# Rajarshi Shahu Mahavidyalaya (Autonomous), Latur

## Biotechnology

## CHOICE BASED CREDIT SYSTEM (CBCS)

## SEMESTER PATTERN

## (w.e.f. Academic Year 2019-20)

## SYLLABUS FOR

## B.Sc. III Year (Biotechnology)

**Revised JUNE 2020**

# Rajarshi Shahu Mahavidyalaya (Autonomous), Latur

## Biotechnology

**1. Introduction:**

Biotechnology is technology based on biology - biotechnology harnesses cellular and biomolecular processes to develop technologies and products that help to improve our lives and health of our planet. Taking into consideration of the importance of Biotechnology Rajarshi Shahu Mahavidyalaya, Latur, have taken an initiative to introduce a new emerging field as a post graduate Programme in biotechnology under the faculty of science. M.Sc. Biotechnology is a Two year post graduate degree program which is started in the academic year 2005-06.

The syllabus was designed according to employability in the field of biotechnology. After designing syllabus, we have taken online feedback on curriculum from the academia and Industry expert. The feedback is analyzed, recommendation is reviewed and necessary changes are made in the syllabus by members of BOS. The board of studies in biotechnology follows the systematic process in design and development of the curriculum. In the design and development of curriculum, the regulation and guidelines of curriculum frame work stipulated by apex bodies such as Parent University and UGC. Faculty members of the department actively participated in syllabus designing, workshop, seminars and conferences. The programme outcome is given in the curriculum display in college website so that students can look for it before taking admission. The learning objectives and course outcome of course are given in the syllabus of respective course and communicated to students on the beginning of course.

**2. Title of the Programme:** **B.Sc. Biotechnology**

**3. Learning Objectives of the Programme:**

The main objective is to create biologically and technologically skilled minds for the understanding theoretical and practical knowledge essential for implementation from LAB to LAND further it will useful to find the solutions of various interacting biological phenomenon. It helps effectively to inculcate scientific temper and social attitude to solve various problems in the field of science.

The member of Board of Studies from various organizations of repute have a strong recommendation for Job oriented syllabus is to be included. Accordingly, the necessary changes has been effectively implemented in Curriculum.

**4. Programme Specific outcomes/ Programme Outcomes:**

At the end of the program the student will be able to

- Students should be able to integrate basic principles of common analytical techniques of protein molecular structures to engage in hands-on practices for implementation of such techniques to facilitate the development of biopharmaceutical manufacturing
- Students should be able to integrate basic principles of protein chemistry and molecular interactions to engage in hands-on practices to facilitate the development and manufacturing of biopharmaceutical formulations suitable for use as human therapeutics
- Students should be able to integrate basic principles of process units operations of recombinant protein production in hands-on practices for implementation of such techniques to facilitate the development of biopharmaceutical manufacturing
- Students should be able to integrate fundamental concepts of leadership, entrepreneurship and innovation, financial decision making and marketing to business enterprises.
- Students should be able to integrate their didactic and practical knowledge of molecular biotechnology, protein expression, and structural biology to the development of new protein drugs.
- Plan, conduct and write-up a programme of original research Practical skills – able to:
- Plan and execute safely a series of experiments;
- Use laboratory methods to generate data;
- Analyze experimental results and determine their strength and validity; • Prepare technical reports;
- Give technical presentations;
- Use the scientific literature effectively;
- Use computational tools and packages. Transferable skills – able to:
- Communicate effectively through oral presentations, computer processing and presentations, and written reports;
- Work independently and as part of a team
- Integrate and evaluate information from a variety of sources;
- Use Information and Communications Technology;

- Manage resources and time;
- Learn independently with open-mindedness and critical enquiry;
- Learn effectively for the purpose of continuing professional development.

**5. Local, Regional and Global relevance of Syllabus:**

Curriculum developed and implemented have relevance to the local, regional and global developmental needs which is reflected in Programme Specific Outcomes/ Programme Outcomes and Course Outcomes of the Programmes offered by the College.

Global and local focus has slowly shifted to using knowledge of life Science for innovative technology development that is being used for betterment of human life. Many fundamental and advanced research fields comes under the umbrella of Biotechnology e.g. Recombinant DNA Technology, Nano Biotechnology and Agriculture Biotechnology etc.

| | |
|---|---|
| **6. Duration of the Course:** | **Three years** |
| **7. Eligibility of the Course:** | **XII Science** |
| **8. Strength of the Students:** | **160** |
| **9. Fees for Course:** | **As per University/College rules.** |
| **10. Admission / Selection procedure:** | **Admission by merit through Registration** |
| **11. Teacher's qualifications:** | As per UGC/University/College rules |
| **12. Standard of Passing:** | As per UGC/University/College rules |
| **13. Nature of question paper with scheme of marking:** | |
| | As per UGC/University/College rules |
| **14. List of books recommended:** | Included in syllabus |

