**THIRUVALLUVAR UNIVERSITY**

**BACHELOR OF SCIENCE**

**B.Sc. BIOTECHNOLOGY**

**UNDER CBCS**

**(With effect from 2020 - 2021)**

**The Course of Study and the Scheme of Examinations**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **S. No.** | **Part** | **Study Components** | | **Ins. Hrs / week** | **Credit** | **Title of the Paper** | **Maximum Marks** | | |
| **Course Title** | |
|  |  | **SEMESTER I** | |  |  |  | **CIA** | **Uni. Exam** | **Total** |
|  | I | Language | Paper-1 | 6 | 4 | Tamil/Other Languages | 25 | 75 | 100 |
|  | II | English (CE) | Paper-1 | 6 | 4 | **Communicative English I** | 25 | 75 | 100 |
|  | III | Core Theory | Paper-1 | 6 | 4 | Cell Biology & Evolution | 25 | 75 | 100 |
|  | III | Core Practical | Practical-1 | 4 | 0 | Lab in Cell Biology & Evolution | 0 | 0 | 0 |
|  | III | Allied -1 | Paper-1 | 4 | 3 | Biodiversity | 25 | 75 | 100 |
|  | III | Allied- 1 | Practical-1 | 2 | 0 | Lab in Biodiversity | 0 | 0 | 0 |
|  | **III** | **PE** | **Paper 1** | **6** | **3** | **Professional English I** | **25** | **75** | **100** |
|  | IV | Environmental Studies |  | 2 | 2 | Environmental studies | 25 | 75 | 100 |
|  |  | **Sem. Total** |  | **36** | **20** |  | **150** | **450** | **600** |
|  |  |  |  |  |  |  |  |  |  |
|  |  | **SEMESTER II** | |  |  |  | **CIA** | **Uni. Exam** | **Total** |
|  | I | Language | Paper-2 | 6 | 4 | Tamil/Other Languages | 25 | 75 | 100 |
|  | II | English (CE) | Paper-2 | 6 | 4 | **Communicative English II** | 25 | 75 | 100 |
|  | III | Core Theory | Paper-2 | 5 | 4 | Biochemistry | 25 | 75 | 100 |
|  | III | Core Practical | Practical-1 | 3 | 2 | Lab in Cell Biology & Evolution and Biochemistry | 25 | 75 | 100 |
|  | III | Allied-1 | Paper-2 | 4 | 3 | Food & Nutrition | 25 | 75 | 100 |
|  | III | Allied  Practical - 1 | Practical-1 | 2 | 2 | Lab in Biodiversity and Food & Nutrition | 25 | 75 | 100 |
|  | **III** | **PE** | **Paper 1** | **6** | **3** | **Professional English II** | 25 | 75 | 100 |
|  | IV | Value Education |  | 2 | 2 | Value Education | 25 | 75 | 100 |
|  | IV | Soft Skill |  | 2 | 1 | Soft Skill | 25 | 75 | 100 |
|  |  | **Sem. Total** |  | **36** | **25** |  | **225** | **675** | **900** |
|  |  |  |  |  |  |  |  |  |  |
|  |  | **SEMESTER III** | |  |  |  | **CIA** | **Uni. Exam** | **Total** |
|  | I | Language | Paper-3 | 6 | 4 | Tamil/Other Languages | 25 | 75 | 100 |
|  | II | English | Paper-3 | 6 | 4 | English | 25 | 75 | 100 |
|  | III | Core Theory | Paper-3 | 4 | 4 | Microbiology | 25 | 75 | 100 |
|  |  | Core practical | Practical - 2 | 3 | 0 | Lab in Microbiology | 0 | 0 | 0 |
|  | III | Allied-2 | Paper-3 | 4 | 3 | Biostatistics & Computer Applications | 25 | 75 | 100 |
|  |  | AlliedPractical - 2 | Practical-2 | 3 | 0 | Lab in Biostatistics & Computer Applications | 0 | 0 | 0 |
|  | IV | Skill Based  Subject | Paper-1 | 2 | 2 | Organic Farming | 25 | 75 | 100 |
|  | IV | Non-Major Elective | Paper-1 | 2 | 2 | Herbal Medicine | 25 | 75 | 100 |
|  |  | **Sem. Total** |  | **30** | **19** |  | **150** | **450** | **600** |
|  |  |  |  |  |  |  |  |  |  |
|  |  | **SEMESTER IV** | |  |  |  |  |  |  |
|  | I | Language | Paper-4 | 6 | 4 | Tamil/Other Languages | 25 | 75 | 100 |
|  | II | English | Paper-4 | 6 | 4 | English | 25 | 75 | 100 |
|  | III | Core Theory | Paper-4 | 4 | 4 | Immunology | 25 | 75 | 100 |
|  | III | Core Practical | Practical-2 | 3 | 3 | Lab in Microbiology and Immunology | 25 | 75 | 100 |
|  | III | Allied-2 | Paper-4 | 4 | 3 | Molecular Genetics | 25 | 75 | 100 |
|  | III | Allied  Practical - 2 | Practical-2 | 3 | 2 | Lab in Biostatistics & Computer Applications and Molecular Genetics | 25 | 75 | 100 |
|  | IV | Skill Based  Subject | Paper-2 | 2 | 2 | Mushroom Cultivation | 25 | 75 | 100 |
|  | IV | Non-Major  Elective | Paper-2 | 2 | 2 | Applied Biotechnology | 25 | 75 | 100 |
|  |  | **Sem. Total** |  | **30** | **24** |  | **200** | **600** | **800** |
|  |  |  |  |  |  |  |  |  |  |
|  |  | **SEMESTER V** | |  |  |  |  |  |  |
|  | III | Core Theory | Paper-5 | 6 | 6 | Genetic Engineering | 25 | 75 | 100 |
|  | III | Core Practical | Practical-3 | 3 | 0 | Lab in genetic Engineering | 0 | 0 | 0 |
|  | III | Core Theory | Paper-6 | 6 | 6 | Industrial Biotechnology | 25 | 75 | 100 |
|  |  | Core Practical | Practical-4 | 3 | 0 | Lab in Industrial Biotechnology | 0 | 0 | 0 |
|  | III | Core Theory | Paper-7 | 5 | 5 | Bioinformatics | 25 | 75 | 100 |
|  | III | Internal Elective | Paper-1 | 4 | 3 | (to choose 1 out of 3)  A. Biofertilizer Technology  B. Public Health & Hygiene  C. Enzyme technology | 25 | 75 | 100 |
|  | IV | Skill Based Subject | Paper-3 | 3 | 2 | Medical Lab Technology | 25 | 75 | 100 |
|  |  | **Sem. Total** |  | **30** | **22** |  | **125** | **325** | **500** |
|  |  |  |  |  |  |  |  |  |  |
|  |  | **SEMESTER VI** | |  |  |  |  |  |  |
|  | III | Core Theory | Paper-8 | 5 | 5 | Plant & Animal Biotechnology | 25 | 75 | 100 |
|  | III | Core Theory | Paper-9 | 5 | 5 | Environmental Biotechnology | 25 | 75 | 100 |
|  | III | Core Practical | Practical-3 | 3 | 3 | Lab in genetic Engineering and Plant & Animal Biotechnology | 25 | 75 | 100 |
|  | III | Core Practical | Practical-4 | 3 | 3 | Lab in Industrial Biotechnology and Environmental Biotechnology | 25 | 75 | 100 |
|  | III | Compulsory Project | Paper-10 | 5 | 5 | Individual / Group Project | 25 | 75 | 100 |
|  | III | Internal Elective | Paper-2 | 3 | 3 | (to choose 1 out of 3)   1. Forensic Science 2. Sericulture 3. Entrepreneurship | 25 | 75 | 100 |
|  | III | Internal Elective | Paper-3 | 3 | 3 | (to choose 1 out of 3)  A. Biosafety, Bioethics & IPR  B. Pharmaceutical Biotechnology  C. Horticulture and Landscaping | 25 | 75 | 100 |
|  | IV | Skill based Subject | Paper-4 | 3 | 2 | Industrial Waste Management | 25 | 75 | 100 |
|  | V | Extension Activities |  | 0 | 1 |  | 100 | 0 | 100 |
|  |  | **Sem. Total** |  | **30** | **30** |  | **300** |  | **900** |
|  |  | **Grand Total** |  |  | **140** |  |  |  | **4300** |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Part** | **Subject** | **Papers** | **Credit** | **Total Credits** | **Marks** | **Total Marks** |
| Part I | Languages | 4 | 4 | 16 | 100 | 400 |
| Part II | Communicative English & English | 4 | 4 | 16 | 100 | 400 |
| Part III | Allied (Odd Semester) | 2 | 3 | 6 | 100 | 200 |
|  | Allied (Even Semester) | 2 | 5  2 | 10 | 100 | 200 |
|  | Allied Practical | 2 | 100 | 200 |
|  | Electives | 3 | 3 | 9 | 100 | 300 |
|  | Core | 9 | (3-5) | 43 | 100 | 900 |
|  | Core practical | 4 | (2-3) | 11 | 100 | 400 |
|  | Professional English | 2 | 3 | 6 | 100 | 200 |
|  | Compulsory Project (Group/Individual Project) | 1 | 5 | 5 | 100 | 100 |
| Part IV | Environmental Science | 1 | 2 | 2 | 100 | 100 |
|  | Soft skill | 1 | 1 | 1 | 100 | 100 |
|  | Value Education | 1 | 2 | 2 | 100 | 100 |
|  | Lang. & Others /NME | 2 | 2 | 4 | 100 | 200 |
|  | Skill Based | 4 | 2 | 8 | 100 | 400 |
| Part V | Extension Activities | 1 | 1 | 1 | 100 | 100 |
|  | **Total** | **43** |  | **140** |  | **4300** |

**THIRUVALLUVAR UNIVERSITY**

**B.Sc. BIOTECHNOLOGY**

**SYLLABUS**

**UNDER CBCS**

**(With effect from 2020-2021)**

**SEMESTER III**

**CORE PAPER - 3**

**MICROBIOLOGY**

**Course Objectives**

1. To understand the classification of microorganisms.
2. To understand the structure of various microorganisms
3. To understand the growth of microorganisms
4. To understand the factors affecting the growth
5. to understand the disease caused by microorganism

**UNIT- I**

History of Microbiology. Classification of microorganisms - Kingdom protista, prokaryotic and eukaryotic microorganisms, the five kingdom concept of classification, archaeobacteria, eubacteria and eukaryotes.

