

DEPARTMENT OF MICROBIOLOGY

FACULTY OF ARTS, SCIENCES AND HUMANITIES

UG PROGRAM (CBCS) – B.Sc. Microbiology

(2018–2019 Batch & onwards)

Course code	Name of the course	Objective and outcomes		Instruction hours / week			Credit(s)	Maximum Marks		
		PEOs	POs	L	T	P		CIA	ESE	Total
								40	60	100
SEMESTER-I										
18LSU101	Language – I	VII	e	4	0	0	4	40	60	100
18ENU101	English	VII	e	4	0	0	4	40	60	100
18MBU101	Introduction to Microbiology and Microbial Diversity	I	a	3	1	0	4	40	60	100
18MBU102	Bacteriology	I	g	4	0	0	4	40	60	100
18MBU103	Biochemistry	I	g	4	0	0	4	40	60	100
18MBU111	Basic Microbiology - Practical	VI	b	0	0	3	2	40	60	100
18MBU112	Bacteriology - Practical	VI	b	0	0	3	2	40	60	100
18MBU113	Basic Biochemistry - Practical	VI	b	0	0	4	2	40	60	100
Semester total				19	1	10	26	320	480	800
SEMESTER-II										
18LSU201	Language –II	VII	e	4	0	0	4	40	60	100
18MBU201	Virology	I	g	4	0	0	4	40	60	100
18MBU202	Microbial Physiology and Metabolism	II	g	4	0	0	4	40	60	100
18MBU203	Microbial genetics	IV	g	3	1	0	4	40	60	100
18MBU211	Virology - Practical	VI	b	0	0	3	2	40	60	100
18MBU212	Microbial Physiology and Metabolism - Practical	VI	b	0	0	3	2	40	60	100
18MBU213	Microbial Genetics - Practical	VI	b	0	0	4	2	40	60	100
18AEC201	Environmental Studies	IV	f	4	0	0	4	40	60	100
Semester total				19	1	10	26	320	480	800

Undergraduate Programme – B.Sc Microbiology

Programme Outcomes

Programme Outcomes of UG Microbiology: Students of all undergraduate microbiology degree Programmes at the time of graduation will be able to

- a. Scientific Knowledge: Microbiology majors able to make observations, develop hypotheses, and design and execute experiments using advanced methods. Able to discuss science and scientific methodology. They will have a good knowledge of Intellectual Property Rights.
- b. Laboratory Skills: Microbiology students will master the following laboratory skills: aseptic culture techniques, microscopy, use of appropriate methods to identify microorganisms and to use high laboratory equipments. They are able to practice safe microbiology, using appropriate protective and emergency procedures.
- c. Data analysis skills: Systematically collect, record, and analyze data, identify sources of error, interpret the results, and reach logical conclusions.
- d. Problem-Solving Skills: Microbiology students will be able to analyze and interpret results from a variety of microbiological methods, and apply these methods to analogous situations. Use mathematical and graphing skills and reasoning to solve problems in microbiology.
- e. Communication Skills: Microbiology majors will demonstrate competence in written and oral communication.
- f. Cooperation/Social Responsibility: Microbiology majors able to understand and appreciate the value of cooperating and working effectively with peers and be able to demonstrate a commitment to the process of developing such skills.
- g. Able to understand the importance of microorganisms in various industries such as pharmaceuticals, food, biofertilizers and biopesticides etc, Students will have a major knowledge on concepts of immunology, biotechnology, molecular biology, biochemistry, genetics. Able to explain the beneficial and harmful role of microorganisms in environment.

Programme Specific Outcomes (PSOs)

h. Students will have a major knowledge on concepts of immunology, biotechnology, molecular biology, biochemistry, genetics. Able to explain the beneficial and harmful role of microorganisms in environment. Able to understand the importance of microorganisms in various industries such as pharmaceuticals, food, biofertilizers and biopesticides etc,

i Describe how microorganisms are used as *model systems* to study basic biology, genetics, metabolism and ecology.

j. Identify ways microorganisms play an *integral role* in disease, and microbial and immunological methodologies are used in disease treatment and prevention.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

Programme Educational Objectives of UG Microbiology: The major objectives of the undergraduate course is

PEO-I: To impart knowledge on basic concepts of microbiology. To understand the beneficial and harmful role of microorganisms in the environment.

PEO-II: To understand the fundamentals of physiological reactions including metabolic pathways and biochemical reactions in microorganisms.

PEO-III: To develop human resource and entrepreneurs in Microbiology with the ability to independently start their own ventures or small biotech units in the field of biotechnology.

PEO-IV: Understand modern microbiology - practices and approaches with an emphasis in technology application in pharmaceutical, medical, industrial, environmental and agricultural areas.

PEO-V: Become familiar with public policy, bio-safety, and intellectual property rights issues related to microbiology applications nationally and globally

PEO-VI: Gain experience with standard bioinstrumentations and molecular tools and approaches utilized: manipulate genes, gene products and organisms.

PEO-VII: To demonstrate the written and oral communication skill .To develop the problem solving and data interpretation skills.

POs	a	b	c	d	e	f	g	h	i	j
PEO I	X							X		X
PEO II	X							X	X	
PEO III				X			X	X		
PEO IV				X			X		X	
PEO V	X					X				X
PEO VI		X	X	X						
PEO VII	X		X	X	X					

18LSU101

MIL-1

Semester I
4H-4C

பகுதி - I தமிழ்ப்பாடத்திட்டம் (2018-2019)

Instruction Hours / week: L:4 T:0 P:0

Marks: Internal: 40 External: 60 Total: 100

End Semester Exam: 3 Hours

பருவம் I - தமிழ்முதல்தாள்
(இளநிலைஅறிவியல்பட்டவகுப்புகளுக்குரியது)

அலகு - I :இக்காலஇலக்கியம்: (10 மணிநேரம்)

கல்வி:மகாகவிபாரதியார் - சுயசரிதை - ஆங்கிலக் கல்வி.

இன்றைய நிலை : கவிமணிதேசிகவிநாயகம்பிள்ளை-
ஒற்றுமையேஉயிர்நிலை.

மனிதநேயம் :கவிஞர்சிற்பிபாலசுப்பிரமணியன் -மலையாளக்காற்று.