**15. Laboratory Equipment's, Instruments, and Measurements etc.:**

The department of biotechnology has well equipped laboratories with all necessary and advance instrumentation facility.

| | |
|---|---|
| **16. Rules and regulations and ordinance if any:** | As per UGC/University/College rules |
| **17. Course duration:** | Each theory course is of 50 Contact hours |
| **18. Medium of the language:** | English |

**Rajarshi Shahu Mahavidyalaya, Latur (Autonomous)**
**Department of Biotechnology**
**Choice Based Credit System**
**Course Structure of B.Sc. Biotechnology Third Year (w.e.f. June 2019)**

## B. Sc. III [Biotechnology] Semester V

| | Code No. | Title of the course | Hours/ Week | Marks (50) | | Credits | Total |
|---|---|---|---|---|---|---|---|
| | | | | In Sem | End Sem | | |
| DSET1 | U- RDT-627 | Recombinant DNA Technology | 04 | 20 | 30 | 03 | 50 |
| DSET2 | U-MIT-628 | Microbial Technology | 04 | 20 | 30 | 03 | 50 |
| DSET3 | U-ANB-629 | Animal Biotechnology | 04 | 20 | 30 | 03 | 50 |
| DSET4 | U-DEB-630 | Developmental Biology | 04 | 20 | 30 | 03 | 50 |
| DSET5 | U-FON-631 | Food Nutrition | 04 | 20 | 30 | 03 | 50 |
| DSET6 | U-NBT-632 | Nano Biotechnology | 04 | 20 | 30 | 03 | 50 |
| DSEP1 | U-LAC-633 | Lab Course XVII | 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<br>U-ADC-540-H | Biofertilizer (Part I)/ Horticulture | 03 | 20 | 30 | 02 | 50 |
| | U-ENS-541 | Environmental Studies | 02 | | | GRADE | |
| | | Total Credits | | | | 22 | 450 |

## B.Sc. III [Biotechnology] Semester VI

| | Code No. | Title of the course | Hours/ Week | Marks (50) | | Credits | Total |
|---|---|---|---|---|---|---|---|
| | | | | In Sem | End Sem | | |
| DSET1 | U-COB-727 | Computational Biology | 04 | 20 | 30 | 03 | 50 |
| DSET2 | U-PBT-728 | Pharmaceutical Biotechnology | 04 | 20 | 30 | 03 | 50 |
| DSET3 | U-BDS-729 | Biodiversity and Systematic | 04 | 20 | 30 | 03 | 50 |
| DSET4 | U-ABT-730 | Agriculture Biotechnology | 04 | 20 | 30 | 03 | 50 |
| DSET5 | U-SGE-731 | Structural Genomics | 04 | 20 | 30 | 03 | 50 |
| DSET6 | U-MBC-732 | Medical biochemistry | 04 | 20 | 30 | 03 | 50 |
| DSEP1 | U-LAC-733 | Lab Course XXI | 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<br>U-ADC-640-S | Biofertilizer (Part II)/<br>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** |

**Rajarshi Shahu Mahavidyalaya (Autonomous), Latur**
**CHOICE BASED CREDIT SYSTEM**
**B.Sc. Biotechnology (Semester Pattern)**
**V Semester**
**Course Title: Recombinant DNA Technology Course Code: U-RDT-627**
**Marks: 50 Lectures: 50 Credit: 03**

---

**Learning Objectives:**

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

**Course Outcomes:**

- Understand the difference between old biotechnology and modern biotechnology
- Provide examples of current applications of biotechnology and advances in the different areas like medical, microbial, environmental, bioremediation, agricultural, plant, animal, and forensic.
- Understand the concept of recombinant DNA technology or genetic engineering
- Describe DNA fingerprinting, and restriction fragment length polymorphism (RFLP) analysis and their applications
- Describe the steps involved in the production of biopharmaceuticals in microbial and mammalian cell systems
- Explain the concept and applications of monoclonal antibody technology
- Explain the general principles of generating transgenic plants, animals and microbes.

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

**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:** **(12 L)**

**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:** **(13 L)**

**Library construction and screening**

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

**Unit-IV:** **(13 L)**

**Applications of r-DNA technology.**

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

**Text & References:**


1. Principles of Gene Manipulation and Cloning - Old & Primrose.
2. Gene Manipulation and Cloning – Christopher Howe.
3. Molecular Biotechnology -Glick
4. Molecular Cloning- A practical approach-T.A. Brown.
5. Genomes 3 - T.A.Brown.
6. Genetic Engineering – Sandhya Mitra
7. Genes – B. Lewin
8. Text book of Biotechnology – U Satyanarayan Arora M.P (2003), Biotechnology, Himalaya Pub.House, Mumbai.
9. Jogdand S.N (2006)- Gene Biotechnology, Himalaya Publishing House, Mumbai.
10. Joshi P (2002) - Genetic Engineering and its applications,Agrobios Pub, Jodhpur.
11. Satyanarayana U. (2007) - Biotechnology, Books and Allied Pvt. Ltd. Kolkata.

