Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Biotechnology

Curriculum

For the Academic Year 2024-25

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, 2024

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-INB-628	Industrial Biotechnology	04	20	30	03	50
DSET3	U-EAE-629	Ecology and Evolution	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	03	20	30	02	50
DSEP2	U-LAC-634	Lab Course XVIII	03	20	30	02	50
DSEP3	U-LAC-635	Lab Course XIX	03	20	30	02	50
DSEP4	U-LAC-636	Lab Course XX	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**

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Choice Based Credit System
Course Structure of B.Sc. Biotechnology Third Year
B.Sc. III [Biotechnology] Semester VI

	Code No.	Title of the course	Hours/ Week	Marks (50)		Credits	Total
				In Sem	End Sem		
DSET1	U-IBI-727	Introduction to Bioinformatics	04	20	30	03	50
DSET2	U-PBT-728	Pharmaceutical Biotechnology	04	20	30	03	50
DSET3	U-PAC-729	Plant and Animal cell Culture	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	03	20	30	02	50
DSEP2	U-LAC-734	Lab Course XXII	03	20	30	02	50
DSEP3	U-LAC-735	Lab Course XXIII	03	20	30	02	50
DSEP4	U-LAC-736	Lab Course XIV	03	20	30	02	50
DSEP5	U-LAC-737	Lab Course XXIII	03	20	30	02	50
DSEP6	U-LAC-738	Lab Course XIV	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**

Semester - Fifth

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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 r DNA technology 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

Construction of Genomic library, 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. R. M. Old & S. B. Primrose, "Principles of Gene Manipulation and Cloning," Wiley-Blackwell, 2006.
2. Christopher Howe, "Gene Cloning and Manipulation," Cambridge University Press, 2007.
3. T. A. Brown, "Essential Molecular Biology," Wiley-Blackwell, 2006.
4. T. A. Brown, "Genomes 3," Garland Science, 2006.
5. Sandhya Mitra, "Genetic Engineering Principles and Practice," McGraw Hill Education, 2015.
6. U. Satyanarayana Arora M.P, "Textbook of Biotechnology," Himalaya Publishing House, Mumbai, 2020.
7. Jogd and S.N, "Gene Biotechnology," Himalaya Publishing House, Mumbai, 2006.
8. Joshi P, "Genetic Engineering and its Applications," Agrobios Pub, Jodhpur, 2002.
9. Sandhya Mitra, "Genetic Engineering," MacMillan India Ltd, Delhi, 2006.
10. Desmond S. T. Nichol, "An Introduction to Genetic Engineering," Cambridge University Press, 1994.

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B.Sc. Biotechnology
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 *E.coli*.
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. Visit to molecular biology & genetic engineering research laboratory

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B.Sc. Biotechnology
V Semester

Course Title: Industrial Biotechnology **Course Code: U-INB-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
- understand the implication 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. Mode and mechanisms employed by of microorganisms to derive nutrients.

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, types of media- Selective media, differential media. Aerobic and anaerobic fermentation, 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. Casida L.E, "Industrial Microbiology," Wiley Eastern, New Delhi, 1991.
2. Crueger W and Crueger A, "Biotechnology: A Textbook of Industrial Microbiology," 2nd Edition, Panima Publishing Corporation, New Delhi, 2000.
3. Patel A.H., "Industrial Microbiology," Macmillan India Ltd., New Delhi, 2004.
4. Peppler H.J and Perlman D, "Microbial Technology, Vol I and II," Academic Press, New York, 2006.
5. Parihar Pradeep, "A Textbook of Biotechnology," Student Edition, Jodhpur, 2007.
6. Stanbury P.F., Whitaker A., and Hall S.J, "Principles of Fermentation Technology," Aditya Books Pub. Ltd., New Delhi, 1997.
7. Satyanarayana U., "Biotechnology," Books and Allied Pvt. Ltd., Kolkata, 2007.
8. E. M. T. El-Mansi, Chris. F. D. Harwood, and Anthony L. Rose, "Fermentation Microbiology and Biotechnology," 2012.
9. James E. Bailey, David F. Ollis, "Biochemical Engineering Fundamentals," 2012.
10. Sandy Weinberg and James M. Woods, "Good Laboratory Practice Regulations," 2007.

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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.

Practical: -

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. Separation of proteins by using column chromatography.
10. Visit to Fermentation Industry

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V Semester

Course Title: Ecology and Evolution **Course Code: U-EAE-629**
Marks 50 **Lectures: 45** **Credit: 03**

Learning Objectives:

- To demonstrate a comprehensive understanding of core ecological principles, including population dynamics, community interactions, and ecosystem processes.
- To develop critical thinking skills through the evaluation and synthesis of ecological literature.
- To utilize evidence from the fossil record, comparative anatomy, molecular biology, and other sources to support evolutionary explanations and critically assess alternative hypotheses.
- To understand the mechanisms of evolution, with a focus on natural selection.

Course Outcome

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

- demonstrate a comprehensive understanding of fundamental ecological concepts, including the structure and function of ecosystems, population dynamics, and community interactions.
- apply ecological principles to analyze and solve real-world environmental problems, such as habitat loss, species extinction, and climate change
- apply evolutionary concepts to explain patterns in biological diversity, such as the evolution of adaptations, the formation of new species, and the development of complex traits.
- recognize the interdisciplinary nature of evolutionary theory and be able to integrate knowledge from other fields.

