Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Biotechnology

CHOICE BASED CREDIT SYSTEM (CBCS)

SEMESTER PATTERN

(Revised Syllabus 2021-22)

शिव छत्रपती
शिक्षण संस्था
लातूर
।। आरोह तमसो ज्योतिः।।

SYLLABUS FOR

B.Sc.III Year (Biotechnology)

Rajarshi Shahu Mahavidyalaya, Latur (Autonomous)

Department of Biotechnology

Choice Based Credit System

Course Structure of B.Sc. Biotechnology Third Year

B. Sc. III [Biotechnology] Semester V

	Code No.	Title of the course	Hours/ Week	Marks (50)		Credits	Total
				In Sem	End Sem		
DSET1	U- RDT-627	Recombinant DNA Technology	04	20	30	03	50
DSET2	U-MIT-628	Microbial Technology	04	20	30	03	50
DSET3	U-ANB-629	Animal Biotechnology	04	20	30	03	50
DSET4	U-DEB-630	Developmental Biology	04	20	30	03	50
DSET5	U-FON-631	Food Nutrition	04	20	30	03	50
DSET6	U-NBT-632	Nano Biotechnology	04	20	30	03	50
DSEP1	U-LAC-633	Lab Course XVII (Practical based on U-RET-607)	03	20	30	02	50
DSEP2	U-LAC-634	Lab Course XVIII (Practical based on U-MIT-608)	03	20	30	02	50
DSEP3	U-LAC-635	Lab Course XIX (Practical based on U-ANB-609)	03	20	30	02	50
DSEP4	U-LAC-636	Lab Course XX (Practical based on U-DEB-610)	03	20	30	02	50
DSEP5	U-LAC-637	Lab Course XXI	03	20	30	02	50
DSEP6	U-LAC-638	Lab Course XXI	03	20	30	02	50
SEC3	U-ADC-540-B U-ADC-540-H	Biofertilizer (Part I)/ Horticulture	03	20	30	02	50
	U-ENS-541	Environmental Studies	02			GRADE	
		Total Credits				22	450

B.Sc. III [Biotechnology] Semester VI

	Code No.	Title of the course	Hours / Week	Marks (50)		Credits	Total
				In Sem	End Sem		
DSET1	U-COB-727	Computational Biology	04	20	30	03	50
DSET2	U-PBT-728	Pharmaceutical Biotechnology	04	20	30	03	50
DSET3	U-BDS-729	Biodiversity and Systematic	04	20	30	03	50

DSET4	U-ABT-730	Agriculture Biotechnology	04	20	30	03	50
DSET5	U-SGE-731	Structural Genomics	04	20	30	03	50
DSET6	U-MBC-732	Medical biochemistry	04	20	30	03	50
DSEP1	U-LAC-733	Lab Course XXI (Practical based on U-COB-705)	03	20	30	02	50
DSEP2	U-LAC-734	Lab Course XXII (Practical based on U-PHB-706)	03	20	30	02	50
DSEP3	U-LAC-735	Lab Course XXIII (Practical based on U-BIS-707)	03	20	30	02	50
DSEP4	U-LAC-736	Lab Course XIV(Practical based on U-AGB-708)	03	20	30	02	50
DSEP5	U-LAC-737	Lab Course XXIII (Practical based on	03	20	30	02	50
DSEP6	U-LAC-738	Lab Course XIV(Practical based on	03	20	30	02	50
Project Work	U-PRW-713	Lab Course XV (Project Work)	03		100	04	100
SEC3	U-ADC-640-B U-ADC-640-S	Biofertilizer (Part II)/ Solid Waste Management	03	20	30	02	50
		TOTAL	34			26	550

Note: For DSE choose any four per Semester

Statement showing number of credits and marks for B.Sc. Biotechnology Programme

Class	**Credits**	**Marks**
B.Sc. BT I Yr	22+22=44	450+450=900
B.Sc. BT II Yr	24+24=48	500+500=1000
B.Sc. BT III Yr	22+26=48	450+550=1000
Total	**140**	**2900**

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CHOICE BASED CREDIT SYSTEM
B.Sc. Biotechnology (Semester Pattern)
V Semester

Course Title: Recombinant DNA Technology **Course Code: U-RDT-627**

Marks 50 **Credit: 03**

Learning Objectives

Understand the methods of genetic manipulations in living organisms

List out tools used for gene exploration.
Utilize the knowledge on creation of a genomic and c-DNA library.
Understand the ethical consideration in about transgenic plants & animals.
Learn the tools and techniques used for genetic manipulation of living organisms

Course Outcomes

Understand the difference between old biotechnology and modern biotechnology

Provide examples of current applications of biotechnology and advances in the different areas like medical, microbial, environmental, bioremediation, agricultural, plant, animal, and forensic.

Understand the concept of recombinant DNA technology or genetic engineering

Describe DNA fingerprinting, and restriction fragment length polymorphism (RFLP) analysis and their applications

Describe the steps involved in the production of biopharmaceuticals in microbial and mammalian cell systems

Explain the concept and applications of monoclonal antibody technology

Explain the general principles of generating transgenic plants, animals and microbes.

UNIT-I:
Principles of Gene cloning

Molecular tools and their applications: Restriction Endonuclease and their types, DNA Ligases, Alkaline phosphatase. Vectors {Plasmids (pBR322, pUC18/19), Bacteriophages (λ Phage, M 13 Phage) and Cosmids.} Gene cloning strategies- insertion of DNA molecule into a vector (Transformation, Conjugation, Electroporation, Agrobacterium-mediated transformation).

UNIT -II:

r- DNA Techniques.

Blotting techniques: Southern Blotting, Northern Blotting, Western Blotting, Dot Blot Blotting, Autoradiography. DNA Sequencing: Sanger's and Maxam Gilbert's Method. PCR: Mechanism, Types and Application. DNA chips (Micro array),DNA-Protein interaction, Protein-Protein interaction.

UNIT-III:

Library construction and screening

Cosntruction of Genomic library Maniatis Strategy, cDNA cloning with conventional cDNA and full length cDNA.-genomic library. Nucleic Acid Probe, Screening of library-Probe based direct and indirect methods.

UNIT - IV:

Applications of r-DNA technology.

Agricultural and Industrial Applications : i) BT-Cotton, ii) Transgenic maize, iii)Golden rice iv) Protein engineering to Improve Detergent Enzymes. Pharmaceutical Applications : i) Recombinant Human Insulin ii)Hepatitis B-vaccine iii) Monoclonal Antibodies iv)Clotting factors v) Tissue Plasminogen Activator vi) Erythropoietin v) Human growth hormone.