**Rajarshi Shahu Mahavidyalaya (Autonomous), Latur**
**B.Sc. Biotechnology (Semester Pattern)**
**V Semester**

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

---

**Learning Objectives:**

- List out tools used for gene exploration
- Utilize the knowledge on creation of a genomic and c-DNA library
- Learn the tools and techniques used for genetic manipulation of livin g organisms

**Course Outcomes:**

- Students will be able to perform practical's related to recombinant DNA technology
- Students will understand all instruments used for genetic study

**Practicals:**

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

**Rajarshi Shahu Mahavidyalaya (Autonomous), Latur**
**B.Sc. Biotechnology (Semester Pattern)**
**V Semester**

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

---

**Learning Objective:**

- To evaluate the role of microorganisms in specific biotechnological processes
- To explain the complex processes behind the development of genetically manipulated organisms.

**Course Outcome:**

- Demonstrate a clear understanding of how biochemical pathways relate to biotechnological applications
- Conduct a comprehensive search for original research literature pertinent to a selected area of microbiology and biotechnology.
- Understanding of upstream and downstream processes.
- Understanding of Quality Control, Process Economics and GLP**.**

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

**Microbial Growth**

Microbial Biotechnology –Historical perspectives

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

Basic nutrition & metabolism. Novel pathways of microorganisms.

**Unit-II:** **(15 L)**

**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:** **(12 L)**

**Fermentation Processes.**

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

**Unit-IV:** **(11 L)**

**Quality Control, Process Economics and GLP.**

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

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

**Text & References:**

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

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

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

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

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

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

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

**Rajarshi Shahu Mahavidyalaya (Autonomous), Latur**
**B.Sc. Biotechnology (Semester Pattern)**
**V Semester**

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

---

**Learning Objective:**

- To evaluate the role of microorganisms in specific biotechnological processes
- To explain the complex processes behind the development of genetically manipulated organisms.

**Course Outcome:**

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

**Practical:**

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

**Rajarshi Shahu Mahavidyalaya (Autonomous), Latur**
**B.Sc. Biotechnology (Semester Pattern)**
**V Semester**

**Course Title: Animal Biotechnology** **Course Code: U-ANB-629**
**Marks: 50** **Lectures: 50** **Credit: 03**

---

**Learning Objectives:**

- To know the exact infrastructure and useful and desirable facilities for developing cell culture labs.
- To know the traditional practices with certain modifications and emphasis on the need to improve the existing methodologies.
- To cater the curiosity and knowledge about newer approaches regarding transgenic cloni9ng artificial vaccine etc.
- To study the interpretation and relationship via forensic and evolutionary studies particularly in animal biotechnology and conservation of endangered animals.

**Course Outcomes:**

- The students would be well aware about basic infrastructure and culture technique of ATC.
- Students would be more beneficial to understand the process concerning with veterinary and biotechnology day to day practices and approaches.
- Students would be more curious and methodical and innovative by studying the approaches and would formulate newer strategies to establish the betterment.

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

**Introduction**

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

**Unit –II:** **(10 L)**

**Vaccine**

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

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

**Transgenic Techniques**

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

**Unit-IV:** **(16 L)**

**Transgenic Animals**

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

**Text & References:**


1. Reproductive Techniques in Farm Animals. CABI. Gordon I. 2005.
2. Kuby Immunology. WH Freeman. Kindt TJ, Goldsby RA & Osbrne BA. 2007.
3. Microbial Biotechnology. World Scientific. Kun LY. 2006.
4. New Generation Vaccines. 3 rd Ed. Informa Healthcare. Levine MM, Kaper JB, Rappuoli R, Liu MA, Good MF. 2004.
5. Forensic DNA Profiling Protocols. Humana Press. Lincoln PJ & Thomson J. 1998.

6. Animal Cell Biotechnology. Humana Press. Portner R. 2007.
7. Hybridoma Technology in Biosciences and Medicine. Plenum Press. Spinger TA. 1985.
8. Advanced Molecular Biology. Bios Scientific Twyman RM. 2003.

**Rajarshi Shahu Mahavidyalaya (Autonomous), Latur**
**B.Sc. Biotechnology (Semester Pattern)**
**V Semester**

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

---

**Learning Objectives:**

- To know the exact infrastructure and useful and desirable facilities for developing cell culture labs.
- To know the traditional practices with certain modifications and emphasis on the need to improve the existing methodologies.
- To cater the curiosity and knowledge about newer approaches regarding transgenic cloning artificial vaccine etc.
- To study the interpretation and relationship via forensic and evolutionary studies particularly in animal biotechnology and conservation of endangered animals.

