

ANNA UNIVERSITY, CHENNAI

AFFILIATED INSTITUTIONS

REGULATIONS 2013

II SEMESTER CURRICULUM

B.Tech. Biotechnology

SEMESTER II

THEORY					
Course Code	Course Title	L	T	P	C
HS6251	Technical English - II	3	1	0	4
MA6251	Mathematics - II	3	1	0	4
PH6252	Physics of Materials	3	0	0	3
CY6252	Chemistry for Technologists	3	0	0	3
BT6201	Biochemistry	3	0	0	3
BT6202	Microbiology	3	0	0	3
PRACTICAL					
Course Code	Course Title	L	T	P	C
BT6211	Biochemistry Laboratory	0	0	4	2
BT6212	Microbiology Laboratory	0	0	4	2
TOTAL		18	2	8	24

II SEMESTER SYLLABI
B.TECH. BIOTECHNOLOGY

HS6251

TECHNICAL ENGLISH II

L T P C
3 1 0 4

OBJECTIVES:

- To make learners acquire listening and speaking skills in both formal and informal contexts.
- To help them develop their reading skills by familiarizing them with different types of reading strategies.
- To equip them with writing skills needed for academic as well as workplace contexts.
- To make them acquire language skills at their own pace by using e-materials and language lab components.

OUTCOMES:

Learners should be able to

- speak convincingly, express their opinions clearly, initiate a discussion, negotiate, argue using appropriate communicative strategies.
- write effectively and persuasively and produce different types of writing such as narration, description, exposition and argument as well as creative, critical, analytical and evaluative writing.
- read different genres of texts, infer implied meanings and critically analyse and evaluate them for ideas as well as for method of presentation.
- listen/view and comprehend different spoken excerpts critically and infer unspoken and implied meanings.

UNIT I

9 + 3

Listening - Listening to informal conversations and participating; Speaking - Opening a conversation (greetings, comments on topics like weather) - Turn taking - Closing a conversation (excuses, general wish, positive comment, thanks); Reading - Developing analytical skills, Deductive and inductive reasoning - Extensive reading; Writing - Effective use of SMS for sending short notes and messages - Using 'emoticons' as symbols in email messages; Grammar - Regular and irregular verbs - Active and passive voice; Vocabulary - Homonyms (e.g. 'can') - Homophones (e.g. 'some', 'sum'); E-materials - Interactive exercise on Grammar and vocabulary - blogging; Language Lab - Listening to different types of conversation and answering questions.

UNIT II

9 + 3

Listening - Listening to situation based dialogues; Speaking - Conversation practice in real life situations, asking for directions (using polite expressions), giving directions (using imperative sentences), Purchasing goods from a shop, Discussing various aspects of a film (they have already seen) or a book (they have already read); Reading - Reading a short story or an article from newspaper, Critical reading, Comprehension skills; Writing - Writing a review / summary of a story / article, Personal letter (Inviting your friend to a function, congratulating someone for his / her success, thanking one's friends / relatives); Grammar - modal verbs, Purpose expressions; Vocabulary - Phrasal verbs and their meanings, Using phrasal verbs in sentences; E-materials - Interactive exercises on Grammar and vocabulary, Extensive reading activity (reading stories / novels), Posting reviews in blogs - Language Lab - Dialogues (Fill up exercises), Recording students' dialogues.

UNIT III**9 + 3**

Listening - Listening to the conversation - Understanding the structure of conversations; Speaking - Conversation skills with a sense of stress, intonation, pronunciation and meaning - Seeking information – expressing feelings (affection, anger, regret, etc.); Reading - Speed reading – reading passages with time limit - Skimming; Writing - Minutes of meeting – format and practice in the preparation of minutes - Writing summary after reading articles from journals - Format for journal articles – elements of technical articles (abstract, introduction, methodology, results, discussion, conclusion, appendices, references) - Writing strategies; Grammar - Conditional clauses - Cause and effect expressions; Vocabulary - Words used as nouns and verbs without any change in the spelling (e.g. 'rock', 'train', 'ring'); E-materials - Interactive exercise on Grammar and vocabulary - Speed Reading practice exercises; Language Lab - Intonation practice using EFLU and RIE materials – Attending a meeting and writing minutes.