Unit I **(12L)**

Ecological Fundamentals

The Environment: Physical environment; biotic environment; biotic and abiotic interactions, biogeochemical cycles Concept of habitat and niche; niche width and overlap; fundamental and realized niche Population Ecology: Characteristics of a population; population dynamics -population growth curves; population regulation; life history strategies (r and K selection)

Unit II **(12L)**

Ecological dynamics

Climate patterns; Terrestrial and aquatic biomes; Environmental constraints on species distribution; Factors affecting population density, Ecosystems,

Interactions among communities; Ecological remediation, species diversity, ecological succession; food webs and energy flow through ecosystem.

Unit III **(11L)**

History and Theories of Evolution

Origin and history of life on earth - abiotic synthesis of biological macromolecules, Concept of Oparin and Haldane; Experiment of Miller (1953); protocell, dating fossils and origin of multicellularity.

Theories of evolution – Lamarckism, Darwinian view – natural selection, fossil record and descent with modification; Species and speciation.

Unit IV **(10L)**

Evolutionary trends

The Geological time scale; Eras, periods and epoch; Major events in the evolutionary time scale, Adaptive radiation; Isolating mechanisms; Speciation; Allopatric and Sympatric; Convergent evolution; Concepts of neutral evolution, molecular divergence and molecular clocks

Recommended Textbooks and References:

1. Robert H. Tamarin, "Principles of Genetics," Tata-McGraw Hill, Seventh Edition, 2002.
2. Eugene P. Odum and Gary W. Barrett, "Fundamentals of Ecology," Brooks/Cole, Fifth Edition, 2004.
3. P.D. Sharma, "Ecology and Environment," Rastogi Publications, Second Edition, 2011.
4. Manuel C. Molles, "Ecology: Concepts and Applications," McGrawHill Education, Seventh Edition, 2015.
5. Thomas M. Smith and Robert L. Smith, "Elements of Ecology," Pearson Education India, Ninth Edition, 2015.
6. M.C. Dash and S.P. Dash, "Fundamentals of Ecology," McGraw Hill Education India, Third Edition, 2009.
7. Douglas J. Futuyma, "Evolution," OUP USA, Fourth Edition, 2017.
8. Monroe W. Strickberger, "Strickberger's Evolution," Jones & Bartlett, Fourth Edition, 2007.
9. R.L. Smith and T.M. Smith, "Ecology and Field Biology," Benjamin Cummings, Sixth Edition, 2000.
10. Veer Bala Rastogi, "Organic Evolution," MedTech Publication, Third Edition, 2018.
11. N. Arumugam, "Organic Evolution," Saras Publication, Eleventh Edition, 2019.

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B.Sc. Biotechnology
V Semester

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

Learning Objectives

- To gain a deeper understanding of ecological principles and evolutionary theories through hands-on experience.
- To learn essential skills such as data collection, sampling techniques, and observation methods, through field work experience.
- To analyze ecological and evolutionary data using statistical tools and software, interpreting the results to draw meaningful conclusions.
- To design Practical sessions for understanding how to design ecological experiments.

Course outcomes

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

- carry out fieldwork techniques such as sampling, data collection, and observational methods with better proficiency.
- analyze ecological data using appropriate statistical tools and interpret the results effectively.
- understand the mechanisms of evolution, including natural selection, genetic drift, and speciation.
- design and implement ecological experiments, including hypothesis formulation and control of variables.

Practical's:

1. Measure and study various water quality parameters like Temperature, pH, dissolved oxygen, and nitrate levels etc.
2. Study the importance of ecological interactions in the ecosystem.
3. Study the basic concept of pest population invasion and its impacts on the ecosystem.
4. Apply the quadrat sampling Method for sampling populations of plants in the regional fields.
5. Study plant growth and responses to environmental changes under controlled conditions.
6. Study the population growth and its dynamics by using available research data of plants and animals.
7. Visit natural areas like forests, wetlands, or beaches allows for observing ecological processes in action.
8. Study the fossils, living fossils and connecting links Archaeopteryx, Peripatus, Limulus, Nautilus, Latimeria using models, photo
9. Examine how ecological interactions, such as competition, predation, and mutualism, drive evolutionary change
10. Study of evolutionary relationships among species, often using molecular data to reconstruct phylogenetic trees.
11. Visit a local park or garden and closely examining a specific organism, like butterflies or birds. Students can observe and record variations in traits like wing color, beak size, or body patterns. This helps them understand the inherent variability within a population, a crucial element for natural selection to act upon.

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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 the fundamentals of embryology.
- To enhance understanding of cell division and cell growth.
- To explore the role of genes in the patterning and morphology of animal and plant cell development.
- To improve skills in interpreting 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

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

UNIT II **(08L)**

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. S.F. Gilbert, "Developmental Biology," Sinauer Associates Inc., 8th Edition, 2006.
2. Lewis Wolpert, "Principles of Development," Oxford University Press, 3rd Edition, 2007.
3. B. I. Balinsky, "An Introduction to Embryology," Thomas Asia Pvt. Ltd, 5th Edition, 2004.
4. R. M. Twyman, "Developmental Biology," Bios Scientific Publishers LTD, 2001.
5. N. Arumugam, "Developmental Biology," Saras Publication, Nagercoil, 1994.
6. Lewis Wolpert, Cheryll Tickle, Alfonso Martinez Arias, "Principles of Development," Oxford University Press, 2015.
7. Scott F. Gilbert, "Developmental Biology," Sinauer Associates Inc., 2010.
8. Bruce M. Carlson, "Developmental Biology," Saunders, 2014.
9. Michael K. Richardson, Manuel Merino Jiménez, "Essentials of Developmental Biology," Wiley-Blackwell, 2020.
10. Sally A. Moody, "Developmental Biology," Academic Press, 2019.
11. Gilbert Scott, "Developmental Biology," Sinauer Associates, 2000.