**Course Outcomes:**

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

**Practicals**

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

**Rajarshi Shahu Mahavidyalaya (Autonomous), Latur**
**B.Sc. Biotechnology (Semester Pattern)**
**V Semester**

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

---

**Learning Objectives:**

- Understand the molecular and cellular mechanisms of development
- Learn about basic embryology
- Strengthen understanding of the design and interpretation of biological experiments
- Gain experience reading the primary developmental biology literature

**Course Outcomes:**

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

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

**Transgenic Animals**

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:** **(10 L)**

**Cellular Development**

Cell division and Growth, Cell lineage, Apoptosis and Aging

Abnormal development

Teratogens and Teratogenesis

**Unit-III:** **(15 L)**

**Cellular Fate**

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:** **(15 L)**

**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

**Text & References:**

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

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

Oxford University Press.
3. *An Introduction to Embryology*, 5th edition (2004), B. I. Balinsky. Publisher - Thomas Asia Pvt. Ltd
4. *Developmental Biology*, (2001), R. M. Twyman, Publisher - Bios Scientific Publishers LTD
5. N. Arumugam (1994) Developmental Biology, Saras Publication, Nagercoil.
6. A practical Guide to Developmental Biology (international student edition), Melissa A. Gibbs, Oxford university press.
7. Developmental Biology by Veerbala Rastogi

**Rajarshi Shahu Mahavidyalaya (Autonomous), Latur**
**B.Sc. Biotechnology (Semester Pattern)**
**V Semester**

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

---

**Learning Objectives:**

- Understand the molecular and cellular mechanisms of development Learn about basic embryology
- Strengthen understanding of the design and interpretation of biological experiments Gain experience reading the primary developmental biology literature

**Course Outcomes:**

- Student will be able get knowledge related to animal and plant embryology
- Students will understand developmental stages of animals
- Students will able to see individual cellular organizations.

**Practicals:**

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

**Rajarshi Shahu Mahavidyalaya (Autonomous), Latur**
**CHOICE BASED CREDIT SYSTEM**
**B. Sc. Biotechnology (Semester Pattern)**
**V Semester**

**Course Title: Food Nutrition** **Course Code: U-FON-631**
**Marks: 50** **Lectures: 50** **Credit: 03**

---

**Learning objectives**

- Students will be aware about different forms of food and their importance
- Students will learn scientific approaches to analyses mineral and vitamin present in different foods.
- Students will be more facilitated with techniques and processing methods

**Course outcome**

- Awareness among students will be increase
- Students will be more up to date about food and processing

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

**Basic concept of Food and Nutrition**

Basic concept on Food, Nutrition and Nutrients. Classification of Food, Classification of Nutrients. Major dietary element and their importance. What is food security, Different food sources and its utility. Global scenario of and Food crisis and its management. Importance of processed and value-added foods. Food and Agricultural organization, various resolution on food safety and food security.

**Unit-II:** **(13 L)**

**Carbohydrate**

Carbohydrates - Definition, Classification, Structure and properties. Monosaccharides - glucose, fructose, galactose. Disaccharides - Maltose, lactose, sucrose Polysaccharides - Dextrin, starch, glycogen, resistant starch. Carbohydrates – Sources and daily requirements, functions. Effects of too high and too Low carbohydrates on health. Digestion and absorption of carbohydrate.

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

**Lipid**

Lipids -Definition, Classification & Properties. Fatty acids-composition, properties, types. Lipids - sources, daily requirements, functions. Digestion & Absorption of nutrients. Role & nutritional significances of PUFA, MUFA, SFA, W-3 fatty acid. Vitamins - Bio-Chemical and Physiological Role Physiological role, bio-availability and requirements, sources, deficiency & excess.

**Unit-IV:** **(13 L)**

**Protein**

Proteins- Definition, Classification, Structure & properties. Amino acids Classification, types, functions. Proteins - Sources, daily requirements, functions. Effect of too high - too low proteins on health. Digestion & absorption. Dietary Fibre-Classification, sources, composition, properties & nutritional significance. Minerals & Trace Elements, Bio-Chemical and Physiological Role, bio-availability & requirements, sources, deficiency & excess (Calcium, Sodium, Potassium Phosphorus, Iron, Fluoride, Zinc, Selenium, Iodine, Chromium)

**Text & References:**

1 Molecular Biotechnology: 4th edition. (2010), Glick B.R., Pasternak J.J., Patten C. L., ASM press, USA

2. Principles of Gene Manipulation & Genomics, 7th Edition (2006), Primrose and Twyman, Blackwell Publishing, USA

3. Leininger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN: 13: 978-1-4641-0962-1 / ISBN:10:1-4292-3414-

4. Textbook of Biochemistry with Clinical Correlations (2011) 7th

5. Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New York), ISBN:978-0-470-28173-4.