**UNIT- II**

Microscope-light, electron and laser optic system; micrometry. Algae, bacteria, fungi, viruses and protozoa - morphology, ultra-structures, sub cellular structure and cell envelope - slime, capsule, cell wall, cell inclusion.Reproduction and life cycle pattern.

**UNIT- III**

Nutritional requirements and nutritional grouping of microorganisms, selective and differential media, enrichment media, microbial assay media. Growth curve; axenic culture, synchronous culture, continuous culture; Methods of enumeration of microorganisms and preservation of microbes

**UNIT- IV**

Factors controlling microbial growth-Physical agents and processes- pH, light, temperatures, desiccations, osmotic pressure, radiation, filtration; Chemical agents-Disinfectants, antiseptics and chemical sterilants; Antimicrobial chemotherapy evaluation-tube dilution, agar plate technique, phenol coefficient techniques.

**UNIT- V**

Microbes as a source of protein - Single Cell Protein. Role microbes in food spoilage and human diseases such as hepatitis, typhoid, TB, cholera, Malaria, fungal skin diseases.

**References / Text Books**

1. Text Book of Microbiology -N. Arumugam
2. Microbiolgoy-Concept and applications, Pelczer M.J.J, E.C.S. Chang & N.R. Krieg, 1993. McGraw Hill company, New York
3. Microbiology. Prescot L.M, J.D. Harley & D. A. Klein, 1999. McGraw Hill.
4. Microbiology, Fundamentals and Applications, Ronald M. Atlas, 1987. Prentice Hall.
5. General Microbiology, Stanier, 1986. McMillan Publishing Co.
6. Microbiology - An Introduction, 4th Edition, Gerard J. Tortora, Berdell R. Funke, Christine L. Care, 1992. The Benjamin/Cummings Publishing Company, Inc.

**Course Outcomes**

1. The student will be able to know classification of microorganisms
2. The student will be able to know the structure of various microorganisms
3. The student will be able to know the growth of microorganisms
4. The student will be able to know factors controlling microbial growth
5. The student will be able to know various disease caused by microbes

**ALLIED II**

**PAPER 3  
BIOSTATISTICS AND COMPUTER APPLICATIONS**

**Course Objectives**

1. To know about collection of data and presentation of data
2. To study measures of central tendency
3. To know the types and methods of correlation analysis
4. To implant computer knowledge
5. To know how to work with Excel

**UNIT- I**

Biostatistics - Introduction, definition, functions, scopes. Collection of data-primary, secondary. Sampling, Classification, Tabulation of data. Presentation of data-graphical and diagram matic representation, Charting of data using MS-Excel.

**UNIT- II**

Measure of central tendency -individual, discrete and continuous series-mean, median, mode. Use of Excel in measures of central tendency, Measure of variation -range. Quartile deviation, Standard deviation, Standard error.

**UNIT- III**

Correlation analysis - types and methods. Calculation r-value, Correlation using MS-Excel. Regression analysis- regression line and regression equation, Linear regression using MS-Excel, student t-test; chi-square test.

**UNIT- IV**

Anatomy and computer peripherals - Anatomy of computer system, Parts of computer system- Hardware, Software, Input devices, Output devices, Memory, Binary numbers in computers, Unit of size, Computer language.

**UNIT- V**

MS-Excel-Introduction, Features-Opening of Spreadsheet, Components of an Excel work book, Entering data and saving a new work book, Mathematical calculations, Moving and copying data, Deleting and adding rows and columns, Aligning data, Changing the size of row and column, Creating a graph, Adding, renaming or deleting a sheet from the work book, Closing the work book, Quitting Microsoft Excel.

**Text Books / References**

1. Biostatistics, Daniel, W.W.1987. New York, John Wiley sons
2. An introduction to biostatistics, 3rd Edn, Sundarrao, P.S.S. and Richards, J Christian Medical College, Vellore.
3. Statistics for Biology, Boston, Bishop, O.N. Houshton, Mifflin.
4. Statistics for biologist, Campbell, T.C.1998. Cambridge University press
5. 1.Elements of biostatistics, Prasad, S. Rastogi Pub
6. Digital computer fundamentals, Bartee,6th Edn, Fundamental of computers, algorithms, Horowitz, Sahhni, Tajasekaran.
7. Textbook of Computer applications and biostatistics, RemethDiasand Kailas KMali, Trinity Publishing House, Satara-415001. India.2011.
8. MS office, Sexena,2001,Vikas pub, House Pvt Ltd, New Delhi
9. Computer programming and application, J. Fernandez and Venkatasamy, Suja Pubs.
10. Statistics for biologist, Campbell, T.C.1998. Cambridge University press.
11. Computer programming and application, J. Fernandez and Venkatasamy, Suja Pubs.
12. https://www.biotecharticles.com/Biotech-Research-Article/Biostatistics-Statistical-Analysis-in-Life-Processes-564.html
13. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3657982/

**Course Outcomes**

1. The student will be able to know about collection of data and presentation of data
2. The student will be able to study measures of central tendency
3. The student will be able to know the types and methods of correlation analysis
4. The student will be able to implant computer knowledge
5. The student will be able to know how to work with excel

**SKILL BASED SUBJECT**

**PAPER - 1**

**ORGANIC FARMING**

**Course Objectives:**

To expose students to principles of agriculture and agricultural practices. To have a basic understanding on agriculture in India with relation to soil types, climatic conditions etc.

**UNIT - I**

Introduction - Introduction to Organic Farming, history, Farming models - Natural Farming, Fukuoka - Japan, Parma Culture, Billmollyson, Australian Organic Farming, Ecological Farming, Palekar Model,

**UNIT - II**

Soil Factor - Physical, chemical and biological properties - Classification of Indian soils - Mineral and organic constituents of soils and their role in maintaining soil productivity.

**UNIT - III**

Composting Technique-Introduction- history of composting - compost - composting processes - microbiology of composting - fate of pathogens - ingredients in composting - various methods of composting: vermi- composting and home composting - steps in composting.

**UNIT - IV**

Agricultural practices-Implements, Seed bed preparation, ploughing, harrowing, sowing, irrigation, weeding, leveling, transplantation.- Inter-cultivation, Crop rotation, harvesting, Post- harvest methods - Cultivation of paddy, tomato and mango

**UNIT - V**

Biofertilizers and their Production-Introduction - Types: Microbes as biofertilizer, Green leaf manure. Mass cultivation and Application of the following biofertilizers: i) Rhizobium ii) Azospirillum iii) Cyanobacteria iv) Mycorrhizae

**References / Textbooks**

1. 1.Shovan Ray (Ed). 2007. Handbook of Agriculture in India. Oxford University Press. New Delhi.
2. Kumar Arvind, 2006. Concepts of Tropical Agriculture.Eastern Books Coprporation. India.
3. Sreenivas, Y.S. 2009. Advances in Agricultural Research in India, Oxford Book Company.Jaipur.
4. RamanandSagar 2009.Advances in Agricultural Biotechnology. Cyber Tech Pub. New Delhi.
5. HemantRawat. 2008. Agricultural Biotechnology. Oxford Book Company. Jaipur.
6. Panda, S.C. 2005. Agronomy. Agrobios. Jodhpur.
7. Rajendra Reddy and J.P. Abhay Shankar. 2007. Encyclopaedia of Agriculture. Commonwealth Pub., New Delhi.

**Course Outcomes:**

1. The students will be able to understand various models of organic farming
2. The students could explain the role of soil health in organic crop production.
3. The students will identify the fundamentals of cultural practices and biological processes for successful establishment of organic farming.
4. The students could provide consultation and make awareness to the society about needs of organic farming for their routine life.
5. The students will be able to set their own business, marketing and to compete with entrepreneurs.

**NON - MAJOR ELECTIVE**

**PAPER -1**

**HERBAL MEDICINE**

**Course Objectives:**

1. To understand the outcome of herbal plant medicinal uses
2. To identify and utilization of medicinal plants.

**UNIT- I**

Introduction: Herbal Medicine-History of Traditional Medicine - History of Islamic Medicine, Siddha, Ayurveda, Homeopathy, Allopathy and Unani medicine.

**UNIT- II**

Ethano botany: *Withaniasomnifera* (Amukkara) *Glycyrrhizaglabra* (Athimathuram), *Myristicafragrans* (Jathikkai), *Gymnemasylvestre* (Cakkaraikkolli), *Pongamiapinnata* (Punkam)-PropertiesandMedicinaluses.

**UNIT- III**

Common medicinal plants: Family, Local Name, Common name, Medicinal uses-*Ocimumsanctum, Solanumtrilobatum, Cardiospermumhalicacabum, Adhatodavasica, Catharanthusroseus, Ecliptaalba*.

**UNIT- IV**

Parts of Medicinal plants: Fruit -Amla, Bulb - Garlic, Rhizome - Ginger, Seed -Castor, Bark - Cinchona, Leaves -Neem and Flower - Clove.

**UNIT- V**

Cultivation methods- crop protection - Harvesting- Storage and Protection-Marketing utilization-Export of medicinally important plant (General aspects).

