Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Biotechnology

Curriculum

For the Academic Year 2022-23

Under CBCS

Three Year Degree Programme in Biotechnology

(Six Semester Programme)

UG Third Year

Semester V and VI

Syllabus Approved by Board of Studies in Biotechnology

With effect from June, 2022

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
NCBC	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-340-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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B.Sc. Biotechnology
V Semester

Course Title: Recombinant DNA Technology **Course Code: U-RDT-627**
Marks 50 **Lectures: 45** **Credit: 03**

Learning Objectives:

- To illustrate the creative use of modern tools and techniques for the manipulation and analysis of genetic contents in living organisms
- To utilize the knowledge on creation of a genomic and c-DNA library.
- To train students in strategizing research methodologies employing genetic engineering techniques.
- To study application of recombinant plants & animal products.

Course Outcomes:
On the successful completion of the course, student will be able to-

- describe construction of cDNA library and Genomic DNA library with 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
- provide examples of current applications of biotechnology and advances in the different areas like medical, microbial, environmental, bioremediation, agricultural, plant, animal, and forensic.

UNIT-I: **(10L)**

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: **(12L)**

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: **(12L)**

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: **(11L)**

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.

Recommended Textbooks and References:

1. Principles of Gene Manipulation and Cloning – R. M. Old & S. B. Primrose (2006) Seventh Edition Publisher Wiley-Blackwell
2. Gene Cloning and Manipulation – Christopher Howe (2007) Publisher Cambridge University Press
3. Essential Molecular Biology -T. A. Brown (2006) Third Edition Publisher Wiley-Blackwell
4. Genomes 3 - T. A. Brown. (2006) Third Edition Publisher Garland Science
5. Genetic Engineering Principles and Practice – Sandhya Mitra (2015) Second Edition Publisher McGraw Hill Education
6. Text book of Biotechnology – U. Satyanarayana Arora (2020) M.P Biotechnology, Himalaya Pub. House, Mumbai.
7. Gene Biotechnology- Jogd and S.N (2006), Himalaya Publishing House, Mumbai.
8. Genetic Engineering and its applications - Joshi P (2002), Agrobios Pub, Jodhpur.
9. Genetic Engineering - Mitra Sandhya (2006), MacMillan India Ltd, Delhi.

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V Semester

Course Title: Lab course XVII **Course Code: U-LAC-633**
Marks 50 **Credit: 02**

Learning Objectives:

- To Provide Hands-on isolation and purification of Nucleic Acids.
- To Provide Hands-on screening of recombinants using blue white screening.
- To Provide Hands on Advanced molecular techniques used in research.
- To utilize the knowledge on creation of a genomic and c-DNA library

Course Outcomes:

On the successful completion of the course, student will be able to-

- perform isolation of nucleic acid from various sources.
- perform PCR, blotting, molecular diagnosis, cell profiling etc...
- study genetic diversity of prokaryotes and eukaryotes.
- provide solution at molecular level for diagnosis of current issues in health care.

Practical's:

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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V Semester

Course Title: Microbial Technology **Course Code: U-MIT-628**
Marks 50 **Lectures: 45** **Credit: 03**

Learning Objectives:

- To provide the information on role of microorganisms in specific biotechnological processes
- To know the technical knowledge about downstream processing
- To inculcate the new approaches of fermentation technology, media preparation and recovery of Product.
- To explain the complex processes behind the quality control and process economics of fermentation technology.

Course Outcomes:

On the successful completion of the course, student will be able to-

- understand the significance of how biochemical pathways relate to microbial growth.
- conduct a various experiment related to purification of fermented product.
- apply the knowledge of upstream and downstream processes development of different product in fermentation industry.
- understanding of quality control, process economics and GLP**.**

UNIT I **(10 L)**

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 **(13L)**

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
(11L)

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: **(11L)**

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.

Recommended Textbooks and References:

1. Industrial Microbiology, Casida L.E (1991) - Wiley Eastern, New Delhi.
2. Biotechnology: A Textbook of Industrial Microbiology, Crueger W and Crueger A (2000) -, 2nd Edi. Panima Publishing Corporation, New Delhi.
3. Industrial Microbiology, Patel A.H. (2004) - Macmillan India Ltd.,New Delhi.
4. Microbial Technology, Vol I and II,Peppler H.J and Perlman D (2006) - Academic Press,New York.
5. A textbook of Biotechnology, Parihar Pradeep (2007) - Student edition, Jodhpur.
6. Principles of Fermentation Technology, Stanbury P.F., Whitaker A. and Hall S.J (1997) - Aditya Books Pub., Ltd., New Delhi.
7. Biotechnology, Satyanarayana U. (2007) Books and Allied Pvt.Ltd.Kolkat

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V Semester

Course Title: Lab Course XVIII **Course Code: U-LAC-634**

Marks 50 **Credit: 02**

Learning Objectives:

- To provide Hands-on production of primary and secondary metabolites.
- To study tools and technical skills in Estimation of the fermentation products by various methods.
- To explain the complex processes behind the development production of cheese.
- To study Isolation & identification of bacteria from different sources of milk product.

Course Outcomes:

On the successful completion of the course, student will be able to-

- perform isolation and characterization of different metabolites from microbial sources.
- perform cell immobilization by using different industrial important strains.
- perform production of organic acid and solvents.
- quantify different fermentation products by using various methods.

Practicals: -

1. Production of primary and secondary metabolite (one organic acid and one antibiotic)
2. Biomass production (Baker's yeast and Spirulina)
3. Production of beverages (alcohol, wine)
4. Immobilization of yeast on calcium alginate
5. Estimation of the fermentation products by titration method
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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V Semester

Course Title: Animal Biotechnology **Course Code: S-ANB-529**
Marks 50 **Lectures:45** **Credit: 03**

Learning Objectives:

- To teach the student about infrastructure and desirable facilities for developing cell culture laboratories.
- To learn how traditional practices and advanced methods used for production of vaccines and monoclonal antibodies
- To cater the curiosity and knowledge about newer approaches regarding transgenic cloning.
- To study the interpretation and relationship via forensic and evolutionary studies particularly in animal biotechnology.

Course Outcomes:

On the successful completion of the course, student will be able to-

- understand basic infrastructure requirements and culture technique of ATC.
- understand the process concerning with veterinary and biotechnology in day to day practices.
- study the approaches and newer strategies in development of transgenic animal and related products.
- study various methodologies in *in-vitro* fertilization.

Unit-I **(10 L)**

Basics of animal tissue culture and useful techniques

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 **(10L)**

Introduction to the concept of vaccines, hybridoma technology

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 **(15 L)**

In vitro fertilization and development of diagnostic kits

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 **(10L)**

Transgenic animal

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.

Recommended Textbooks and References:

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

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Course Title: Lab Course XIX **Course Code: U-LAC-635**

Marks 50 **Credit: 02**

Learning Objectives:

- To provide Hands-on Media and reagent preparation and related sterilization techniques.
- To provide Hands-on for developing animal cell culture and products.
- To provide Hands-on for primary culture by chick embryo
- To learn the technique in disaggregation of animal tissue for primary culture establishment

Course Outcomes:

On the successful completion of the course, student will be able to-

- solve problems in media preparation and sterilization techniques.
- aware about basic infrastructure and culture technique of ATC.
- perform different cell counting methods.
- perform viability testing using various traditional methods.