சூழலியல் :கவிஞர்வைதீஸ்வரன் - விரல்மீட்டியமழை.

பெண்ணியம் :கவிஞர்சுகந்திசுப்பிரமணியம் - புதையுண்டவாழ்க்கை.

அலகு - II :அறஇலக்கியம்: (8 மணிநேரம்)

கொன்றைவேந்தன்: 1-50 பாடல்கள்

திருக்குறள்: பண்புடைமை, வினைத்திட்டம் - 20 குறள்கள்

பழமொழிநானூறு: 5 பாடல்கள்

அலகு - III :சிற்பிலக்கியம்: (8 மணிநேரம்)

மூவருலா: 1-26 கண்ணிகள்

திருச்செந்தூர்முருகன்பிள்ளைத்தமிழ்: 2 பாடல்கள்

கலிங்கத்துப்பரணி: போர்பாடியது - 9 பாடல்கள்

அலகு - IV :கட்டுரை: (8 மணிநேரம்)

1. உயர்தனிச்செம்மொழி-பரிதிமாற்கலைஞர்

2. கட்டிடக்கலை- அ. இராசமாணிக்கனார்

3. வாழ்க்கை - இளவழகனார்

4. ஆளுமைத்திறன்அறிவோம் - ஸ்ரீகண்ணன்

5. மணற்கேணி - நெ.து.சுந்தரவடிவேலு

அலகு- V :மொழிப்பயிற்சி: (6 மணிநேரம்)

1. பொருத்தமானதமிழ்ச்சொற்களைப்பயன்படுத்துதல்

2. செய்யுள்பொருளுணர்திறன்

3. மொழிபெயர்ப்புப்பயிற்சிகள்

4. கடிதங்கள்மற்றும்விண்ணப்பங்கள்எழுதுதல்

பாடநூல்:கற்பகச்சோலை - தமிழ் ஏடு.கற்பகம்பல்கலைக்கழகத்தமிழ்த்துறைவெளியீடு.

18ENU101

ENGLISH -I

Semester – I
4H –4C**Instruction Hours / week: L: 4 T: 0P: 0****Marks: Internal: 40 External: 60 Total:100**
End Semester Exam: 3 Hours**COURE OBJECTIVES**

- To train students to acquire proficiency in English by reading different genres of literature and Learning grammar.
- To provide aesthetic pleasure through literature.

COURSE OUTCOME (CO'S)

1. Communication skills will get developed.
2. Genres of literature will give moral values of life.

UNIT I -PROSE

1. Morals in the Indian Context - Francis Nicholas Chelliah
2. How Comic Books help us to relive our Childhood - Benoit Peeters
3. Let's Do What India Needs From Us -Dr.A.P.J. Abdul Kalam

UNIT II - POEM

1. The Stolen Boat - William Wordsworth
2. Telephone Conversation- Wole Soyinka
3. A River - A.K.Ramanujan

UNIT III - SHORT STORIES

1. Rapunzel - Brothers Grimm
2. The Ant and The Grasshopper- W. Somerset Maugham
3. The Nightingale and the Rose - Oscar Wilde.

UNIT IV-DRAMA

1. The Merchant of Venice- Act 4-Scene 1
2. The Death Trap-Saki

UNIT V- GRAMMAR AND COMPOSITION

GRAMMAR : 1. Tenses
2. Articles
3. Auxiliaries (Primary and Modal)
4. Tag Questions

Composition: 1. Reading to Comprehend
2. Letter Writing
3. Resume Writing
4. General Essay

Prescribed Text: Reminisce, Published by the Department of English, Karpagam Academy of Higher Education.

Suggested Reading: Hewings Martin, 1999 Advanced English Grammar, Cambridge University Press.

COURSE OBJECTIVES

- To provide a strong, fundamental foundation in microorganism for advanced studies in biological sciences, particularly microbiology.

COURSE OUTCOME (CO'S)

1. After completion of this course paper, the students clearly understand the contributions of various scientists for development of microbiology field.
2. This paper also makes the student study the diversity of microbes and their applications.

Unit I- History of microbiology

Development of microbiology as a discipline, spontaneous generation vs biogenesis. Contribution of Anton von Leewenhoek, Golden era of Microbiology Louis Pasteur, Robert Koch, Joseph Lister, Alexander Flemming. Role of microorganism in fermentation, Germ theory of disease, Establishment of fields of medical microbiology and immunology through the work of Paul Ehrlich, Ellie Metchnikoff, Edward Jenner. Microscopy Application in industries, Application in medicine, Application in agriculture, Application in biotechnology, Application in biology.

Unit II- Classification of microorganisms

Bergey's Manual, Binomial Nomenclature and Universal Phylogenetic tree. Classification system: Phenetic and Phylogenetic, Whittaker's Five Kingdom and Carl Woese's three kingdom classification system and their utility. Difference between prokaryotic and eukaryotic microorganism. Major diversity of microbial life. General characteristics of Bacteria, Bacterial ultra structure and Nutrients.

Unit III- Algae

General characteristics of algae including algal cell ultra-structure. Classification of algae- Chlamydomonas, Volvox, Diatoms, red algae and brown algae. Application of Algae in agriculture, industry, environment and food. General characteristics of Actinobacteria.

Unit IV- Fungi

General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultra-structure. Economic importance of fungi. Classification of fungi.

Unit V- Parasites

General characteristics, special references with *Entamoeba histolytica*, *Trichomonas*, *Giardia* and *Plasmodium*. Classification and general properties of viruses.

SUGGESTED READINGS

1. Tortora, G.J., Funke, B.R., and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education.
2. Madigan, M.T., Martinko J.M., Dunlap, P.V., and Clark, D.P. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition.
3. Cappuccino, J., and Sherman, N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited.

4. Wiley, J.M., Sherwood, L.M., and Woolverton, C.J. (2013) Prescott's Microbiology. 9th edition. McGraw Hill International.
5. Atlas, R.M. (1997). Principles of Microbiology. 2nd edition. W.M.T.BrownPublishers.
6. Pelczar, M.J., Chan, E.C.S., and Krieg, N.R. (1993). Microbiology. 5thedition. McGraw Hill Book Company.
7. Stanier, R.Y., Ingraham, J.L., Wheelis, M.L., and Painter, P.R. (2005). General Microbiology. 5thedition.McMillan.8
8. Duby, R.C. (2014) Textbook of Microbiology. 5th edition. S. ChandPublishing.
9. Talaro., Kathleen, P.T., Chess., and Berry, C., (2018). Foundations in Microbiology.(10th Ed).McGraw-Hill Higher Education, UnitedStates.