**References / Text Books**

1. Gokhale, S.S,C.K.Kokate and A.P.Purohit (1994). Pharmacognosy. Niraliprakashan, Pune.
2. Faroogi, A.A. and B.S.Sreeramu (2004), Cultivation of Medicinal and Aromatic crops. University Press (India) P. Ltd., Hyderabad.
3. Pal. D.C and S.K. Jain (1998), Tribal medicine, Naya Prakash, 206, Bidhan Sarani, Calcutta.
4. Thirugnanam, Akbarsha and Krishnamurthy (2010), Indian Medicinal plants and Home Remedies, SelviPathipagam, Trichy.
5. Rasheeduzzafar (2006), Medicinal plants of India, CBS publication.
6. International Journal of Herbal Medicine
7. Journal of Herbal medicine Elsevier
8. [http://herbal - medicine.imedpub.com/](http://herbal-medicine.imedpub.com/)
9. en.wikipedia.org/wiki/Herbal\_medicine

**Course Outcomes**

1. The student will be able to gain knowledge on traditional medicine
2. The student will be able to study some important medicinal plants
3. The student will be able to know the common herbal plants
4. The student will be able to know the preservation of herbal medicine
5. The student will be able to learn cultivation methods of herbal plants

**SEMESTER IV**

**CORE PAPER - 4**

**IMMUNOLOGY**

**Course Objectives**

1. To understand the system and cells of the immune system.
2. To know about Immunoglobulins
3. To understand the role of MHC’s
4. To learn about Immuno hematology

**UNIT- I**

Immunology-Introduction, Historical perspective to the immune system.Innate immunity and acquired immunity.Primary and secondary lymphoid organs-structure and functions.Cells of the immune system, Antigens, Immune responses.

**UNIT- II**

Immuno globulin -structure and functions, Immunoglobulin classes and biological activities.Epitopes - Properties of B-cell and T- cellepitopes. Monoclonal anti bodies -Production, Classical uses.

**UNIT- III**

Immune cells -T- cells-Receptors, Maturation, Activation and differentiation. Cell mediated immune response, Cytokines and cytokine receptors. B- cells- Activation of B- cells by T-cell independent antigen and T-cell dependent antigens. Antibody mediated immune responses, Differentiation of B-cells.

**UNIT- IV**

Major His to compatibility complex-MHC, HLA complex, HLA typing. Immunological tolerance, auto immunity and autoimmune diseases.

**UNIT- V**

Immuno hematology - ABO blood grouping, Rh Blood grouping, and medical applications of blood grouping, blood transfusion and hemolytic disease of the new born.Hyper sensitivity-Type I, II, III, IV and V.

**References / Text Books**

1. Immunology-Dulsy Fatima and N.Arumugam-Saras Publication.
2. Immunology (7th Edition)-David Male, Jonathan Brost off, David Roth, Ivan Roitt, Mosby. Elsevier
3. Immunology-A short course-Eli Benjamin, Geoffrey Suashine, Sidney Leskowitz. John wiley&sons.Inc. Publications.
4. Fundamental Immunology (6th Edition)- William E Paul, Walters Kluwer Hedth, Lippincott William Wilkins.
5. <https://www.researchgate.net/publication/313343876_Immunology_Lecture_Notes_Immune_responses>
6. https://www.easybiologyclass.com/tag/immunology-short-notes/

**Course Outcomes**

1. The student will be able to learn the basics of immunology.
2. The student will be able to learn about the structure of immunoglobulins.
3. The student will be able to know about the details of immune cells.
4. The student will be able to learn about the mhc&autoimmune disease.
5. The student will be able to learn the details of blood grouping and its applications.

**ALLIED-II**

**PAPER - 4**

**MOLECULAR GENETICS**

**Course Objectives**

1. To make the students familiar with the DNA as a Genetic Material.
2. To understand the genetics of bacteria.
3. To Understand the Students about the mutation at the molecular level and Gene Expression.

**UNIT- I**

Central dogma: Structure of DNA and RNA, DNA as the Genetic Material: Griffith’s experiment, Hershey-Chase Experiment, Experimental Proof by Avery, McLeod and McCarty. RNA as genetic material.

**UNIT- II**

DNA Replication: Types. Mechanism of Replication. DNA Repair Mechanism and Recombination -Holliday Model.

**UNIT- III**

Mutation: Spontaneous, Induced mutation, Radiation Induced Mutation - (Ionizing and UV radiation), Chemically Induced mutation. Point Mutation. Chromosomal Abnormalities.

**UNIT- IV**

Genetics of Bacteria and Viruses: Transformation, Conjugation, F+, Hfr, Transduction- Generalized and Specialized.

**UNIT- V**

Regulation of Gene Expression: Operon Concept - Lac and Trp Operons. Transposable Genetic elements - IS elements.Ac and Ds Elements in Maize, Elements in Drosophila.

**References / Text Books**

1. Textbook of population genetics by tomar
2. Textbook of Genetics by R.P. Meyyan (Saras Publication)
3. Text book of Genetics from Genes to Genomes-A joy Paul
4. Genetics-P.S. Verma,V.K. Agarwal
5. Essential of human genetics (5th Edn)-Manu L Kothari, Opa A Metha and Sadhana S Roy chodhury, Universities Press, Hyderabad.
6. Molecular Biology of Genes. 4th edition by Watson, Hopkins, Roberts, Steitz, Weiner.
7. The Cell - A molecular approach. 3rd edition by Geoffrey M. Cooper, Robert E. Hausman.
8. iGenetics (A Molecular Approach)- 2nd edition by Peter J. Russell
9. Genetics- A Conceptual Approach (2nd Edition)-Benjamin A. Pierce.W.H. Freeman Company
10. <https://www.khanacademy.org/science/biology/bacteria-archaea/prokaryote-structure/a/genetic-variation-in-prokaryotes>

**Course Outcomes**

1. The student will be able to explain Central Dogma and DNA as a Genetic Material
2. The student will be able to understand Replication, Repair and Recombination.
3. The student will be able to know Mutation, Chromosomal Abnormalities
4. The student will be able to understand Genetics of Bacteria and Virus
5. The student will be able to know the Regulation of Gene Expression and Transposable Elements.

**SKILL BASED SUBJECT**

**PAPER - 2**

**MUSHROOM CULTIVATION**

**Course Objectives**

1. To teach to the students’ knowledge and skills about mushroom cultivation.
2. To establish a mushroom cultivation enterprise.
3. To cultivate mushrooms in a form of extra-earnings or as hobby.

**UNIT- I**

Mushroom cultivation - Introduction-History-Edible and poisonous mushrooms - common Indian mushrooms -Nutritional value, Medicinal value and advantage - systematic poison, distribution, structure and life cycle of Agaricus.

**UNIT- II**

Structure and construction of mushroom house - layout of traditional and green house method - maintenance of sanitation in mushroom plant.

**UNIT- III**

Isolation and culture of spores-culture media preparation-production of mother spawn-multiplication of spawn.

**UNIT- IV**

Post harvesting management-harvesting methods, storage-Freezing, dry freezing, and drying,canning,quality assurance of mushroom - preservation of mushroom.

**UNIT- V**

Disease and problem in mushroom cultivation: Disease of mushroom-Bacterial, brown blotch disease-Bacterial soft rot-pest and nematode disease-insect pest attacking mushroom and mushroom bed- Environmental changes affecting mushroom production.

**References / Text Books**

1. Pandey B P 1996. A textbook of fungi.Chand and Company N Delhi
2. Nita Bhal. (2000). Handbook on Mushrooms. 2nd ed. Vol. I and II. Oxford and IBH
3. Publishing Co. Pvt. Ltd., New Delhi
4. Kannaiyan, S. Ramasamy, K. (1980). A hand book of edible mushroom, Today & Tomorrows Printers &Publishers, New Delhi.
5. Mushroom cultivation - an illustrated guide to growing your own mushrooms at home by Tavis Lynch 2018
6. Pathak, V. N. and Yadav, N. (1998). Mushroom Production and Processing Technology. Agro bios, Jodhpur.
7. Mushroom Cultivation, Tripathi, D.P. (2005) Oxford & IBH Publishing Co. Pvt.Ltd, New Delhi.
8. Marimuthu, T. et al. (1991). Oster Mushroom. Department of Plant Pathology. Tamil Nadu Agricultural University, Coimbatore.
9. Tripathi, D. P. (2005). Mushroom Cultivation. Oxford& IBH Publishing Co. Pvt.ltd., New Delhi.
10. <https://www.sceltamushrooms.com/en/themes/cultivation-harvesting-mushrooms/>
11. <https://www.krishisewa.com/articles/production-technology/46-technology-for-mushroom-cultivation.html>
12. <http://www.biologydiscussion.com/fungi/mushrooms-meaning-values-and-cultivation-procedure/46635>

**Course Outcomes**

1. The student will be able to distinguish the principle differences of mushroom cultivation from the cultivation of plants and animals.
2. The student will be able to determine the most important (ca12) species of cultivated mushrooms and knows the basic ways of the cultivation of each of them.
3. The student will be able to know the most important kinds of substrata for mushroom cultivation, belonging to the wastes of agricultural, silvi cultural and forest industry management, and have skills to prepare media for the mushroom cultivation from these wastes.
4. The student will be able to maintain mushroom farmin hygienic and scientific way cultivation.
5. The student will be able to know the disease and problems in mushroom cultivation.

**NON-MAJOR ELECTIVE**

**PAPER -2**

**APPLIED BIOTECHNOLOGY**

**Course Objectives**

1. To understand and familiarize with some of the molecular biology tools
2. It is easy to handle this technique and to apply in the agriculture, medicine, animal husbandry.

**UNIT- I**

PCR Technology: Introduction, Principle, Components of standard PCR-PCR Buffers and enzymes. Variants of PCR-Multiplex, Nested, Quantitative, RT-PCR. Medical applications of PCR.

