SEMESTER-III			
Core-IX- Industrial and Pharmaceutical Microbiology			
Course Code:21PMIC31	**Hrs/Week:5**	**Hrs/Sem:75**	**Credits:4**

Objectives:

1. To impart the professional ability and skill by increasing the global knowledge, Understanding and application in Industrial and Pharmaceutical Microbiology.
2. To empower the learners to address current and future challenges faced by the humanity using Industrial and Pharmaceutical Microbiology.

Course outcome:

CO No	Upon completion of this course, students will be able to	PSO addressed	CL
CO -1	revise the idea about the usage of microorganisms in the field of industrial microbiology	3	An
CO -2	analyse the knowledge of various industrial and pharmaceutical products and its impacts on the society.	4	Un
CO -3	knowledgeable in industrial fermentation	3	Un
CO -4	have an insight on industrial microbiological techniques	2	Re
CO -5	understands in the field of pharmaceutical microbiology	1	Un
CO-6	Knowledge of basics and applied microbiological aspects of industries.	1	Un
CO-7	acquire the knowledge about production of various industrial and pharmaceutical products	4,5	Un
CO-8	know the detail knowledge about antibiotics and production of hormones	2,3,4	Un, Ap

SEMESTER-III			
Core-IX- Industrial and Pharmaceutical Microbiology			
Course Code: 21PMIC31	**Hrs/Week:5**	**Hrs/Sem:75**	**Credits:4**

Unit-I- Basics of Industrial Microbiology

Historical account of microbes in industrial Microbiology; Screening, isolation, preservation and improvement of industrially important microorganisms; Strain improvement; Fermenter - principles and design - types of Fermenter, Instrumentation and control- aeration and agitation. Raw materials and media formulation for fermentation processes; Industrial Sterilization; Microbial growth kinetics in Batch, Continuous and Fed batch fermentation. Downstream processing.

Unit-II- Microbial products

Microbial production of industrially important products: Solvents (Alcohol and Acetone); Aminoacids (Glutamic acid and Lysine); Organic acids (Citric acid and Acetic acid); Enzymes (Microbial rennet, Amylase, Protease); Biopolymers (Xanthan gum and PHB); Biopreservatives (Nisin); Antibiotics - (Penicillin, Cephalosporin and Streptomycin); Vitamins (Riboflavin and Cyanocobalamin); Production of Hormones (Auxins and Gibberellins). Production of protein in bacteria and yeast (Chymosin production) – Synthetic and recombinant vaccines.

Unit-III- Bio pesticides and Bio fertilizers

Bio pesticides – history of development, production of bio pesticides from bacteria (BT), fungi (*Trichoderma viride*), virus (NPV) and their applications against different types of pathogens. Bio fertilizer – mass production of bio fertilizer (*Rhizobium*, *Azotobacte*r), quality control and field applications.

Unit-IV- Basics of Pharmaceutical Microbiology

Properties of antimicrobial agents, types of chemotherapeutic agents – Synthetic, Semi synthetic, Natural therapeutic agents. Types of antibiotics and their mode of action: antibacterial, antifungal, antiviral, antiprotozoal. Pharmaceutical Formulation (Tablets, Capsule, Oinments, Syrup, Gel), stages of pharmaceutical product development.

Unit-V- Spoilage and preservation of Pharmaceutical products

Types of spoilage, factors affecting the microbial spoilage of pharmaceutical products, sources and types of microbial contaminants, assessment of microbial contamination and spoilage. Objectives of preservation, the ideal preservative, preservative system. Antimicrobial preservatives and their properties. Preservative stability and efficacy.

Text books:

1) Dubey, R.C. *A Textbook of Biotechnol*ogy. New Delhi: S Chand and Company Limited. 4th Rev. Edition 2006.

2) Gupta, P.K. *Elements of Biotechnology.* Meerut: Rastogi Publications, 2005.

3) Jogdand, S. N. *Gene Biotechnology.* New Delhi: Himalaya publishing house. 4th Edition, 2016.

4) Reed, G Prescott and Dunn. *Industrial Microbiology.* US: Macmillan Publication. 1982.

Books for Reference:

1) Wulf Crueger. *A Text Book of Industrial Microbiology.* New Delhi: Panima Publishing Corporation. 1st edition 2000

2) Patel A.H. *Industrial Microbiology.* India: Macmillan Limited. 2017.

3) Casida L.E. *Industrial Microbiolog*y. NewYork: Eastern Limited. 1986.