Practical's

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 counts 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

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V Semester

Course Title: Developmental Biology **Course Code: U-DEB-630**
Marks 50 **Lectures: 45** **Credit: 03**

Learning Objectives:

- To teach basics of embryology.
- To strengthen understanding of cell division and cell growth.
- To learn role of genes in Patterning and morphology of animal and plant cell development.
- To help interpretation of biological experiments

Course Outcomes:

On the successful completion of the course, student will be able to-

- acquaint the knowledge of basics of embryology and can interpret biological experiments related to animal development.
- understand process of cell division and cell growth
- describe the role of cellular signaling in embryo development.
- understand plant development process.

UNIT I **(12L)**

Overview and stages of development

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 *Drosophila melanogaster*

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

UNIT II **(8L)**

Cell division and ageing

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

Unit III **(13L)**

Cell development and signaling

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 **(12L)**

Plant Development

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

Recommended Textbooks and References:

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. Developmental Biology, N. Arumugam (1994) 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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Course Title: Lab **Course Code: U-LAC-636**

Course XX Marks 50 **Credit: 02**

Learning Objectives:

- To provide Hands-on frog development by using permanent mounted slides.
- To study T.S. of ovary for arrangement of ovules within ovary.
- To learn Flower development from vegetative shoot
- To study morphological and anatomical changes in plants

Course Outcomes:

On the successful completion of the course, student will be able to-

- seek knowledge related to animal and plant embryology
- check pollen genesis by using T.S. of Anther
- check the process of chick development up to eight days through egg incubation,
- candling and Egg dissection technique.
- describe morphological and anatomical changes in plants

Practicals:

1. Introduction to developmental biology-embryo, protocols, ethics, and model Systems.
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 and Egg 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 organization) during plant development from germinated seed, seedling and other stages of development.

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V Semester

Course Title: Food Nutrition **Course Code: U-FON-631**

Marks: 50 **Lectures: 45** **Credit: 03**

Learning objectives:

- To make the student aware about different forms of food and their importance
- To learn scientific approaches to analyses biomolecules, present in different foods.
- To teach different facilities for processing and preservation of food
- To make the student aware about food safety and food security

Course outcomes:

On the successful completion of the course, student will be able to-

- understand different methods of food classification and their importance
- understand food safety and regulations
- understand importance of processed and value-added foods.
- understand important of sampling in community nutrition

Unit-I: **(10L)**

Introduction to Nutrition

Basic concept on Food, Nutrition and Nutrients. Classification of Food, Classification of Nutrients. Major dietary element (Carbohydrates, Proteins, Fats) and their importance.

Unit-II: **(12L)**

Food safety and food security

What is food security, Different food sources and its utility. Global scenario of and Food crisis and its management various resolution on food safety and food security.

Unit-III **(11L)**

Importance of processed and value-added foods.

Introduction to process food, example, mode of action, method of food processing, byproducts and raw material required for large scale food processing. Milk and dairy products.

Unit IV **(11L)**

Assessment of nutritional status of community

Important of sampling in community nutrition, dilatory assessment, important and its types, clinical assessment, biochemical assessment its significance and limitation.

Recommended Textbooks and References:

1. Molecular Biotechnology: 4th edition. (2010), Glick B.R., Pasternak J.J., Patten C. L., ASM press, USA
2. Principles of Gene Manipulation & Genomics, 7th Edition (2006), Primrose and Twyman,

a. Blackwell Publishing, USA

3. Leininger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN: 13: 978-1-4641-0962-1 / ISBN:10:1-4292-3414-
4. Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New York), ISBN:978-0-470-28173-4.
5. Shubhangini Joshi, Textbook of food and nutrition, Tata Macgrohill Publishing Co., New Delhi.
6. B. Shrilakshmi, Nutrition Science, New Age International Publishers
7. Muddambi S.R. and Rajgopal M. V., Fundamentals of Food and Nutrition, Wiley Eastern Ltd., New Delhi.
8. Nutritive Value of Indian Foods, NIN, Hyderabad.

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Course Title: Lab Course XXI **Course Code: U-LAC-637**
Marks: 50 **Credit: 02**

Learning objectives:

- To learn different forms of food and methods of food analysis
- To teach scientific approaches to analyses protein present in different foods.
- To make understand various techniques concerning with food and processing methods
- To make student understand about nutritional requirement for different age group people through survey.

Course outcome:
On the successful completion of the course, student will be able to-

- Perform analysis of biomolecules in food.
- Understand quantitative estimation of proteins and carbohydrates.
- Determination of mineral and moisture content in foods

Practical's

1. Identification of Mono, Di and polysaccharides
2. Estimation of Proteins
3. Identification of glycerol.
4. Determination of Ash content in food
5. Determination of Moisture content in food
6. Determination of calcium, iron, Vitamin C content in foods.
7. Diet and nutrition surveys.
8. Field visit

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Course Title: Nano Biotechnology **Course Code: U-NBT-632**
Marks: 50 **Lectures: 45** **Credit: 03**

Learning objectives:

- To make students aware about role of nanotechnology in biological science
- To create foundation of research and development in nano Biotechnology
- To train the students with industry requirement as per the field of nano biotechnology
- To guide the students to build up career in the field of nano biotechnology

Course outcomes:

On the successful completion of the course, student will be able to-

- understand the method of analysis of nanoparticles with biological material
- understand the nanoscale properties and its utilization in various field
- understand various carbon based nanomaterials
- understand the importance and applications of nanoscience in today's era.

Unit-I: **(12 L)**
Introduction To Nanotechnology

Importance of Nanotechnology-History of Nanotechnology-Opportunity at the nano scale-length and time scale in structures-energy landscapes-Interdynamic aspects of inter molecular forces -classification based on the dimensionality- nanoparticles nanoclusters-nanotubes-nanowires and nanodots- Semiconductor nanocrystals carbon nanotubes-Influence of Nano structuring on Mechanical, optical, electronic, magnetic and chemical properties

Unit-II: (13L)

Biological nanomaterial

What is nanotechnology and Development of nanobiotechnology – timelines and progress, overview Biological nanoparticles and its applications :Introduction to biological nanoparticles, Exosolipoproteins, Ferritin, Biological nanometers and machines: Biological nanomachines: protein assemblies, muscle myosin, ATPase, Hemoglobin, Biological

nanometers: Bacterial Flagella, cilia: Structure and function Biological nanopores: Ion channels :bacteriorhodopsin, Bioinspired nanomaterial and its applications: DNA and protein based nanomaterial.

Unit-III: (12 L)
Carbon based nanomaterials

Production of carbon nanotubes (Single walled and multi walled), arc discharge method, Laser ablation, Chemical vapour deposition, Pyrolatic technique, purification and separation of carbon nanotubes, diamond synthesis routes, preparation of nanodiamond.

UNIT-IV: (13L)

Applications of Nano biotechnology

Semiconductor (metal) nanoparticles and nucleic acid and protein based recognition groups– Application in optical detection methods – Nanoparticles as carrier for genetic material– Nanotechnology in agriculture – Fertilizer and pesticides. Designer proteins, Peptide nucleic acids, Nanomedicine, Drug delivery, DNA computing, Molecular design using biological selection, Harnessing molecular motors, Artificial life, Hybrid materials, Biosensors - Future directions.