18MBU102

BACTERIOLOGY

4H – 4C

Instruction Hours / week: L: 4 T: 0P: 0

Marks: Internal: 40 External: 60 Total:100

End Semester Exam: 3 Hours

COURSE OBJECTIVES

- To provide a strong base in the fundamentals of bacteria.
- To learn techniques and methods used in the cultivation and isolation of bacteria.
- To obtain with the knowledge about the habitat and characteristics of prokaryotes in detail.

COURSE OUTCOME (CO'S)

- 1.A candidate undertaking this course gets involved in the identification, classification, and characterization of bacterial species.
2. Completion of this course shall provide an understanding of the concepts of bacteriology which is one of the basic requirements for microbiological research.

Unit I- Structure of bacteria

Cell shape and arrangement, glycocalyx, capsule, flagella, fimbriae and pili. Cell-wall structure and composition of Gram-positive, Gram-negative and archae cell wall. Action of antibiotics and enzymes on the cell wall (sphaeroplasts, protoplasts, and L-forms). Cell Membrane- Structure, function and chemical composition of bacterial and Archaeal cell membranes. Cell organelles. Endospore: Structure, formation, stages of sporulation.

Unit II – Microscopic staining

Staining-principle and types of staining (Simple and Differential). Pure culture technique-microbial preservation- cultivation of anaerobic bacteria.

Unit III- Media and Sterilization

Culture media-types, composition. Sterilization technique-Physical and Chemical methods of microbial control-types and mode of action. Bacterial growth curve-bacterial motility and cell count technique. Calculation of generation time and specific growth rate.

Unit IV- Microbial classification

Aim and principles of classification, systematics and taxonomy, concept of species, taxa, strain; conventional, molecular and recent approaches to polyphasic bacterial taxonomy, evolutionary chronometers, rRNA oligonucleotide sequencing, signature sequences, and protein sequences. Differences between eubacteria and Archaeobacteria.

Unit V- Archae, bacteria and Eubacteria

Archae bacteria and Eubacteria- General characteristics, Classification (Overview), metabolism and ecological significance. Gram Positive and Gram Negative (Low G+C and High G+C)-General characteristics with suitable examples. Cyanobacteria: An Introduction.

SUGGESTED READINGS

1. Pelczar, J.r M.J., Chan, ECS., and Krieg, N.R. (2004). Microbiology. 5th edition. Tata McGrawHill.
2. Willey, J.M., Sherwood, L.M., and Woolverton, C.J. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.
3. Madigan, M.T., and Martinko, J.M. (2014). Brock Biology of Micro-organisms. 14th edition. Parker J. Prentice Hall International, Inc.

4. Tortora, G.J., Funke, B.R., and Case, C.L. (2008). *Microbiology: An Introduction*. 9th edition. Pearson Education.
5. Black, J.G. (2008). *Microbiology: Principles and Explorations*. 7th edition. PrenticeHall
6. Stanier, R.Y., Ingraham, J.L., Wheelis, M.L., and Painter, P.R. (2005). *General Microbiology*. 5th edition. McMillan.
7. Atlas, R.M. (1997). *Principles of Microbiology*. 2nd edition. W.M.T. Brown Publishers.
8. Cappuccino, J., and Sherman, N. (2010). *Microbiology: A Laboratory Manual*. 9th edition. Pearson Education Limited
9. Srivastava, S., and Srivastava, P.S. (2003). *Understanding Bacteria*. Kluwer Academic Publishers, Dordrecht.

18MBU103

BIOCHEMISTRY

Semester – I
(4H – 4C)

Instruction Hours / week: L: 4 T: 0P:0

Marks:Internal:40

External: 60 Total:100

End Semester Exam: 3 Hours

COURSE OBJECTIVES

- • **To provide the basics of biochemistry and its applications.**
- It serves as a good research techniques and the ability to combine and analyze information.

COURSE OUTCOME (CO'S)

1. A candidate able to understand structures and functions of enzymes, proteins, carbohydrates, fats, process of metabolism.
2. This course will provide clear understanding of Nucleic acid.

Unit I- Basics of Chemistry

Atoms and molecules, cell structure, cell organelles, developing membrane structure, transport of molecules, Beer and Lambert's Law, Colorimeter, Anabolism and catabolism and standard for energy change.

Unit II- Carbohydrates

Monosaccharides-families, stereo isomerism, epimers, Mutarotation and anomers. Forms of glucose and fructose, Fischer and Haworth projection. Sugar derivatives. Disaccharides- occurrence, concept of reducing and non-reducing sugars and Haworth projections. Polysaccharides-storage and structural polysaccharides.

Unit III- Lipids

Classification and functions of lipids. Storage lipids- structure and function of fatty acids. Triacylglycerols. Saponification. Structural lipids- structure, functions and properties of phosphoglycerides and sphingolipids.

Unit IV- Proteins

Classification and functions of proteins and amino acids, Structure of amino acids and concept of zwitterion. Ninhydrin reaction. Natural modifications of amino acids in proteins. Non protein amino acids, Oligopeptides: Structure and functions of glutathione, insulin and aspartame. Primary and Secondary structure of proteins- alpha helix, beta pleated sheet. Tertiary and quaternary structures of proteins. Human haemoglobin structure.

Structure and classification of enzymes, mechanism of action of enzymes. Km equation and enzyme activity. Allosteric enzyme and its mechanism. Multienzyme complex. Enzyme inhibition. Vitamins- classification and characteristics, sources and importance.

Unit V- Nucleic Acids

Nucleic Acids-Purines & Pyrimidines nucleotides, RNA, & DNA base pairing schemes, types of RNA: mRNA, rRNA, tRNA, aminoacyl tRNA synthetase, Secondary structure of DNA, Watson and Crick model. Denaturation of DNA keto-enol tautomerism and consequences.