**UNIT- II**

Vaccine Technology-Introduction, Generation of vaccine-First generation vaccines, Second generation vaccine (Cell Culture vaccine),Third generation vaccine (Recombinant and sub-unit and synthetic vaccines), fourth Generation vaccine (DNA vaccine). Medical Applications - Edible vaccines.

**UNIT- III**

RNA Technology-Introduction-Biogenesis of micro RNA, miRNA, siRNA. Applications - Medical, Veterinary and Agriculture fields.

**UNIT- IV**

Biosensor Technology- Introduction, Types, Immunosensors-Application, Medical. Blood Glucose monitoring for diabetes. Agricultural application-Pathogen detection, Food, Toxicology test. Industrial applications - Drug delivery - Military application-DID stick test.

**UNIT- V**

DNA foot printing-Southern blotting, Western blotting. Hybridoma technology-Monoclonal anti body production, application, advantages and disadvantages-DNA finger printing.

**References / Text Books**

1. Biotechnology and medicine and agriculture principles and practices -Anilkumar,
2. Applied Animal Biotechnology, V Kumaresan, Saras Publications, 2008
3. Advances in Applied Biotechnology, Tong-Cun Zhang Motowo Nakajima, Springer Link
4. Ashwan’sPareak, Sanjay Mohan Gupta. International Publishing House Pvt. Ltd. New Delhi.
5. Applied Plant Biotechnology, V Kumaresan, Saras Publications, 2008

**Course Outcomes**

1. The student will be able to know the importance of PCR technique
2. The student will be able to study about vaccines
3. The student will be able to learn about applications of RNA technology
4. The student will be able to know about Biosensors and its uses
5. The student will be able to study about blotting techniques

**LAB IN MICROBIOLOGY**

**Semester: III & IV**

**Core Practical -2**

1. Microscope - calibration using ocular stage micrometers
2. Sterilization methods
3. Preparation of culture media for bacteria and fungi
4. Isolation and enumeration of bacteria and fungi
5. Culture technique - streak plate, pour plate and spread plate
6. Measurement of bacterial growth rate
7. Identification - staining techniques, biochemical tests.

**LAB IN BIOSTATISTICS AND BASIC COMPUTER APPLICATIONS**

**Semester: III & IV**

**Allied Practical-2**

1. Collection of data and tabulation
2. Graphical representation of data-line graph, histogram
3. Diagram matic representation of data-pie diagram, bar diagram
4. Calculation of Mean, median and mode (using Neem leaves or height and weight of the students)
5. Calculation of correlation co-coefficient (r-value) for length and breadth of Neem leaves or height and weight of the students
6. Measurement of central tendencies for the given data using MS Excel
7. Calculation of r-value using MS Excel / Regression line using MS Excel
8. Drawing of graph with complete label for a given data

**LAB IN IMMUNOLOGY**

**Semester: IV**

**Core Practical-2**

1. ABO Blood Grouping and Rh Factor typing
2. RBC and WBC Count by Hemo cytometers.
3. Blood cell Analysis
4. Measurement of pulse and blood pressure.
5. Precipitation reactions (Radial immuno or Double immuno diffusion test)

**LAB IN MOLECULAR GENETICS**

**Semester: IV**

**Allied Practical-2**

1. Development of Auxotrophic mutants employing EMS
2. Screening of multiple antibiotic resistant mutants of *E. coli*
3. Replica plating technique
4. Estimation of DNA / RNA
5. Isolation of genomic DNA from plant / Bacteria/ Animal

**SEMESTER V**

**CORE PAPER - 5**

**GENETIC ENGINEERING**

**Course Objectives**

1. To impart the basic knowledge of tools used in genetic engineering, cloning vectors, PCR and DNA finger printing.
2. To make aware on vectors
3. To make understand about molecular markers

**UNIT- I**

Tools of genetic engineering - DNA polymerase, poly nucleotidekinase, alkaline phosphates, DNA ligase, nick translation systems, deoxynucleotidyltranserase, reverse transcriptase, restriction endo nucleases.

**UNIT- II**

Cloning vectors - Plasmid vectors-pBR322, PUC, Tiplasmid.Phage vectors-lambda, M13, cosmids, phagemid. Yeast vector-expression vector, shuttle vector. Plant and animal vector-CaMV, SV40.Artificial chromosomes - BAC and YAC.

**UNIT- III**

Polymerase Chain Reaction-Introduction, principle, steps involved in PCR amplification. Types of PCR, applications of PCR. Primers.

**UNIT- IV**

Molecular markers -Nuclearmarkers -RFLP, RAPD, VNTR, SSRs, AFLP, Coxgene. Mitochondrialmarkers-CO1, Cox, ITS,16SRNA, 18SRNA. DNA bar coding -introduction, components of DNAbarcoding.DNA sequencing technology-Maxamand Gilbert method, Sanger chain termination method.

**UNIT- V**

DNA finger printing, Production of recombinant proteins-insulin and HGH.Genelibraries-Establishing a library, screening the gene library, cDNA library.

**References / Text Books**

1. Genes to clones -Ernst L Winnacker, Panima Publishing House, New Delhi. (2003)
2. A text book of Biotechnology, RC Dubey, S. Chand and Company Ltd (2006).
3. Molecular Biotechnology-Bernard R Glick and Jack J Pasternak, Panima Publishing House, New Delhi (2002).
4. Biotechnology by satyanarayana (2010).
5. Genes to clones -Ernst L Winnacker, Panima Publishing House, New Delhi.(2003)
6. Gene cloning-TA brown, Blackwell Science (2001).
7. Molecular Biotechnology-Bernard R Glick and Jack J Pasternak, Panima Publishing House, New Delhi (2002).
8. [https://www.ncbi.nlm.nih.gov/probe/docs/techPCR/](https://www.ncbi.nlm.nih.gov/probe/docs/techpcr/)
9. <https://www.sciencedirect.com/topics/neuroscience/polymerase-chain-reaction>

**Course Outcomes**

1. The student will be able to learn about molecular marker
2. The student will be able to study about the important tools in genetic engineering.
3. The student will be able tolearn about different type of cloning vectors.
4. The student will be able to study about principle and different types of polymerase chain reaction
5. The student will be able to study about recombinant DNA technology.

**CORE PAPER - 6**

**INDUSTRIAL BIOTECHNOLOGY**

**Course Objectives**

1. To impart knowledge in microbial production of industrial products.
2. Industrial products and their separation techniques.
3. Media formulation.

**UNIT- I**

Introduction to biotechnology and products. Major classes of commercial products using microorganisms-enzymes, amino acids, vitamins, antibiotics, organic solvents, organic acids.

**UNIT- II**

Industrially important microorganisms: screening techniques - strain improvements - mutations, protoplast fusion and rDNA techniques for strain development.

**UNIT- III**

Bioreactors / Fermentor: Types, features, operation: sterilization (Batch and ContinuousMicrobial growth and media formulation. Microbial culture - batch, fed batch, semi-continuous, continuous. Growth kinetics of microorganisms.

**UNIT- IV**

Downstream processing: Solid-liquid separation, flotation, flocculation, filtration, centrifugation, cell disruption, concentration, evaporation, liquid-liquid extraction, membrane filtration, precipitation, adsorption. Product purification by chromatography.

**UNIT- V**

Fermented foods and Agricultural products-Production of Cheese, Yoghurt, Milk products, Bio-fertilizers -SCP, Mush room cultivation &Cyano bacteria.

**References / Text Books**

1. Manual of industrial microbiology and Biotechnology, Demain A.L. Solomon, J.J., 1986. ASM press.
2. Biotechnology, Satyanarayana, U., 2006. Books and Allied (P) Ltd.
3. Industrial Microbiology, Reed C., Prescott and Dann’s, 1982. Macmillan publishers.
4. An introduction to Genetic Engineering, Desmond, S.T., Nicholl, 1994. Cambridge press.
5. Text book of biotechnology by V.Kumaresan
6. Industrial biotechnology by N.Arumugam
7. Principles of Gene Manipulation. 4th edition, Old R.W. and S.B. Primrose, 1994. Blackwell scientific publication London.
8. Fundamentals of Biotechnology, P.Prave, P.Faust, V. Sitting, word sukatasch D., 1987. VCH verlasgetellSchafor MBH, Weinhkeim.
9. http://www.biologydiscussion.com/biotechnology/biotechnology-introduction-scope-and-applications-of-biotechnology/11608
10. https://courses.lumenlearning.com/boundless-microbiology/chapter/industrial-microbiology/
11. http://www.biologydiscussion.com/biotechnology/downstream-processing/stages-in-downstream-processing-5-stages/10160

**Course Outcomes**

1. The student will be able to know about Introduction to biotechnology and products
2. The student will be able to understand Industrially important microorganisms.
3. The student will be able to know Bioreactors / Fermentor: Types
4. The student will be able to know Downstream processing
5. The student will be able to understand Fermented foods and Agricultural products

**CORE PAPER - 7**

**BIOINFORMATICS**

**Course Objectives**

The course aims to provide the students with an experimental and computational knowledge to embrace a systems biology approach and experience authentic systems genetics research by designing and conducting independent research projects.

**UNIT- I**

Introduction about bioinformatics and biological databases- BioInformatics: Introduction, definition, objectives and scope. Application of BioInformatics.General Introduction of Biological Databases; Nucleic acid databases (NCBI, DDBJ, and EMBL), Protein databases.

**UNIT- II**

Sequence analysis -Introduction to Sequences, alignments and Dynamic Programming; Pairwise alignment (BLAST and FASTA Algorithm) and multiple sequence alignment (Clustal W algorithm) and phylogenetic analysis.

**UNIT- III**

Similarity search, gene identification and prediction -Similarity Search Introduction, Working with FASTA, Working With BLAST.Basis of gene prediction, Pattern Recognition, Gene prediction Methods, Other gene prediction tools.