Recommended Textbooks and References:

1. Principles of Biochemistry, Leininger, Nelson, Cox, CBS publishers and distributors, New Delhi, 2004.
2. Fundamentals of Biochemistry, Donald Voet, Akif Uzman, Judith G. Voet, CharlotteWPratt, John Wiley and Sons, New York, 2008.
3. Biochemistry, Geoffrey L. Zubay , WCB publishers, 1998.
4. Biochemistry – Lubert Stryer, 1995. _
5. C. M. Niemeyer, C. A. Mirkin,Nanobiotechnology: Concepts, Applications and Perspectives||, Wiley – VCH, (2004).
6. Nanoscience: Nanobiotechnology and Nanobiology, P. Boisseau, P. Houdy and M. Lahmani, Springer, 2007.
7. Handbook of Nanostructured Biomaterials and Their Applications in Nanobiotechnology, Hari Singh Nalwa, American Scientific Publishers, 2005.
8. Nanobiotechnology, C.M.Niemeyer, C.A. Mirkin, Wiley VCH, 2004. 8. Nanobiotechnology, C.M.Niemeyer, C.A. Mirkin, Wiley VCH, 2004.
9. Challa, S.S.R. Kumar, Josef Hormes, Carola Leuschaer," Nanofabrication Towards Biomedical Applications, Techniques, Tools, Applications and Impact", Wiley – VCH, 2005.

10. Nicholas A. Kotov, “Nanoparticle Assemblies and Superstructures”, CRC, 2006.
11. T. Pradeep, —Nano: The Essentials||, McGraw – Hill education, (2007).
12. David S Goodsell, “Bio nanotechnology ||, John Wiley & Sons, (2004).
13. Molecular Biology of the Gene, 6th Edition (2008), James D. Watson, Tania Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Lodwick, Pearson Education, Inc. and Dorling Kindersley Publishing, Inc. USA

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V Semester

Course Title: Lab Course XXI **Course Code: U-LAC 638**
Marks: 50 **Credit: 03**

Learning objectives:

- To make student aware about nanotechnology technique in biological science
- To make the students aware about the methods in Nanotechnology
- To learn various methods in Nano-biotechnology research

Course outcomes:
On the successful completion of the course, student will be able to

- understand the method of analysis of nanoparticles with biological material
- understand the nanoscale properties and its utilization in various field and will be able to understand the techniques
- understand production of silver nanoparticle
- understand electrodeposition of different metals.

Practical’s:

1. Biosynthesis of silver nanoparticle from plants
2. Biosynthesis of silver nanoparticle from Fungi
3. Biosynthesis of silver nanoparticle by Bacteria
4. Synthesis of silver nanoparticles by using biological method
5. Synthesis of ZnO by hydrothermal method
6. Synthesis of Polyaniline nanofibers by CBD method
7. Synthesis of Fe2O3 by Sol-gel method
8. Preparation of CdS by chemical bath deposition
9. Electrodeposition of Cobalt thin films
10. Preparation of CdSe by Successive Ionic Layer, Adsorption and Reaction (SILAR) method

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V Semester
Skill Enhancement Course

Course Title: Bio-fertilizer I **Course Code: U-ADC-540(B)**
Marks 50 **Lectures: 30** **Credit: 02**

Learning objectives:

- To make the students to understand role of bio-fertilizers and its mechanism of action in agriculture.
- To make the students understand the basic principles of production of different bio-fertilizers as per need of agriculture.
- To make the students understand the basic concepts of mechanism of action of nitrogen fixing and phosphate solubilizing bacteria.
- To teach isolation, characterization, mass inoculum production and field application of bio-fertilizers.

Course Outcomes:
On the successful completion of the course, student will be able to-

- explain isolation and role of various soil bacteria in bio-fertilizer production.
- describe production steps and specific requirements for each bio-fertilizers
- restore the soil fertility by performing the sustainable agriculture practices via organic farming
- apply the knowledge gained to generate opportunities of self-employability.

Unit I **(8L)**

Overview of biofertilizers

General account about the microbes used as bio-fertilizer – *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)**

Isolation and production of biofertilizers

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)**

Algal fertilizers

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)**

PSB production

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

Recommended Textbooks and References:

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

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V Semester
Skill Enhancement Course

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

Marks 50 **Lecture 30** **Credit: 02**

Learning Objectives:

- To teach the methods of horticultural practices in agriculture
- To make the student to understand use of different tools and utensil for horticulture practices
- To learn establishment of own Nursery
- To learn the growth regulators in horticulture

Course Outcomes:

- On the successful completion of the course, student will be able to-
- understand the difference between the real practices and traditional practices of horticultural farming.
- understand the different nursery techniques in management
- describe principles and methods of development of fruit crops by grafting techniques.
- describe methods of Inter cropping and multi-tier cropping systems.

Unit – I **(08L)**

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.

Practical

1. Study of tools and utensils used in horticulture.
2. Layout of different planting systems.
3. Layout of nutrition garden.

Unit – II **(10L)**

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.

Practicals

1. Preparation of nursery beds for sowing of vegetable seeds.
2. Digging of pits for fruit plants.

Unit – III **(6L)**

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.

Practicals

1. Preparation of fertilizer mixtures and field application.
2. Identification and management of nutritional disorders in vegetables.

Unit – IV **(6L)**

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.

Practicals

1. Study and practice different propagation methods by cutting, layering.
2. Study and practice different propagation methods by grafting and budding.
3. Visit to Botanical Garden and Different Nurseries.

Recommended Textbooks and References:

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.

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VI Semester

Course Title: Environment Studies **Course Code : U-ENS-616**
Marks :50 **Grade**

Learning Objectives:

- To learn Scope and Importance of natural resources.
- To educate the students about Structure and function of an ecosystem
- To teach strategies to study Biodiversity and its conservation.
- To learn Causes, effects and control measures of different types of pollution.

Course Outcomes:
On the successful completion of the course, student will be able to-

- describe importance and need of renewable and non-renewable resources.
- understand concepts of an ecosystems
- study social, ethical, aesthetic, and option values of biodiversity and its
- conservation.
- study causes, effects and control of solid waste management

Unit I: Introduction & Natural Resources:
Environment: Definition, Scope, Importance, Need for public awareness.
Natural Resources: Renewable and Non Renewable resources, Natural resources and associated problems.
a) Forest Resources: Utility and natural renewal balance, Uses and over exploitation of forest resources, Deforestation case studies, Mining, Dams and their effects on forests.
b) Water Resources: Uses of water, over utilization of surface and ground water, Floods, Draughts, Dams: Benefits and problems.
C) Mineral Resources: Environmental effects of extracting and using mineral resources.
D) Agricultural Resources: Changes caused by agriculture and overgrazing, Effects of modern agriculture, Fertilizer and pesticide problems, Water logging, Salinity.
E) Land Resources: Land as a resource, Effects on productivity, Man induced landslides, Soil erosion, Desertification
F) Energy Resources: Needs, Types of energy and quantities available, Growing energy needs, renewable and nonrenewable energy resources, Use of alternate energy sources.

Unit II: Ecosystems:

Concepts of an ecosystems, Structure and function of an ecosystem, Producers, Consumers, and Decomposers, Energy flow in an ecosystem, Ecological succession, Food chain, Food webs, Ecological pyramids,
Introduction, Types, Characteristic features & Structure of following ecosystems
(01) Forest ecosystem,
(02) Grassland ecosystem,
(03) Desert ecosystem
(04) Aquatic ecosystem (Ponds, Streams, Lakes, Rivers, Oceans, Estuaries).