SUGGESTED READINGS

1. Campbell, M.K. (2012) Biochemistry, 7th edition. Published by CengageLearning.
2. Campbell, P.N., and Smith, A.D., (2011) Biochemistry Illustrated, 4th edition. Published by ChurchillLivingstone.
3. Tymoczko, J.L., Berg, J.M., and Stryer, L. (2012) Biochemistry: A short course, 2nd edition. W.H.Freeman.
4. Berg, J.M., Tymoczko, J.L., and Stryer, L. (2011) Biochemistry, W.H.Freeman and Company.
Nelson, D.L and Cox, M.M. (2008) Lehninger Principles of Biochemistry, 5th edition. W.H. Freeman andCompany.
5. Willey, M.J., Sherwood, L.M., &Woolverton, C. J. (2013) Prescott, Harley and Klein's Microbiology. 9th edition. McGrawHill.

18MBU111

BASIC MICROBIOLOGY-PRACTICAL

Semester – I
(3H –2C)

Instruction Hours / week: L: 0 T: 0P: 3

Marks: Internal: 40 External: 60 Total:100

End Semester Exam: 3 Hours

COURSE OBJECTIVES

To develop skills related to

- Isolation and culture techniques of bacteria
- The external feature of bacteria and colony characteristics.
- Various staining techniques

COURSE OUTCOME (CO'S)

1. This practical paper will give those hands on experience in handling of various important instruments.
2. They also will develop knowledge on preparing permanent temporary mounts for fungi, protozoans and algae.

EXPERIMENTS

1. Microbiology Good Laboratory Practices and Biosafety.
2. To study the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, microscope, pH meter) used in the microbiology laboratory.
3. Preparation of culture media for bacterial cultivation.
4. Sterilization of heat sensitive material by membrane filtration and assessment for sterility.
5. Demonstration of the presence of micro flora in the environment by exposing nutrient agar plates to air.
6. Temporary mounts Lacto phenol cotton blue mount – *Rhizopus*, *Penicillium*, *Aspergillus*.
7. Study of *Spirogyra* and *Chlamydomonas*, *Volvox* using temporary mounts.
8. Study of the following protozoans using permanent mounts/photographs: *Amoeba*, *Entamoeba*, *Paramecium* and *Plasmodium*

SUGGESTED READINGS

1. Tortora, G.J., Funke, B.R, and Case, C.L. (2008). Microbiology: An Introduction. 9th edition. Pearson Education.
2. Madigan, M.T., Martinko, J.M., Dunlap, P.V., and Clark, D.P. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International edition.
3. Cappucino, J., and Sherman, N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited.
4. Wiley, J.M., Sherwood, L.M., and Woolverton, C.J. (2013) Prescott's Microbiology. 9th edition. McGraw Hill International.
5. Atlas, R.M. (1997). Principles of Microbiology. 2nd edition. W.M.T. Brown Publishers.
6. Pelczar, M.J., Chan, ECS., and Krieg, N.R. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
7. Stanier, R. Y., Ingraham, J.L., Wheelis, M.L., and Painter, P.R., (2005). General Microbiology. 5th edition. McMillan.

18MBU112

BACTERIOLOGY-PRACTICAL

Semester – I
(3H – 2C)

Instruction Hours / week: L: 0 T: 0P: 3

Marks: Internal: 40 External: 60 Total:100

End Semester Exam: 3 Hours

COURSE OBJECTIVES

To develop skills related to

- Isolation and culture techniques of bacteria
- The external feature of bacteria and colony
- characteristics. Various staining techniques.

COURSE OUTCOME (CO'S)

1. Students undertaking this course shall have a broad knowledge on different staining techniques and the structure of bacteria.
2. This practical enable the students to know about morphology and cultivation of bacteria.

EXPERIMENTS

1. Preparation of different media: synthetic media BG-11, Complex media - Nutrient agar, McConkey agar, EMB agar.
2. Micrometry.
3. Motility by hanging drop method.
4. Simple staining
5. Negative staining
6. Gram's staining
7. Acid fast staining – demonstration permanent slide only.
8. Capsule staining
9. Endospore staining.
10. Isolation of pure cultures of bacteria by streaking method - Quadrant, Continuous and T-streaking.
11. Preservation of bacterial cultures by various techniques - Agar slants and deeps - Mineral Oil, Glycerol stocks
12. Estimation of Colony Forming Unit (CFU) count by spread plate method/pour plate method.

SUGGESTED READINGS

1. Pelczar Jr, M.J., Chan, ECS., and Krieg, N.R. (2004). Microbiology. 5th edition. Tata McGraw Hill.
2. Willey, J.M., Sherwood, L.M., and Woolverton, C.J. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.
3. Madigan, M.T., and Martinko, J.M. (2014). Brock Biology of Micro-organisms. 14th edition. Parker J. Prentice Hall International, Inc.
4. Tortora, G.J., Funke, B.R., and Case, C.L. (2008). Microbiology: An Introduction. 9th edition. Pearson Education.
5. Black, J.G. (2008). Microbiology: Principles and Explorations. 7th edition. Prentice Hall
6. Stanier, R.Y., Ingraham, J.L., Wheelis, M.L., and Painter, P.R. (2005). General Microbiology. 5th edition. McMillan.
7. Atlas, R.M. (1997). Principles of Microbiology. 2nd edition. W.M.T. Brown Publishers.
8. Cappuccino, J., and Sherman, N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited
9. Srivastava, S., and Srivastava, P.S. (2003). Understanding Bacteria. Kluwer Academic Publishers, Dordrecht.

18MBU113

BASIC BIOCHEMISTRY-PRACTICAL

Semester – I
(4H –2C)

Instruction Hours / week: L: 0 T: 0P:4

Marks: Internal: 40 External: 60 Total:100

End Semester Exam: 3 Hours

COURSE OBJECTIVE

- To familiarize the students with the basic cellular processes at molecular level
- To make students familiar with practical techniques used for studying biochemical structure and analysis of biochemical methods.

COURSE OUTCOME

1. Students will get practical knowledge about various techniques used in Biochemistry.

EXPERIMENTS

1. Properties of water, concept of pH and buffers, preparation of buffers and numerical problems to explain the concepts.
2. Numerical problems on calculations of standard free energy change and equilibrium constant.
3. Standard free energy change of coupled reactions.
4. Qualitative/Quantitative tests for carbohydrates, reducing sugars, and non-reducing sugars.
5. Qualitative/Quantitative tests for lipids and proteins.
6. Study of protein secondary and tertiary structures with the help of models.
7. Study of enzyme kinetics – calculation of V_{max} , K_m , K_{cat} values.
8. Study effect of temperature, pH and heavy metal on enzyme activity.
9. Estimation of any one vitamin.