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V Semester

Course Title: Lab Course XX **Course Code:- U-LAC-636**

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,
- perform candling and egg dissection technique.
- describe morphological and anatomical changes in plants

Practical's:

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. 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. Study of different types of sperms and its features by using charts.
8. Study of pollen genesis by using T.S. of Anther preparation technique.
9. Study of T.S. of ovary for arrangement of ovules within ovary.
10. Study of Flower development from vegetative shoot of any suitable plant.
11. 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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B.Sc. Biotechnology
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-

- acquire the knowledge of different methods of food classification and their importance
- understand food safety and regulations
- understand importance of processed and value-added foods.
- adapt the importance 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. B. Srilakshmi, "Nutrition Science," New Age International Publishers, 2020.
2. Maurice E. Shils, Moshe Shike, A. Catharine Ross, Benjamin Caballero, and Robert J. Cousins, "Modern Nutrition in Health and Disease," Lippincott Williams & Wilkins, 10th Edition, 2005.
3. Michael J. Gibney, Susan A. Lanham-New, Aedin Cassidy, and Hester H. Vorster, "Introduction to Human Nutrition," Wiley-Blackwell, 2nd Edition, 2009.
4. Michael P. Doyle, Larry R. Beuchat, and Thomas J. Montville, "Food Microbiology: Fundamentals and Frontiers," ASM Press, 4th Edition, 2012.
5. Paul Insel, Don Ross, Kimberley McMahon, and Melissa Bernstein, "Nutrition," Jones & Bartlett Learning, 5th Edition, 2016.
6. William M. Muir, "Food Security and Food Safety: The New Challenge," Springer, 2016.
7. Norman N. Potter, Joseph H. Hotchkiss, "Food Science," Springer, 5th Edition, 1995.
8. J. Scott Smith, Y. H. Hui, "Food Processing: Principles and Applications," Wiley-Blackwell, 2nd Edition, 2008.
9. Gordon W. Fuller, "New Food Product Development: From Concept to Marketplace," CRC Press, 3rd Edition, 2011.
10. Robert E. C. Wildman, "Handbook of Nutraceuticals and Functional Foods," CRC Press, 2nd Edition, 2006.

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V Semester

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 detailed analysis of biomolecules in food.
- understand and execute the quantitative estimation of proteins and carbohydrates.
- determine the mineral and moisture content in various foods.
- understand the methods involved in the production of caffeine and carotene.

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. Separation of Caffeine from tea power
9. Extraction of beta carotene from carrot
10. Field visit

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V Semester

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 nanobiotechnology
- To train the students with industry requirement as per the field of nanobiotechnology
- To guide the students to build up career in the field of nanobiotechnology

Course outcomes:

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

- understand the methods of analyzing nanoparticles with biological material.
- grasp the properties of materials at the nanoscale and their utilization in various fields.
- understand various types of carbon-based nanomaterials.
- comprehend 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, Apolipoproteins, 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 **(10L)**

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 **(10L)**

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. Nanobiotechnology: Concepts, Applications and Perspectives, C. M. Niemeyer, C. A. Mirkin, Wiley – VCH, 2004.
2. Nanoscience: Nanobiotechnology and Nanobiology, P. Boisseau, P. Houdy and M. Lahmani, Springer, 2007.
3. Handbook of Nanostructured Biomaterials and Their Applications in Nanobiotechnology, Hari Singh Nalwa, American Scientific Publishers, 2005.
4. Nanobiotechnology, C.M.Niemeyer, C.A. Mirkin, Wiley VCH, 2004. 8. Nanobiotechnology, C.M.Niemeyer, C.A. Mirkin, Wiley VCH, 2004.
5. Nanofabrication Towards Biomedical Applications, Techniques, Tools, Applications and Impact, Challa, S.S.R. Kumar, Josef Hormes, Carola Leuschaer, Wiley – VCH, 2005.
6. Nanoparticle Assemblies and Superstructures, Nicholas A. Kotov, CRC, 2006.
7. Nano: The Essential, T. Pradeep, McGraw – Hill education, 2007.
8. Bionanotechnology, David S Goodsell, John Wiley & Sons, 2004.
9. Nanobiotechnology: Principles and Applications, Chaudhary Mustansar Hussain, Wiley-Scrivener, 2016.
10. Nanobiotechnology: Concepts, Applications and Perspectives, S. Suresh, Wiley-VCH, 2018.

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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
- To gain the skills for the biosynthesis process of nanoparticles from microorganisms

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

- acquaint the methodology for analysis of nanoparticles with biological material
- acquire the knowledge nanoscale properties and its utilization in various field and will be able to understand the techniques
- adapt the knowledge about production process of silver nanoparticle
- understand electrodeposition technique of different metals.