UNIT IV**9 + 3**

Listening - Listening to a telephone conversation, Viewing model interviews (face-to-face, telephonic and video conferencing); Speaking - Role play practice in telephone skills - listening and responding, -asking questions, -note taking – passing on messages, Role play and mock interview for grasping interview skills; Reading - Reading the job advertisements and the profile of the company concerned – scanning; Writing - Applying for a job – cover letter - résumé preparation – vision, mission and goals of the candidate; Grammar - Numerical expressions - Connectives (discourse markers); Vocabulary - Idioms and their meanings – using idioms in sentences; E-materials - Interactive exercises on Grammar and Vocabulary - Different forms of résumés- Filling up a résumé / cover letter; Language Lab - Telephonic interview – recording the responses - e-résumé writing.

UNIT V**9 + 3**

Listening - Viewing a model group discussion and reviewing the performance of each participant - Identifying the characteristics of a good listener; Speaking - Group discussion skills – initiating the discussion – exchanging suggestions and proposals – expressing dissent/agreement – assertiveness in expressing opinions – mind mapping technique; Reading - Note making skills – making notes from books, or any form of written materials - Intensive reading; Writing – Checklist - Types of reports – Feasibility / Project report – report format – recommendations / suggestions – interpretation of data (using charts for effective presentation); Grammar - Use of clauses; Vocabulary – Collocation; E-materials - Interactive grammar and vocabulary exercises - Sample GD - Pictures for discussion, Interactive grammar and vocabulary exercises; Language Lab - Different models of group discussion.

TOTAL: 60 PERIODS**TEXTBOOKS**

1. Department of English, Anna University. Mindscapes: English for Technologists and Engineers. Orient Blackswan, Chennai. 2012
2. Dhanavel, S.P. English and Communication Skills for Students of Science and Engineering. Orient Blackswan, Chennai. 2011

REFERENCES

1. Anderson, Paul V. Technical Communication: A Reader-Centered Approach. Cengage. New Delhi. 2008
2. Muralikrishna, & Sunita Mishra. Communication Skills for Engineers. Pearson, New Delhi. 2011
3. Riordan, Daniel. G. Technical Communication. Cengage Learning, New Delhi. 2005
4. Sharma, Sangeetha & Binod Mishra. Communication Skills for Engineers and Scientists. PHI Learning, New Delhi. 2009
5. Smith-Worthington, Darlene & Sue Jefferson. Technical Writing for Success. Cengage, Mason USA. 2007

EXTENSIVE Reading (Not for Examination)

1. Khera, Shiv. You can Win. Macmillan, Delhi. 1998.

Websites

1. <http://www.englishclub.com>
2. <http://owl.english.purdue.edu>

TEACHING METHODS:

- Lectures
- Activities conducted individually, in pairs and in groups like individual writing and presentations, group discussions, interviews, reporting, etc
- Long presentations using visual aids
- Listening and viewing activities with follow up activities like discussions, filling up worksheets, writing exercises (using language lab wherever necessary/possible) etc
- Projects like group reports, mock interviews etc using a combination of two or more of the language skills

EVALUATION PATTERN:

Internal assessment: 20%

3 tests of which two are pen and paper tests and the other is a combination of different modes of assessment like

- Project
- Assignment
- Report
- Creative writing, etc.

All the four skills are to be tested with equal weightage given to each.

- ✓ Speaking assessment: Individual presentations, Group discussions
- ✓ Reading assessment: Reading passages with comprehension questions graded following Bloom's taxonomy
- ✓ Writing assessment: Writing essays, CVs, reports etc. Writing should include grammar and vocabulary.
- ✓ Listening/Viewing assessment: Lectures, dialogues, film clippings with questions on verbal as well as audio/visual content graded following Bloom's taxonomy.

End Semester Examination: 80%

OBJECTIVES:

- To make the student acquire sound knowledge of techniques in solving ordinary differential equations that model engineering problems.
- To acquaint the student with the concepts of vector calculus, needed for problems in all engineering disciplines.
- To develop an understanding of the standard techniques of complex variable theory so as to enable the student to apply them with confidence, in application areas such as heat conduction, elasticity, fluid dynamics and flow the of electric current.
- To make the student appreciate the purpose of using transforms to create a new domain in which it is easier to handle the problem that is being investigated.

UNIT I VECTOR CALCULUS**9+3**

Gradient, divergence and curl – Directional derivative – Irrotational and solenoidal vector fields – Vector integration – Green's theorem in a plane, Gauss divergence theorem and Stokes' theorem (excluding proofs) – Simple applications involving cubes and rectangular parallelepipeds.