Unit III: Biodiversity and its conservation:
Introduction, Definition, Biogeographical classification of India, Value of Biodiversity: Productive use, Social, Ethical, Aesthetic, and option values, India as a mega diversity nation, Endangered and endemic species of India, Conservation of biodiversity.

Unit IV: Environmental pollution and its mitigation:
Definition of Pollution; Causes, effects and control measures of
(A) Air pollution,
(B) Water pollution,
(C)Soil pollution,
(D) Noise pollution
Solid waste management: causes, effects and control measures of urban and industrial wastes, nuclear hazards, Environmental hazards and their mitigation, Role of an individual in pollution and abatement.

Unit V: Field Work:
01. Visit to local area to document environmental assets – River, Forest, Grass land, Hill, Mountain etc.
02. Visit to local polluted site: Urban, Industrial, Agricultural
03. Study of common plants, Insects, birds etc,
04. Study of simple ecosystems: Pond, River, Hill, Slopes etc.

Recommended Textbooks and References:

1. Introduction to Environment - M. N. Sastri, Himalaya Publishing House, New Delhi.
2. Environmental Studies - H. Kaur, Pragati Prakashan, Meerut
3. Environmental Studies - Erach Bharucha, University press Pvt. Ltd., Hyderabad
4. Environmental Studies - S. V. S. Rana, Rastogi Publication, Meerut
5. Environmental Studies - C. P. Kaushik, New age international Ltd. New Delhi
6. Environmental Studies - Arumugam, Saras Publication Kanyakumari

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B.Sc. Biotechnology

VI Semester

Course Title: Computational Biology **Course Code: U-COB-727**

Marks 50 **Lectures: 45** **Credit: 03**

Learning objectives:

- To educate the students about public and private data repositories such as NCBI
- To teach algorithms and analytical tools in bioinformatics,
- To study the interpretation and analysis of results using computational knowledge and techniques to the healthcare applications.
- To teach prediction of secondary structure of protein and computational protein modelling

Course outcomes:

On the successful completion of the course, student will be able to-

- use different tools related to database and generation of large-scale molecular biology data through genome sequencing.
- describe nucleic acid databases and protein data base and their applications.
- apply bioinformatics analysis knowledge and techniques to answer scientific questions in the health sciences
- apply the knowledge of computational biology for study of molecular phylogeny

Unit I: **(13L)**

Introduction to bioinformatics and data generation

What is bioinformatics and its relation with molecular biology. Examples of related tools (FASTA, BLAST, RASMOL), databases (GENBANK, Pub-med, 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: **(12L)**

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: **(10L)**

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: **(10L)**

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

Recommended Textbooks and References:

1. Introduction to Bioinformatics Teresa Attwood, David Parry-Smith - Prentice Hall, (1999)
2. Bioinformatics: The Machine Learning Approach (2001) Pierre Baldi, Søren Brunak - MIT Press,
3. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins (1998) Andreas D. Baxevanis, B.F. Francis Ouellette -, J. Wiley,
4. Structural Bioinformatics Philip E. Bourne, Helge Weissig - Wiley, (2003). Projected Pub. Date: 0311
5. Bioinformatics for Dummies Jean-Michel Claverie, Cedric Notredame – (2002) Wiley Pub.,
6. Computational Molecular Biology: An Introduction Peter Clote, Rolf Backofen – (2000) Wiley,
7. Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids Richard Durbin, Sean R. Eddy, Anders Krogh, Graeme Mitchison (1998)-, Cambridge University Press,
8. Statistical Methods in Bioinformatics: An Introduction Springer, c2001 Warren J. Ewens, Gregory R. Grant -
9. Computer Science and Computational Biology (1997) Dan Gusfield, Algorithms on Strings, Trees, and Sequences: Cambridge University Press,
10. Bioinformatics: Sequence, Structure, and Databanks: a Practical Approach, (2000) D. Higgins and W. Taylor - BOxford University Press, 2000.
11. Models for Bioinformatics (2001) Timo Koski , Hidden Markov - Kluwer Academic Publishers, c2001.

12. Introduction to Bioinformatics: A Theoretical and Practical Approach (2002) Stephen A. Krawetz and David D. Womble - Humana Press,
13. Introduction to Bioinformatics (2002) Arthur M Lesk -, Oxford University Press
14. Bioinformatics: Sequence and Genome Analysis, Cold Spring Harbor Laboratory Press, (c2001)-David W. Mount -.
15. Computational Molecular Biology: An Algorithmic Approach (2000) Pavel A. Pevzner - MIT Press.
16. Introduction to Computational Molecular Biology (1997) João Carlos Setubal, João Meidanis -, PWS Pub.,
17. Introduction to Computational Biology: Maps, Sequences, and Genomes: Interdisciplinary Statistics Michael S. Waterman -, Chapman & Hall/CRC, 1995 (2000 printing)

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VI Semester

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

Learning objectives:

- To learn the various data sources in computational biology
- To learn about various structure visualization and analysis tools in computational biology
- To make the student understand about sequence alignment tools and its applications in molecular taxonomy
- To teach the students of methods of protein modelling

Course outcomes:
On the successful completion of the course, student will be able to-

- apply the bioinformatics analysis tools for DNA sequencing, structure modeling, sequence alignment.
- construct phylogenetic tree using molecular phylogeny approach
- understand protein modelling using computational tools.
- apply bioinformatics analysis knowledge and techniques to answer scientific questions in the health sciences.

Practicals:

1. 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.
2. Sequence homology as product of molecular evolution, sequence similarity searches, sequence alignment-global, local, end free-space; measurement of sequence similarity, similarity and homology.
3. Multiple sequence alignment
4. Phylogeny reconstruction, PHYLIP package
5. Getting an amino acid sequence, nucleotide sequence by BLAST.
6. Multiple sequence alignment
7. Homology modeling
8. Protein identification & characterization with peptide mass fingerprinting data.
9. Secondary structure analysis of proteins (helical content of peptide).

10. Tertiary structure analysis of proteins (3D structure prediction).

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VI Semester

Course Title: Pharmaceutical Biotechnology **Course Code: U-PBT-728**
Marks 50 **Lectures: 45** **Credit: 03**

Learning Objectives:

- To provide a deeper insight into the fundamentals of production of pharmaceuticals by genetically engineered cells.
- To provide examples of use of antibodies, enzyme in clinical diagnosis.
- To teach different methods of drug stability and tissue engineering.
- To learn diagnostic kit development for microanalysis.

Course Outcomes:
On the successful completion of the course, student will be able to-

- understand steps involved in the development of new generation antibiotics.
- describe the concept and applications of monoclonal antibody technology
- study of general principles of tissue engineering and their related social and ethical issues.
- gain the understanding for FDA approved biotechnology product and their application.