Practical:

1. Biosynthesis of silver nanoparticle from plants
2. Biosynthesis of silver nanoparticle from Fungi
3. Biosynthesis of silver nanoparticle by Bacteria
4. Detection of Silver Nano Particle using Spectrophotometric methods.
5. Synthesis of ZnO by hydrothermal method
6. Synthesis of Polyaniline nanofibers by CBD method
7. Synthesis of Fe2O3 by Sol-gel method
8. Electrodeposition of Cobalt thin films
9. Preparation of CdSe by Successive Ionic Layer, Adsorption and Reaction (SILAR) method
10. Design nanoparticles for environmental remediation applications.

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B.Sc. Biotechnology
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 **(08L)**

Overview of biofertilizers

General account about the microbes used as bio-fertilizer – *Rhizobium* – isolation, identification, mass multiplication, carrier-based inoculants, Actinomycorrhizal 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 **(06L)**

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 **(06L)**

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., S. Chand & Co, New Delhi, 2005.
2. Biotechnology, Kumaresan, V., Saras Publications, New Delhi, 2005.
3. Vermiculture and Organic Farming Sathe, T.V., Daya publishers, 2004.
4. Soil Microbiology, Subha Rao, N.S. Oxford & IBH Publishers, New Delhi, 2000.
5. Bio-fertilizers and Organic Farming, Vayas, S.C, Vayas, S. and Modi, H.A., Akta Prakashan, Nadiad, 1998.
6. Biotechnology of Biofertilizers, Kannaiyan, S., CHIPS, Texas, 2003.
7. Hand book of Microbial Biofertilizers, Rai, M.K., The Haworth Press, Inc. New York, 2005.
8. Biofertilizers: A Sustainable Eco-Friendly Agricultural Approach, Dhananjaya Pratap Singh, Harikesh Bahadur Singh, Springer, 2018.
9. Biofertilizers and Biopesticides: A Sustainable Approach, N. Amaresan, D. S. Aravind, D. Ramesh Sundar, CRC Press, 2018.
10. Biofertilizers: Commercial Production Technology", Y. V. Singh, R. B. Singh, Satish Serial Publishing House, 2011.

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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.

Practical

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

Unit III **(06L)**

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, Tata McGraw Hill Publishing Co., New Delhi, 1963.
2. Introductions to Horticulture, Kumar, N. Rajyalakshmi Publications, 1990.
3. Basic Horticulture, Jitendra Sing, Kalyani Publishers, 2002.
4. Fundamentals of Fruit Production, Garner V R, Bradford F C and Hooker Jr. H D, McGraw Hill Book Co., New York, 1957.
5. Plant Propagation, Principles and Practices, Hartman, HT and Kester, D.E. Prentice Hall of India Pvt. Ltd. Bombay, 1976.
6. Plant Propagation. Sadhu, M.K. New Age International Publishers, New Delhi, 1996.
7. Principles of Horticulture, C.R. Adams, Butterworth-Heinemann, 2011.
8. The Reference Manual of Woody Plant Propagation: From Seed to Tissue Culture, Michael A. Dirr, Charles W. Heuser Jr., Varsity, 2006.
9. Horticulture: Principles and Practices, George Acquaah, Pearson, 2014.
10. The Grape Grower: A Guide to Organic Viticulture, Lon Rombough, Chelsea Green, 2002.

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V Semester

Course Title: Environmental 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.
- acquaint the knowledge about the structure and functions of ecosystem
- 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,2006.
2. Environmental Studies, H. Kaur, Pragati Prakashan, Meerut, 2012.
3. Environmental Studies, Erach Bharucha, University press Pvt. Ltd., Hyderabad, 2005.
4. Environmental Studies, S. V. S. Rana, Rastogi Publication, Meerut, 2009.
5. Environmental Studies, C. P. Kaushik, New age international Ltd. New Delhi, 2004.
6. Environmental Studies, Arumugam, Saras Publication Kanyakumari, 2010.
7. Environmental Studies, Erach Bharucha, University Press Pvt. Ltd., Hyderabad, 2005.
8. Environmental Studies: Basic Concepts, S. C. Sharma, Kalyani Publishers, New Delhi, 2006.
9. Introduction to Environmental Science and Engineering, A. K. De, Wiley Eastern Ltd., New Delhi, 2003.
10. Environmental Science: A Global Concern, M. L. Sharma, Rastogi Publications, Meerut, 2009.

Semester - Sixth

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B.Sc. Biotechnology

VI Semester

Course Title: Introduction to Bioinformatics **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 with 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, T. Attwood and D. Parry-Smith, Prentice Hall, 1999.
2. Bioinformatics: The Machine Learning Approach, P. Baldi and S. Brunak, MIT Press, 2001.
3. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, A. D. Baxevanis and B. F. F. Ouellette, Wiley, 1998.
4. Structural Bioinformatics, P. E. Bourne and H. Weissig, Wiley, 2003.
5. Bioinformatics for Dummies, J.-M. Claverie and C. Notredame, Wiley Pub., 2002.
6. Computational Molecular Biology: An Introduction, P. Clote and R. Backofen, Wiley, 2000.
7. Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids, R. Durbin, S. R. Eddy, A. Krogh, and G. Mitchison, Cambridge University Press, 1998.
8. Statistical Methods in Bioinformatics: An Introduction, W. J. Ewens and G. R. Grant, Springer, 2001.
9. Computer Science and Computational Biology: Algorithms on Strings, Trees, and Sequences, D. Gusfield, Cambridge University Press, 1997.
10. Bioinformatics: Sequence, Structure, and Databanks: a Practical Approach, D. Higgins and W. Taylor, Oxford University Press, 2000.
11. Models for Bioinformatics: Hidden Markov, T. Koski, Kluwer Academic Publishers, 2001.
12. Introduction to Bioinformatics: A Theoretical and Practical Approach, S. A. Krawetz and D. D. Womble, Humana Press, 2002.