UNIT II ORDINARY DIFFERENTIAL EQUATIONS**9+3**

Higher order linear differential equations with constant coefficients – Method of variation of parameters – Cauchy's and Legendre's linear equations – Simultaneous first order linear equations with constant coefficients.

UNIT III LAPLACE TRANSFORM**9+3**

Laplace transform – Sufficient condition for existence – Transform of elementary functions – Basic properties – Transforms of derivatives and integrals of functions - Derivatives and integrals of transforms - Transforms of unit step function and impulse functions – Transform of periodic functions. Inverse Laplace transform -Statement of Convolution theorem – Initial and final value theorems – Solution of linear ODE of second order with constant coefficients using Laplace transformation techniques.

UNIT IV ANALYTIC FUNCTIONS**9+3**

Functions of a complex variable – Analytic functions: Necessary conditions – Cauchy-Riemann equations and sufficient conditions (excluding proofs) – Harmonic and orthogonal properties of analytic function – Harmonic conjugate – Construction of analytic functions – Conformal mapping: $w = z+k$, kz , $1/z$, z^2 , e^z and bilinear transformation.

UNIT V COMPLEX INTEGRATION**9+3**

Complex integration – Statement and applications of Cauchy's integral theorem and Cauchy's integral formula – Taylor's and Laurent's series expansions – Singular points – Residues – Cauchy's residue theorem – Evaluation of real definite integrals as contour integrals around unit circle and semi-circle (excluding poles on the real axis).

TOTAL: 60 PERIODS**TEXT BOOKS:**

1. Bali N. P and Manish Goyal, "A Text book of Engineering Mathematics", Eighth Edition, Laxmi Publications Pvt Ltd.,(2011).
2. Grewal. B.S, "Higher Engineering Mathematics", 41st Edition, Khanna Publications, Delhi, (2011).

REFERENCES:

1. Dass, H.K., and Er. Rajnish Verma," Higher Engineering Mathematics", S. Chand Private Ltd., (2011)
2. Glyn James, "Advanced Modern Engineering Mathematics", 3rd Edition, Pearson Education, (2012).
3. Peter V. O'Neil," Advanced Engineering Mathematics", 7th Edition, Cengage learning, (2012).
4. Ramana B.V, "Higher Engineering Mathematics", Tata McGraw Hill Publishing Company, New Delhi, (2008).

UNIT I PREPARATION AND PROCESSING OF MATERIALS 9

Phases - Phase rule – binary systems – tie line rule – lever rule – phase diagram – invariant reactions – diffusion Fick's law - Nucleation – homogeneous and heterogeneous nucleation – Free energy of formation of a critical nucleus – crystal growth – Czochralski, Bridgman, Solution methods - Thin films – preparation: PVD method - Sol-gel method – heat treatment and hardening processes..

UNIT II PROPERTIES OF CONDUCTING AND SUPER CONDUCTING MATERIALS 9

Classical free electron theory of metals –Fermi function - Schrödinger wave equation - Time independent and time dependent equations. Physical significance of wave function, particle in a box (in one dimension) – electrons in a metal - Density of energy states – effect of temperature on Fermi energy – carrier concentration in metals - Superconducting Phenomena, Properties of superconductors – Meissner effect and Isotope effect. Type I and Type II superconductors, High T_c superconductors – Magnetic levitation and SQUIDS.

UNIT III ELECTRONIC MATERIALS 9

Elemental and compound semiconductors - Origin of band gap in solids (qualitative) - Concept of effective mass of electron and hole – carrier concentration in an intrinsic semiconductor (derivation) – Fermi level – Variation of Fermi level with temperature – electrical conductivity – band gap determination – carrier concentration in n-type and p-type semiconductors (derivation) – variation of Fermi level with temperature and impurity concentration – Compound semiconductors – Hall effect – Determination of Hall coefficient – LED and Solar cells.

UNIT IV INSULATING AND MAGNETIC MATERIALS 9

Dielectric, paraelectric and ferroelectric materials - Electronic, Ionic, Orientational and space charge polarization – Internal field and deduction of Clausius Mosotti equation – dielectric loss – different types of dielectric breakdown – classification of insulating materials and their applications - Introduction to magnetic materials - Domain theory of ferromagnetism, Hysteresis, Soft and Hard magnetic materials – Anti-ferromagnetic materials – Ferrites, Giant Magneto Resistance materials. Magnetic bubbles.