Unit I: **(10L)**

Drug Development in Pharmaceutical Process

Production of pharmaceuticals by genetically engineered cells (hormones, interferons) - 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, immuno-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

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

Recommended Textbooks and References:

1. Pharmaceutical Microbiology- Hugo W. B. and Russell A. D.(1998) – 6th edition Wiley India
2. Pharmacology and Pharmacobiotechnology- Ashutosh Kar-(2017) – 3rd edition Publisher New Age
3. Essentials of Pharmaceuticals-FSK Barar- (1985) Publisher S. Chand
4. Molecular Biotechnology B. Glick and J Pasernak –(1994) Publisher ASM Press.
5. Drug Designing- Doble- (2010) Publisher McGraw Hill
6. Pharmaceutical Biotechnology S.P. Vyas, Dixit-(2018)- Publisher CBS
7. Medicinal Chemistry B.Razdan-(1999) Publisher CBS
8. Pharmacology and Pharmacotherapeutics Satoskar, Bhandarkar-(2020) Publisher Popular
9. Pharmaceutical Biotechnology Purohit,(2002) Saluja- -Student Edition
10. Biotechnology: Secondary Metabolites Ramawat K.G; Merillon J.M (2007)- Publisher Oxford
11. Chemistry of Natural Products Ed. R.H. Thomson-(2012) Publisher Springer
12. Biopharmaceuticals Jogdand S.N (2002)-, Publisher Himalaya Publishing

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B.Sc. Biotechnology
VI Semester

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

Learning Objectives:

- To provide hands-on assay of antimicrobial activity of different (API) against common pathogens.
- To determination Minimum Inhibitory Concentration (MIC) of Antibiotic
- To learn sterility testing of commercial pharmaceuticals
- To determine role of chemical disinfectants on growth of bacteria

Course Outcomes:
On the successful completion of the course, student will be able to-

- perform antimicrobial activity of different antibiotics on common pathogens.
- describe how effective sterilization techniques control the contamination in pharmaceutical products
- analyze microbial spoilage of pharmaceuticals
- determination of shelf life (expiry) of antibiotics

Practical's:

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

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B.Sc. Biotechnology
VI Semester

Course Title: Biodiversity &Systematics **Course Code: U-BDS-729**
Marks 50 **Lectures: 45** **Credit: 03**

Learning Objectives:

- To educate the students about the existing biodiversity in world with special reference to Indian continent
- To teach remedial conservation and mitigation strategies of animals.
- To inculcate the values and knowledge about classification of flora and fauna
- To learn the interpretation and analysis of results with the reference material for identification of new plants and animals.

Course Outcomes:
On the successful completion of the course, student will be able to-

- understand losses and global pattern of biodiversity.
- understand how overexploitation threatening living organism and related laws
- study ethics and values for biodiversity conservation.
- understand the traditional and newer methods of molecular evolution, genetic markers for taxonomic purposes.

Unit-I **(11L)**

Basic concept of Biodiversity

What is Biodiversity, why should we conserve it, Elements of Biodiversity - Ecosystem Diversity, Genetic Diversity, Species Abundance & Diversity, Patterns of Species Diversity. Global patterns of Biodiversity – measuring biodiversity, Cataloging and Discovering Species, Geographical Patterns of Species Richness, Biogeography, Importance of Distribution Patterns (Local Endemics, Sparsely Distributed Species, Migratory Species).

Unit-II **(12L)**
Biodiversity & Conservation

Overexploitation threatening living species, International Trade, Animals threatened by International trade, Problems in Controlling International Trade (Enforcement, Reservations, Illegal Trade), Free Trade & the Environment, Free Trade & Conservation, Common patterns of Over exploitation. Exotic Species – Plants, Invertebrates, Fishes, Amphibians, Reptiles, Birds, Mammals, Detrimental Effects of Exotic Species.

Unit III **(13L)**

Endangered Species Conservation

The US Endangered Species Act, State Endangered Species Acts Successes and Failures of the Endangered Species Act Role of ESA in Habitat Protection, Critical Habitat, Problems with the Endangered Species Act, Habitat Conservation Plans.
Ethics of Conservation – Values of Biodiversity, Biopiracy, Hybridized plants, GM crops (benefits & criticism), and Economic Value of Biodiversity & Legal, Ethical and Conservation issues related to uses of biodiversity, Global Conservation Issues.

Unit IV **(09L)**

Basic concept of Taxonomy

Classification, Construction of Phylogenetic tree, Systematics, Cladistics, Cladograms, Phonetics, Nomenclature. Molecular Taxonomy in relation to DNA characteristics & Protein sequences – modes of molecular evolution, Neutral theory of Molecular evolution, genetic markers for taxonomic purposes, comparing total genome by DNA-DNA hybridization, comparing DNA sequences, Cladistics, biological identification through DNA barcodes.

Recommended Textbooks and References:

1. The Biology of Biodiversity (2012) M. Koto – Springer-Verlag Tokyo.
2. Principle of Animal Taxonomy G. G.–Simpson Oxford IBH Publication company.
3. Biodiversity (2003) E.O. Wilson – Academic Press Washington
4. Principle of Animal taxonomy (1961) G. G.–Simpson Oxford IBH Publication company.
5. Ecology and Environment (2009). P. D. Sharma Rastogi Publications.
6. Fundamentals of Ecology (1953). 5 th ed. Eugene P. Odum and Garry Barret University of Georgia press.
7. An advance textbook on Biodiversity (2004) Kulithalai V. Krishnamurthy Oxford and IBH publishing.

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VI Semester

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

Learning Objectives:

- To provide Hands-on Herbarium preparation of different plant groups
- To teach morphology of different insects and reptiles.
- To teach morphology of different plant parts.
- To provide Hands-on dissection of plant and animal specimens.

Course Outcomes:
On the successful completion of the course, student will be able to-

- perform Herbarium for different plant groups.
- understand morphology of leaf and flower
- understand morphology of insect and fishes
- describe plant and animal taxonomy

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 of different plant groups
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 Insects
10. Morphological studies of Fishes.

11. Visit to local market for identification.
12. Visit to Botanical, Zoological Gardens, Biosphere Reserves, Project Tiger and National sanctuaries.

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Course Title: Agricultural Biotechnology **Course Code: U-ABT-730**
Marks 50 **Lectures: 45** **Credit: 03**

Learning Objectives:

- To learn basic methods, management and problems in agriculture biotechnology
- To educate the students about various process of bio-fertilizer and Bio-pesticide formulations
- To teach strategies for introducing genes for genetic manipulation.
- To learn direct and indirect methods of gene transfer

Course Outcomes:
On the successful completion of the course, student will be able to-

- describe methods of plant breeding.
- understand biomass production at piolet scale
- study molecular markers for molecular mapping of genes.
- study methods of genetic engineering in development of commercially important plant products.

UNIT- I: **(10L)**
Agriculture and its recent trends
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: **(12L)**
Biomass, Bio fertilizer, Biopestiside
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 Biofertilier, -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: **(10L)**

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: **(13L)**

Genetic engineering:

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.

Recommended Textbooks and References:

1. Textbook of Modern Plant Pathology-Bilgrami K.S and Dube H.G.(1994) -, Vikas Publications, New Delhi.
2. Genetics and Biotechnology in Crop Improvement -Gupta P.K. (1998) -, Rastogi Publications, Meerut.
3. Fundamentals of Plant Pathology-Pathak V.N,Khatri N.K.,Pathak M.(1996) - Agrobotanical Publications, Bikaner.
4. General Microbiology,Vol. II- Powar C.B., Daginawala H.F., (1990) -,Himalaya Publishing House,Mumbai.
5. Agricultural Biotechnology- Purohit S.S.(2002) - Agrobios India, Jodhpur.
6. Biotechnology, Satyanarayana U. (2007) - Books and Allied Pvt.Ltd.Kolkata.
7. Biofertilizer and Organic Farming-Vyas S.C.,Vyas S., Vyas S.,and Modi H.A.(1998), Akta Prakashan, Nadiad,G.S, Meerut.
8. Experiments in Microbiology- Vyas S.C.,Vyas S., Vyas S.,and Modi H.A (1998) -,

Plant pathology, Tissue culture and Mushroom cultivation, Vishwa Prakashan, New age international (p) Ltd.,New Delhi.