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B.Sc. Biotechnology
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.

Practical's:

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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B.Sc. Biotechnology
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. Toxicogenomic.

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

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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-

- gain the skills to carry out antimicrobial activity of different antibiotics on common pathogens.
- acquire the knowledge about effective sterilization techniques control the contamination in pharmaceutical products
- acquaint the knowledge about microbial spoilage of pharmaceuticals
- grasp the methodology for determining MIC 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: Plant and Animal Cell culture **Course Code: U-BDS-729**
Marks 50 **Lectures: 45** **Credit: 03**

Learning Objectives:

- To gain knowledge of cell culture history, types of cultures, and the significance of cell culture in biotechnology.
- To develop practical skills in the culture of plant and animal cells, including the use of serum and serum-free media.
- To understand the applications of cell culture in producing biologicals like vaccines and therapeutic proteins.
- To learn about the translational significance of cell culture in research and industry.

Course Outcomes:

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

- understand the fundamental principles of cell culture, including the requirements for growth and maintenance of plant and animal cells in vitro.
- develop technical skills in the culture and handling of eukaryotic cell lines, including aseptic techniques and media preparation.
- apply cell culture techniques to solve problems in biotechnology, such as the production of recombinant proteins and monoclonal antibodies.
- evaluate the ethical, legal, and social implications of using cell cultures in biotechnology, including considerations of biosafety and bioethics.

Unit-I **(11L)**

Introduction to Cell Culture

History and development of cell culture technology, Concept of Cellular Totipotency, Basic requirements for plant and animal cell cultures, Types of cell cultures: Primary, secondary, and continuous cell lines, Laboratory setup, equipment and safety measures.

Unit-II **(12L)**

Techniques in Cell Culture

Aseptic techniques and media preparation, Cell line initiation, maintenance and preservation, Characterization and authentication of cell lines, "Synthetic seeds" and haploid production advantages and methods, Cell counting, viability assays, and quality control.

Unit III **(13L)**

Applications of Cell Culture

Production of recombinant proteins and monoclonal antibodies, Cell culture in pharmacology and toxicology studies, Role of cell culture in gene therapy and vaccine development, Ethical, legal, and social issues in cell culture technology.

Unit IV **(09L)**

Advanced Topics in Cell Culture

Stem cell cultures and regenerative medicine, Three-dimensional cultures and tissue engineering, Scale-up processes in industrial biotechnology, Future directions and innovations in cell culture technology.

Recommended Textbooks and References:

1. "Animal tissue culture principles and applications" - Anju Verma, Megha Verma, Anchal Singh, 2020.
2. "Animal-cell culture media: History, characteristics, and current issues" - Tatsuma Yao, Yuta Asayama, 2017.
3. "Culture of Animal Cells" - R. Ian Freshney, Wiley, 6th Edition, 2010.
4. "Introduction to Cell Culture" - Thermo Fisher Scientific, 2024.
5. "Introduction to animal cell culture technology—past, present and future" - Allison DW et al., 2006.
6. "Plant Cell and Tissue Culture" - A Practical Approach, 2nd Edition, Edited by J. A. Bryant and M. R. Davey, Oxford University Press, 1995.
7. "Principles of Tissue Engineering" - R. Lanza, R. Langer, J. Vacanti, Academic Press, 4th Edition, 2013.
8. "Methods in Plant Cell Biology" - D. W. Galbraith, D. P. Bourque, H. J. Bohnert, Academic Press, 1995.
9. "Plant Cell Culture Protocols" - V. M. Loyola-Vargas, F. Vázquez-Flota, Humana Press, 3rd Edition, 2012.
10. "Animal Cell Culture: A Practical Approach" - E. J. Jenkins, Oxford University Press, 2000.

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B.Sc. Biotechnology
VI Semester

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

Learning Objectives:

- To understand the principles and importance of aseptic techniques in laboratory settings.
- To demonstrate proficiency in preparing various types of culture media for microbial and cell culture applications.
- To gain knowledge of plant cell biology to isolate and culture plant cells from tissues successfully.
- To develop skills in subculturing, passaging, cryopreserving, and thawing cell cultures for long-term maintenance and experimental purposes.

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

- apply fundamental biological principles and techniques to solve practical problems in laboratory settings.
- demonstrate proficiency in handling and culturing different types of cells, including plant and animal cells, with precision and accuracy.
- apply critical thinking and problem-solving skills in the design and execution of experiments involving cell culture techniques.
- communicate effectively, both orally and in writing, about experimental procedures, results, and interpretations in the context of cell culture applications.