UNIT V CERAMIC AND NEW MATERIALS 9

Introduction to Ceramics and its applications - Ceramic Fibres - Fibre reinforced Plastics – Fibre reinforced Metal – Metallic glasses – Shape memory alloys – Copper base alloys – Nickel – Titanium alloys – Relaxor Ferroelectric materials – Electro and magneto rheological fluids - Sensors and Actuators – polymer semiconductors – photoconducting polymers – liquid crystals - Bio-sensors - Scintillation detectors (Position sensitive) –Bio materials – hydroxyapatite – PMMA – Silicone

TOTAL : 45 PERIODS**REFERENCES**

1. Raghavan. V. Materials Science and Engineering, Prentice Hall of India, 2002.
2. Kumar.J, Moorthy Babu. S and Vasudevan. S., Engineering Physics, Vijay Nicole Imprints, 2006
3. Palanisamy.. P.K., Materials Science, Scitech., 2003.
4. Calister, W.D., Materials Science and Engineering an Introduction, John Wiley, 2003.
5. Raghavan, V., Physical Metallurgy, Prentice Hall of India, 2002.

CY6252**CHEMISTRY FOR TECHNOLOGISTS****L T P C****3 0 0 3****UNIT I WATER****9**

Water quality parameters- determination of hardness (EDTA method), TDS, BOD, COD and iron and their significance. Softening – Zeolite and demineralization processes. Boiler troubles and remedies – removal of oils and silica, internal conditioning. Desalination by electro-dialysis and reverse osmosis. Water quality parameters and standards for textile wet processing.

UNIT II CHEMISTRY OF INTERFACES**9**

Interface region-curved interfaces-thermodynamics of surfaces - Surface film on liquids-Adsorption of gases on Solids-adsorption isotherms. Applications of adsorption studies- detergency, wetting, foaming, defoaming, spreading, water repellency.

UNIT III OILS, FATS, SOAPS & LUBRICANTS**9**

Chemical constitution, Chemical analysis of oils and fats – acid, saponification and iodine values, Definitions, determinations and significance. Definition, mechanism of lubrication, preparation of petrolubes, desirable characteristics – viscosity, viscosity index, carbon residue, oxidation stability, flash and fire points, cloud and pour points, aniline point. Semisolid lubricant – greases, preparation of sodium, lithium, calcium and axle greases and uses, consistency test and drop point test. Solid lubricants – graphite and molybdenum disulphide

UNIT IV CHEMICALS AND AUXILIARIES**9**

Surfactant Chemistry, bleaching powder, sodium hypochlorite, hydrogen peroxide, chlorine dioxide, preparation, estimation of available chlorine in hypochlorite bleach liquor. determination of strength of hydrogen peroxide.

UNIT V COLORANTS**9**

Theory of color and constitution: chromophore and auxochrome, classification of dyes based on application. Chemistry and synthesis of, azo dye

TOTAL: 45 PERIODS**REFERENCES**

1. Dhara S. S., "A Text Book of Engineering Chemistry", S. Chand & Co. Ltd., New Delhi, 2002
2. Jain. P.C. and Monica Jain, "Engineering Chemistry", Dhanpet Rai & Sons, New Delhi, 2001
3. Puri B. R., Sharma L. R. and Madhan S. Pathania, "Principles of Physical Chemistry", Shoban Lal Nagin Chand & Co., Jalandar, 2000
4. Shore J., "Colourants and Auxiliaries: Volume I Colorants", Wood head Publishing Ltd., 2002, ISBN 0 901956 77 5
5. Shore J., "Colourants and Auxiliaries: Volume II Auxiliaries", Wood head Publishing Ltd., 2002, ISBN 0 901956 78 3
6. Trotman E. R., "Dyeing and Chemical Technology of Textile Fibres", B.I Publishing Pvt. Ltd., New Delhi, 1994
7. Shenai V. A., "Chemistry of Dyes and Principles of Dyeing", Sevak Publications, Mumbai, 1995

BT6201**BIOCHEMISTRY****L T P C****3 0 0 3****OBJECTIVES**

- To develop understanding and provide scientific basics of the life processes at the molecular level and explain the structure, function and inter-relationships of bio-molecules and their deviation from normal and their consequences for interpreting and solving clinical problems.