Text & References:

1. Principles of Gene Manipulation and Cloning - Old & Primrose.

2. Gene Manipulation and Cloning – Christopher Howe.

3. Molecular Biotechnology -Glick

4. Molecular Cloning- A practical approach-T.A. Brown.

5. Genomes 3 - T.A.Brown.

6. Genetic Engineering – Sandhya Mitra

7. Genes – B. Lewin

8. Text book of Biotechnology – U Satyanarayan Arora M.P (2003), Biotechnology, Himalaya Pub.House, Mumbai.

9. Jogdand S.N (2006)- Gene Biotechnology, Himalaya Publishing House, Mumbai.

10. Joshi P (2002) - Genetic Engineering and its applications,Agrobios Pub, Jodhpur.

11. Mitra Sandhya (2006) - genetic Engineering, MacMillan India Ltd,Delhi.

12. Satyanarayana U. (2007) - Biotechnology, Books and Allied Pvt. Ltd .Kolkata.

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CHOICE BASED CREDIT SYSTEM
B.Sc. Biotechnology (Semester Pattern)
V Semester

Course Title: Lab course XVII **Course Code: U-LAC-633**

Marks 50 **Credit: 02**

Course Outcomes

- Students will be able to perform practical's related to recombinant DNA technology

Practicals :

1. Isolation of Genomic DNA from Bacterial cell.
2. Isolation of Plasmid DNA from resistant clinical isolates.
3. Agarose gel electrophoresis and restriction digestion of DNA.
4. Ligation of DNA
5. Preparation of competent cells and Bacterial transformation
6. Screening of recombination by blue white selection.
7. Southern blotting
8. Western blotting
9. PCR amplification of isolated bacterial genomic DNA using universal primers
10. Extraction and purification of amplified DNA fragment from gel.
11. RFLP
12. RAPD
13. GFP cloning

14. Visit to Molecular Biology & Genetic Engineering Research Laboratory

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CHOICE BASED CREDIT SYSTEM
B.Sc. Biotechnology (Semester Pattern)
V Semester

Course Title: Microbial Technology **Course Code: U-MIT-628**

Marks 50 **Credit: 03**

Learning Objective

To evaluate the role of microorganisms in specific biotechnological processes

To explain the complex processes behind the development of genetically manipulated organisms.

Course Outcome

Demonstrate a clear understanding of how biochemical pathways relate to biotechnological applications

Conduct a comprehensive search for original research literature pertinent to a selected area of microbiology and biotechnology.

Understanding of upstream and downstream processes.

- Understanding of Quality Control, Process Economics and GLP**.**

UNIT I **(12)**

Microbial Growth

Microbial Biotechnology –Historical perspectives

Microbial growth kinetics: Continuous culture, Batch culture, fed Batch culture, Thermodynamics of Growth, Fermentation concept and types.

Basic nutrition & metabolism. Novel pathways of microorganisms.

UNIT II **(15)**

Down Stream Processing.

Removal and Recovery of cell mass (Precipitation, Filtration and Centrifugation). Cell disruption: Physical and Chemical methods. Purification of Product: Liquid-liquid extraction,

Solvent Recovery. Chromatography: Adsorption, Ion-exchange, HPLC. Membrane processes: Ultrafiltration and Reverse Osmosis. Drying and Crystallization.

UNIT -III

Fermentation Processes.

Fermentation processes: Microorganisms involved, Inoculum preparation, Medium used, Fermentation process, Recovery. Enzyme: Protease, Pectinase. Organic acid: Citric acid. Antibiotic: Penicillin, Erythromycin. Vitamin: Vitamin B12, vitamin B2.

UNIT- IV :

Quality Control, Process Economics and GLP.

Sterility testing. Pyrogen testing. Carcinogenicity testing. Toxicity testing.

Fermentation Economics: Cost Estimates, Process Design ,Capital Cost Estimates, Operating Cost Estimates. Good Laboratory Practices.

Text & References :

1. Casida L.E (1991) - Industrial Microbiology, Wiley Eastern, New Delhi.

2. Crueger W and Crueger A (2000) - Biotechnology: A Textbook of Industrial Microbiology, 2nd Edi. Panima Publishing Corporation, New Delhi.

3. Patel A.H. (2004) - Industrial Microbiology, Macmillan India Ltd.,New Delhi.

4. Peppler H.J and Perlman D (2006) - Microbial Technology,Vol I and II,Academic Press,New
York.

5. Parihar Pradeep (2007) - A textbook of Biotechnology, Student edition, Jodhpur.

6. Stanbury P.F., Whitaker A. and Hall S.J (1997) - Principles of Fermentation Technology, Aditya Books Pub., Ltd., New Delhi.

7. Satyanarayana U. (2007) - Biotechnology, Books and Allied Pvt.Ltd.Kolkat

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CHOICE BASED CREDIT SYSTEM
B.Sc. Biotechnology (Semester Pattern)
V Semester

Course Title: Lab Course XVIII **Course Code: U-LAC-634**
Marks 50 **Credit: 02**

Course Outcome

- Critically evaluate the role of micro-organisms in specific biotechnological processes
- Students will be able to development genetically manipulated organisms.
- Students will be able to develop skills in production of organic acid and solvents

Practical:-

1. Production of primary and secondary metabolite (one organic acid and one antibiotic)
2. Biomass production (Baker's yeast and Spirulina) 2P
3. Production of beverages (alcohol, wine) 2P
4. Immobilization of yeast on calcium alginate
5. Estimation of the fermentation products by titration method 2P
6. Estimation of fermentative product (Acetic acid from vinegar).
7. Production of cheese using different substrate from microorganism.
8. Isolation & identification of bacteria from different milk & water samples.
9. Visit to Fermentation Industry

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CHOICE BASED CREDIT SYSTEM
B.Sc. Biotechnology (Semester Pattern)
V Semester

Course Title: Animal Biotechnology **Course Code: U-ANB-629**

Marks 50 **Credit: 03**

Learning Objectives

To know the exact infrastructure and useful and desirable facilities for developing cell culture labs.

To know the traditional practices with certain modifications and emphasis on the need to improve the existing methodologies.

To cater the curiosity and knowledge about newer approaches regarding transgenic cloni9ng artificial vaccine etc.

To study the interpretation and relationship via forensic and evolutionary studies particularly in animal biotechnology and conservation of endangered animals.

Course Outcomes

The students would be well aware about basic infrastructure and culture technique of ATC.

Students would be more beneficial to understand the process concerning with veterinary and biotechnology day to day practices and approaches.

Students would be more curious and methodical and innovative by studying the approaches and would formulate newer strategies to establish the betterment.