**Rajarshi Shahu Mahavidyalaya (Autonomous), Latur**
**CHOICE BASED CREDIT SYSTEM**
**B.Sc. Biotechnology (Semester Pattern)**
**V Semester**

**Course Title: Lab Course XXI** **Course Code: U-LAC-637**
**Marks: 50** **Credit: 03**

---

**Learning objectives:**

- Students will be aware about different forms of food and methods of food analysis
- Students will learn scientific approaches to analyses mineral and vitamin present in different foods.
- Students will be more facilitated with techniques concerning with food and processing methods

**Course outcome:**

- Awareness will increase among students
- Students will be more up to date about food and processing technology

**Practical's**

1. Identification of Mono, Di and polysaccharides
2. Identification 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.

**Rajarshi Shahu Mahavidyalaya (Autonomous), Latur**
**CHOICE BASED CREDIT SYSTEM**
**B.Sc. Biotechnology (Semester Pattern)**
**V Semester**

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

---

**Learning objectives:**

- Students will be aware about role of nanotechnology in biological science
- Student will be more aware about the principles and involved techniques of Nanotechnology
- Student will be up to date with advancement in the current research in Nanobiotechnology

**Course outcome:**

- Understand the method of analysis of nanoparticles with biological material
- Understand the nanoscale properties and its utilization in various fields

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

**Basic biomolecules**:

Basic biomolecules: Sugars: classification, occurrence, properties and biological reactions Proteins: Amino acids and peptides-classification, chemical reactions and physical properties. Peptide bond, Primary structure of proteins, structural comparison at secondary and tertiary levels - Lipids: Classification, structure and functions. Triglycerides; Phospholipids; Steroids and terpenes. Glyco and lipoproteins-structure and function. Lipid Membranes: Structure and Properties - Models Nucleic acids: Structure of double stranded DNA (B, A, C, D, T and Z DNA). Physical properties of double stranded DNA, Types of RNAs and their biological significance, Conformational properties of polynucleotides.

**Unit-II**: (13 L)

**Biological nanomaterial**

What is nanotechnology and Development of nanobiotechnology – timelines and progress, overview Biological nanoparticles and its applications :Introduction to biological nanoparticles, Exosolipoproteins, Ferritin, Biological nanomoters and machines: Biological nanomachines: protein assemblies, muscle myosin, ATPase, Hemoglobin, Biological nanometers: Bacterial Flagella, cilia: Structure and function Biological nanopores: Ion channels:bactriorhodopsin, Bioinspired nanomaterial and its applications: DNA and protein based nanomaterial.

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

**Recombinant DNA technology**

Recombinant DNA technology: Introduction, Restriction enzymes, cloning vectors (plasmids, bacteriophages, cosmids, expression), Transformation, PCR technique, Blotting techniques, (Southern blotting, Northern blotting and Western blotting), DNA sequencing: Maxam-Gilbert's method, Sanger's Dideoxy method, Automated DNA sequencing, Next generation sequencing, Hybridoma technology and production of monoclonal antibody

**Unit-IV:** (13 L)

**Bioinformatics**

Concept of Genomics and proteomics Introduction, Database and its classification, NCBI, Data retrieval tools, INTREZ, OMIN, BLAST, FASTA, Applications of Bioinformatics. Molecular modeling tools: Graphic visualization, structure and functional prediction, Protein folding prediction and the homology modeling, Docking simulation and Computer assisted molecular design.

**Text & References:**

1. Principles of Biochemistry, Leininger, Nelson, Cox, CBS publishers and distributors, New Delhi, 2004.
2. Fundamentals of Biochemistry, Donald Voet, AkifUzman, Judith G. Voet, Charlotte WPratt, John Wiley and Sons, New York, 2008.
3. Biochemistry, Geoffrey L. Zubay , WCB publishers, 1998.
4. Biochemistry – Lubert Stryer, 1995. _ 5. C. M. Niemeyer, C. A. Mirkin,

Nanobiotechnology: Concepts, Applications and Perspectives‖, Wiley – VCH, (2004).
6. Nanoscience: Nanobiotechnology and Nanobiology, P. Boisseau, P. Houdy and M. Lahmani, Springer, 2007.
7. Handbook of Nanostructured Biomaterials and Their Applications in Nanobiotechnology, Hari Singh Nalwa, American Scientific Publishers, 2005.
8. Nanobiotechnology, C.M.Niemeyer, C.A. Mirkin, Wiley VCH, 2004. 8. Nanobiotechnology, C.M.Niemeyer, C.A. Mirkin, Wiley VCH, 2004.
9. Challa, S.S.R. Kumar, Josef Hormes, Carola Leuschaer," Nanofabrication Towards Biomedical Applications, Techniques, Tools, Applications and Impact", Wiley – VCH, 2005.
10. Nicholas A. Kotov, "Nanoparticle Assemblies and Superstructures", CRC, 2006.
11. T. Pradeep, ―Nano: The Essentials‖, McGraw – Hill education, (2007).
12. David S Goodsell, "Bio nanotechnology ‖, John Wiley & Sons, (2004).
13. Molecular Biology of the Gene, 6th Edition (2008), James D. Watson, Tania Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Lodwick, Pearson Education, Inc. and Dorling Kindersley Publishing, Inc. USA
14. Molecular Biotechnology: 4th edition. (2010), Glick B.R., Pasternak J.J., Patten C. L., ASM press, USA 15. Principles of Gene Manipulation & Genomics, 7th Edition (2006), Primrose and Twyman, Blackwell Publishing, USA.