SEMESTER-III			
Core-X- Genetic Engineering			
Course Code -21PMIC32	**Hrs/Week:5**	**Hrs/Sem:75**	**Credits:4**

Objectives:

1. To promote applicable genetics, bioengineering, and bio technological knowledge through education and state of the art technologies

2. Educate students for technical competence and knowledge management in different areas of Genetic engineering.

Course outcomes:

C O No	Upon completion of this course, students will be able to	PSO's Addressed	CL
CO- 1	Explain the knowledge about cloning	2	An,Un
CO -2	Perceive the applications of genetic engineering in various fields	4	Un, Re
CO- 3	Understands the hazardous and potential risk in releasing transgenic into environment	5	Un
CO -4	Create the techniques used in genetic engineering	2	An, Re
CO -5	Understands the concepts of blotting techniques and its applications	3	Un
CO -6	Discuss the cloning techniques and the production of transgenic materials	4	Un,An
CO -7	Understand the synthesis of genetically modified commercial products	4	Un
CO- 8	Make use of enzymology in genetic engineering	1	Cr

SEMESTER-III			
Core-X- Genetic Engineering			
Course Code -21PMIC32	**Hrs/Week:5**	**Hrs/Sem:75**	**Credits:4**

Unit – I: Gene cloning and vectors

Biology of vectors – Cosmids, phasmids, specialized vectors – Plant viral vectors, Animal viral vectors, Virus vectors and other plasmid vectors – Biology of host – *Escherichia coli* , *Saccharomyces cerevisiae*. Cloning strategies: Cloning of genomic DNA, cDNA cloning

Unit II: Enzymology of genetic engineering

Restriction enzymes – Types - Nomenclature – Recognition sequences – Cleavage patterns. Other enzymes used in Genetic engineering – DNA Ligase, Nuclease, Alkaline phosphatase, Kinase, Reverse transcriptase, Taq DNA polymerase, Thermal transferase, DPN1 enzyme.

Unit-III: Recombinant techniques

Blotting techniques – Southern, Northern and Western Blotting – Transformation of E.coli- PCR – types and variation- RFLP – AFLP – RAPD – SSCP and VNTR- Construction of cDNA library – Molecular mapping of genome – Genetic and physical maps.

Unit- IV: Synthesis of commercial products by Recombinant microorganisms

Antibiotics, Vitamins, Amino acids, Recombinant vaccines, Hormones, Monoclonal antibodies, Biopolymers. Genetic engineering of bio-degradative pathways – Manipulation by Transfer of plasmids and Gene alteration.

Unit – V: Cloning in plants and animals

Transgenic plant (Golden rice, Tearless onion, Colourful cauliflower, FlavrSavr Tomato) – Transgenic animal (Transgenic Fish, Transgenic Mouse, Transgenic Pig, Dolly) – GEM (Super bug) – Ethical aspects of Biotechnology

Books for Reference:

1. Burrel, M.M. *Enzymes of Molecular Biology*, Humana press. 1993.
2. Chirikjian, J.G. *Biotechnology- Theory and Techniques.*Vol.II, Jones and Burtlett Publishers. 1995.
3. Gerhardt, P., Murray, R.G., Wood, W.A., and Kreig, N.R. *Methods for General and Molecular Bacteriology*. Washington D.C: ASM Press, 1994.
4. Cafferty. Mc. J., Hoogenboom, H.R. and Chiswell, D.J. *Antibody Engineering- A Practical Approach,* Oxford University Press, 1996.
5. Lewin, B. *Genes VII*, Oxford: Oxford University Press,. 2000.
6. Murray Moo Young . *Plant Biotechnology*. Pergamon Press. 1992.
7. Radledge, C. and Kristiansen, B. *Basic Biotechnology*.2nd Edition.Cambridge University Press. 2001.
8. Das. H.K. *Text Book of Biotechnology*. New Delhi: Wiley Dreamtech India (P) Ltd., 2005.
9. Rigby. P.W.J.Ed. *Genetic Engineering*. London: 6thAcadamic press, 1987.
10. Wiseman.A. *Principles of Biotechnology*. New York: Chapman and Hall, 1983.
11. Desmond.S.T., Nicholl. *An Introduction to Genetic Engineering.* Cambridge Press. 1994.
12. Winnacker, E.L. *From Genes to Clones. Introduction to Gene technology*. New Delhi: Panima Publishing Corporation, 1st Edition. 1987.
13. Brown, T.A. *Gene Cloning – An Introduction*. Chapman and Hall, UK: 3rd Edition. 1995.
14. Glick, B.K. and Pasternik, J.J. *Molecular Biotechnology. Principles and applications of recombinant DNA.* ASM Press. 2nd Edition. 1998.
15. Mitra. *Genetic engineering*. Chennai: Published by Macmillan India Ltd., 2005.
16. Jogdand S.N . *Gene biotechnology*. Mumbai: Himalaya Publishing House, 2005.
17. Satyanarayan, *Biotechnology*. Kolkata: Books and Allied (P) Ltd., 1st edition, 2005.
18. Preeti Joshi, *Genetic engineering and its application*. Agrobios. India: 1st edition, 2002.
19. Bernad R Glick, *Molecular Biotechnology - Principles and Applications of Recombinant DNA*. Washington, D.C: ASM Press, 3rd edition, 2003.
20. Ramawat K and Shaily Goyal, *Molecular Biology and Biotechnology*. New Delhi: S.Chand and company Ltd., 1st edition, 2010.