SUGGESTED READING

1. Campbell, M.K. (2012) Biochemistry, 7th edition. Published by Cengage Learning.
2. Campbell, P.N., and Smith, A.D. (2011) Biochemistry Illustrated, 4th edition. Published by Churchill Livingstone.
3. Tymoczko, J.L., Berg, J.M., and Stryer, L. (2012) Biochemistry: A short course, 2nd edition. W.H. Freeman
4. Berg, J.M., Tymoczko, J.L., and Stryer, L. (2011) Biochemistry, W.H. Freeman and Company.
5. Nelson, D.L., and Cox, M.M. (2008) Lehninger Principles of Biochemistry, 5th Edition. W.H. Freeman and Company.
6. Willey, M.J., Herwood, L.M. & Woolverton, C.J. (2013) Prescott, Harley and Klein's Microbiology 9th Edition. McGraw Hill
7. Voet, D., and Voet, J.G. (2004) Biochemistry 3rd edition, John Wiley and Sons.

18LSU201

MIL-2

Semester II
4H-4C

பகுதி - I தமிழ்ப்பாடத்திட்டம் (2018 - 2019)

Instruction hours per week: L:4 T:0 P:0

Marks: Internal: 40 External: 60 Total: 100

End Semester Exam: 3 Hours

பகுதி - I, தமிழ்

பருவம் II

தமிழ்இரண்டாம்தாள்

(இளநிலைஅறிவியல்பட்டவகுப்புகளுக்குரியது)

அலகு - I :பக்திஇலக்கியம்

(10 மணிநேரம்)

சைவ, வைணவஇலக்கியங்கள் - தோற்றம் ,வளர்ச்சி, வரலாறு.

1. சைவம் -பெரியபுராணம் - திருமூலநாயனார்புராணம்.

2.வைணவம் - பெரியாழ்வார்திருமொழி: 10 பாடல்கள்.

அலகு - II :சங்கஇலக்கியம் :

(15 மணிநேரம்)

சங்கஇலக்கியங்கள்அறிமுகம்

அ).எட்டுத்தொகை

நற்றிணை : பிரசம்கலந்த - பாலை -110

குறுந்தொகை : கருங்கட்டாக்கலை - குறிஞ்சி- 69

ஐங்குறுநூறு :நெய்தல்-தொண்டிப்பத்து:

திரைஇமிழ் இன்னிசை-171

பதிற்றுப்பத்து : சிதைந்ததுமன்ற - 27

பரிபாடல்: பரிபாடல்திரட்டு-மதுரைநகர்ச்சிறப்பு -

உலகம்ஒரு நிறையாத்தான்-6, மாயோன் கொப்பூழ்-7, செய்யாட்கு இழைத்த-9, கார்த்திகை

காதில்-10, ஈவாரைக் கொண்டாடி-11.

கலித்தொகை:சுடர்தொடிகேளாய்: குறிஞ்சிக்கலி- 36

அகநானூறு:அன்னாய்வாழிவேண்டன்னை - குறிஞ்சி - 48

புறநானூறு :யாதும்ஊரேயாவருங்கேளிர் -பொதுவியல்- 192

ஆ). பத்துப்பாட்டு

திருமுருகாற்றுப்படை -பழமுதிர்ச்சோலையின்சிறப்பு

முருகன்இருப்பிடங்கள் - 'சிறுதினைமலரொடு' என்பதிலிருந்துதொடங்கி,

'அறிந்தவாறே' என்பதுவரையிலானதொடர்கள்: 218-249.

முருகன்அருள்புரிதல் - 'தெய்வம்சான்ற' என்பதிலிருந்துதொடங்கி, 'நல்குமதி'

என்பதுவரையிலானதொடர்கள்: 286-295.

அலகு - III :காப்பியம்

(6 மணிநேரம்)

சிலப்பதிகாரம்:

மங்கலவாழ்த்துப்பாடல்: (21-29) – கண்ணகியின்சிறப்பு:

‘நாகநீள்நகரொடு’ என்பதிலிருந்துதொடங்கி,

‘கண்ணகிஎன்பாண்மன்னோ’ என்பதுவரையிலானதொடர்கள்.

நடுகற்காதை: (207-234)- சேரன்செங்குட்டுவன்கண்ணகிக்குக்கோயில்எடுத்தல்: ‘அருந்திறலரசர்’

என்பதிலிருந்துதொடங்கி, ‘மன்னவரேறென்’ என்பதுவரையிலானதொடர்கள்.

வாழ்த்துக்காதை: (482-485)- செங்குட்டுவனுக்குக்கண்ணகிகாட்சியளித்தல்: ‘என்னே’

என்பதிலிருந்துதொடங்கி, ‘விசும்பில்தோன்றுமால்’ என்பதுவரையிலானதொடர்கள்.

வழக்குரைகாதை:பத்தினிப்பெண்டிர்எழுவர்கதை: ‘நீர்வார்கண்ணை’

என்பதிலிருந்துதொடங்கி, ‘புகாரென்பதியே’ என்பதுவரையிலானதொடர்கள்.

வஞ்சினமாலை: ‘வன்னிமரமும்’

என்பதிலிருந்துதொடங்கி,

‘பதிப்பிறந்தேன்’

என்பதுவரையிலானதொடர்கள்.

அலகு – IV :சிறுகதை

(10 மணிநேரம்)

1. குளத்தங்கரைஅரசமரம் – வ.வே.சு.ஐயர்

2. காட்டில்ஒருமான் - அம்பை

3. நாற்காலி – கி.ராஜநாராயணன்

4. நகரம் – சுஜாதா

அலகு- V :மொழிப்பயிற்சி

(7 மணிநேரம்)

படைப்பிலக்கியப் பயிற்சிகள் (கதை, கவிதை, கட்டுரை, உரைநடை)

மொழிபெயர்ப்பு

பாடநூல்:கற்பகச்சோலை – தமிழ்எடு.கற்பகம்பல்கலைக்கழகத்தமிழ்த்துறை வெளியீடு.