Unit-I

Structure of animal cell, history of animal cell culture, cell culture media and reagents, culture of mammalian cells, tissues and organs, primary culture, secondary culture, continuous cell lines, suspension cultures, somatic cell cloning and hybridization, transfection and transformation of cells, commercial scale production of animal cells, application of animal cell culture for *in vitro* testing of drugs, testing of toxicity of environmental pollutants

in cell culture, application of cell culture technology in production of human and animal viral vaccines and pharmaceutical proteins

Unit –II

Introduction to the concept of vaccines, conventional methods of animal vaccine production, recombinant approaches to vaccine production, hybridoma technology, phage display technology for production of antibodies, commercial scale production of diagnostic antigens and antisera, animal disease diagnostic kits.

Unit-III

Structure of sperms and ovum, cryopreservation of sperms and ova of livestock, artificial insemination, super ovulation, *in vitro* fertilization, culture of embryos, cryopreservation of embryos, embryo transfer, embryo-spliting, embryo sexing, transgenic manipulation of animal embryos, different applications of transgenic animal technology, animal viral vectors, animal cloning basic concept, cloning from- embryonic cells and adult cells, cloning of different animals, cloning for conservation of endangered species, ethical, social and moral issues related to cloning, *in situ* and *ex situ* preservation of germplasm, *in utero* testing of foetus for genetic defects, pregnancy diagnostic kits, antifertility animal vaccines.

Unit-IV

Transgenic animal production and application in expression of therapeutic proteins, Immunological and nucleic acid based methods for identification of animal species, detection of meat adulteration using DNA based methods, and detection food/feed adulteration with animal protein, identification of wild animal species using DNA based methods using different parts including bones, hair, blood, skin and other parts confiscated by anti-poaching agencies.

Reference:-

- Gordon I. 2005. Reproductive Techniques in Farm Animals. CABI.
- Kindt TJ, Goldsby RA & Osbrne BA. 2007. Kuby Immunology. WH Freeman.
- Kun LY. 2006. Microbial Biotechnology. World Scientific.
- Levine MM, Kaper JB, Rappuoli R, Liu MA, Good MF. 2004. New Generation Vaccines. 3 rd Ed. Informa Healthcare.
- Lincoln PJ & Thomson J. 1998. Forensic DNA Profiling Protocols. Humana Press.
- Portner R. 2007. Animal Cell Biotechnology. Humana Press.
- Spinger TA. 1985. Hybridoma Technology in Biosciences and Medicine. Plenum Press.
- Twyman RM. 2003. Advanced Molecular Biology. Bios Scientific

CHOICE BASED CREDIT SYSTEM

B.Sc. Biotechnology (Semester Pattern)

V Semester

Course Title: Lab Course XIX **Course Code: U-LAC-635**
Marks 50 **Credit: 02**

Course Outcomes

- The students would be well aware about basic infrastructure and culture technique of ATC.
- Students will learn to handle cell line

Practicals

1. Laboratory organization of Animal tissue culture and safety rules
2. Sterilization of glassware and equipment
3. Media and reagent preparation and its sterilization
4. Differential leucocyte count
5. Total leucocyte count by haemocytometer
6. Viability testing
7. Establishment of primary culture by chick embryo
8. Disaggregation of animal tissue for primary culture establishment
9. Study visit to centers for AI, Pet clinic, food adulteration testing laboratories and Veterinary Science Departments.
10. Study visit to Research Institute/Industries concern to ATC

CHOICE BASED CREDIT SYSTEM

B.Sc. Biotechnology (Semester Pattern)

V Semester

Course Title: Developmental Biology **Course Code: U-DEB-630**

Marks 50 **Credit: 03**

Learning Objectives

Understand the molecular and cellular mechanisms of development

Learn about basic embryology

Strengthen understanding of the design and interpretation of biological experiments

Gain experience reading the primary developmental biology literature

Course Outcomes

Students understand the basics of embryology and can interpret biological experiments related to animal development.

UNIT I-How development works in Animals **17**

Developmental biology-Introduction, Present and future impact of developmental biology on biology.

Gametogenesis-Spermatogenesis and Oogenesis in animals;

Fertilization in animals

Embryonic Development in Animals – Blastulation, gastrulation, Germ layers , Neurulation

1. ***Drosophila melanogaster***
2. ***Xenopus laevis***
3. **The Chick(** *Gallus gallus***)**

UNIT II- 08

Cell division and Growth,
Cell lineage
Apoptosis and Aging
Abnormal development
Teratogens and Teratogenesis

Unit III **10**

Morphogenesis

Stem cell, Cell fate and potency, Organogenesis, Axes and symmetry determination

Developmental commitment

Fate Determinants, Inducers (induction), Competence, Potency, Determination (commitment/specification), Differentiation

Control of gene expression

Signaling systems -inducers, Signal (ligand) Binds receptor

Receptor is altered: modification/ second messengers/ cascade

And alters cell function via changing = metabolism, gene expression, shape Leading to change in fate

Drosophila melanogaster-Role of genes in Patterning during development

Regeneration of missing parts in animals-Planarian regeneration, vertebrate limb Regeneration

UNIT IV-.Plant Development **10**

Plant Life Cycles

Gamete Production in Angiosperms

Pollination, Fertilization in plant

Germination, Senescence

Embryonic Development in plant

Embryonic Development in

Monocotyledonous plant

Arabidopsis thaliana (A dicotyledonous plant)-Role of genes in embryogenesis, Role of genes in Organogenesis-Shoot patterning, Root patterning, Leaf Patterning, Flower patterning

Reference Books:

1. *Developmental Biology*, 8th edition (2006), S.F. Gilbert. Publisher - Sinauer Associates Inc.

2. *Principles of Development*, 3rd edition (2007), Lewis Wolpert, Publisher- Oxford University Press.

3. *An Introduction to Embryology*, 5th edition (2004), B. I. Balinsky. Publisher - Thomas Asia Pvt. Ltd

4. *Developmental Biology*, (2001), R. M. Twyman, Publisher - Bios Scientific Publishers LTD

5. N. Arumugam (1994) Developmental Biology, Saras Publication, Nagercoil.

6. A practical Guide to Developmental Biology(international student edition), Melissa A. Gibbs, Oxford university press.

7. Developmental Biology by Veerbala Rastogi

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CHOICE BASED CREDIT SYSTEM
B.Sc. Biotechnology (Semester Pattern)
V Semester

Course Title: Lab Course XX **Course Code: U-LAC-636**
Marks 50 **Credit: 02**

Course Outcomes

- Student will be able seek knowledge related to animal and plant embryology

PRACTICALS:

1. Introduction to developmental biology-embryo protocols, ethics, and model Systems.
    - General embryo protocols and ethics (1 practical)
2. Study of frog development by using permanent mounted slides from zygote to Tadpole.
3. Study of chick development by using permanent slides from 18 hours to 96 hours Of chick embryos.
4. Study types of egg by using charts, as well as real specimen eggs.
5. A study of chick blastodisc for their feature from hen egg.
6. A study of chick development up to eight days through egg incubation, candling andEgg dissection technique.
7. A study of different types of sperms and its features by using charts.
8. A study of pollen genesis by using T.S. of Anther preparation technique.
9. A study of T.S. of ovary for arrangement of ovules within ovary.
10. A study of Flower development from vegetative shoot of any suitable plant.
11. A study of morphological and anatomical changes in plants- (about tissue organisation) during plant development from germinated seed, seedling and other stages of development.