SEMESTER – IV			
Core – XIII- Environmental Microbiology			
Course Code :21PMIC41	**Hrs/ Week: 4**	**Hrs/ Sem: 60**	**Credit: 4**

Objectives:

1. To provide the learners with the best learning experience in Microbiology by providing standard education and enabling the students to become entrepreneurs and socially responsible.
2. Developing young students with active and creative minds in the field of microbiology enabling the students to become entrepreneur by applying the microbial technology.
3. Motivating learners to contribute to sustainable development of nation through environmental protection and social responsibility.

Course Outcome:

CO.No	**Upon completion of this course, students will be able to**	**PSO addressed**	**CL**
CO-1	recall the ecological groups of microbes	1	Re,
CO -2	have knowledge about the interaction between microbes and organisms at other tropic level.	1,2	Un, An
CO-3	interpret the microbiology of sewage and its treatment	2,3	Co
CO-4	explain about aero microbiology and microbial ecology	2	Un, An
CO-5	acquire basic knowledge about water purification	2	Ap
CO-6	gets knowledge about biogeochemical cycles	2,4	Co
CO-7	understanding about biodegradation.	2	Sy
CO-8	develop the application of biodegradation and bioremediation.	5	Ap, Cr

SEMESTER – IV			
Core – XIII- Environmental Microbiology			
Course Code :21PMIC41	**Hrs/ Week: 4**	**Hrs/ Sem: 60**	**Credit: 4**

Unit I: Microbial Ecology

Interaction between abiotic and biotic factors in an ecosystem, ecological niche, limiting factor, concept of community, fluctuation and succession. Basic concept of food chain, food web and energy flow. Microbial symbiosis: commensalism, mutualism, parasitism and predation with examples.

Unit II: Biogeochemical cycles

Types of biogeochemical cycles: Water cycle, gaseous cycle (Oxygen, Carbon & Nitrogen), and sedimentary cycles (Sulphur & Phosphorus). Biogeochemical cycles of micronutrients.

Unit III: Aerobiology

Air space in different layers of atmosphere, bioaerosol, assessment of air quality - sedimentation, impaction impingement, suction, and filtration. Brief account of transmission of airborne microbes (Bacteria, Virus & Fungi). Microbiology of indoor and outdoor. Allergy: causes and tests for detection of allergy.

Unit IV: Aquatic Microbiology

The aquatic ecosystem (Pond)– factors governing micro flora and their distribution in natural water. Water pollution and its sources. Role of organic pollutants in water, concepts of C-BOD, N-BOD & COD. Treatment of waste water by aerobic and anaerobic processes (like trickling filter, activated sludge, oxidative pond, anaerobic digestion and chemical disinfection).

Unit V: Advancement in Bioremediation

Concept, principle and mechanism of bioremediation, factors affecting bioremediation, types of bioremediation. Bioremediation of metals with examples. Biodegradation and biotransformation of xenbiotics including pesticides, chlorinated and nitrated aromatic compounds, phenolic compounds and polycyclic aromatic compounds.