UNIT I BIOCHEMICAL ORGANIZATION AND BIOENERGETICS 10

Scope of clinical biochemistry, component of the cell, structure and biochemical functions, membrane structure and functions, transport through biological cell membrane, the concept of free energy, determination of change in free energy from equilibrium constant and reduction potential, bioenergetics and biological oxidation – general concept of oxidation and reduction, electron transport chain, oxidative phosphorylation, uncouplers and theories of biological oxidation and oxidative phosphorylation

UNIT II BIOMOLECULES 12

Carbohydrates – classification, properties. starch, glycogen, dextrin, inulin, cellulose, metabolism of carbohydrates – gluconeogenesis, glycogenolysis, glycolysis. citric acid cycle and its biological significance, role of sugar in nucleotide biosynthesis and pentose phosphate pathway. **Lipids** – Classification, properties. sterols, essential fatty acids, eicosanoids, phospholipids, sphingolipids, metabolism of lipids, oxidation of fatty acids, α, β - oxidation and biosynthesis of ketone bodies, cholesterol, porphyrin biosynthesis, metabolism of bile pigments. **Proteins and amino acids** – Classification, properties, biosynthesis of amino acids and proteins, essential amino acids, metabolism of amino acids and proteins, Nitrogen balance. **Nucleic acids** – genetic code, nucleic acids, and structure of DNA and RNA, purine biosynthesis and pyrimidine biosynthesis.

UNIT III BIOENERGETICS 5

High energy compounds, electronegative potential of compounds, respiratory chain, ATP cycle, Calculation of ATP during oxidation of glucose and fatty acids.

UNIT IV MACROMOLECULES, VITAMINS, HORMONES, ENZYMES 10

Physical and chemical properties, structure of haemoglobin, immunoglobulins and nucleoprotein, classification and their properties, occurrence, functions, requirements, deficiency manifestations and role of vitamins as coenzyme, chemical nature and properties, hormones, Nomenclature, enzyme kinetics, classification and their properties, mechanism of action, enzyme induction and inhibition, coenzyme significance and enzymes of clinical importance

UNIT V BIOCHEMISTRY OF CLINICAL DISEASES 8

Diabetes mellitus, atherosclerosis, fatty liver, and obesity, hormonal disorders, aging, inborn errors of metabolism organ function tests

TOTAL: 45 PERIODS

TEXTBOOKS

1. Lehninger A.L., Nelson D.L. and Cox M.M. Principles of Biochemistry. CBS publishers and distributors
2. Murray R.K., Granner D.K., Mayes P.A. and Rodwell V.W. Harpers Biochemistry. Appleton and Lange, Stanford, Connecticut.
3. Thomas M. Devlin. Textbook of Biochemistry with clinical correlations. Wiley Liss Publishers

REFERENCES

1. Burtis & Ashwood W.B. Tietz Textbook of Clinical chemistry. Saunders Company
2. Lubert Stryer W.H. Biochemistry. Freeman and company, New York.
3. Donald Voet & Judith G. Voet. Biochemistry. John Wiley and Sons, Inc.
4. Rama Rao Textbook of Biochemistry.
5. Deb. Textbook of Biochemistry.

BT6202

MICROBIOLOGY

L T P C
3 0 0 3

OBJECTIVES

- To introduce students to the principles of Microbiology to emphasize structure and biochemical aspects of various microbes.
- To solve the problems in microbial infection and their control.

UNIT I INTRODUCTION

6

Basics of microbial existence; history of microbiology, classification and nomenclature of microorganisms, microscopic examination of microorganisms, light and electron microscopy; principles of different staining techniques like gram staining, acid fast, capsular staining, flagellar staining.

UNIT II MICROBES- STRUCTURE AND MULTIPLICATION

12

Structural organization and multiplication of bacteria, viruses, algae and fungi, with special mention of life history of actinomycetes, yeast, mycoplasma and bacteriophages.

UNIT III MICROBIAL NUTRITION, GROWTH AND METABOLISM

12

Nutritional requirements of bacteria; different media used for bacterial culture; growth curve and different methods to quantify bacterial growth; aerobic and anaerobic bioenergetics and utilization of energy for biosynthesis of important molecules.

UNIT IV CONTROL OF MICROORGANISMS

6

Physical and chemical control of microorganisms; host-microbe interactions; anti-bacterial, anti-fungal and anti-viral agents; mode of action and resistance to antibiotics; clinically important microorganisms.