CHOICE BASED CREDIT SYSTEM

B.Sc. Biotechnology (Semester Pattern)

V Semester

Course Title: Biofertilizer I **Course Code: U-ADC-540(B)**
Marks 50 **Credit: 02**

Learning objective:

This course aims to give the student an overview of Biofertilizers and its mechanism of action agriculture system. In particular, this module will focus on production steps of different Biofertilizers for various crops.

Course Outcomes:

Explains MoA of various Biofertilizers

Describe productions steps and specific requirements for each Biofertilizers

To make skilled manpower for Biofertilizer industry

Course can generate opportunities of self entrepreneurship among students

Unit I **8L**

General account about the microbes used as biofertilizer – *Rhizobium* – isolation, identification, mass multiplication, carrier based inoculants, Actinorrhizal symbiosis.

Practical 1: Isolation and characterization of Rhizobium
Practical 2: Mass production and carrier based inoculum preparation of Rhizobium

Unit II **10L**

Azospirillum: isolation and mass multiplication – carrier based inoculant, associative effect of different microorganisms. *Azotobacte*r: classification, characteristics – crop response to Azotobacter inoculum, maintenance and mass multiplication.

Practical 1: Isolation and characterization of *Azospirillum* and *Azotobacte*r

Practical 2: Mass production and carrier based inoculum preparation of *Azospirillum* and *Azotobacte*r

Unit III **6L**

Cyanobacteria (blue green algae), Azolla and Anabaena azolla association, nitrogen fixation, factors affecting growth, blue green algae and Azolla in rice cultivation.

Practical 1: Isolation and characterization of Cyanobacteria from water bodies
Practical 2: Production of Cyanobacteria based flakes

Unit IV **6L**

Phosphate solubilizing microbes (any one / consortia) - Isolation, characterization, mass inoculum production, field Application

Practical 1: Isolation and characterization of PSM from soil
Practical 2: Mass production and carrier based inoculum preparation of PSB

Reference Books:

1. Dubey, R.C., 2005 A Textbook of Biotechnology S.Chand & Co, New Delhi.
2. Kumaresan, V. 2005, Biotechnology, Saras Publications, New Delhi.
3. Sathe, T.V., 2004, Vermiculture and Organic Farming. Daya publishers.
4. Subha Rao, N.S. 2000, Soil Microbiology, Oxford & IBH Publishers, New _Delhi.
5. Vayas,S.C, Vayas, S. and Modi, H.A. 1998 Bio-fertilizers and organic _Farming Akta Prakashan, Nadiad
6. Kannaiyan, S., 2003, Biotechnology of Biofertilizers. CHIPS, Texas.
7. Rai, M.K., 2005, Hand book of Microbial Biofertilizers. The Haworth Press, Inc. New York

CHOICE BASED CREDIT SYSTEM

B.Sc. Biotechnology (Semester Pattern)

V Semester

Course Title: Horticultural Practices **Course Code: U-ADC-540(H)**

Marks 50 **Credit: 02**

Learning Objective:

- Understand the methods of horticultural practices in agriculture
- List out the tools and utensil for practices
- Utilize the knowledge on creation of own Nursery
- Learn the tools and techniques used for effective practice.

Course Outcome:

- Understand the difference between the real practices and traditional practices.
- Understand the concept by practical utilization and day to day practice for plant production
- Understand the overall practices concerning effective management of agricultural practices.

Unit – I

Introduction and Principles of Horticulture practices:

Definition of Horticulture. Importance of horticulture in terms of economy, production, employment. Generation, environmental protection and human resource development. Scope for horticulture in India. Nutritive value of horticultural crops. Divisions of horticulture with suitable examples and their importance.

Unit – II

Definition of a nursery. Different types of nursery beds – flatbeds, raised beds and sunken Beds, their merits and demerits. Different nursery techniques and their management. Vegetable gardens, nutrition and kitchen garden, truck garden, Vegetable forcing, Market

gardens and roof gardens. Different steps in planning and layout establishment and management of orchards.

Unit – III

Pruning: Definition, objectives. Principles and methods of pruning of fruit crops.

Training: Definition, objectives. Principles and methods of training of fruit crops: Open center, closed center and Modified leader systems, their merits and demerits.

Irrigation: definition, different methods of irrigation followed in horticultural crops, their merits and demerits.

Unit – IV

Cropping systems: Inter cropping and multi – tier cropping, their merits and Demerits with suitable examples. Practical uses of growth regulators in horticulture.

Fruitfulness and unfruitfulness: Definitions, Factors influencing the Fruitfulness and unfruitfulness with suitable examples.

Practical

1. Study of tools and utensils used in horticulture.

2. Layout of different planting systems.

3. Layout of nutrition garden.

4. Preparation of nursery beds for sowing of vegetable seeds.

5. Digging of pits for fruit plants.

6. Preparation of fertilizer mixtures and field application.

7. Identification and management of nutritional disorders in vegetables.

8. Study and practice different propagation methods by cutting, layering.

9. Study and practice different propagation methods by grafting and budding.

10. Visit to Botanical Garden and Different Nurseries.

Reference Books:

1 Fundamentals of Horticulture, Edmond, J.B., Sen., T.L., Andrews, F.S and Half acre R.G, 1963. Tata McGraw Hill Publishing Co., New Delhi.

2 Introductions to Horticulture, Kumar, N. 1990. Rajyalakshmi Publications, Nagarcoil, Tamilnadu.

3 Basic Horticulture, Jitendra Sing, 2002. Kalyani Publishers, Hyderabad.

4 Fundamentals of Fruit Production, Garner V R, Bradford F C and Hooker Jr. H D, 1957. McGraw Hill Book Co., New York.

5 Plant Propagation. Principles and Practices, Hartman, HT and Kester, D.E.1976, Prentice Hall of India Pvt. Ltd. Bombay.

6 Plant Propagation. Sadhu, M.K. 1996. New Age International Publishers, New Delhi.

CHOICE BASED CREDIT SYSTEM

B.Sc. Biotechnology (Semester Pattern)
VI Semester

Course Title: Computational Biology **Course Code: U-COB-727**
Marks 50 **Credit: 03**

Learning objectives

To gain insight into the public and private data repositories,

To understand search algorithms and analysis tools in bioinformatics,

To integrate and apply the learned computational knowledge and techniques to the healthcare applications.