**UNIT- IV**

Protein classification and structure visualisation-Overview of the Protein Structure, Protein Structure Visualization and prediction: Pymol, Rasmol, and Structure - based Protein Classification, Protein Structure databases, Protein Structure Visualization Databases and tools.

**UNIT- V**

Protein structure prediction-Protein Identification and Characterization, Primary structure analysis and Prediction, Secondary Structure Analysis and Prediction, Protein Function Prediction and Protein Prediction from a DNA Sequence., Homology modeling.

**References / Textbooks**

1. Attwood.T.K. Parry D.J. and Smith. Introduction to Bioinformatics. A joint Publications. 1999
2. Baldi, P. and Brunak, S. Bioinformatics: The Machine Learning Approach. MIT Press. 2001
3. A.D. Baxevanis and B.F.F. Ouellette (Eds). Bioinformatics: A practical guide to the analysis of genes and proteins. John Wiley and Sons. 2002
4. Gentleman, R. Bioinformatics and Computational Biology Solutions using R and Bioconductor. Springer Science and Business media Inc. 2005
5. <http://www.biologydiscussion.com/biodiversity/bioinformatics/notes-on-bioinformatics-genetics/38224>
6. <http://www.biotechnologynotes.com/bioinformatics/notes-on-bioinformatics/693>

**Course Outcomes**

1. The student will be able to learn the basics of bioinformatics.
2. The student will be able to learn about sequence analysis.
3. The student will be able to bioinformatics tools like Blast and Fasta.
4. The student will be able to learn about protein structure using protein visualizing tools.
5. The student will be able to protein and its prediction.

**INTERNAL ELECTIVE**

**PAPER -1**

**(to choose one out of three)**

1. **BIOFERTILIZER TECHNOLOGY**

**Course Objectives**

1. To make the students familiar with the Biofertilizers and its Uses .
2. To make the Students well known about Isolation and Identification methods of Biofertilizers

**UNIT- I**

An introduction to fertilizers, synthetic fertilizers, natural fertilizers, inorganic fertilizers, organic fertilizers, bio-fertilizers - importance, advantages and constraints.

**UNIT- II**

Isolation, culturing methods - Rhizobium, AzospirillumAzotobacters, blue green algae and phosphate solubilisers.

**UNIT- III**

Enumeration and identification of microbial species - Rhizobium, AzospirillumAzotobacters, blue green algae and phosphate solubilisers.Staining Techniques of Bacteria.

**UNIT- IV**

Preparation of microbial inoculants - large-scale production of microbes - their application as biofertilizers - crop responses to biofertilizers.

**UNIT- V**

Azolla - distribution, morphological and biochemical characteristics - cyanobacterial symbionts. Azolla applications and limitations.

**References / Textbooks**

1. A textbook of microbiology by R. C. Dubey
2. N.S.Subba Rao, (2000). Biofertilizers in Agriculture. Oxford & IBH publishing Co., New Delhi.
3. Daniel Sundararaj, D. and G. Thulasidas. (1993). Botany of Field Crops. (2nd Ed.) Macmilan India Ltd.
4. Jeswani, L.M. and Balddev, B. (1990). Advances in Pulse Production Technology. ICAR, New Delhi
5. Malsen, L.J.G.V. and S. Somaatmadja, (1993). PROSEA - Plant Resources of South East Asia. No.1. Pulses. International Book Distributors, Dehradun.
6. https://www.bio-fit.eu/q8/lo1-why-biofertilizers?start=4

**Course Outcomes**

1. The student will be able to understand the Biofertilizers
2. The student will be able to know the Isolation Methods of Biofertilizers .
3. The student will be able to know the Identification Methods of Biofertilizers.
4. The student will be able to know the Large Scale Production Process of Biofertilizers.
5. The student will be able to know the Large Scale Production Process of Biofertilizers.

**INTERNAL ELECTIVE**

**PAPER -1**

1. **PUBLIC HEALTH AND HYGIENE**

**Course Objectives**

1. To understand the communicable and infectious diseases
2. To learn other aspects of health care.

**UNIT- I**

Introduction to Public Health-Introduction, Definition, Significance. Evolution of Public & community health. Determinants of Health - Biological, Behavioral, Socio-economic, Cultural, Environmental, Geographical etc.

**UNIT- II**

Concept of Primary Health Care - Public Health delivery system in India-Introduction to National Health Policy - 1983&2002, National Population Policy -2005, National Rural Health Mission (NRHM) and National Urban Health Mission (NUHM), National Public Health Programs.

**UNIT- III**

Medical Terminology - Introduction to bacteriology /virology/ Mycology/ Parasitology/ Genetic diseases /Genetics /Pediatric diseases/ Problems/ Neoplasia/ Inflammation & healing.

**UNIT- IV**

Communicable & Infectious Diseases -General overview of communicable diseases, impact of communicable diseases on developing. Non - Communicable Diseases-Overview and introduction to NCDs-risk factors, prevention and management. General strategies, new approaches and policies of NCDs. NCDs programs of WHO, PAHO and Government of India.

**UNIT- V**

Occupational, Industrial and Urban Health-Occupational Safety & Health-Chemical and physical exposures, control of occupational exposures, injury control occupational health disorders and diseases. Occupational health of working population of organized and unorganized sectors -Farmers, Industrial workers, health workers, etc

**References / Textbooks**

1. World Health Organization: Report on infectious diseases and Report on Multi drug resistance, World Health Organization, Geneva
2. Principles and Practice of Medicine: Davidson, Edward, Bouchieret. Al., Pearson Professional Ltd. London, 1995
3. Global Hand book On Non-Communicable Diseases and Health Promotion By David V.Mcqueen, Springer Publication.
4. Occupational Health: Management and Practice for Health Practitioners By S.P.Hattingh, 3rd edition.
5. Urban Health: Global Perspectives edited by David Vlahov, JoIveyBoufford, Clarence E.Pearson, Laurie Norris, published by Jossey bass
6. International Journal of Hygiene and Environmental Health.
7. Journal of Public Health Hygiene and Safety.
8. https://en.wikipedia.org/wiki/Hygiene.<https://www.open.edu/openlearncreate/mod/oucontent/view.php?id=187&printable=1>
9. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4718376/

**Course Outcomes**

1. The student will be able to learn public health
2. The student will be able to understand health policy
3. The student will be able to know about medical terminology
4. The student will be able to learn communicable diseases
5. The student will be able to identify safety of working populations

**INTERNAL ELECTIVE**

**PAPER -1**

1. **ENZYME TECHNOLOGY**

**Course Objectives**

1. To learn Historic background-General Terminology of enzymes
2. To understand mechanism of enzymes, enzyme kinetics

**UNIT- I**

Introduction: Historic background-General Terminology, Nomenclature and Classification of Enzymes. Enzyme activity- chemical nature of enzymes. Protein nature of enzymes and Non protein enzymes.

**UNIT- II**

Enzyme Mechanism: Lock and key, Induced fit and Transition state Hypotheses. Mechanism of enzyme catalysis-Acid-base catalysis, covalent catalysis, Classification of coenzymes, Coenzymes and Cofactors- Prosthetic group. Reversible Inhibition-Competitive, Non Competitive, Un competitive.

**UNIT- III**

Metabolic regulation: Feedback Regulation, Allosteric Regulation, Reversible Covalent Modification and Proteolytic Activation. Organization of enzymes in the cell. Enzymes in the cell, localization, compartmentation of metabolic pathways, enzymes in membranes

**UNIT- IV**

Factors affecting the enzyme activity: Concentration, pH and temperature. Kinetics of a single-substrate enzyme catalysed reaction, Michealis - Menten Equation, Km, Vmax, L.B Plot, Turn over number.

**UNIT- V**

Clinical enzymes: Enzymes as thrombolytic agents, Anti-in flammatory agents, streptokinase, asparagines, Iso enzymes like CK and LDH, Transaminases (AST, ALT), Amylases, Cholinesterases, Phosphates. Immobilization of enzymes, ELIZA. Biosensors. Enzyme Engineering and site direct edmuta genesis, Designer enzymes

**References / Textbooks**

1. Fundamentals of Enzymology: Nicholas Price & Lewis Stevens
2. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry- Trevor Palmer
3. Biochemistry textbooks by Stryer,Voet and Lehninger (Relevant Chapters)
4. Proteins by Gary Walsh
5. Principles of Enzyme Technology, Khan M.Y, Khan Farha
6. [www.journals.elsevier.com/enzyme-and-microbial-technology](http://www.journals.elsevier.com/enzyme-and-microbial-technology)
7. https://en.wikipedia.org/wiki/Enzyme
8. https://application.wiley-vch.de/books/sample/3527329897\_c01.pdf

**Course Outcomes**

1. The student will be able to study about basics in Enzyme
2. The student will be able to learn about mechanism of Enzyme.
3. The student will be able to Study about principle and regulations of Enzyme.
4. The student will be able to learn about Kinetic activity of Enzyme.
5. The student will be able to Study about applications of enzyme.

**SKILL BASED SUBJECT**

**PAPER - 3**

**MEDICAL LAB TECHNOLOGY**

**Course Objectives**

1. To gain the knowledge of anatomy and physiology of organ system.
2. To gain the knowledge of histopathology and tissue processing.
3. To gain the knowledge of cardiac profile and heart diseases.

**UNIT- I**

General Anatomy - Cell-structure & function. Tissue - Epithelium, Connective, Sclerous muscle. Systemic anatomy - Basic features of Cardio vascular system, Respiratory system, Digestive system, Excretory system, Reproductive (Male &Female) system, Nervous system.

**UNIT- II**

Blood -Blood cells, Haemoglobin, Blood grouping, Coagulation Factors. Haematological Disorders-Classification of Anaemia-Iron Deficiency anaemia, Megaloblastic anaemia, HaemolyticAnaemia.