9. Microbiology and Biotechnology: A Laboratory Manual, Kalaichelvan P.T. and Dandiya P.C (2004), MJP Publishers, Chennai.
10. Laboratory manual of Plant Biotechnology,Purohit S.S. (1995), A . Aneja K.R. Agrobotonical Pub.India.
11. Methods in Biotechnology, Schmauder Hans Peter (1997) - Taylor and Francis, London.
12. Methods in Plant Molecular Biology, Schuler M. A. and Zielinski R. E. (1989) –
13. Methods in Biotechnology and Bioengineering, Vyas S.P. and Kohli D.V. (2002) – CBS Publishers and Distributors, New Delhi.

Rajarshi Shahu Mahavidyalaya, Latur (Autonomous)

B.Sc. Biotechnology

VI Semester

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

Learning Objectives:

- To provide Hands-on isolation, characterization of *Rhizobium sp.* from root nodule
- To learn methods for stress response in plant.
- To learn extraction of plant metabolites and their applications.
- To provide Hands-on Production of pearl oyster mushroom

Course Outcomes:
On the successful completion of the course, student will be able to-

- perform isolation and production of bio fertilizer for Leguminous crops.
- understand stress response in plant
- understand identification of plant secondary metabolites
- perform production of pearl oyster mushroom

Practical's

1. Isolation of *Rhizobium sp.* from root nodule and application of rhizobium bio fertilizer 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 plant.
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.

Rajarshi Shahu Mahavidyalaya, Latur
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B.Sc. Biotechnology
VI Semester

Course Title: Structural Genomics **Course Code: U-SGE-731**
Marks: 50 **Lectures: 45** **Credit: 03**

Learning Objectives:

- To aware the students about structural organization of genome and its functional aspects.
- To make the students to understand computational approaches for structure analysis
- To teach the students about various algorithms & methods for structure prediction
- To make the student understand the principles of macromolecular interactions

Course outcomes:
On the successful completion of the course, student will be able to-

- understand the structural organization of genome.
- describe computational approaches and its utilization for analysis of genome organization.
- analyze the structural coordinates in the complexity of genome.
- understand genome mapping.

Unit I **(12L)**

Structural Bioinformatics

Overview of Structural Bioinformatics, 1D-3D Profile-based methods, threading methods abinitio methods Threading methods ab initio methods Structural alignments of proteins Superimposition of structures & calculation of RMSD o Vector-based, distance matrix-based and combined algorithms for structural alignments Structure-based classification of proteins: SCOP & CATH Prediction of binding pockets on protein structures Structure-based function Prediction, Prediction of RNA structures

Unit II **(11L)**

Co-ordinate systems

Rectangular, Cylindrical and spherical coordinate systems. Experimental Methods for determination of biomolecular structures X-ray Diffraction NMR Spectroscopy Protein Structure Internal Coordinates – Bond lengths, bond angles, torsional angles; peptide unit, Ramachandran Map; Calculation of dihedral angles; Fourth atom fixing

Unit III **(10L)**

Genome Organization

Organization of bacterial genome, Structure of eucaryotic chromosomes. Role of nuclear matrix in chromosome organization and function, matrix binding proteins, heterochromatin and euchromatin, molecular components. DNA reassociation kinetics (Cot curve analysis), repetitive and unique sequences, kinetics and sequence complexities. Satellite DNA, DNA melting and buoyant density, packing and organization of chromatin, nucleosome phasing, DNase I hypersensitive regions, DNA methylation & Imprinting. Mutation:-Nonsense, missense and point mutations, intragenic and intergenic suppression, frameshift mutations, physical, chemical and biological mutagens.

Unit IV **(12L)**

Genome map and structural features

Goals of the Human Genome Project, cloning vectors, concept of maps, physical maps, shotgun libraries, DNA polymorphism, nucleotides, DNA sequences. Genome information and special features, coding sequences (CDS), untranslated regions (UTR's), cDNA library, expressed sequence tags (EST). Approach to gene identification; masking repetitive DNA, database search, codon-bias detection, detecting functional sites in the DNA. Internet resources for gene identification, detection of functional sites, gene expression.

Recommended Textbooks and References:

1. Forbes Burkowski. Structural bioinformatics: An algorithmic approach. Publisher: CRC Press, 2009. ISBN: 9781584886839.

2. Drenth Jan. Principles of Protein X-Ray Crystallography. Publisher: Netherlands, Springer Science. 2007. ISBN: 9780387333342.
3. Bourne Philip E., Weissig Helge. Structural Bioinformatics (Methods of Biochemical Analysis, V. 44), 2003. Publisher: Wiley-Liss. ISBN: 0471202002.
4. Höltje Hans-Dieter, Sippl Wolfgang, Rognan Didier, Folkers Gerd. Molecular Modeling: Basic Principles and Applications. Publisher: New York, Wiley-VCH. 2003. ISBN: 3527305890.
5. Leach, Andrew. Molecular Modelling: Principles and Applications. Publisher: Prentice Hall. 2001. ISBN: 0582239338.
6. Rhodes Gale.Crystallography Made Crystal Clear, Third Edition: A Guide for Users of Macromolecular Models. Publisher: USA, Academic Press 2000 ISBN: 0125870728.

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VI Semester

Course Title: Lab course XXIII **Course Code: U-LAC-737**
Marks: 50 **Credit: 02**

Learning Objectives:

- To educate the students about methods of structure prediction of genome.
- To educate the students about methods of genome analysis
- To make the student to understand computational methods of macromolecular interaction.
- To make the students aware about various algorithms & methods used for structure prediction and analysis.

Course outcomes:

On the successful completion of the course, student will be able to

- Visualize the Nucleic acid data using various structure visualization tools.
- Understand the structural organization of genomes using computational methods.
- Collect and analyze genomic data from various data sources.
- Compare and contrast the data available at public and private data sources.

Practical's:

1. Studies of Nucleic Acid Databank
2. Visualization of structures (SWISS-PDB Viewer, Discovery Studio)
3. Calculation of structural parameters of gnome
4. Calculation of structural parameters of DNA & RNA
5. Understanding Macromolecular interactions through visualization & structure analysis
6. Understanding Macromolecular interactions through Protein – Nucleic acids
7. Understanding Macromolecular interactions through Protein – carbohydrates
8. Understanding assemblies of biomolecules through visualization: Ribosome,
9. Computational nucleosome analysis.
10. To detect presence of non-bonded interactions

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B.Sc. Biotechnology
VI Semester

Course Title: Medical Biochemistry **Course Code: U-MBC-732**
Marks: 50 **Lectures: 45** **Credit: 03**

Learning Objectives:

- To illustrate basics of nutrition and diet
- To comprehend heme metabolism
- To study metabolic disorders and diagnostic enzymology
- To learn to diagnose the disease

Course outcomes:
On the successful completion of the course, student will be able to

- acquaint the importance of nutrition in our day-to-day life
- understand role of hemoglobin and allied diseases
- diagnose metabolic disorders
- explain role of enzymes in disease diagnosis

Unit I: **(12L)**
Nutrition and dietetics

respiratory quotient, Basel metabolic rate, specific dynamic action, nitrogen balance, protein quality, biological value, dietary fiber, balanced diet. Preservatives and adulterants in food. Obesity, Protein – energy malnutrition, Starvation Diet therapy for DM, Atherosclerosis and hyper tension.