**Rajarshi Shahu Mahavidyalaya (Autonomous), Latur**
**CHOICE BASED CREDIT SYSTEM**
**B.Sc. Biotechnology (Semester Pattern)**
**V Semester**

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

---

**Learning objectives:**

- Students will be aware about nanotechnology technique in biological science
- Student will be more aware about the methods in Nanotechnology
- Student will be up to date with advancement in the current research in Nanobiotechnology

**Course outcome:**

- Understand the method of analysis of nanoparticles with biological material
- Understand the nanoscale properties and its utilization in various field and will be able to understand the techniques

**Practicals:**

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

**Rajarshi Shahu Mahavidyalaya (Autonomous), Latur**
**B.Sc. Biotechnology (Semester Pattern)**
**V Semester**

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

---

**Learning objective:**

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

**Course Outcomes:**

- Explains MoA of various Biofertilizers
- Describe productions steps and specific requirements for each Biofertilizers
- To make skilled manpower for Biofertilizer industry
- Course can generate opportunities of self-entrepreneurship among students

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

**Rhizobium**

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

Practical 1: Isolation and characterization of Rhizobium

Practical 2: Mass production and carrier-based inoculum preparation of Rhizobium

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

**Azospirillum**

*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:** **(13 L)**

**Blue green algae**

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:** **(13 L)**

**Phosphate solubilizing microbes**

Phosphate solubilizing microbes (anyone / 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

**Text & References:**


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

**Rajarshi Shahu Mahavidyalaya (Autonomous), Latur**
**B.Sc. Biotechnology (Semester Pattern)**
**V Semester**

**Course Title: Horticultural Practices** **Course Code: U-ADC-540(H)**
**Marks: 50** **Credit: 02**

---

**Learning Objective:**

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

**Course Outcome:**

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

**Unit – I:** **(8 L)**

**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.

**Practicals:**

**1.** Study of tools and utensils used in horticulture.

**2.** Layout of different planting systems.

**3.** Layout of nutrition garden.

**Unit – II:** **(7 L)**

**Definition of a nursery**

Different types of nursery beds – flatbeds, raised beds and sunken

Beds, their merits and demerits. Different nursery techniques and their management. Vegetable gardens, nutrition and kitchen garden, truck garden, Vegetable forcing, Market gardens and roof gardens. Different steps in planning and layout establishment and management of orchards.

**Practicals:**

**1.** Preparation of nursery beds for sowing of vegetable seeds.

**2.** Digging of pits for fruit plants.

**Unit – III:** **(8 L)**

**Pruning**, **Irrigation**

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:** **(7 L)**

**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.

**Text & References:**

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

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

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

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

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

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

**Rajarshi Shahu Mahavidyalaya (Autonomous), Latur**
**B.Sc. Biotechnology (Semester Pattern)**
**VI Semester**

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

---

**Learning objectives:**

- To gain insight into the public and private data repositories,
- To understand search algorithms and analysis tools in bioinformatics,
- To integrate and apply the learned computational knowledge and techniques to the healthcare applications.

**Course outcomes:**

- Demonstrate knowledge of the world-renowned biotechnology information repositories, such as NCBI databases, and the proficient use of the search algorithms for genes, proteins, RNA's, peptides, disease biomarkers, compounds and biologics from these repositories;
- Apply the bioinformatics analysis tools for DNA sequencing, structure modeling, sequence alignment, microarray analysis and pathway analysis; and
- Apply bioinformatics analysis knowledge and techniques to answer scientific questions in the health sciences.

**Unit I:** **(12 L)**

**Introduction to bioinformatics and data generation**

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

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

**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: (13 L)**

**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: (13 L)**

**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

**Text & References:**

1. Introduction to Bioinformatics Prentice Hall, 1999 Teresa Attwood, David Parry-Smith

2. Bioinformatics: The Machine Learning Approach MIT Press, c2001. Pierre Baldi, Søren Brunak

3. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, J. Wiley, c1998. Andreas D. Baxevanis, B.F. Francis Ouellette

4. Structural Bioinformatics Wiley, c2003. Projected Pub. Date: 0311 Philip E. Bourne, Helge Weissig

5. Bioinformatics for Dummies Wiley Pub., 2002. Projected Pub. Date: 0211 Jean-Michel Claverie, Cedric Notredame

6. Computational Molecular Biology: An Introduction, Wiley, 2000. Peter Clote, Rolf Backofen

7. Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids, Cambridge University Press, 1998 Richard Durbin, Sean R. Eddy, Anders Krogh, Graeme Mitchison