Books for Reference:

1. Atlas,R.M and Bartha.M. *Microbial Ecology –Fundamentals and applications.* California: *Benjamin – Cummings*, Mento Park, 2003.
2. SubbaRao, N.S. *Soil Microorganisms and Plant growth*. NewDelhi Oxford and IBH Publishing Co, Pvt. Ltd, 3rdEdition, 1995.
3. Gupta,S.K. *Approaches and trends in plant disease management*. India: Scientificpublishers.Jodhpur, 5th Edition, 2014.
4. Jammaluddin et al. . *Microbes and sustainable plant productivity* India*:* Jodhpur: Scientific Publishers,. 3rdEdition, 2013.
5. G.Purohit, S.S.Kothari,P.R.andMathur. *Basic and Agricultural Biotechnology*, India: Agrobotanical Publishers Bikaner. 1993.
6. Prescott, L.M., Harley, J.P. and Helin, D.A.. *Microbiology*, , New York. McGraw Hill, 5th Edition, 2008.
7. Schlegal, H.G.. *General Microbiology*, Cambridge: Cambridge Univeristy. 7th edition, 1995.
8. Prabhakaran, G. *Introduction to Soil and Agricultural Microbiology, New Delhi:* Himalaya Publishing House. 2004.
9. George N. Agrios.. *Plant Pathology*. Academic Press. 5th Edition. 2005
10. Raina M. Maier, Ian A. Pepper and Charles Gerba. *Environmental Microbiology*. Academic Press. 2nd edition. 2009.
11. Dubey, R.C. and Maheswari, D.K.. *A text book of Microbiology*, NewDelhi: S. Chand and Company Ltd, 2013.
12. Shiva Aithal, C. *Mordern approaches in Soil,Agricultural and Environmental Microbiology*. NewDelhi: Himalaya Publishers. 2010.
13. Madigan, M.T., Martinka, M., Parker, J. and Brock, T.D.. *Biology Microorganisms*, NewDelhi: Prentice Hall, 12th Edition, 2000.
14. Pelczar, M.J., Schan, E.C. and Kreig, N.R. *Microbiology – An application based approach*, NewDelhi: Tata McGraw Hill Publishing Company Limited, 5th Edition, 2010.

SEMESTER – IV			
Core – XIV- Soil and Agricultural Microbiology			
Course Code :21PMIC42	**Hrs/ Week: 4**	**Hrs/ Sem: 60**	**Credit: 4**

Objectives:

1) To provide the learners with the best learning experience in Soil and agricultural Microbiology by providing standard education and enabling the students to become entrepreneurs and socially responsible.

2) To develop young students with active and creative minds in the field of microbiology

3) To enabling the students to become entrepreneur by applying the microbial technology.

4) To motivate learners to contribute to sustainable development of nation through environmental protection and social responsibility

Course Outcome:

CO.No	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	recall the ecological groups of microbes and properties of soil	1	Re, Un
CO -2	have knowledge about the soil fertility	1,2	Un
CO-3	recall the previous basic knowledge about nitrogen fixing	1,2	Re, Co
CO-4	explain about plant microbe interaction.	2	Un
CO-5	acquire basic knowledge about important of plant microbe interaction for different layers (rhizosphere, phyllosphere)	2	Ap ,Un
CO-6	gets knowledge about recombinant microbes in agriculture.	2,4	Un, Co
CO-7	demonstrate an understanding of bio fertilizer	2	Sy
CO-8	develop the application of bio fertilizers in agricultural	5	Ap, Cr

SEMESTER – IV			
Core – XIV- Soil and Agricultural Microbiology			
Course Code :21PMIC42	**Hrs/ Week: 4**	**Hrs/ Sem: 60**	**Credit: 4**

Unit I : Microbes and soil fertility

Introduction and concepts of agricultural microbiology- soil microorganisms – bacteria (Cyanobacteria and Actinobacteria), algae, fungi, protozoans, nematodes and viruses Soil formation - Soil properties – Physical and chemical - Role of microbes in soil fertility. Soil fertility evaluation and improvement.

Unit II: Biogeochemical cycling and microbes

Biogeochemical cycles – Carbon, Phosphorus, Sulphur, Iron, Nitrogen - Symbiotic nitrogen fixation (*Rhizobium, Frankia*), non- symbiotic nitrogen fixation (*Azotobacter, Azospirillum*); Nitrogenase enzyme, *nif*genes and molecular mechanism of nitrogen fixation. Role of nodulin genes in nodule development and symbiosis. Genetic engineering of BNF.

Unit III: Plant-microbial interaction

Interrelationships between plants and microorganisms and their interactions with plants. Microbial associations in Spermosphere, Phytosphere, Rhizosphere (Mycorrhiza types and importance to agriculture) –phyllosphere (Anabaena-Azolla) -decomposition of organic Matter by microorganisms - cellulose, hemicellulose, lignin. Humus formation.