Unit II: (13L)

Heme Metabolism

Heme metabolism- chemistry and properties of hemoglobin and myoglobin, transport of gases, oxygen dissociation curve, Biosynthesis of Hb, catabolism of heme. Bile pigments-bilirubin and related chromoproteins Hb derivatives, hemoglobin variants, Jaundice.

Unit III: (10L)

Metabolic disorders and Diagnostic enzymology

Disorders of metabolism: carbohydrate, Lipids, Amino acids and Nucleic acids. Diagnostic enzymes: Role of Enzymes in Clinical Practice: Marker enzymes in myocardium, liver and pancreas. Tumor markers, Radio isotope techniques

Unit IV (10L)

Role of metabolism in disease diagnosis

Development of diagnostic kit using biomaterial, biosensors in disease diagnosis, metabolic disorders, techniques used to study metabolic disorders.

Recommended Textbooks and References:

1. Medical Biochemistry For Nurses,2nd Edition By Kasarla Rajeshwar Reddy · 2008 (JAYPEE)
2. Textbook of Medical Biochemistry Eighth Edition by MN Chatterjea, Rana Shinde · 2011(JAYPEE)
3. Textbook of Medical Biochemistry by Dinesh Puri · 2010(Elsevier Health Sciences)
4. Medical Biochemistry by Antonio Blanco (M.D.), Gustavo Blanco (M.D.) · 2017(Elsevier Science)
5. Biochemistry by Deba Jyothi Das ,1978.
6. Textbook of Medical Biochemistry by M N Chaterjae, 2017.
7. Textbook of Biochemistry by Vasudevan and Sreekumari.S,2011

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B.Sc. Biotechnology
VI Semester

Course Title: Lab Course XIV **Course Code: U-MBC-738**
Marks: 50 **Credit: 02**

Learning Objectives:

- To provide Hands-On sample collection and demonstration using different types of microscope.
- To make the student able to analyze Blood glucose level.
- To teach the student how to estimation Serum creatinine
- To learn the method of protein estimation.

Course outcomes:
On the successful completion of the course, student will be able to

- understand the concept of biomolecules estimation
- study estimation of serum components for various disease diagnosis.
- Perform various lab investigations
- Understand Collection, handling and transportation of specimens

Practical's:

1. Demonstrates skills in collecting samples for different biochemical investigation.
2. Blood glucose analysis.
3. Estimation of Vitamins (A, E,C etc)
4. Blood urea analysis.
5. Estimation of Calcium and Phosphorous
6. Serum uric acid estimation.
7. Serum cholesterol estimation.
8. Serum bilirubin estimation.
9. Estimation of total protein.
10. Urine analysis.
11. Estimation of Serum Electrolytes.

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B.Sc. Biotechnology
VI Semester
Skill Enhancement Course

Course Title: Biofertilizer II **Course Code: U-ADC-640-B**
Marks 50 **Lectures 30** **Credit: 02**

Learning objectives:

- To explain the role of genetically engineered micro-organisms for improvement of bio fertilizers.
- To understand Socio-economic constraints in organic farming
- To understand the Quality control of bio-fertilizers
- To distinguish Lab to land application of bio-fertilizers

Course Outcomes:
On the successful completion of the course, student will be able to-

- describe productions steps and specific requirements for biofertilizers
- produce composting from various resources and study recycling.

- make skilled manpower for biofertilizer industry
- perform field experiment to check efficacy of biofertilizers

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

Recommended Textbooks and References:

1. A Text book of Biotechnology Dubey, R.C., (2005) S.Chand & Co, New Delhi.

2. Biotechnology- Kumaresan, V. (2005), Saras Publications, New Delhi.

3. Vermiculture and Organic Farming Sathe, T.V., (2004), Daya publishers.

4. Soil Microbiology, Subha Rao, N.S. (2000), Oxford & IBH Publishers, New _Delhi.

5. Bio-fertilizers and organic _Farming Vayas,S.C, Vayas, S. and Modi, H.A. (1998) Akta Prakashan, Nadiad

6. Bioetchnology of Biofertilizers- Kannaiyan, S., (2003), CHIPS, Texas.

7. Hand book of Microbial Biofertilizers Rai, M.K., (2005), The Haworth Press, Inc. New York

Rajarshi Shahu Mahavidyalaya, Latur
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B.Sc. Biotechnology
VI Semester
Skill Enhancement Course

Course Title: Solid Waste Management **Course Code: U-ADC-340(S)**
Marks 50 **Lectures: 30** **Credit: 02**

Learning Outcomes:

- To teach the students different methods of disposal of solid waste.
- To learn characteristics, Composition and identifiable of municipal solid waste.
- To teach processing of municipal solid waste and related facilities.
- To impart knowledge of different methods of waste recycling

Course objectives :

On the successful completion of the course, student will be able to-

- set up a municipal solid waste management system.
- make physical and chemical analysis of municipal solid wastes and apply them for a management system.
- 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.

Unit I **(8L)**

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

Practicals

1. Field trip - Composting facility & household waste sorting facility.
2. Field trip - WTE Recycling facility

Unit II **(10L)**

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

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

Practicals

1. Field trip - Paper and cardboard recycling facility.
2. Field trip - Metal salvage and recovering facility.

Unit III **(6L)**

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

Practicals

1. Field trip - Waste tires conversion and recycling facility.
2. Field trip - Waste-to-energy facility.

Unit IV **(6L)**

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

Practicals

1. Field trip - Wastewater treatment and sludge composting facility.
2. Field trip - Hazardous and electronic waste recycling facility.

Recommended Textbooks and References:

1) "Environmental Science and Engineering" -(2004) J. Glynn Henry and Gary. W. Heinke, Pretice Hall of India.

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

3) Solid Waste Engineering Principles and Management (2007) Techobanoglous Thiesen Ellasen; McGraw - Hill

Summary of cross cutting issues:

Biotechnology is a collective term for a group of technologies that use biological matter or processes to generate new and useful products and processes. As such, it ranges in complexity and maturity from ancient brewing and bread-making techniques to genetic modification through hybridization and interbreeding of plants and animals, as well as the manipulation of individual genes in humans, animals, plants and micro-organisms. Biotechnology is a key technology for the new millennium. It has an immense range of applications in agriculture, medicine, food processing, environmental protection, mining, and even Nano electronics. It is expected to cover some critical issues in the designed curriculum for the development of Students. In our syllabus we tried to include following cross cutting issues.