8. Statistical Methods in Bioinformatics: An Introduction Springer, c2001. Warren J. Ewens, Gregory R. Grant
9. Algorithms on Strings, Trees, and Sequences: Computer Science and Computational Biology, Cambridge University Press, 1997. Dan Gusfield,
10. Bioinformatics: Sequence, Structure, and Databanks: a D. Higgins and W. Taylor

**Rajarshi Shahu Mahavidyalaya (Autonomous), Latur**
**B.Sc. Biotechnology (Semester Pattern)**
**VI Semester**

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

---

**Learning objectives:**

- To gain insight into the public and private data repositories.
- To understand search algorithms and analysis tools in bioinformatics,
- To integrate and apply the learned computational knowledge and techniques to the healthcare applications.

**Course outcomes:**

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

**Practicals:**

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

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

**Rajarshi Shahu Mahavidyalaya (Autonomous), Latur**
**B.Sc. Biotechnology (Semester Pattern)**
**VI Semester**

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

---

**Learning Objectives:**

- To understand the difference between old biotechnology and modern biotechnology
- To provide examples of current applications of biotechnology and advances in the different areas like medical, microbial, environmental, bioremediation, agricultural, plant, animal, and forensic.
- To understand the concept of recombinant DNA technology or genetic engineering

**Course Outcome:**

- Understanding of steps involved in the production of biopharmaceuticals in microbial and mammalian cell systems
- Understanding of the concept and applications of monoclonal antibody technology
- Study of general principles of generating transgenic plants, animals and microbes

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

**Drug Development**

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

**Unit II:** **(10 L)**

**Antibodies Production**

Antibodies in research, diagnostics and therapeutics

Production of monoclonal antibodies and techniques to make them clinically applicable

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

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

**Unit III:** **(15 L)**

**Tissue Engineering**

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

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

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

Brief introduction to clinical trails

**Unit IV:** **(15 L)**

**Products of Biotechnology**

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

**Text & References:**


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

**Rajarshi Shahu Mahavidyalaya (Autonomous), Latur**
**B.Sc. Biotechnology (Semester Pattern)**
**VI Semester**

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

---

**Learning Objectives**

- To understand the difference between old biotechnology and modern biotechnology
- To provide examples of current applications of biotechnology and advances in the different areas like medical, microbial, environmental, bioremediation, agricultural, plant, animal, and forensic.
- To understand the concept of recombinant DNA technology or genetic engineering

**Course Outcome**

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

**Practicals:**

1. Assay of antimicrobial activity of Penicillin, Chloramphenicol, streptomycin and Quinolones
2. Determination of Minimum Inhibitory Concentration (MIC) of Antibiotic
3. Extraction of natural molecules
4. Stability of drugs using spectrophotometry
5. Determination of shelf life of antibiotics (Expired drugs)
6. Sterility testing of commercial pharmaceuticals.
7. Sterility testing of injectable as per IP.
8. Effect of chemical disinfectants on growth of bacteria
9. Study of microbial spoilage of pharmaceuticals.
10. Visit to Pharmaceutical industry

**Rajarshi Shahu Mahavidyalaya (Autonomous), Latur**
**B.Sc. Biotechnology (Semester Pattern)**
**VI Semester**

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

---

**Learning Objectives:**

- To educate the students about the existing biodiversity in the world with special reference to Indian continent, various geographical hotspots and losses and remedial conservation and mitigation strategies.
- To inculcate the values and knowledge about classification of flora and fauna and their detail studies with new methods such as identification keys and evolutionary relationship.
- To study the interpretation and analysis of results with the reference material it would be key to identification of new plants and animals.

**Course Outcomes:**

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

**Unit-I (13 L)**

**Biodiversity**

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

**Unit-II** **(13 L)**

**Biodiversity & Conservation**

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

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

**Unit-III** **(12 L)**

**Species Conservation strategies**

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

Problems with the Endangered Species Act, Habitat Conservation Plans or restoration. strategies Conservation strategies by National and International communities, conventions etc. Ethics of Conservation – Values of Biodiversity, Bio piracy, Hybridized plants, GM crops (benefits & criticism), and Economic Value of Biodiversity & Legal, Ethical issues related to uses of biodiversity, Global Conservation Issues.

**Unit-IV** **(12 L)**

**Taxonomy**

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

**Text & References:**


1. The biology of biodiversity – Springer M. Koto
2. Biodiversity – Academic Press Washington E.O. Wilson
3. Principle of animal taxonomy Oxford IBH Publication company. G. G. – Simpson
4. Elements of Taxonomy E- Mayer

**Rajarshi Shahu Mahavidyalaya (Autonomous), Latur**
**B.Sc. Biotechnology (Semester Pattern)**
**VI Semester**

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

---

**Learning Objectives:**

- To educate the students about the existing biodiversity in the world with special reference to Indian continent, various geographical hotspots and losses and remedial conservation and mitigation strategies
- To study the interpretation and analysis of results with the reference material it would be key to identification of new plants and animals.