Unit IV: Plant Pathology

Plant pathogens: Bacterial – *Xanthomonas, Agrobacterium,*Fungal – *Cercospora, Pyricularia,* Viral – TMV, Bunchy top virus) Mechanisms of plant pathogenicity, symptoms of plant diseases, transmission of plant diseases. signaling events in pathogenesis and resistance to pathogens. Molecular basis of Plant disease control along with cultural practices, chemical and biological control.

Unit V: Bio fertilizers & **Bio pesticides**

Principles of mass production, Quality Control and Field applications - Bacterial bio fertilizer: *Rhizobium, Azotobacter- Azopirillum,*–Phosphobacteria. Algal biofertilizer - Blue green algae, Azolla.Fungal biofertilizers - Mycorrhizae – ecto and endo mycorrhiza. Biopesticides – Viral (NPV, CPV & GV), bacterial (*Bacillus thuringiensis*, *B. papillae* & *Pseudomonas* sp.), Fungal (*Beaveria* sp., *Metarrhizium* sp. & *Verticillium* sp.), Protozoan (*Mattesia* sp., *Nosema* sp., & *Lambornella* sp.)

Text books:

1. Dubey R.C. and Maheswari D.K.*A text book of Microbiology*.New Delhi:S. Chand and Company Ltd. Reprint, 2006.

2. Rangaswamy G and BagyarajD.J. *Agricultural Microbiology*. NewDelhi: Prentice-Hall of India Pvt Ltd.2nd edition, 2004.

Books for Reference:

1. Atlas R.M, and BarthaM. *Microbial Ecology –Fundamentals and applications.* California: Benjamin & Cummings, 2003.

2. Subba RaoN.S. *Soil Microorganisms and Plant growth*. New Delhi: Oxford and IBH Publishing Co, Pvt. Ltd, 3rd edition, 1995.

3. SahaT.K. *Ecology and Environmental Biology*. Kolkata: Books and Allied Pvt. Ltd., 2010.

4. Shiva Aithal, C. *Modern approaches in Soil, Agricultural and Environmental Microbiology*. New Delhi: Himalaya Publishers,.1st edition, 2010.

SEMESTER – III			
Core Practical - V – Laboratory in Industrial and Pharmaceutical Microbiology, Genetic Engineering			
Course Code: 21PMICR5	**Hrs/week: 6**	**Hrs/Sem: 90**	**Credits: 3**

Objectives:

1. To impart advanced level practical training in Industrial, Pharmaceutical and Genetic Engineering.
2. To make the students skilled in the field of Industrial, Pharmaceutical and Genetic Engineering.

Course Outcome:

CO.No	Upon completion of this course, students will be able to	PSO addressed	CL
CO 1	Relate the procedures and principle of pharmaceutical products test	1	Re
CO 2	Conclude the procedure for isolation of hydrocarbon, plastic degrading micro organisms	4,6	An
CO 3	Outline kirby-bauer disc diffusion technique, minimum inhibitory concentration.	4	Un
CO 4	Recall how to perform enzyme immobilization in sodium, calcium alginate gel	2,3	Re
CO 5	Examine isolation of spontaneous and induced mutants	3	An
CO 6	Evaluate polymerase chain reaction	2	Ev
CO 7	Assess the isolation of autotrophic mutants	3	Ev
CO 8	Distinguish between transformation, conjugation and transduction	2	An

SEMESTER – III			
Core Practical - V – Laboratory in Industrial and Pharmaceutical Microbiology, Genetic Engineering			
Course Code: 21PMICR5	**Hrs/week: 6**	**Hrs/Sem: 90**	**Credits: 3**

1. Production and characterization of citric acid using *Aspergillus niger*.
2. Laboratory scale cultivation of Mushroom.
3. Ethanol production using *Saccharomyces cerevisiae*.
4. Sterility test for pharmaceutical products (any two product)
5. Assay of amylase from bacteria.
6. Cell immobilization in calcium alginate gel.
7. Isolation of antibiotic producing microorganisms.
8. Screening of antibiotic producing microorganisms.
9. Isolation of chromosomal DNA.
10. Isolation of Plasmid DNA.
11. SDS PAGE
12. Western blotting -Demonstration.
13. Southern blotting -Demonstration.
14. Restriction digestion -Demonstration.
15. Polymerase Chain Reaction -Demonstration.