Course outcomes

Demonstrate knowledge of the world-renowned biotechnology information repositories, such as NCBI databases, and the proficient use of the search algorithms for genes, proteins, RNA's, peptides, disease biomarkers, compounds and biologics from these repositories;

Apply the bioinformatics analysis tools for DNA sequencing, structure modeling, sequence alignment, microarray analysis and pathway analysis; and

Apply bioinformatics analysis knowledge and techniques to answer scientific questions in the health sciences.

Unit I: Introduction to bioinformatics and data generation

What is bioinformatics and its relation with molecular biology.Examples of related tools (FASTA, BLAST, RASMOL), databases (GENBANK, Pubmed, PDB) and software (RASMOL) Data generation; Generation of large scale molecular biology data (Through Genome sequencing, Protein sequencing, Gel electrophoresis, Applications of Bioinformatics.

Unit II: Biological Database and its Types

Introduction to data types and Source. Population and sample, Classification and Presentation of Data. Quality of data, private and public data sources. General Introduction of Biological

Databases; Nucleic acid databases (NCBI, DDBJ, and EMBL). Protein databases (Primary, Composite, and Secondary).

Unit III: Sequence Alignments and Visualization

Introduction to Sequences, alignments, Local alignment and Global alignment (algorithm and example),Pairwise alignment (BLAST and FASTA Algorithm) and multiple sequence alignment (Clustal W algorithm). Methods for presenting large quantities of biological data: sequence viewers, 3D structure viewers (Rasmol, SPDBv, Chime, Cn3D, PyMol).

Unit IV: Introduction to Genomics and Proteomics

General introduction to Gene expression in prokaryotes and eukaryote, transcription factors binding sites. SNP, EST, STS.

General introduction to protein structure, prediction of secondary structure of protein, computational protein modelling

References

1. Teresa Attwood, David Parry-Smith - Introduction to Bioinformatics Prentice Hall, 1999
2. Pierre Baldi, Søren Brunak -Bioinformatics : the Machine Learning Approach MIT Press, c2001.
3. Andreas D. Baxevanis, B.F. Francis Ouellette - Bioinformatics : A Practical Guide to the Analysis of Genes and Proteins, J. Wiley, c1998.
4. Philip E. Bourne, Helge Weissig - Structural Bioinformatics Wiley, c2003. Projected Pub. Date: 0311
5. Jean-Michel Claverie, Cedric Notredame - Bioinformatics for Dummies Wiley Pub., 2002. Projected Pub. Date: 0211
6. Peter Clote, Rolf Backofen - Computational Molecular Biology : an Introduction, Wiley, 2000.
7. Richard Durbin, Sean R. Eddy, Anders Krogh, Graeme Mitchison - Biological Sequence Analysis : Probabilistic Models of Proteins and Nucleic Acids ,Cambridge University Press, 1998
8. Warren J. Ewens, Gregory R. Grant - Statistical Methods in Bioinformatics : an Introduction Springer, c2001.
9. Dan Gusfield, Algorithms on Strings, Trees, and Sequences : Computer Science and Computational Biology, Cambridge University Press, 1997.
10. D. Higgins and W. Taylor - Bioinformatics : Sequence, Structure, and Databanks : a Practical Approach, Oxford University Press, 2000.
11. Timo Koski , Hidden Markov - Models for Bioinformatics Kluwer Academic Publishers, c2001.
12. Stephen A. Krawetz and David D. Womble - Introduction to Bioinformatics : a Theoretical and Practical Approach Humana Press, 2002.
13. Arthur M Lesk - Introduction to Bioinformatics, Oxford University Press, 2002.
14. David W. Mount - Bioinformatics : Sequence and Genome Analysis, Cold Spring Harbor Laboratory Press, c2001.
15. Pavel A. Pevzner - Computational Molecular Biology : an Algorithmic Approach MIT Press, c2000.

16. João Carlos Setubal, João Meidanis - Introduction to Computational Molecular Biology, PWS Pub., 1997.
17. Michael S. Waterman - Introduction to Computational Biology : Maps, Sequences, and Genomes : Interdisciplinary Statistics, Chapman & Hall/CRC, 1995 (2000 printing)

CHOICE BASED CREDIT SYSTEM

B.Sc. Biotechnology (Semester Pattern)

VI Semester

Course Title: Lab Course XXIII **Course Code: U-LAC-733**
Marks 50 **Credit: 02**

Course outcomes

- Apply the bioinformatics analysis tools for DNA sequencing, structure modeling, sequence alignment.
- Apply bioinformatics analysis knowledge and techniques to answer scientific questions in the health sciences.

Practicals:

1. Study architecture of computer system
2. Study of different modern computers.
3. Study of internet
4. Practical bases on Windows o/s
5. A guided tour of NCBI/EBI : Data acess – standard search engines : data retrievals tools – Entrez, DBGET and SRS (sequence retrieval systems); software for data building. submission of new revised data.
6. Sequence homology as product of molecular evolution, sequence similarity searches, sequence alignment-global, local, end free-space; measurement of sequence similarity, similarity and homology.
7. Multiple sequence alignment
8. Phylogeny reconstruction, PHYLIP package
9. Word processing.
10. Getting an amino acid sequence, nucleotide sequence by blasting.
11. Multiple sequence alignment

12. Homology modeling
13. Protein identification & characterization with peptide mass fingerprinting data.
14. Primary structure analysis of proteins.
15. Secondary structure analysis of proteins (helical content of peptide).
16. Tertiary structure analysis of proteins (3D structure prediction).

CHOICE BASED CREDIT SYSTEM

B.Sc. Biotechnology (Semester Pattern)

VI Semester

Course Title: Pharmaceutical Biotechnology **Course Code: U-PBT-728**
Marks 50 **Credit: 03**

Learning Objectives

To understand the difference between old biotechnology and modern biotechnology

To provide examples of current applications of biotechnology and advances in the different areas like medical, microbial, environmental, bioremediation, agricultural, plant, animal, and forensic.