Practical

1. Aseptic techniques and preparation of culture media.
2. Isolation and culture of plant cells from tissues.
3. Subculturing and passaging animal cell lines.
4. Cryopreservation and thawing of cell cultures.
5. Viability assays and characterization of cell lines.
6. Production of Synthetic Seed.
7. Anther culture and pollen culture.
8. Isolation of Protoplast and regeneration.
9. Application of cell culture in vaccine production.
10. Use of bioinformatics tools in the analysis of cell culture data.
11. Micropropagation technique.

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B.Sc. Biotechnology
VI Semester

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, Biopesticide

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

Rajarshi Shahu Mahavidyalaya, Latur
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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-

- adapt the isolation and production techniques of bio fertilizer for leguminous crops.
- understand stress response in plant
- acquire skills about identification techniques 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. Isolation and Characterization of Plant pathogens.
9. Determination of growth response in controlled condition.
10. Visit to Cell Culture Facilities /Production /Biofertilizer Industry.

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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, Ab Initio Methods ,Structural Alignments of Proteins, Methods of superimposing protein structures & calculation of RMSD , Algorithms for Structural Alignment :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. Structural bioinformatics: An algorithmic approach, Forbes Burkowski, CRC Press, 2009.
2. Principles of Protein X-Ray Crystallography, Drenth Jan., Netherlands, Springer Science. 2007.
3. Structural Bioinformatics (Methods of Biochemical Analysis, V. 44), Bourne Philip E., Weissig Helge. S, Wiley-Liss, 2003.
4. Molecular Modeling: Basic Principles and Applications, Hans-Dieter, Sippl Wolfgang, Rognan Didier, Folkers Gerd. New York, Wiley-VCH. 2003.
5. Molecular Modelling: Principles and Applications Leach, Andrew, Prentice Hall. 2001.
6. Crystallography Made Crystal Clear, Third Edition: A Guide for Users of Macromolecular Models, Rhodes Gale, USA, Academic Press 2000.
7. Journal of Biological Chemistry, Bertrand Garcia-Moreno, E., & Dwyer, J. J., 2014.
8. The Protein Data Bank. Nucleic Acids Research, Berman, H. M., Westbrook, J., Feng, Z., Gilliland, G., Bhat, T. N., Weissig, H., Shindyalov, I. N., & Bourne, P. E., 2000.
9. Structural Genomics: Current Status and Future Directions, K. K. Shukla, Springer, 2013.
10. Structural Biology and Bioinformatics, N. K. Singh, Wiley-VCH, 2011.

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B.Sc. Biotechnology
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
- acquire the knowledge of role of hemoglobin and allied diseases
- diagnose metabolic disorders
- adapt the knowledge about radioisotopes techniques

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, Kasarla Rajeshwar Reddy , 2nd Edition, JAYPEE, 2008.
2. Textbook of Medical Biochemistry, MN Chatterjea, Rana Shinde Eighth Edition, JAYPEE, 2011.
3. Textbook of Medical Biochemistry, Dinesh Puri, Elsevier Health Sciences, 2010.
4. Medical Biochemistry, Antonio Blanco (M.D.), Gustavo Blanco (M.D.), Elsevier Science, 2017.
5. Biochemistry, Deba Jyothi Das, Ahuja Publishing House, 1978.
6. Textbook of Medical Biochemistry, M N Chaterjae, Jaypee Brothers Medical Publishers, 2017.
7. Textbook of Biochemistry, Vasudevan and Sreekumari.S, Jaypee Brothers Medical Publishers, 2011.
8. Medical Biochemistry, Baynes, J. W., & Dominiczak, M. H., USA, Elsevier, 2014.
9. Basic Medical Biochemistry: A Clinical Approach, Marks, D. B., Marks, A. D., & Smith, C. M., USA, Lippincott Williams & Wilkins, 2012.
10. Textbook of Biochemistry with Clinical Correlations, Devlin, T. M., USA, John Wiley & Sons, 2010.

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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.
- acquire the knowledge about 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-

- acquaint the production steps and specific requirements for biofertilizers
- gain the skills to produce composting from various resources and study recycling.
- acquaint the skills required for biofertilizer industry
- perform field experiment to check efficacy of biofertilizers

Unit I **(08L)**

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 **(06L)**
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 **(06L)**

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 Textbook of Biotechnology, Dubey, R.C., S. Chand & Co, New Delhi, 2005.
2. Biotechnology, Kumaresan, V., Saras Publications, New Delhi, 2005.
3. Vermiculture and Organic Farming Sathe, T.V., Daya publishers, 2004.
4. Soil Microbiology, Subha Rao, N.S. Oxford & IBH Publishers, New Delhi, 2000.
5. Bio-fertilizers and Organic Farming, Vayas, S.C, Vayas, S. and Modi, H.A., Akta Prakashan, Nadiad, 1998.
6. Biotechnology of Biofertilizers, Kannaiyan, S., CHIPS, Texas, 2003.
7. Hand book of Microbial Biofertilizers, Rai, M.K., The Haworth Press, Inc. New York, 2005.
8. Biofertilizers: A Sustainable Eco-Friendly Agricultural Approach, Dhananjaya Pratap Singh, Harikesh Bahadur Singh, Springer, 2018.
9. Biofertilizers and Biopesticides: A Sustainable Approach, N. Amaresan, D. S. Aravind, D. Ramesh Sundar, CRC Press, 2018.
10. Biofertilizers: Commercial Production Technology", Y. V. Singh, R. B. Singh, Satish Serial Publishing House, 2011.