**UNIT- III**

Cardio vascular system-Heart rate, cardiac cycle, cardiac output, blood pressure, hypertension, radial pulse.Cardiac Profile-Description, Hypertension, Angina, Myocardial Infarction, Pattern of Cardiac Enzymes in heart diseases.Respiratory System-Ventilation, functions, Lungs- Volumes and capacities.

**UNIT- IV**

Gastrointestinal System - Process of digestion. Endocrinology - Endocrine Glands-Description. Hormones-their secretion and functions. Excretory system, Structure of nephron, Urine formation.

**UNIT- V**

Histopathology -Introduction. Basic steps for tissue processing-Fixing, Embedding, Microtomy, Staining, Mounting, methods of decalcifications.

**References / Textbooks**

1. Medical Laboratory Manual for Tropical Countries, Volume II: Microbiology, by Monica Chees brough ELBS.
2. Haematology: principles and procedures 6th Ed Lea &Febiger. 5. Bernadette F. Rodak, George A. Fritsma, Kathryn Doig (2007).
3. Haematology: Clinical Principles and Applications 3rd Ed, Elsevier Health Sciences.
4. Text book of Medical Physiology by G.K. Pal.
5. Medical Laboratory Technology by Lynch.
6. Medical Laboratory procedures Manual (T-M) by K.L.Mukherjee, Vol.I, II, III.
7. Hematology: principles and procedures 6th Ed Lea &Febiger. 5.Bernadette F. Rodak, George A. Fritsma, Kathryn Doig (2007).
8. Shirley Mitchell Lewis, Barbara J. Bain, Imelda Bates (2006) Dacia and Lewis Practical Haematology, 10th Ed, Churchill Livingstone /Elsevier.4.Barbara A. Brown (2008).
9. <https://www.academia.edu/32040390/LECTURE_NOTES_For_Medical_Laboratory_Students>
10. <https://www.sciencedirect.com/book/9780407001541/introduction-to-medical-laboratory-technology>

**Course out Comes**

1. The student will be able to know the anatomy oforgans in the human body.
2. The student will be able to understand the blood and blood related diseases.
3. The student will be able to know the cardiac profile and heart diseases.
4. The student will be able to know the gastrointestinal system and hormone secretion.
5. The student will be able to know the steps in tissue processing and staining.

**SEMESTER VI**

**CORE PAPER - 8**

**PLANT & ANIMAL BIOTECHNOLOGY**

**Course Objectives**

1. To provide the knowledge of various aspects of plant biotechnology including micro propagation.
2. To provide the knowledge of genetic improvement of plants through hybridization
3. To provide the knowledge of somatic hybridization
4. To provide the knowledge of genetic transformation.

**UNIT- I**

Introduction of plant tissue culture, basic requirements form plant tissue culture, plant tissue culture media, plant hormones and growth regulators in tissue culture, preparation of suitable explants.

**UNIT- II**

Cell culture, callus culture, anther and ovary culture for haploid plant production, somatic embryogenesis, protoplast culture, protoplast fusion, cybrids, somatic hybridization, synthetic seeds. Genetic engineering in plants-delay of fruit ripening, cytoplasmic male sterility.

**UNIT- III**

Introduction to animal cell culture, media preparation for animal cell culture, principles of sterile techniques and cell propagation- Preservation and characterization of animal cells organ culture-Cytotoxicity and viability assays.

**UNIT- IV**

Molecular diagnosis of genetic disorder, Gene therapy, transgenic animals, transgenic fish. Production of useful proteins in transgenic animals.

**UNIT- V**

Artificial insemination, super-ovulation, embryo transfer, In vitro-fertilization, pregnancy diagnosis, sexing of embryos, embryo splitting, cryopreservation of embryo.

**References / Textbooks**

1. Basic Biotechnology, S. Ignachimuthu. 1995. Tata McGraw Hill Publishers, New Delhi
2. Text book of biotechnology by U.Satyanarayana
3. Animal Biotechnology, P. Ramadas.
4. Animal cell culture, Freshney.
5. Text book of Animal biotechnology by M.M.Ranga
6. Text book of biotechnology by V.Kumaresan
7. Applied Plant biotechnology by N.Arumugam
8. Genetic engineering of animals, (Ed) A. Puhler, l993. VCH publishers Weinheim, FRG
9. <https://link.springer.com/article/10.1007/s40502-013-0039-6>
10. <https://www.microscopemaster.com/cell-culture.html>
11. <https://www.sciencedirect.com/topics/nursing-and-health-professions/anther-culture>
12. <https://www.qiagen.com/us/service-and-support/learning-hub/molecular-biology-methods/animal-cell-culture/>

**Course Outcomes**

1. The student will be able to know about basic plant tissue media preparation.
2. The student will be able to understand plant tissue culture techniques.
3. The student will be able to know animal cell media preparation and sterilization.
4. The student will be able to know transgenic animals.
5. The student will be able to understand in vitro fertilization.

**CORE PAPER - 9**

**ENVIRONMENTAL BIOTECHNOLOGY**

**Course Objectives**

1. To understand Ecosystem
2. To understand waste water treatment
3. To understand Biodegradation and xenobiotics
4. To understand Biofuel production
5. To understand Environmental Genetics

**UNIT- I**

Ecosystem - structure, functions. Energy flow and mineral cycle-C, N, P. Environmental problems -Ozone depletion, Green House Effect, Water, Air, Soil pollution, Land degradation.

**UNIT- II**

Waste water-Physical, Chemical and biological characteristics. Introduction to water microbiology, Water borne diseases. Waste water treatment - Physical, Chemical and biological. Membrane filtration and Reverse Osmosis. Waste water treatment efficiency assessment.

**UNIT- III**

Xenobiotics - Xenobiotic compounds, Biodegradation of xenobiotics, Biological detoxification, Hazardous waste management. Mining and metal biotechnology-Copper and Iron, Microbial transformation, accumulation and concentration of metals, Metal leaching -extraction.

**UNIT- IV**

Bio fuels - Introduction, Production of non-conventional fuels-Methane (Biogas), Hydrogen, Alcohols and algal hydrocarbons. Use of microorganisms in augmentation of petroleum recovery

**UNIT- V**

Environmental Genetics- Degradation plasmids (TOL), Release of genetically engineered microbes (GEM) in the environment, Impact of GEM in environment, Role of GEM in degradation of industrial pollutants. Bio sensors and microprobes.

**References / Textbooks**

1. Environmental Biotechnology by1995, S.N. Jogd and Himalaya Publishing.
2. Environmental Biotechnology by S.K.Agarwal, APH Publishing Corporation, 2001.
3. Bio degradation & Bio remediation (1999), Martin Alexander, Academic press
4. Waste water Engineering- Treatment, Disposal and Re use, Metcalf and Eddy. Inc. Tata McGraw Hill, New Delhi.1991
5. Bio remediation engineering, design and application 1995 John’s. Cookson, Jr. Mc Graw Hill, Inc.
6. Environmental Biotechnology by A.K. Chatterjee, 2004 Prentice - Hall of India Pvt. Limited.
7. Alan Scragg, Environmental Biotechnology, Longman, 1999.
8. Milton Wain Wright, An Introduction to Environmental Biotechnology, Kluwer Academic Press, 1999.

**Course Outcomes**

1. The student will be able to know ecosystem
2. The student will be able to know waste water treatment
3. The student will be able to know biodegradation of xenobiotics
4. The student will be able to know biofuel production
5. The student will be able to know environmental genetics

**INTERNAL ELECTIVE**

**PAPER -2**

**(to choose one out of three)**

1. **FORENSIC SCIENCE**

**Objective:** To understand and learn the basic knowledge of Forensic Science.

**UNIT I:Crime Scenario in India:** Introduction to crime and history, Sociological aspects of crime and criminals in society, Types of crime and its causes – property crimes, public order crimes, violent crimes, cyber-crimes.

**UNIT II:Forensic Examination of Body and Semen Fluids:** Molecular mechanisms for identification of the evidences from the criminal.

**UNIT III:Forensic Examination of Hair and Tissue:** Molecular mechanisms for identification of the evidences from the criminal.

**UNIT IV:Personal Identification:** Personal identification techniques as somatoscopy, somatometery, osteometery and craniometery their importance in determination of age and sex.

**UNIT V:Instrumentation & Investigation Techniques:**Crime Detection Devices –Microscopy –Chromatography – Documents – Ballistics - Fingerprints Examination. New and future technologies - DNA chips - SNPs and limitations of DNA profiling.

**Text Books:**

1. Dr.Rukmani Krishnamurthy. Introduction to Forensic Science in Crime Investigation.Selective and scientific books publishers and distributors, New Delhi. (2005).

2. Kirby, LT. DNA Fingerprinting Technology. Palgrave Macmillan UK. (2009).

**Books for Reference:**

1. Richard Saferstein. Criminalistics: An Introduction to Forensic Science, 9th Ed. (2001).

2. Sharma, B.R., Forensic Science in Criminal Investigation and Trial, 4th Ed. (2008).

3. Stern C, Principles of Human Genetics, Freeman, California. (2012).

**Course outcome:**

* To understand the techniques for identification of the evidences from the criminal.
* To study the personal identification aspects, molecular mechanisms and its application in forensic science.
* It helps to study the sociological aspects, mechanisms and its application in forensic science
* To know about personal identification techniques.
* To understand the molecular identifications.

**INTERNAL ELECTIVE**

**PAPER -2**

**B. SERICULTURE**

**Objective:** To understand and learn the basic knowledge of silkworm and their technology.

**UNIT-I**

**Sericulture**- Introduction, History & Scope, lifecycle of *Bombyx mori*–Egg, Larva, Pupa and Adult. Species of silk worm-Tasar silk, Muga silk &Eri silk.

**UNIT-II**

**Mori culture**–Propagation–stem cutting, grafting and layering. Harvesting methods, Preservation of leaves and Medicinal uses of mulberry.