To understand the concept of recombinant DNA technology or genetic engineering

Course Outcome

Understanding of steps involved in the production of biopharmaceuticals in microbial and mammalian cell systems

Understanding of the concept and applications of monoclonal antibody technology

Study of general principles of generating transgenic plants, animals and microbes

Unit I: **10L**

Drug Development in Pharmaceutical Process - Production of pharmaceuticals by genetically engineered cells (hormones, interferon) - Microbial transformation for production of important pharmaceuticals (steroids and semi-synthetic antibiotics) - Techniques for development of new generation antibiotics

Unit II: **10L**

Antibodies in research, diagnostics and therapeutics

Production of monoclonal antibodies and techniques to make them clinically applicable

Gene therapy – background, types of gene therapy (ex vivo & in vivo)

Vaccines – Vaccine vectors, nucleic acid vaccines, immune-enhancing technology. Toxicogenomics

Unit III: **15L**

Delivery of Biotechnology products: transdermal, parenteral, oral, mucosal, ocular, buccal, rectal and pulmonary delivery

Tissue Engineering – Skin, Liver, Pancreas, Xenotransplantation – terminology, technology behind it, organ donors, social & ethical issues

Stability of Biotechnology products: Physical instability- denaturation, aggregation, adsorption; Chemical instability- oxidation, hydrolysis.

Brief introduction to clinical trials

Unit IV: **10L**

Diagnosis and Kit Development - Use of enzymes in clinical diagnosis - Use of biosensors for rapid clinical analysis - Diagnostic kit development for microanalysis

Products of Biotechnology-current FDA approved biotechnology: drugs- human insulin, growth hormone, interferon; Future biotechnology drugs

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CHOICE BASED CREDIT SYSTEM
B.Sc. Biotechnology (Semester Pattern)
VI Semester

Course Title: Lab Course XXIV **Course Code: U-LAC-734**
Marks 50 **Credit: 02**

Course Outcome

- To provide examples of current applications of biotechnology and advances in the different areas like medical, microbial, environmental, bioremediation, agricultural, plant, animal, and forensic.
- Able to develop skills in detection of toxicity of drugs, antimicrobial activity and MIC.

Practicals:

1. Assay of antimicrobial activity of Penicillin, Chloramphenicol, streptomycin and Quinolones
2. Determination of Minimum Inhibitory Concentration (MIC) of Antibiotic
3.Extraction of natural molecules

4.Stability of drugs using spectrophotometry

5. Determination of shelf life of antibiotics (Expired drugs)

6. Sterility testing of commercial pharmaceuticals.
7. Sterility testing of injectable as per IP.
8. Effect of chemical disinfectants on growth of bacteria
9. Study of microbial spoilage of pharmaceuticals.
10. Visit to Pharmaceutical industry

Rajarshi Shahu Mahavidyalaya, Latur
(Autonomous College)

CHOICE BASED CREDIT SYSTEM
B.Sc. Biotechnology (Semester Pattern)
VI Semester

Course Title: Biodiversity & Systematics **Course Code: U-BDS-729**
Marks 50 **Credit: 03**

Learning Objectives:

To educate the students about the existing biodiversity in the world with special reference to Indian continent, various geographical hotspots and losses and remedial conservation and mitigation strategies.

To inculcate the values and knowledge about classification of flora and fauna and their detail studies with new methods such as identification keys and evolutionary relationship.

- To study the interpretation and analysis of results with the reference material it would be key to identification of new plants and animals.

Course Outcomes:

- The students would be more learned about reasons of losses of biodiversity and existing conservation strategies and laws with new approaches such as gene bank etc.
- Students would be more beneficial and facilitated with appropriate understanding of the traditional and newer method of classification and identifying characters.

Unit-1.

Basic concept of Biodiversity – What is Biodiversity, Why should we conserve it, Elements of Biodiversity - Ecosystem Diversity, Genetic Diversity, Species Abundance & Diversity, Types of biodiversity (Alpha, Beta) Cataloging and Discovering Species, Geographical Patterns of Species Richness, what is Biogeography, Importance of Distribution Patterns (Local Endemics, Sparsely Distributed Species, Migratory Species).

Unit-II.

Biodiversity & Conservation – Major drivers of biodiversity loss such as Overexploitation, habitat destruction, latitudinal gradient and invasive species etc. threatening living species and IUCN, RED Data Book,

Current status of International illegal trade of animals, Problems in Controlling International Trade (Enforcement, Reservations, Illegal Trade).

Unit III

Endangered Species Conservation – endangered categories (Extinct, threatened, critically endangered etc.) The US Endangered Species Act, State endangered Species Acts Successes and Failures of the Endangered Species Act

Problems with the Endangered Species Act, Habitat Conservation Plans or restoration .strategies Conservation strategies by National and International communities, conventions etc.

Ethics of Conservation – Values of Biodiversity, Bio piracy, Hybridized plants, GM crops (benefits & criticism), and Economic Value of Biodiversity & Legal, Ethical issues related to uses of biodiversity, Global Conservation Issues.

Unit IV

Basic concept of Taxonomy – Nomenclature and Species concept. Classification and , systematics Construction of Phylogenetic tree, , Cladistics, Cladograms, Phenetics, Molecular Taxonomy in relation to DNA characteristics & Protein sequences,genetic markers for taxonomic purposes, comparing total genome by DNA-DNA hybridization, important bioinformatics based tools and databases for evaluation biological identification through DNA barcodes.

Reference:

1. M. Koto-The Biology of biodiversity – Springer

2. E.O. Wilson – Biodiversity – Academic Press Washington
3. G. G. – Simpson-Principle of animal taxonomy Oxford IBH Publication company.
4. E- Mayer – Elements of Taxonomy

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(Autonomous College)

CHOICE BASED CREDIT SYSTEM
B.Sc. Biotechnology (Semester Pattern)
VI Semester

Course Title: LAB COURSE XXV **Course Code: U-LAC-735**
Marks 50 **Credit: 02**

Course Outcomes:

- Students would be more beneficial and facilitated with appropriate understanding of the traditional and newer method of classification and identifying characters.

Taxonomy – Field Methods

1. Morphological studies of major groups

   A) Bryophytes B) Pteridophytes C) Gymnosperms D) Angiosperms

2. Study of Leaf Morphology and Flower morphology
3. Study of fruits morphology
4. Surveys, collection and Herbarium preparation
5. Study of plant Identification using reference material
6. Visits to herbarium and culture collections centers.
7. Photography and illustration in the field.
8. Documentation and dissemination of information.
9. Morphological studies of Fishes. Visit to local market for identification.
10. Visit to Botanical, Zoological Gardens, Biosphere Reserves, Project Tiger and National sanctuaries.

CHOICE BASED CREDIT SYSTEM

B.Sc. Biotechnology (Semester Pattern)

VI Semester

Course Title: Agricultural Biotechnology **Course Code: U-ABT-730**
Marks 50 **Credit: 03**

Learning Objectives

-To learn agriculture basics includes methods, management and problems
-To educate the students about various process of Biofertilizer preparation and Biopesticide formulations.
-To develop the skill of agricultural solid waste management through mushroom cultivation
-To study the modern trends in agricultural biotechnology.

Course Outcomes

Student would be facilitated with day to day process of traditional methods and newer Methods of microbial inoculum preparation.

Students would be more beneficial and facilitated by studying aspect related to latest technology which has been incorporated in agriculture and agricultural products.