18MBU201

VIROLOGY

Semester – II
(4H –4C)

Instruction Hours / week: L: 4 T: 0P: 0

Marks: Internal: 40 External: 60 Total:100

End Semester Exam: 3 Hours

COURSE OBJECTIVES

- To study general aspects of viral morphology and classification, replication, interactions and immunity to viruses
- To discuss the application of various immunological and molecular diagnostic tools.

COURSE OUTCOME (CO'S)

1. This paper will have clear understanding the role of various in plant, animal and human disease
2. Candidate able to understand their various mechanisms to enter and escape from host.

Unit I- History of viruses

History of viruses. Structure, Classification, nomenclature of viruses. Isolation, purification and cultivation of viruses. Viral assay. Concept of viroids, virusoids, satellite viruses, Virophage and Prions.

Unit II- Bacteriophages

Diversity, classification, one step multiplication curve, lytic and lysogenic phages (lambda phage) concept of early and late proteins, regulation of transcription in lambda phage

Unit III- Transmission of virus

Modes of viral transmission, Salient features of viral Nucleic acid-unusual bases, overlapping genes, splicing genes, terminal redundancy, cohesive ends, capping and tailing. Viral genome Organisation.

Unit IV- Viral multiplication and replication

Viral multiplication and replication-Interaction, and entry, assembly, maturation and release of virions. Oncogenic viruses and its types, mechanism. Viral replication strategies as per Baltimore classification. Prevention and control of viral diseases.

Unit V- Antiviral compounds

Antiviral compounds and their mode of action. Interferon and their mode of action. General principles of viral vaccination. Immunization schedule. Use of viral vectors in cloning and expression, gene therapy and phage display.

SUGGESTED READINGS

1. Dimmock, N.J., Easton, A.L., Leppard, K.N. (2007). Introduction to Modern Virology. 6th edition, Blackwell Publishing Ltd.
2. Carte, J., and Saunders, V. (2007). Virology: Principles and Applications. John Wiley and Sons.
3. Flint, S.J., Enquist, L.W., Krug, R.M., Racaniello, V.R., Skalka, A.M. (2004). Principles of Virology, Molecular biology, Pathogenesis and Control. 2nd edition. ASM press Washington DC.
4. Levy, J.A., Conrat, H.F., Owens, R.A. (2000). Virology. 3rd edition. Prentice Hall publication, New Jersey.
5. Wagner, E.K., Hewlett, M.J. (2004). Basic Virology. 2nd edition. Blackwell Publishing.
6. Mathews. (2004). Plant Virology. Hull R. Academic Press, New York.
7. Nayud, M.V. (2008). Plant Viruses. Tata McGraw Hill, India.
8. Bos, L. (1999) Plant viruses-A text book of plant virology by. Backhuys Publishers.

18MBU202 MICROBIAL PHYSIOLOGY AND METABOLISM**Semester – II
(4H – 4C)****Instruction Hours / week: L: 4 T: 0P: 0****Marks: Internal: 40 External: 60 Total: 100****End Semester Exam: 3 Hours****COURSE OBJECTIVES**

- It Gives brief description on the microbial metabolism and its energetics
- It deals with the various aerobic and anaerobic processes through which the organisms obtain and utilize the energy for their growth.
- Explains photosynthesis and photosynthetic bacteria.

COURSE OUTCOME (CO'S)

1. The students will be able to understand and predict the various metabolic reactions in microbial cell.
2. This will make them predict the intermediate products which can be employed in industrial production processes.

Unit I- Microbial nutrition

Microbial nutrition – nutrient requirements, Nutritional groups of microorganisms. Uptake of nutrients by cell – Passive, Facilitated diffusion, Active transport, Group translocation and Iron uptake.

Unit II- Microbial growth

Different phases of growth curve - generation time. Measurement of microbial growth. Batch, Continuous and Synchronous culture, Diauxic growth, Influence of environmental factors on growth (Temperature, pH, solute, water activity, oxygen and pressure).

Unit III- Carbohydrate metabolism

Carbohydrate metabolism – EMP, ED, Pentose phosphate pathway, TCA cycle, Aerobic respiration, oxidative phosphorylation, electron transport chain (Prokaryotic and Eukaryotic), substrate level phosphorylation. Anaerobic respiration. Uncouplers and inhibitors.

Unit IV- Anaerobic respiration

Anaerobic respiration with special reference to dissimilatory nitrate reduction (Denitrification; nitrate/nitrite and nitrate/ammonia respiration; fermentative nitrate reduction). Fermentation - Alcohol fermentation and Pasteur effect; Lactate fermentation (homofermentative and heterofermentative pathways), concept of linear and branched fermentation pathways

Unit V- Cyanobacteria

Photosynthesis – bacteria and cyanobacteria, photosynthetic pigments – oxygenic (cyanobacterial) and Anoxygenic (Purple, green bacteria) photosynthesis. Nitrogen metabolism-overview of nitrogen cycle.

SUGGESTED READINGS

1. Madigan, M.T., and Martinko, J.M. (2014). Brock Biology of Microorganisms. 14th edition. Prentice Hall International Inc.
2. Talaro., Kathleen, P.T., Chess., and Berry, C., (2018). Foundations in Microbiology. (10th Ed). McGraw Hill Higher Education.

3. Moat, A.G., and Foster, J.W. (2002). Microbial Physiology. 4th edition. John Wiley & Sons.
4. Reddy, S.R., and Reddy, M. (2005). Microbial Physiology. Scientific PublishersIndia.
5. Gottschalk, G. (1986). Bacterial Metabolism. 2nd edition. SpringerVerlag.
6. Stanier, R.Y., Ingrahm, J.I., Wheelis, M.L., and Painter, P.R. (1987). General Microbiology. 5th edition, McMillan Press.
7. Willey, J.M., Sherwood, L.M., and Woolverton, C.J. (2013). Prescott's Microbiology. 9th edition. McGraw Hill HigherEducation.

18MBU203

MICROBIAL GENETICS

Semester – II
(4H –4C)

Instruction Hours / week: L: 3 T: 1 P: 0

Marks: Internal: 40 External: 60 Total:100

End Semester Exam: 3 Hours

COURSE OBJECTIVES

- To focus on the basic principles of genetics incorporating the concepts of classical, molecular and population genetics.
- Compilation is required for recent advances in genetic principles for strong foundation in Biotechnology.