Books for Reference:

1. James G. Cappuccino and Natalie Sherman - *Microbiology – A Laboratory Manual*. Pearson Education,Inc. 7th Edition 2012
2. Gunasekaran.P *Laboratory Manual in Microbiology.* New Delhi: New Age International(P) Ltd Publishers, 2007.
3. Rajan S & Selvi Christy R *Experimental procedure in Life sciences*. Chennai: Anjanaa Book House, 2012.
4. Aneja.K.R. *Experiments in Microbiology, Plant pathology and Biotechnology.* New Age International Publishers. 4th Revised Edition. 2003.
5. Janarthanan. S. and Vincent.S. *Practical Biotechnology: Methods and Protocols.* Hyderabad: Universities press (India) private limited. 2007.
6. JyotiSaxena, MamtaBaunthiyal, Indu Ravi. *Laboratory manual forMicrobiology, Biochemistry and Molecular Biology*. India: Scientific Publishers. 2012.
7. John Vennison S. *Laboratory manual for Genetic engineering.* Delhi: PHI Learning Pvt Ltd, 2009.

SEMESTER- IV			
Core Practical -VII – Laboratory in Environmental Microbiology, Soil and Agricultural Microbiology			
Course Code : 21PMICR7	**Hrs/week: 6**	**Hrs/Sem:90**	**Credits: 3**

Objectives:

1) To impart skill on isolation of various microbes from Environment, soil and plant.

2) To enhance advanced level laboratory training in Soil and Agricultural Microbiology and Environmental microbiology.

Course Outcome:

CO. No	Upon completion of this course, students will be able to	PSO addressed	CL
CO -1	test for isolation of various soil microbes	5	An
CO- 2	infer quantitative assay of microbes from air borne.	5	Ap
CO -3	interpret the preparation of bio fertilizer and its assay	4	Un
CO -4	experiment with isolation of microbes from various agro samples.	2	Un
CO- 5	interpret staining of VAM	5	Un
CO -6	analyse antagonism between microorganisms	2	An
CO -7	demonstrate the isolation of phosphate solubilizing bacteria and fungi	5	Un
CO- 8	identify nitrogen fixing bacteria	5	Ap

SEMESTER- IV			
Core Practical -VII – Laboratory in Environmental Microbiology, Soil and Agricultural Microbiology			
Course Code : 21PMICR7	**Hrs/week: 6**	**Hrs/Sem:90**	**Credits: 3**

1. Testing antagonistic activity of soil microorganisms.
2. Estimation of soil mineral contents a) pH b) nitrate c) nitrite d) sulphate e) phosphate.
3. Effect of high salt concentration on microbial growth.
4. Quantitative assay of microbes in Rhizosphere and phyllosphere.
5. Isolation of air borne bio-particles.
6. Determination of biological oxygen demand.
7. Determination of chemical oxygen demand.
8. Determination of Soil pH and temperature.
9. Isolation of Phosphate solubilizing bacteria & fungi
10. MPN Technique.
11. Isolation of *Rhizobium sp* from root nodules of leguminous plants.
12. Isolation of *Azotobacter sp* from soil.
13. Isolation of *Azospirillum sp* from soil.
14. Identification of Cyanobacteria from soil. (*Anabaena* and *Nostoc*).
15. Assay of bio fertilizer (Seed treatment, Seedling treatment, Soil inoculation, Measurement of root and shoot system.

Books for Reference:

1. Jyoti Saxena, Mamta Baunthiyal, Indu Ravi. *Laboratory manual for Microbiology, Biochemistry and Molecular Biology*. India: Scientific Publishers, 2012.
2. Gunasekaran. P. *Laboratory Manual in Microbiology*. New Delhi: New Age International Ltd., Publishers, 1 st edition. 2005.
3. Dubey, R.C. and Maheswari,D.K. *Practical Microbiology*. India: Chand and Company Ltd., 2 ndedition. 2002.
4. Aneja K.R. *Experiments in Microbiology, Plant Pathology and Biotechnology.* New Delhi: New Age International Publishers, 4th edition. 1993.
5. Harold J. Benson, Alfred E. Brown - *Benson's Microbiologicalapplications: Laboratory manual in General Microbiology.* International Edition, McGraw Hill Higher Education. 2006.
6. Plummer. D.T. *An Introduction to Practical Biochemistry*. NewDelhi: Tata McGraw Hill, 1998.