. Microbial degradation of organic matter
6. Efficacy testing for biofertilizers (nodulation test for rhizobia) and biopesticides
7. Municipal solid waste treatment and Waste water treatment
8. Production of hydrogen and methane

References

1. Microbial Biotechnology – A Laboratory Manual for bacterial systems by Das, Surajit, Dash, Hirak Ranjan, Springer-Verlag
2. Plant Tissue Culture by Kalyan Kumar De
3. Biogas Technology by B.T. Nijaguna
4. Biotechnology procedures and experiments handbook by S. Harisha, Infinity Science Press LLC.