COURSE OUTCOME (CO'S)

1. This course provided candidates with basic knowledge and understanding of Molecular Biology with special reference to microbial genome.
2. Students undertaking this course will be able to describe the nature of molecular world and its application in modern Microbiological sectors.

Unit I- History of genetics

Concept of Genetics, Mendelian principles, DNA as a genetic material, Experimental evidence – Chromosomal theory of inheritance. DNA structure, models of DNA, DNA replication, transcription, translation, RNA structure and types.

Unit II- Plasmids

Types of plasmids- replication, partitioning, host range, plasmid-incompatibility, amplification, curing and application.

Unit III- Genetic code

Genetic code- Operon concept-Lactose, tryptophan. Genetic recombination in bacteria- Conjugation, Transformation-Transduction and its types. Gene Mapping techniques-gene and chromosome walking.

Unit IV- Mutations

Mutations and mutagenesis, types of mutations and mutagens. Identification of mutants- Ames test.

Unit V- Transposons

Transposons-definition, types of Transposons, mechanism of transposition and application. Mu transposon and eukaryotic transposable elements. Applications.

SUGGESTED READINGS

1. Klug, W.S., Cummings, M.R., Spencer, C., Palladino, M. (2011). Concepts of Genetics, 10th edition, Benjamin Cummings.
2. Krebs, J., Goldstein, E., Kilpatrick, S. (2013). Lewin's Essential Genes, 3rd edition, Jones and Bartlett Learning.
3. Pierce, B.A. (2011) Genetics: A Conceptual Approach, 4th edition, Macmillan Higher Education Learning.
4. Watson, J.D., Baker, T.A., Bell, S.P., et al. (2008) Molecular Biology of the Gene, 6th edition, Benjamin Cummings.
5. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). Principles of Genetics. 8th edition, Wiley-India.
6. Russell, P.J. (2009). *iGenetics- A Molecular Approach*. 3rd edition, Benjamin Cummings.
7. Sambrook, J., and Russell, D.W. (2001). Molecular Cloning: A Laboratory Manual. 4th edition, Cold Spring Harbour Laboratory press.
8. Maloy, S.R, Cronan, J.E., and Friefelder, D. (2004) Microbial Genetics 2nd edition, Jones and Barlett Publishers.

18MBU211

VIROLOGY–PRACTICAL**Semester – II
(3H –2C)****Instruction Hours / week: L: 0 T: 0P:3****Marks: Internal:40****External: 60 Total:100****End Semester Exam: 6 Hours****COURSE OBJECTIVES**

- To study general aspects of viral morphology and classification.
- Cultivation of viruses and various methods of propagation.
- To discuss the application of various immunological and molecular diagnostic tools.

COURSE OUTCOME (CO'S)

1. Upon paper completion, students will have knowledge on structure of plants, animal, bacteria and viruses.
2. This paper also enables the student on isolation, propagation of various viruses.

EXPERIMENTS

1. Study of the structure of important animal viruses (rhabdo, influenza, paramyxo hepatitis B and retroviruses) using electron micrographs –Demonstration.
2. Study of the structure of important plant viruses (caulimo, Gemini, tobacco ring spot, cucumber mosaic and alpha-alpha mosaic viruses) using electron micrographs –Demonstration.
3. Study of the structure of important bacterial viruses (ϕ X174, T4, λ) using electron micrograph – Demonstration.
4. Isolation and enumeration of bacteriophages (PFU) from water/sewage sample using double agar layer technique
5. Studying isolation and propagation of animal viruses by chick embryo technique
6. Study of cytopathic effects of viruses using photographs
7. Perform local lesion technique for assaying plant viruses.

SUGGESTED READING

1. Dimmock, N.J., Easton, A.L., Leppard, K.N. (2007). Introduction to Modern Virology. 6th edition, Blackwell Publishing Ltd.
2. Carter, J., and Saunders, V. (2007). Virology: Principles and Applications. John Wiley and Sons.
3. Flint, S.J., Enquist, L.W., Krug, R.M., Racaniello, V.R., Skalka, A.M. (2004). Principles of Virology, Molecular biology, Pathogenesis and Control. 2nd edition. ASM press Washington DC.
4. Levy, J.A., Conrat, H.F., Owens, R.A. (2000). Virology. 3rd edition. Prentice Hall publication, New Jersey.
5. Wagner, E.K., Hewlett, M.J. (2004). Basic Virology. 2nd edition. Blackwell Publishing.
6. Mathews. (2004). Plant Virology. Hull R. Academic Press, New York.
7. Nayudu, M.V. (2008). Plant Viruses. Tata McGraw Hill, India.
8. Bos, L. (1999) Plant viruses-A text book of plant virology by. Backhuys Publishers.
9. Versteeg, J. (1985). A Color Atlas of Virology. Wolfe Medical Publication.

18MBU212 MICROBIAL PHYSIOLOGY AND METABOLISM–PRACTICAL Semester – II
(3H –2C)**Instruction Hours / week: L: 0 T: 0P: 3****Marks: Internal: 40 External: 60 Total:100****End Semester Exam: 6 Hours****COURSE OBJECTIVES**

- To enhance the students knowledge on various aspects of microbial physiology like growth, extremophiles studies and chemical characterization of microbes.

COURSE OUTCOME

1. The students will understand the growth curve and various factors for optimal growth of *E.coli*.

EXPERIMENTS

1. Study and plot the growth curve of *E. coli* by turbidometric and standard plate count methods.
2. Calculations of generation time and specific growth rate of bacteria from the graph plotted with the given data
3. Effect of temperature on growth of *E.coli*
4. Effect of pH on growth of *E.coli*
5. Effect of carbon and nitrogen sources on growth of *E.coli*
6. Effect of salt on growth of *E.coli*
7. Demonstration of alcoholic fermentation
8. Demonstration of the thermal death time and decimal reduction time of *E.coli*.