UNIT V INDUSTRIAL AND ENVIRONMENTAL MICROBIOLOGY

9

Primary metabolites; secondary metabolites and their applications; preservation of food; production of penicillin, alcohol, vitamin B-12; biogas; bioremediation; leaching of ores by microorganisms; biofertilizers and biopesticides; microorganisms and pollution control; biosensors

TOTAL: 45 PERIODS

TEXT BOOKS

1. Talaron K, Talaron A, Casita, Pelczar and Reid. Foundations in Microbiology, W.C. Brown Publishers, 1993.
2. Pelczar M.J, Chan ECS and Krein NR, Microbiology, Tata McGraw Hill Edition, New Delhi, India.
3. Prescott L.M., Harley J.P., Klein DA, Microbiology, 3rd Edition, Wm. C. Brown Publishers, 1996.

BT6211

BIOCHEMISTRY LABORATORY

L T P C
0 0 4 2

OBJECTIVES

- To learn and understand the principles behind the qualitative and quantitative estimation of biomolecules (proteins, carbohydrates, lipids, metabolites etc.) and laboratory analysis of the same in the body fluids.

EXPERIMENTS

1. Preparation and measurement of pH of standard buffers (phosphate, carbonate, borate, TRIS etc.).
2. Qualitative analysis of carbohydrates (monosaccharides, disaccharides, polysaccharides etc.)
3. Enzymatic hydrolysis of glycogen by α and β amylase
4. Qualitative analysis of proteins

5. Qualitative analysis of lipids (triglycerides, cholesterol, phospholipids etc.)
6. Quantitative analysis of proteins (Lowry's method, Bradford, UV)
7. Quantitative analysis of carbohydrates (Benedict's method etc.) lipids
8. Quantitative analysis of lipids (Benedict's method etc.)
9. Quantitative estimation of blood glucose
10. Acid hydrolysis and action of salivary amylase on starch
11. Estimation of chloride, glucose, ammonia and creatinine in urine.
12. Quantitative analysis of urea in serum
13. Quantitative analysis of serum bilirubin
14. Quantitative estimation of serum cholesterol by Libermann Burchard's method
15. Isolation and assay of glycogen from the liver and skeletal muscle of mice

TOTAL: 60 PERIODS

Equipment Required

1. UV-Visible Spectrophotometers
2. pH meter
3. Centrifuge

TEXT BOOKS

1. Gupta R.C. and Bhargavan S. Practical Biochemistry.
2. David T. Phummer. Introduction of Practical Biochemistry (II Edition).

REFERENCES

1. Murray R.K., Granner D.K., Mayes P.A. and Rodwell V.W. Harpers Biochemistry, Appleton and Lange, Stanford, Connecticut.
2. Thomas M. Devlin. Textbook of Biochemistry with clinical correlations. Wiley Liss Publishers

BT6212

MICROBIOLOGY LABORATORY

L T P C
0 0 4 2

Experiments

1. Introduction, Laboratory Safety, Use of Equipment; Sterilization Techniques;
2. Culture Media-Types and Use; Preparation of Nutrient broth and agar
3. Culture Techniques. Isolation and Preservation of Cultures- Broth: flask, test tubes; Solid: Pour plates, streak plates, slants, stabs
4. Microscopy – Working and care of Microscope
5. Microscopic Methods in the Study of Microorganisms; Staining Techniques- Simple, Differential- Gram's Staining
6. Quantification of Microbes: Sampling and Serial Dilution; Bacterial count in Soil – TVC
7. Effect of Disinfectants- Phenol Coefficient
8. Antibiotic Sensitivity Assay
9. Growth Curve in Bacteria and Yeast
10. Effect of pH, Temperature, UV radiation on Growth Bacteria

TOTAL: 60 PERIODS

Equipment Needed for 20 Students

Autoclave	1
Hot Air Oven	1
Incubators	2
Light Microscopes	4
Incubator Shaker	1
Colorimeter	2
Lamina Flow Chamber	2
Glassware, Chemicals, Media	as required

REFERENCE BOOKS

1. Cappuccino, J.G. and N. Sherman "Microbiology : A Laboratory Manual", 4th Edition, Addison-Wesley, 1999.
2. Collee, J.G. et al., "Mackie & McCartney Practical Medical Microbiology" 4th Edition, Churchill Livingstone, 1996.

www.enggedu.com