**UNIT III**

**Rearing Facilities**-Rearing appliances for rearing- Rearing stand, Ant wells, Rearing tray, Paraffin paper, Foam rubber strips, Chopsticks, appliances for feeding-Feathers, leaf basket, leaf chamber, chopping board, chopping knife,mats,feeding stand. Silk worm rearing–Disinfection, Brushing, maintenance of temperature, Feeding, Bed cleaning, Spacing, Mounting, Moulting and Harvesting.

**UNIT-IV**

**Silk Reeling** –Methods of reeling operation –a brief account on Reeling end formation, twisting, drying, reeling, re-reeling and finishing. By products of sericulture.

**UNIT-V**

**Diseases of *Bombyx mori***– Protozoan disease – Pebrine. Bacterial disease –Flacherie. Viral disease –Grasserie. Fungal disease– Muscardine. Pest of Silkworm– Uzi fly.

**SUGGESTED BOOKS:**

1. Ganga, G. and J.Sulochana Chetty, 2006. An Introduction to sericulture. Oxford and IBH Publishing Co. Pvt .Ltd.

2. An Introduction to Sericulture -G. Ganga and SulochanaChetty.J, (1997) Oxford and IBH Publishing Co. Pvt. Ltd.

# 3.An Introduction to Sericulture-M.Madan Mohan Rao, (2019) BS Publications Co. Pvt .Ltd.

**Course outcome:**

CO1: To learn about History of silkworm & their life cycle.

CO2: The students able to understand the propagation methods of mulberry.

CO3: It will be very useful for studying step by step process in rearing technology.

CO4: And to identify the useful by products of sericulture.

CO5: To identify the diseases damage the silkworm.

**INTERNAL ELECTIVE**

**PAPER -2**

**C.ENTREPRENEURSHIP**

**Objective:** To Understand the concept and process of entrepreneurship - its contribution in and role in the growth and development of individual and the nation

**UNIT -I**

**Entrepreneurship:** Concept, Functions and need; Entrepreneurship: Characteristics and Competency ; Relevance of Entrepreneurship to Socio- Economic Gain: generating National Wealth, creating Wage and Self -Employment, Micro, Small and Medium Enterprises ; Process of Entrepreneurship Development – Start-up and its stages

**UNIT -II**

Types of Entrepreneurs: Competencies and characteristics: Ethical Entrepreneurship; Entrepreneurial Values, Attitudes and Motivation; Mindset of an employee and an entrepreneur difference; Intrapreneur: Importance in any organization

**UNIT -III**

Acquiring Entrepreneurial Values and Motivation: Entrepreneurial Values, Attitude and Motivation- Meaning and concept; Developing Entrepreneurial Motivation and Competency – concept and process of Achievement Motivation, Self-efficacy, Creativity, Risk Taking, Leadership, communication and Influencing Ability and Planning Action.

**UNIT -IV**

Entrepreneurship as Innovation and Problem Solving: Entrepreneurs - as problem solvers; Innovations and Entrepreneurial Ventures – Global and Indian ; New Industries of New Age Economy ; Role of Technology – E-commerce and Social Media.

**UNIT -V**

Entrepreneurial Opportunities and Enterprise Creation: Sensing Entrepreneurial Opportunities. Introduction to Market Dynamics: Understanding a Market ; Competitive Analysis of the Market ;Patents, Trademarks and Copyright

**SUGGESTED BOOKS:**

1. Entrepreneurial Development – Dr. S. Moharana and Dr. C.R.Dash, Pub. by RBSA Publishers, Jaipur.
2. Entrepreneurship Development – Principles, Policies and Programmes by P. Saravanavel, Publishers Ess Pee Kay Publishing House, Madras
3. Fayolle A (2007) Entrepreneurship and new value creation. Cambridge, Cambridge University Press •
4. Hougaard S. (2005) The business idea. Berlin, Springer
5. Lowe R & S Mariott (2006) Enterprise: Entrepreneurship & Innovation. Burlington, Butterworth Heinemann

**Course Outcome:**

CO1: Entrepreneurial attitude to the students

CO2: Opportunities available for the entrepreneurial support

CO3: IPR related understanding on the developed products

CO4: Market needs and dynamics both locally and globally

**INTERNAL ELECTIVE**

**PAPER -3**

**(to choose one out of three)**

1. **BIOSAFETY, BIOETHICS & IPR**

**Course Objectives**

1. To create awareness regarding safety and ethical issues
2. To know about copy rights aspects of the biotechnological products and process.

**UNIT- I**

Biosafety - Introduction, biosafety issues in biotechnology, historical background. Primary Containment for Biohazards, Biosafety Levels, Biosafety Levels of Specific Microorganisms.

**UNIT- II**

Biosafety Guidelines - Biosafety guidelines and regulations - National and International. Definition of GMOs & LMOs. Environmental release of GMOs, Risk Analysis, Assessment, management and communication.

**UNIT- III**

Bioethics - What is bioethics - legal and socioeconomic impacts of biotechnology, Public education of the process of biotechnology, making ethical concerns of biotechnology research and innovation.

**UNIT- IV**

Intellectual Property Rights - Intellectual property rights - TRIPS, GATT. International conventions patents and methods of application of patents - Legal implications - Biodiversity and farmer rights

**UNIT- V**

Patents and patent laws - Objectives of the patent system, Basic principles and general requirements of patent law. Biotechnological inventions and patent law. Legal development - Patentable subjects and protection in biotechnology. The patenting living organisms.

**References / Textbooks**

1. Beier, F.K., Crespi, R.S. and Straus, T. Biotechnology and Patent protection-Oxford and IBH Publishing Co. New Delhi
2. Hoosetti, B.B.2002. Glimpses of Biodiversity. Daya, New delhi.
3. Ethics in engineering, Martin. M.W. and Schinzinger.R. III Edition, Tata McGraw-Hill, New Delhi. 2003.
4. Senthil Kumar Sadhasivam and Mohammed, Jaabir. 2008. IPR, Biosafety and Biotechnology Management. Jasen Publications, Tiruchirapalli, India.
5. Bare Act, Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., 2007
6. Journals on Intellectual Property Laws.
7. Bioethics and Health Law Journal (BHL)
8. http://www.cbd.int/biosafety/background.shtml
9. http://web.princeton.edu/sites/ehs/biosafety/biosafetypage/section 3.html.

**Course Outcomes**

1. The student will be able to understand about biosafety
2. The student will be able to learn about the biosafety guidelines
3. The student will be able to understand about bioethics
4. The student will be able to learn about IPR
5. The student will be able to learn about patents and patent law

**INTERNAL ELECTIVE**

**PAPER -3**

**B. PHARMACEUTICAL BIOTECHNOLOGY**

**Course Objectives**

1. Biotechnology has a long promise to revolutionize the biological sciences and technology.
2. Scientific application of biotechnology in the field of genetic engineering, medicine and fermentation technology makes the subject interesting.
3. Biotechnology is leading to new biological revolutions in diagnosis, prevention and cure of diseases, new and cheaper pharmaceutical drugs.

**UNIT- I**

Introduction: Brief introduction to Biotechnology with reference to Pharmaceutical Sciences and pharmacology. History & principle of pharmacology. Drug names & classification systems. Routes of Drug administration, Absorption, Distribution and Metabolism. General principle of drug action - Pharmacokinetics, Pharmacodynamics. Measurement of drug action

**UNIT- II**

Chemotherapeutic drugs - Protein Synthesis Inhibitors, Anti-Inflammatory, Antibacterial, Antifungal, Antiviral, Antihelminthic, Anticancer Drugs. Genetic recombination and drugs-Development of hybridoma for monoclonal antibodies. Human insulin, HGH, Erythropoietins, IFN, TNF, IL, Clotting factor VIII

**UNIT- III**

Enzyme immobilization: Techniqes of immobilization, factors affecting enzyme kinetics. Study of enzymes such as hyaluronidase, penicillinase, streptokinase and streptodornase, amylases and proteases etc. Immobilization of bacteria and plant cells.

**UNIT- IV**

Micro-encapsulation: Types of microcapsules, importance of microencapsulation in pharmacy, microencapsulation by phase separation, coacervation, multi orifice, spray drying and other techniques, evaluation of micro capsules. Macro capsules: Advantages and disadvantages of capsule dosage form, material for production of hard and soft gelatin capsules.

**UNIT- V**

Design and Development of Drugs: Drug discovery process: Principles, Techniques and Strategies used in new drug discovery. Regulations for laboratory animal care and ethical requirements. Bioassays: Basic principles of bioassays, official bioassays and experimental models. Pre-clinical and clinical models employed in the screening of new drugs

**References / Textbooks**

1. R.S. Satoskar, S.D. Bhandarkar, Nirmala N. Rege, R.R. Satoskar. Pharmacology and Pharmacotherapeutics 20th Revised Edition, Popular Prakashan (P) Ltd (2014)
2. Torchilin, V. P. (2012). Immobilized enzymes in medicine (Vol. 11). Springer Science & Business Media.
3. S.S. Purohit, Kaknani, Saleja Pharmaceutical Biotechnology
4. Handbook of Encapsulation and Controlled Release by Munmaya Mishra first edition CRC Press
5. Pharmaceutical manufacturing handbook production and processes by shayne cox gad, A John Wiley & Sons, Inc., Publication
6. Drugs: From Discovery to Approval by Rick Ng, 3rd Edition, Wiley-Blackwell
7. Research and Reviews: A Journal of Pharmacology
8. The Journal of Pharmacology and Experimental Therapeutics by American society of pharmacology and Experimental Therapeutics
9. The Journal of Pharmacology & Pharmacotherapeutics (JPP), a publication of Phcog.Net, published by Medknow Publications and Media Pvt. Ltd.
10. H.P. Rang, M.M. Pale, J.M. Moore, Churchill Livingston. Pharmacology.
11. N.Murugesh, A concise Text Book of Pharmacology. Sixth edition. Sathya Publishers, Madurai.
12. R.C. Dubey, A Text Book of Biotechnology. S.Chand& Co Ltd, New Delhi.
13. Lynn Wecker, Lynn Crespo, George Dunaway, Carl Faingold and Stephanie Watts. Brody's Human Pharmacology, Elsevier 5th Edition 2010.
14. <https://www.healthline.com/health/administration-of-medication#takeaway>
15. <http://howmed.net/pharmacology/routes-drug-administration/>
16. <https://www.nature.com/scitable/topicpage/genetic-recombination-514/>
17. <https://www.fda.gov/patients/drug-development-process/step-1-discovery-and-development>
18. <https://ebrary.net/18050/environment/application_immobilized_enzymes_pharmaceutical>
19. <https://wis-wander.weizmann.ac.il/space-physics/immobilized-enzymes-used-pharmaceutical-industry>

**Course Outcomes**

1. The student will be able to learn about Drugs and their action in our body
2. The student will be able to learn about Chemotherapeutic drugs, Genetic recombination and drugs
3. The student will be able to learn about Enzyme immobilization and its application in pharmaceutical industry
4. The student will be able to learn about current trending microencapsulation technique
5. The student will be able to learn about Designing and Development of Drugs

**INTERNAL ELECTIVE**

**PAPER -3**

**C. HORTICULTURE & LANDSCAPING**

**Course Objectives:**

The course aims to provide a good knowledge on the art of gardening and horticulture - the principle, types and establishment of home gardens.