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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-

- acquaint the skills to set up a municipal solid waste management system.
- acquire the knowledge about physical and chemical analysis of municipal solid wastes and apply them for a management system.
- adapt the knowledge about municipal solid waste characteristics
- grasp the skills in hierarchical structure in solid waste management and an integrated solution.

Unit I **(08L)**

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", J. Glynn Henry and Gary. W. Heinke, Pretice Hall of India, 2004.
2. "Solid Waste Management – Collection, Processing and disposal", A. D.Bhide and B.B.Sundaresan, Mudrashilpa Offset Printers, Nagpur, 2001.
3. Solid Waste Engineering Principles and Management, Techobanoglous Thiesen Ellasen; McGraw – Hill, 2007.
4. Integrated Solid Waste Management: Engineering Principles and Management Issues, Tchobanoglous, G., Theisen, H., & Vigil, S., USA, McGraw-Hill Education, 1993.
5. Municipal Solid Waste Management in Developing Countries, Agamuthu, P. Malaysia, University of Malaya Press, 2009.
6. Environment: Waste Production, Hoornweg, D., Bhada-Tata, P., & Kennedy, C. Must Peak This Century, 2013.
7. Solid Waste Management: Principles and Practice, Kumar, S., & Alappat, B. J., India, Springer, 2020.
8. Global Waste Management Outlook, UNEP, Nairobi, United Nations Environment Programme, 2016.
9. Integrated Solid Waste Management Towards Sustainable Society, Ali, M., Wang, W., Chaudhry, N., Geng, Y., & Ashraf, U. Journal of Cleaner Production, 2020.
10. Role of Informal Sector Recycling in Waste Management in Developing Countries, Wilson, D. C., Velis, C., & Cheeseman, C., Habitat International, 2006.

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 engage in research and development in life sciences, upholding ethical standards in biotechnology.
2	Industrial Biotechnology	U-MIT-628	Professional Ethics	Opportunities in fermentation industries with a focus on ethical practices in industrial biotechnology.
3	Ecology and Evolution	U-ANB-629	Environment & Sustainability	Students will gain an understanding of biodiversity, sustainability, and environmental ethics.
4	Developmental Biology	U-DEB-630	Professional Ethics	Practical experience in clinical embryology enables ethical practices in hospitals and research as embryologists.
5	Nano Biotechnology	U-NBT-632	Professional Ethics	Career opportunities in medicine and energy production, focusing on ethical nanotechnology applications.
6	Food Nutrition	U-FON-631	Professional Ethics	Ethical considerations in the food industry with a focus on nutrition, health, and safety standards.
7	Biofertilizer (Part I)/ Horticulture	U-ADC-540-B	Professional Ethics, Sustainability	Careers in biofertilizer industries with a focus on sustainable agriculture and ethical entrepreneurship.

8	Introduction to Bioinformatics	U-COB-727	Professional Ethics	Opportunities in research and development related to bioinformatics and computational biology, adhering to professional ethics.
9	Pharmaceutical Biotechnology	U-PBT-728	Professional Ethics	Ethical practices in pharmaceutical industries, ensuring safety and efficacy in biotechnology products.
10	Plant and Animal cell culture	U-BDS-729	Professional Ethics	Ethical standards in cell culture techniques for research and industrial applications.
11	Agriculture Biotechnology	U-ABT-730	Professional Ethics, Sustainability	Careers in biofertilizer industries, KVK, and seed companies with a focus on sustainable and ethical agricultural practices.
12	Structural Genomics	U-SGE-731	Professional Ethics	Research opportunities in genomics, ensuring ethical use of data and genomic analysis.
13	Medical Biochemistry	U-MBC-732	Professional Ethics	Ethical roles in pathology labs, research organizations, and industries, ensuring integrity in medical biochemistry.
14	Bio-fertilizer II/ Solid Waste Management	U-ADC-640-B/ U-ADC-340-S	Professional Ethics, Environment & Sustainability	Ethical roles in pathology labs, research organizations, and industries, ensuring integrity in medical biochemistry.

This revised content integrates cross-cutting issues like professional ethics, environment, sustainability, and human values into the curriculum while emphasizing relevant industry roles and ethical considerations in each field.

Sr. No.	Course Name	Code	Relevant to	Description
1	Plant and Animal Cell culture	U-BDS-729	**Environment and Sustainability**	Students will 1) Create awareness about biodiversity, and 2) Address environmental issues such as conservation of endangered species and data compilation.
2	Agriculture Biotechnology	U-ABT-730	**Environment and Sustainability**	Students will 1) Develop post-harvest management techniques, and 2) Address food

				security issues, contributing to sustainable agricultural practices.

This curriculum integration emphasizes practical solutions for environmental sustainability, biodiversity, and food security through the respective courses.