Cross-cutting issues relevant to Professional Ethics, Gender, Environment and Sustainability, and Human Values into the curriculum:

Sr. No.	Course Name	Code	Relevant to Professional Ethics	Description
1	Recombinant DNA technology	U- RDT-627	Professional Ethics	Students will get an opportunity in research and development pertaining to life sciences
2	Microbial Technology	U-MIT-628	Professional Ethics	Students will be absorbed in Fermentation Industries.
3	Animal Biotechnology	U-ANB-629	Professional Ethics	Job opportunities as Lab Technician in ATC Lab
4	Developmental Biology	U-DEB-630	Professional Ethics	After practical experience in clinical embryology, students can work at hospitals or research centers as an embryologists
5	Nano Biotechnology	U-NBT-632	Professional Ethics	Students will get job in medicine, energy production as a nanotechnologist,
6	Food Nutrition	U-FON-631	Professional Ethics	Students will get job in food industry.
7	Biofertilizer (Part I)/ Horticulture	U-ADC-540-B	Professional Ethics	Students will get job in Bio-fertilizer Industries and become Self entrepreneur
8	Computational Biology	U-COB-727	Professional Ethics	Students will get jobs in research and development sectors of industries and research institutes doing research pertaining to bioinformatics and computational biology
9	Pharmaceutical Biotechnology	U-PBT-728	Professional Ethics	Students will be absorbed in Pharmaceutical Industries.
10	Biodiversity and Systematic	U-BDS-729	Professional Ethics	Student will be enable to understand the concept of biodiversity conservation and various conservation measures and will be able to work as a consultant and resources person for conservation of biodiversity
11	Agriculture Biotechnology	U-ABT-730	Professional Ethics	Students will get job in Biofertilizer Industries, KVK, Seed company etc.
12	Structural Genomics	U-SGE-731	Professional Ethics	Students will get jobs in research and development

				sectors of industries and research institutes doing research pertaining to genomics analysis.
13	Medical Biochemistry	U-MBC-732	Professional Ethics	Students will get job in Pathology lab., research organization and Industries.
14	Bio-fertilizer II/ Solid Waste Management	U-ADC-640-B/ U-ADC-340-S	Professional Ethics	Students will get job in Bio-fertilizer Industries, Municipal corporation, and become Self entrepreneur

Sr. No.	Course Name	Code	Relevant to	Description
1	Biodiversity and Systematics	U-BDS-729	**Environment and Sustainability**	Students will be able to 1. Create awareness about Biodiversity 2. Solve Environment issues (Conservation of endangered Species and Data Compilation)
2	Agriculture Biotechnology	U-ABT-730	**Environment and Sustainability**	Students will be able to 1.develope post-harvest Management techniques. 2. fulfill food security issues

Curricula developed and implemented have relevance to the local, national, regional and global developmental needs

Sr. No.	Course code	Course Name	Linkage with Local/National/Regional/Global development
1	U-RDT-627	Recombinant DNA Technology	Molecular Techniques
2	U-MIT-628	Microbial Technology	Production and Recovery of industrial products, Set Up Industrial Plant
3	U-ANB-629	Animal Biotechnology	Cell Culture Techniques
4	U-DEB-630	Developmental Biology	Embryo development
5	U-NBT-632	Nano Biotechnology	Silver Nano particle and Nano

			robots, Biosensors
6	U-FON-631	Food Nutrition	Production, Marketing of food products
7	U-ADC-540B	Bio-fertilizer I	Production, Marketing of Bio-fertilizers in Organic Farming
8	U-COB-727	Computational Biology	Database Generation
9	U-PBT-728	Pharmaceutical Biotechnology	Start Up (Pharmaceutical)
10	U-BDS-729	Biodiversity and Systematic	Conservation of endangered species
11	U-ABT-730	Agriculture Biotechnology	Post Harvesting Technologies
12	U-SGE-731	Structural Genomics	Structural determination and Analysis of Macromolecules
13	U-MBC-732	Medical Biochemistry	Disease diagnosis
14	U-ADC-640-B/ U-ADC-340-S	Bio-fertilizer II/ Solid Waste Management	Production, Marketing of Bio-fertilizers in Organic Farming and give solution to global issue of Solid waste management.

Courses having focus on employability/ entrepreneurship/ skill development

Sr. No	**Name of the Course**	**Course Code**	**Activities/Content with a direct bearing on Employability/ Entrepreneurship/ Skill development**			**Year of introduction**
			Employability	**Entrepreneurship**	**Skill development**	
1	Recombinant DNA technology	U- RDT-627	Get an opportunity in research and development pertaining to life sciences		Students will be updated with the soft skills related to the tools and techniques in molecular biology, molecular diagnostics and	2019-20

					treatment, molecular phylogeny, recombinant product development	
2	Microbial Technology	U-MIT-628	Students will be absorbed in Fermentation Industries.	Start up (Industrial Plant)	Students will get idea about upstream and downstream in Fermentation Technology.	2019-20
3	Animal Biotechnology	U-ANB-629	Students will be enable to understand the basic concept of animal tissue culture and current technologies		Expertise in Cell culture techniques	2019-20
4	Developmental Biology	U-DEB-630	After practical experience in clinical embryology, students can work at hospitals or research centres as an embryologists		handing of animal embryos in research.	2019-20
5	Food Nutrition	U-FON-631		Start Up (Food Processing Industry)	students will develop skills related to food and nutrition which is more important nowadays because in fast life people are more aware and conscious about their nutritive food	2019-20
6	Nano Biotechnology	U-NBT-632	Students will get job in medicine, energy production as a nanotechnologis.		To make the students acquire an understanding of Nanoscience and Applications. To help them understand the broad outline of	2019-20

					Nanoscience and Nanotechnology.	
7	Biofertilizer (Part I)/ Horticulture	U-ADC-540-B	Students will get absorbed in Biofertilizer Industry	Start Up (Biofertilizer Plant and Nursery)	Student will be a successful entrepreneur in biofertilizer	2019-20
8	Computational Biology	U-COB-727	the students will get jobs in research and development sectors of industries and research institutes doing research pertaining to bioinformatics and computational biology		the students will gain the knowledge on virtual simulations of techniques in molecular biology, protein modelling, drug designing	2019-20
9	Pharmaceutical Biotechnology	U-PBT-728	Students will be absorbed in Pharmaceutical Industries.	Start Up (Pharmaceutical)	Student will be expertise in analysis of pharmaceutical product	2019-20
10	Biodiversity and Systematic	U-BDS-729	Student will be enable to understand the concept of biodiversity conservation and various conservation measures and will be able to work as a consultant and resources person for conservation of biodiversity		Student will get updated with current problems and strategies to mitigate the loss of biodiversity	2019-20
11	Agriculture Biotechnology	U-ABT-730	Students will get job in Biofertilizer Industries, KVK, Seed company etc.	Students can start Biofertilizer Industry.	Detection of molecular markers for further improvement in crops.	2019-20

12	Structural Genomics	U-SGE-731			Students will develop a resource of representative protein fold structures to extrapolate any protein structure by homology modeling.	2019-20
13	Medical biochemistry	U-MBC-732	The students will get jobs in research and development sectors of industries and research institutes.		The students will gain the knowledge on laboratory analysis of medical samples.	2019-20
14	Biofertilizer (Part II)/ Solid Waste Management	U-ADC-640-B	Students will get absorbed in Biofertilizer Industry	Start Up (Biofertilizer Plant and Recycling Plant)	Student will be a successful entrepreneur in biofertilizer and Waste Management	2019-20
15	Lab Course XV (Project Work)	U-PRW-713	.		Project work helps the student to develop research aptitude and Laboratory Skills etc.	2019-20