SUGGESTED READINGS

1. Madigan, M.T., and Martinko, J.M. (2014). Brock Biology of Microorganisms. 14th edition. Prentice Hall International Inc.
2. Moat, A.G., and Foster, J.W. (2002). Microbial Physiology. 4th edition. John Wiley & Sons
3. Reddy, S.R., and Reddy, S.M. (2005). Microbial Physiology. Scientific Publishers India
4. Stanier, R.Y, Ingrahm, J.I., Wheelis, M.L., and Painter, P.R. (1987). General Microbiology. 5th edition, McMillan Press.
5. Willey, J.M., Sherwood, L.M., and Woolverton, C.J. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.

18MBU213

MICROBIAL GENETICS- PRACTICAL

Semester – II
(4H –2C)

Instruction Hours / week: L: 0 T: 0P:4

Marks: Internal: 40 External: 60 Total:100

End Semester Exam: 6Hours

COURSE OBJECTIVES

- To focus on the basic principles of Genetics incorporating the concepts of classical, molecular and population genetics.
- Compilation is required for recent advances in genetic principles for strong foundation in Biotechnology.

COURSE OUTCOME (CO'S)

1. Students undertaking this practical shall be able to describe the steps involved in the basic Microbial Genetics
2. Effectively understand the implication of mutation and its characteristics.
3. Further, the experiments would allow students to recall and relate the information gained from Microbial Genetics theory paper.

EXPERIMENTS

1. Preparation of Master and Replica Plates.
2. Study the effect of chemical (HNO₂) and physical (UV) mutagens on bacterial cells.
3. Study survival curve of bacteria after exposure to ultraviolet (UV) light.
4. Isolation of Plasmid DNA from *E.coli*.
5. Estimation of DNA
6. Study different conformations of plasmid DNA through Agarose gelelectrophoresis.
7. Demonstration of Bacterial Conjugation.
8. Demonstration of bacterial transformation and transduction.
9. Demonstration of AMEStest.

SUGGESTED READINGS

1. Klug, W.S., Cummings, M.R., Spencer, C., Palladino, M. (2011). Concepts of Genetics, 10th edition, Benjamin Cummings
2. Krebs, J., Goldstein, E., Kilpatrick, S. (2013). Lewin's Essential Genes, 3rd edition, Jones and Bartlett Learning.
3. Pierce, B.A. (2011) Genetics: A Conceptual Approach, 4th edition, Macmillan Higher Education Learning.
4. Watson, J.D., Baker, T.A., Bell, S.P., et al. (2008) Molecular Biology of the Gene, 6th edition, Benjamin Cummings.
5. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). Principles of Genetics. 8th edition, Wiley-India.
6. Sambrook, J., and Russell, D.W. (2001). Molecular Cloning: A Laboratory Manual. 4th edition, Cold Spring Harbour Laboratory press.
7. Maloy, S.R., Cronan, J.E., and Friefelder, D. (2004) Microbial Genetics 2nd edition, Jones and Barlett Publishers.
8. Peter J. Russell, i Genetics – A molecular approach, 7th edition, 2010. Pearson Benjamin Cummings Publishers, Boston, USA.
9. David Friefelder, Microbial Genetics. Narosa Publishing House, 10th edition, 2004. New Delhi, India.

18AEC201

ENVIRONMENTALSTUDIES

Semester – II
(4H –4C)

Instruction Hours / week: L: 4 T: 0P: 0

Marks: Internal: 40 External: 60 Total:100

End Semester Exam: 3Hours

COURSE OBJECTIVES

- Creating the awareness about environmental problems among people.
- Developing an attitude of concern for the environment.
- Motivating public to participate in environment protection and improvement.

COURSE OUTCOME

1. The study creates awareness among the students to know about various renewable and nonrenewable resources of the region, enables environmentally literate citizens (by knowing the environmental acts, rights, rules, legislation, etc.) to make appropriate judgments and decisions for the protection and improvement of the earth.

Unit I- Ecosystem

Environment Definition, scope and importance, components, Ecosystem Definition, Concept, Scope, importance, Structure and functions of ecosystem. Energy flow, Ecological succession Food chains and food webs. Classification of ecosystem.

Unit II- Natural Resources

Natural Resources - Renewable and Non-renewable Resources: Natural resources and associated problems. Forest resources, Water resources, Mineral resources, Food resources, Energy resources, Land resources : Use and over-utilization, exploitation. Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles. III-effects of fireworks.

Unit III- Biodiversity and Its Conservation

Biodiversity and Its Conservation: Introduction, definition: genetic, species and ecosystem diversity. Biogeographical classification of India. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity at global, National and local levels. India as a mega-diversity nation. Hot-spots of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemic species of India. Conservation of biodiversity: in-situ and ex-situ conservation of biodiversity.

Unit IV- Environmental Pollution

Environmental Pollution - Definition, Causes, effects and control measures of Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards, Solid waste management: Causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution. Pollution case studies. Disaster management: Floods, earthquake, cyclone and landslides.

Unit V- Social Issues and the Environment

Social Issues and the Environment: From unsustainable to sustainable development. Urban problems related to energy. Water conservation, rain water harvesting, watershed management. Resettlement and rehabilitation of people; its problems and concerns. Environmental ethics: Issues and possible solutions. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case studies. Wasteland reclamation. Consumerism and waste products. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and Control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Issues involved in enforcement of environmental legislation. Public awareness. Population growth, variation among nations. Population explosion—Family Welfare Programme. Environment and human health. Human rights. Value education. HIV/AIDS. Women and Child Welfare. Role of Information Technology in environment and human health.

SUGGESTED READINGS

1. Singh, M.P., Singh, B.S., and Dey, S.S., (2004). Conservation of Biodiversity and Natural Resources. Daya Publishing House, Delhi.
2. Botkin, D.B., and Keller, E.A., (1995). Environmental Science, John Wiley and Sons, Inc., New York.
3. Uberoi, N.K., (2005). Environmental Studies, Excel Books Publications, New Delhi, India.
4. Tripathy, S.N., and Panda, S., (2004). Fundamentals of Environmental Studies; 2nd Edition, Vrianda Publications Private Ltd., New Delhi.
5. Kumar, A., (2004). A Textbook of Environmental Science; APH Publishing Corporation, New Delhi.
6. Verma, P.S., Agarwal, V.K., (2001). Environmental Biology (Principles of Ecology); S.Chand and Company Ltd., New Delhi.
7. Kaushik, A., Kaushik, C.P., (2004). Perspectives in Environmental Studies, New Age International Pvt. Ltd. Publications, New Delhi.