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 applicable in genetic research, medical diagnostics, and biotechnology industries.
2	U-MIT-628	Industrial Biotechnology	Production and Recovery of industrial prod Production and recovery of industrial products, setting up industrial plants for regional economic growth.
3	U-ANB-629	Ecology and Evolution	Addressing local and global biodiversity, conservation efforts, and understanding evolutionary processes.
4	U-DEB-630	Developmental Biology	Understanding embryo development with applications in fertility research and regenerative medicine.
5	U-NBT-632	Nano Biotechnology	Applications of silver nanoparticles, nanorobots, and biosensors in healthcare and environmental monitoring.
6	U-FON-631	Food Nutrition	Local and national food production and marketing, addressing nutrition and health needs.
7	U-ADC-540B	Bio-Fertilizer I	Production and marketing of bio-fertilizers in organic farming, supporting sustainable agriculture.
8	U-COB-727	Introduction to Bioinformatics	Database generation and management for bioinformatics research, relevant to global genomics studies.
9	U-PBT-728	Pharmaceutical Biotechnology	Startup opportunities in pharmaceutical industries, addressing healthcare needs and drug production.

10	U-BDS-729	Plant and Animal Cell Culture	Conservation of endangered species, addressing biodiversity and ecosystem preservation globally.
11	U-ABT-730	Agricultural Biotechnology	Development of post-harvest technologies for improving food security and agricultural sustainability.
12	U-SGE-731	Structural Genomics	Structural determination and analysis of macromolecules, advancing research in molecular biology globally.
13	U-MBC-732	Medical Biochemistry	Disease diagnosis and healthcare advancements through biochemical analysis, supporting public health.
14	U-ADC-640B / U-ADC-340-S	Bio-Fertilizer II / Solid Waste Management	Production and marketing of bio-fertilizers in organic farming, addressing global issues of waste management.

This updated curriculum highlights the linkages between academic courses and their contributions to addressing local, national, regional, and global developmental challenges.

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	Opens career opportunities in genetic research and biotechnology labs.	Encourages starting ventures in genetic engineering and diagnostics.	Provides skills in recombinant DNA techniques and genetic modification.	2019-20
2	Industrial Biotechnology	U-INB-628	Prepares students for roles in biotechnology and industrial processes.	Supports entrepreneurship in industrial biotech startups.	Develops expertise in industrial applications and bioprocessing.	2024-25

3	Ecology and Evolution	U-ECE-629	Offers employment opportunities in environmental science and conservation.	Encourages entrepreneurial projects in ecological management and conservation.	Provides skills in ecological analysis and evolutionary biology.	2024-25
4	Developmental Biology	U-DEB-630	Creates job opportunities in developmental research and clinical applications.	Supports ventures in developmental biology research and therapeutic development.	Develops skills in studying and manipulating developmental processes.	2019-20
5	Food Nutrition	U-FON-631	Opens careers in nutrition science, food industry, and public health.	Encourages startups in food technology and nutritional products.	Provides skills in nutrition analysis and food processing.	2019-20
6	Nano Biotechnology	U-NBT-632	Provides job opportunities in nanotechnology and its applications in various fields.	Supports entrepreneurship in nanotech startups and innovations.	Develops skills in nanomaterials and nanotechnology applications.	2019-20
7	Biofertilizer (Part I)/ Horticulture	U-ADC-540-B	Prepares students for roles in biofertilizer production and horticulture industries.	Encourages starting biofertilizer and horticultural ventures.	Provides skills in biofertilizer production and horticultural techniques.	2019-20

8	Introduction to Bioinformatics	U-IBI-727	Opens careers in bioinformatics, data analysis, and computational biology.	Supports entrepreneurship in bioinformatics tools and services.	Provides skills in bioinformatics techniques and data analysis.	2024-25
9	Pharmaceutical Biotechnology	U-PBT-728	Creates job opportunities in pharmaceutical research and development.	Encourages startups in pharmaceutical biotech and drug development.	Develops skills in pharmaceutical biotechnology and product development.	2019-20
10	Plant and Animal Cell Culture	U-PAC-729	Provides employment in cell culture laboratories and research institutes.	Supports entrepreneurial ventures in cell culture technology and services.	Develops skills in plant and animal cell culture techniques.	2024-25
11	Agriculture Biotechnology	U-ABT-730	Opens careers in agricultural biotech industries and research.	Encourages startups in agricultural biotechnology and bio-agriculture.	Provides skills in crop improvement and agricultural biotech applications.	2019-20
12	Structural Genomics	U-SGE-731	Creates job opportunities in structural biology and genomics research.	Supports entrepreneurial projects in structural genomics and drug design.	Develops skills in structural analysis and genomic data interpretation.	2019-20
13	Medical Biochemistry	U-MBC-732	Opens careers in medical research, diagnostics, and	Encourages startups in medical diagnostics and biochemistry research.	Provides skills in biochemical analysis and medical research techniques.	2019-20

			biochemical analysis.			
14	Biofertilizer (Part II)/ Solid Waste Management	U-ADC-640-B	Prepares students for roles in biofertilizer production and waste management industries.	Supports entrepreneurial ventures in biofertilizer production and waste recycling.	Develops skills in biofertilizer production, waste management, and recycling techniques.	2019-20
15	Lab Course XV (Project Work)	U-PRW-713	Provides practical experience and enhances employability in research and industry.	Encourages project-based entrepreneurial ventures and innovations.	Develops research, project management, and practical laboratory skills.	2019-20

This table outlines the various courses that focus on employability, entrepreneurship, and skill development, contributing to the holistic development of students in their respective fields.