UNIT- I: Agriculture and its recent trends **10**

Basics of agriculture
Methods of agriculture
Agricultural crops
Need of agricultural management
Plant pathology/diseases
Plant -pathogen interaction
Plant breeding – Concept and types
Agricultural nanotechnology
.

UNIT-II: **10**

Biomass: Composition, Types, Biomass as a energy Source, Biomass conversion and Utilization.

- Bioethanol production
- Mushroom cultivation

-Biofertilizers: Concept and Types of Biofertilizer.
-Microbial Inoculum - Rhizobium Inoculant, Azotobacter, and Phosphate Solubilizing Biofertilizer
-Bio-pesticides- Definition and Types (Microbial and Botanical)
-Advantages of Biopesticides over chemical pesticides.
-Single Cell Protein and its Nutritive Value eg. Spirulina.

-Secondary metabolites and its applications

UNIT- III: 12

Marker assisted selection (MAS), Development of population, RILs, BCILs, NIL, ILs Molecular markers - hybridization and PCR based markers RFLP, RAPD, STS, SSR, AFLP, SNP markers; DNA fingerprinting-principles and applications; introduction to mapping of genes/QTLs; marker-assisted selection - strategies for Introducing genes of biotic and abiotic stress resistance in plants; molecular diagnostics of pathogens in plants .
-A Case study

UNIT- IV:

Genetic engineering:
13

Agrobacterium-plant interaction; virulence; Ti and Ri plasmids; opines and their significance; T-DNA transfer; disarmed Ti plasmid;
Genetic transformation - Agrobacterium-mediated gene delivery; co integrate and binary vectors and their utility; direct gene transfer - PEG-mediated, electroporation, particle bombardment and alternative methods; screen able and selectable markers; characterization of transgenics; chloroplast transformation; marker-free methodologies; advanced methodologies - cisgenesis, intragenesis and genome editing; molecular pharming - concept of plants as biofactories, production of industrial enzymes and pharmaceutically important compounds.

Text & References :

1. Bilgrami K.S and Dube H.G.(1994) - Textbook of Modern Plant Pathology, Vikas Publications, New Delhi.
2. Gupta P.K. (1998) - Genetics and Biotechnology in Crop Improvement, Rastogi Publications, Meerut.
3. Pathak V.N,Khatri N.K.,Pathak M.(1996) - Fundamentals of Plant Pathology, Agrobotanical Publications, Bikaner.
4. Powar C.B., Daginawala H.F., (1990) - General Microbiology,Vol. II,Himalaya Publishing House,Mumbai.
5. Purohit S.S.(2002) - Agricultural Biotechnology,Agrobios India, Jodhpur.
6. Satyanarayana U. (2007) - Biotechnology, Books and Allied Pvt.Ltd.Kolkata.
7. Vyas S.C.,Vyas S., Vyas S.,and Modi H.A.(1998) - Biofertilizer and Organic Farming, Akta Prakashan, Nadiad,G.S, Meerut.
8. Vyas S.C.,Vyas S., Vyas S.,and Modi H.A (1998) - Experiments in Microbiology, Plant pathology, Tissue culture and Mushroom cultivation, Vishwa Prakashan, New age international (p) Ltd.,New Delhi.
9. Kalaichelvan P.T. and Dandiya P.C (2004), Microbiology and Biotechnology: A Laboratory Manual, MJP Publishers, Chennai.
10. Purohit S.S. (1995), A . Aneja K.R. - Laboratory manual of Plant Biotechnology, Agrobotonical Pub.India.
11. Schmauder Hans Peter (1997) - Methods in Biotechnology, Taylor and Francis, London.
12. Schuler M. A. and Zielinski R. E. (1989) - Methods in Plant Molecular Biology.
13. Vyas S.P. and Kohli D.V. (2002) - Methods in Biotechnology and Bioengineering, CBS

Publishers and Distributors, New Delhi.

CHOICE BASED CREDIT SYSTEM

B.Sc. Biotechnology (Semester Pattern)

VI Semester

Course Title: Lab course XXVI **Course Code: U-LAC-736**
Marks 50 **Credit: 02**

Course Outcomes

- Students will be able to estimate and detect the concentration of hormones, secondary and primary metabolites.

1. Isolation of *Rhizobium sp.*from root nodule and application of rhizobium biofertilizer for Leguminous crops.
2. Isolation of phosphate solubilizing bacteria from given soil sample and its application in the Field.
3. Determination of Total Phosphorus, sulphur and nitrogen of soil.
4. Study of stress response in plants.
5. Extraction and identification of plant secondary metabolites.
6. Preparation of bio extract for the detection of antimicrobial / anti pathogenic activity.
7. Production of pearl oyster mushroom from agricultural residues.
8. Visit to Cell Culture Facilities /Production /Biofertilizer Industry.

CHOICE BASED CREDIT SYSTEM

B.Sc. Biotechnology (Semester Pattern)

VI Semester

Course Title: Biofertilizer II **Course Code:U-ADC-640(B)**

Marks 50 **Credit: 02**

Learning objective:

This course aims to give the student an overview of Biofertilizers and its mechanism of action agriculture system. In particular, this module will focus on production steps of different Biofertilizers for various crops.

Course Outcomes:

Describe productions steps and specific requirements for each Biofertilizers

To make skilled manpower for Biofertilizer industry

Course can generate opportunities of self entrepreneurship among students

Unit I **8L**

Biofertilizer- Current and future needs, Use of Genetically Engineered Micro-organisms for improvement of biofertilizers, Indigenous technology based Biofertilizers and its advantages over standard Biofertilizers

Practical 1: Survey of Biofertilizer products in market
Practical 2: Introduction to GMO and Indigenous Technology

Unit II **10L**

Component of organic farming system Manures: compost, FYM, biogas slurry, sewage and sludge, green manures, biofertilizers. Role of manures. Socio-economic constraints in organic farming, Integrated nutrient management.

Practical 1: Production of compost from various resources
Practical 2: C, N, P and K analysis of organic manure

Unit III **6L**

Standards for commercial production of biofertilizers- Quality control of biofertilizers. Packaging, labeling and storage of Biofertilizers, Certifications for commercial Biofertilizer units, Effect of storage on efficacy of Biofertilizers.

Practical 1: Effect of storage on efficacy of Biofertilizer
Practical 2: QC tests of Biofertilizers

Unit IV **6L**

Lab to land application of Biofertilizers, Designing and implementation of Pot experiments, field applications to check efficacy of Biofertilizers, Nodulation experiment, Application of Randomized block design for field experiments. Awareness program among surrounding community for Biofertilizers use.