**UNIT - I**

Introduction-Importance and scope of horticulture. Classification of horticultural crops -fruits and vegetables. Types of gardens: formal, informal, vertical and roof and kitchen gardens.

**UNIT - II**

Plant propagation-Plant propagation methods: cutting, layering, budding and grafting. Stock -scion relationship in important horticultural crops. Use of plant growth regulators in horticulture: Induction of rooting, flowering, fruit set, fruit development and control of fruit crops.

**UNIT - III**

Nursery structures and Garden Practices-Store house, potting and packing shed, nursery beds, mist chamber, propagating frames, hot beds, green house and glass house. Pot culture: Selection of pots, preparation of soil mixture, potting repotting and pot arrangements and watering. Aftercare of plants: weeding, mulching, top dressing methods of pruning, pricking, topiary. landscaping, Plants suitable for hedges and edges

**UNIT - IV**

Floriculture-Floriculture: cultivation of commercial flowers - Rose, Jasmine and Chrysanthemum. Cut flowers - flower preservation methods, flower arrangement, Ikebana.

**UNIT - V**

Landscaping-Principles, categories and components of landscaping - Planning designs for residential and non- residential gardens - vertical landscaping-Plants in the landscape - establishment, maintenance of lawns and planting methods of grass.

**References / Textbooks**

1. Kumar, H.D., 2010. Introduction to Horticulture, Oxford & IBH Publishers, New Delhi.
2. Hariharan, Y. ThottaKalaiyumThottaviyalum (Tamil), BharathidhasanUniversity Publications, Tiruchirappalli.
3. Chadha, 2001. Hand Book of Horticulture, ICAR Publications.
4. EdmentSenn Andrews, 1994. Fundamentals of Horticulture. Tata McGraw Hill publishing Co. Ltd, Delhi.
5. MacMillan H, 1989. A Hand Book of Tropical Plants & Gardening, Anmol Publications,
6. New Delhi.
7. Randhava, G. S., 1973. Ornamental horticulture in India, Today and Tomorrow Printers
8. and Publishers, New Delhi.
9. Yawalkar, K. S., 1961.Vegetables crops of India,Agri-Horticultural Publishing House, Nagpur.
10. Chauhan, D. V. S., 1981.Vegetable Production in India, Ram Prasad Publications, Agra.

**Course outcomes:**

1. The students will be able to gain knowledge on the horticultural crop propagation techniques, export, import and marketing value of horticultural crops.
2. The students will understand the principles of plant growth, quality, nutritional value, yield and resistance to insects, diseases, and environmental stresses.
3. The students will be able to elucidate the importance of kitchen garden, horticultural crops, gardening and organic farming.
4. The students will acquire knowledge on entrepreneurship related to horticulture.
5. The students will be aware of job opportunities in the fields of horticulture, seed production, fertilizers, landscaping and gardening.

**SKILL BASED SUBJECT**

**PAPER - 4**

**INDUSTRIAL WASTE MANAGEMENT**

**Course Objectives**

1. To understand the industrial pollution and how it affects the human health also the prevention and control of the hazardous wastes.
2. To expose the students to understand the waste management and its recycle, reuse and its applications.
3. To provide adequate knowledge on pollutions from major industries and the wastewater reclamation concepts.
4. To learn about the methods used for waste minimization and finally the knowledge about the pollution prevention.
5. To make the student to understand about the waste treatment and disposal and to know the methods of handling these problems.

**UNIT- I**

Types of industries and industrial pollution - Characteristics of industrial wastes - Population equivalent - Bioassay studies - Effects of industrial effluents on streams, sewer, land, sewage treatment plants and human health Environmental legislations related to prevention and control of industrial effluents and hazardous wastes.

**UNIT- II**

Waste management Approach - Waste Audit - Volume and strength reduction - Material and process modifications - Recycle, reuse and byproduct recovery - Applications.

**UNIT- III**

Sources, Characteristics, waste treatment flow sheets for selected industries such as Textiles, Tanneries, Pharmaceuticals, Electroplating industries, Dairy, Sugar, Paper, Distilleries, Steel plants, Refineries, Fertilizer, Thermal power plants - Wastewater reclamation concepts.

**UNIT- IV**

Source reduction, Waste segregation schemes, Waste recycling and reuse, Pretreatment of wastes; USEPA’s waste management hierarchy Multimedia and integrated approaches to waste management, Pollution prevention programs.

**UNIT- V**

Overview of waste treatment technologies, Domestic wastewater and trade effluent treatment plants, Operation and control of wastewater treatment plants and air pollution control systems, Disposal of treated effluents, Scrap management, Strom water management, Management and handling of solid and hazardous wastes.

**References / Textbooks**

1. Industrial pollution control: Issues and Techniques Second Edition Nancy J. Sell (1992) Wiley-Blackwell.
2. Handbook of Industrial and Hazardous Waste Treatment second edition, revised and expanded Lawrence K. Wang and two more (2004).
3. Solid Waste Technology and management, Thomas H. Christensen (2010).
4. Re-use and Recycling of materials: solid waste management and water treatment, AngeNzihou, Sabu Thomas, NandakumarKalarikkal and Jibin K.P (2019).
5. Industrial WasteWater Treatment, A.D. Patwardhan (2017).
6. Wastewater Treatment concepts and designing approach, G.L. Karia and R.A. Christian (2013).
7. Handbook of Solid Waste Management and Waste minimization Technologies 1st edition, Nicholas P Cheremisinoff (2002).
8. Pollution Prevention: Fundamentals and Practice, Paul L. Bishop (1999).
9. Waste treatment technologies, Prof. Dr. Mahendra Pal (2015).
10. Solid and Hazardous Waste Management, S.C. Bhatia (2008).
11. AshrafulKabir et al., (2019). Heavy metals in egg contents of Hens (Gallus gallusdomesticus) and Ducks (Anasplatyrnhyncas) from Chittagong region, Bangladesh. Journal of pollution effects and control.
12. VsevolodMymrin et al., Hazardous industrial wastes treatment for production of environment friendly materials, journal of pollution effects and control.
13. Marin Khan and Md. Tarique (2019). Industrial pollution in Indian industries: A Post reform scenario, journal of enemy research and environmental technology (JERET).
14. Mika ilomaki and MattiMelanen (2001). Waste minimization in small and medium sized enterprises do environmental management systems help, journal of cleaner production.
15. Wesley Eckenfelder, “Industrial Water Pollution Control”, Second edition, McGraw Hill, 1989.
16. https://www.conserve-energy-future.com/cause-effects-of-industrial-pollution.php
17. https://en.m.wikipedia.org/wiki/waste\_treatment

**Course Outcomes**

1. The student will be able to get an insight into the pollution form major industries including the sources and characteristics of pollutants.
2. The student will be able to understand the plan of waste management approaches and applications.
3. The student will be able to learn the design facilities for the understand the pollution form major industries
4. The student will get an idea to identify and formulate waste minimization.
5. The student will be able to acquire a knowledge about the develop conceptual schematics required for the treatment of industrial water and industrial waste water treatment.

**LAB IN GENETIC ENGINEERING**

**Semester: V& VI**

**Core Practical-3**

1. Isolation of plasmid DNA
2. PCR amplification of marker gene
3. Separation of DNA by agarose gel electrophoresis
4. Restriction digestion of DNA (Optional)

**LAB IN INDUSTRIAL BIOTECHNOLOGY**

**Semester: V & VI**

**Core Practical-4**

1. Isolation of industrially important bacteria
2. Isolation of industrially important fungi (yeast)
3. Immobilization of yeast, microbes and enzyme
4. Microbial Production and estimation of ethanol.

**LAB IN PLANT & ANIMAL BIOTECHNOLOGY**

**Semester: VI**

**Core Practical-3**

1. Plant culture media preparation and sterilization.
2. Explant selection, sterilization and inoculation.
3. Callus culture/ Anther culture
4. Isolation and quantification of DNA in plant tissue by spectrophotometer.
5. Protoplast isolation and culturing.
6. Preparation of animal cell culture media and sterilization.
7. Cell counting and viability. (Optional)

**LAB IN ENVIRONMENTAL BIOTECHNOLOGY**

**Semester: VI**

**Core Practical-4**

1. Estimation of total solids in industrial wastes
2. Analysis of TDS in industrial wastes
3. Estimation of suspended solids in effluent water
4. Determination of COD and BOD in sewage water
5. Analysis of Microbial contamination in air by open plate method

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