Practical 1: Designing of pot experiments for efficacy study of Biofertilizers
Practical 2: Designing of field experiment to efficacy study of Biofertilizers

Reference Books:

1. Dubey, R.C., 2005 A Text book of Biotechnology S.Chand & Co, New Delhi.
2. Kumaresan, V. 2005, Biotechnology, Saras Publications, New Delhi.
3. Sathe, T.V., 2004, Vermiculture and Organic Farming. Daya publishers.
4. Subha Rao, N.S. 2000, Soil Microbiology, Oxford & IBH Publishers, New _Delhi.
5. Vayas,S.C, Vayas, S. and Modi, H.A. 1998 Bio-fertilizers and organic _Farming Akta Prakashan, Nadiad
6. Kannaiyan, S., 2003, Bioetchnology of Biofertilizers. CHIPS, Texas.
7. Rai, M.K., 2005, Hand book of Microbial Biofertilizers. The Haworth Press, Inc. New York

CHOICE BASED CREDIT SYSTEM

B.Sc. Biotechnology (Semester Pattern)

VI Semester

Course Title: Solid Waste Management **Course Code: U-ADC-640(S)**
Marks 50 **Credit: 02**

Course objectives

- evaluate the subject from the technical, legal and economical points by learning of all terms related to general solid waste management.
- explain the hierarchical structure in solid waste management and a requirement for an integrated solution.
- examine the technical points that are required to set up a solid waste management system.
- set up a municipal solid waste management system.
- make physical and chemical analysis of municipal solid wastes and apply them for a management system that will be set up.

Learning Outcomes

- design a packaging waste separation facility.
- design a compost facility.
- plan a solid waste management system for decision makers.
- collect required data for a Solid Waste Management Plan.
- use multiple criteria decision making systems for an optimum and sustainable integrated solid

Unit I Integrated solid waste management

Solid waste in history, Economics and solid waste, Legislation and regulations, Materials flow, Reduction, Reuse, Recycling, Recovery, Disposal of solid waste in landfills, Energy conversion, The need for integrated solid waste management, Special wastes

Unit II Municipal solid waste characteristics and quantities

Definitions, Municipal solid waste generation, Municipal solid waste characteristics, Composition by identifiable items, Moisture content, Particle size, Chemical composition, Heat value, Bulk and material density, Mechanical properties, Biodegradability, Measuring particle size

Collection

Refuse collection systems

Phase 1: house to can, Phase 2: can to truck, Phase 3: truck from house to house, Phase 4: truck routing, Phase 5: truck to disposal, Commercial wastes, Transfer stations, Collection of recyclable materials, Litter and street cleanliness, Design of collection systems

Landfills

Planning, siting, and permitting of landfills, Planning, Siting, Permitting, Landfill processes, Biological degradation, Leachate production, Gas production, Landfill design, Liners, Leachate collection, treatment, and disposal, Landfill gas collection and use, Geotechnical aspects of landfill design, Stormwater management, Landfill cap, Landfill operations, Landfill equipment, Filling sequences, Daily cover, Monitoring, Post-closure care and use of old landfills, Landfill mining

Unit III Processing of municipal solid waste

Refuse physical characteristics, Storing MSW, Conveying, Compacting, Shredding, Use of shredders in solid waste processing, Types of shredders used for solid waste processing, Describing shredder performance by changes in particle size distribution, Power requirements of shredders, Health and safety, Hammer wear and maintenance, Shredder design, Pulping, Roll crushing, Granulating, The pi breakage theorem

Materials separation

General expressions for materials separation, Binary separators, Polynary separators, Effectiveness of separation, Picking (hand sorting), Screens, Trommel screens, Reciprocating and disc screens, Float/sink separators, Theory of operation, Jigs, Air classifiers, Other float/sink devices, Magnets and electromechanical separators, Magnets, Eddy current separators, Electrostatic separation processes, Other devices for materials separation, Materials separation systems, Performance of materials recovery facilities

Combustion and energy recovery

Heat value of refuse, Ultimate analysis, Compositional analysis, Proximate analysis, Calorimetry, Materials and thermal balances, Combustion air, Efficiency, Thermal balance on a waste-to-energy combustor, Combustion hardware used for MSW, Waste-to-energy combustors, Modular starved air combustors, Pyrolysis, Mass burn versus RDF, Undesirable effects of combustion, Waste heat, Ash, Air pollutants, Dioxin

Biochemical processes

Methane generation by anaerobic digestion, Anaerobic decomposition in mixed digesters, Potential for application of anaerobic digesters, Methane extraction from landfills, Potential for the application of methane extraction from landfills, Composting, Fundamentals of composting, Composting municipal solid waste, Potential for composting municipal solid waste, Composting wastes other than refuse, Other biochemical processes, Glucose production by acid and enzymatic hydrolysis, Other bacterial fermentation processes

Unit IV Other methods of waste recycling

Biogas: concept of biogas, Design of biogas, types of biogas model, feeding material, operations and maintenance, process scale ups, Microorganisms involved. Skills and technological advancements required

Plastic to fuel: introduction to concept, types of reactors used in plastic to fuel conversion, skills and technological advancements required

Waste to fuel : concept of energy from waste, types of material required for waste to fuel/briquette fuel, machineries required, process flow, use of biomass pallets/briquettes as a domestic/ industrial fuel source. Skills and technological advancements required

Plastic recycling : Concept, hazardous effects of plastic on environment, need of recycle, reuse concept in reference to plastic and related waste, methods of plastic recycling, technologies in plastic recycling, skills and technological advancements required

References

1) J. Glynn Henry and Gary. W. Heinke, “Environmental Science and Engineering”, Pretice Hall of India, 2004.

2) A. D.Bhide and B.B.Sundaresan, “Solid Waste Management – Collection, Processing and disposal” Mudrashilpa Offset Printers, Nagpur, 2001.

3) Techobanoglous Thiesen Ellasen; Solid Waste Engineering Principles and Management, McGraw - Hill 1997. 14

Lab (1): Field trip - Composting facility & household waste sorting facility.

Lab (2): Field trip - WTE Recycling facility

Lab (3): Field trip - Paper and cardboard recycling facility.

Lab (4): Field trip - Metal salvage and recovering facility.

Lab (5): Field trip - Waste tires conversion and recycling facility.

Lab (6): Field trip - Waste-to-energy facility.

Lab (7): Field trip - Wastewater treatment and sludge composting facility.

Lab (8): Field trip - Hazardous and electronic waste recycling facility.

Statement showing number of credits and marks for B.Sc. Biotechnology Programme

Class	**Credits**	**Marks**
B.Sc. BT I Yr	22+22=44	450+450=900
B.Sc. BT II Yr	24+24=48	500+500=1000
B.Sc. BT III Yr	22+26=48	450+550=1000
Total	**140**	**2900**