**Course Outcomes:**

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

**Taxonomy – Field Methods**

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

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

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

---

**Learning Objectives:**

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

**Course Outcomes:**

- Student would be facilitated with day to day process of traditional methods and newer
- Methods of microbial inoculum preparation.
- Students would be more beneficial and facilitated by studying aspect related to latest technology which has been incorporated in agriculture and agricultural products.

**UNIT- I:** **(12 L)**

**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:** **(13 L)**

**Biofertilizer**

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

Mushroom cultivation

Biofertilizers: Concept and Types of Biofertilizer,

Microbial Inoculum - Rhizobium Inoculant, Azotobacter, and Phosphate Solubilizing Biofertilizer

Bio-pesticides- Definition and Types (Microbial and Botanical)

Advantages of Biopesticides over chemical pesticides.

Single Cell Protein and its Nutritive Value eg. Spirulina.

Secondary metabolites and its applications

**UNIT- III**: **(12 L)**

**DNA Markers**

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:** **(13 L)**

**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.

**Text & References:**

1. Textbook of Modern Plant Pathology, Vikas Publications, New Delhi. Bilgrami K.S and Dube H.G.(1994)

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

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

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

---

**Learning Objectives:**

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

**Course Outcomes:**

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

**Practicals:**

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

**Rajarshi Shahu Mahavidyalaya (Autonomous), Latur**
**CHOICE BASED CREDIT SYSTEM**
**B.Sc. Biotechnology (Semester Pattern)**
**VI Semester**

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

---

**Learning Objectives:**

- Student will be aware about three-dimensional structures which can be analyzed for gaining insights into functions and other biological aspects
- Student will know the computational approaches for structure analysis
- Student will be able to acquire knowledge of various algorithms & methods for structure prediction
- understand the principles of macromolecular interactions

**Course outcome:**

- Understanding of structural organization of Biomolecules
- The computational approaches and its utilization for analysis
- The concept will be utilize for further research in the filed of Advances in Biological science

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

**Biomolecules**

Carbohydrates Conformations of mono and oligosaccharides and Correlation with properties Glycoproteins, Proteoglycans and Glycolipids: Structural aspects Lipids & Membranes Membrane microdomains and organization Basic physico-chemical principles involved in structural organization of macromolecules Organization of the structures of proteins, DNA, RNA, carbohydrates and lipids experimental methods of structure determination Physicochemical Principles of biomolecular structure organization Basic concepts of atom structure, hybridization of atomic orbitals, valence, covalent bonds, atomic interactions and forces, formation of polymeric molecules

**Unit-II:** **(13 L)**

**Structural Bioinformatics**

Overview of Structural Bioinformatics Prediction of protein structure o secondary structure prediction methods ( First, second and third generation methods Tertiary structure prediction , Homology modeling Fold Recognition: 1D-3D Profile-based methods, Threading methods ab initio methods Threading methods ab initio methods Structural alignments of proteins Superimposition of structures & calculation of RMSD o Vector-based, distance matrix-based and combined algorithms for structural alignments Structure-based classification of proteins: SCOP & CATH Prediction of binding pockets on protein structures Structure-based function Prediction Prediction of RNA structures

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

**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-IV:** **(13 L)**

**DNA and RNA Structure**

Base pairing in DNA & RNA Double Helix – Organization, types and structural features Structural & Geometric parameters associated with DNA o Secondary structures of DNA (triple helices, quadruplex, cruciform) Sequence-structure relationships in DNA Secondary Structures in RNA; Representations of RNA structures Energetics of RNA structure o tRNA structure

**Text & References:**


1. Forbes Burkowski. Structural bioinformatics: An algorithmic approach. Publisher: CRC Press, 2009. ISBN: 9781584886839.
2. Drenth Jan. Principles of Protein X-Ray Crystallography. Publisher: Netherlands, Springer Science. 2007. ISBN: 9780387333342.
3. Bourne Philip E., Weissig Helge. Structural Bioinformatics (Methods of Biochemical Analysis, V. 44), 2003. Publisher: Wiley-Liss. ISBN: 0471202002.

4. Höltje Hans-Dieter, Sippl Wolfgang, Rognan Didier, Folkers Gerd. Molecular Modeling: Basic Principles and Applications. Publisher: New York, Wiley-VCH. 2003. ISBN: 3527305890. •
5. Leach, Andrew. Molecular Modelling: Principles and Applications. Publisher: Prentice Hall. 2001. ISBN: 0582239338.
6. Friesner Richard A. Computational Methods for Protein Folding:advances in Chemical Physics Volume 120 Kindle Edition. Publisher: New York, John Wiley & Sons. 2002. ISBN: 0471209554.
7. Heilmeyer L., Friedrich P. Protein Modules in Cellular Signalling. Publisher: Amsterdam, IOS Press. 2001. ISBN: 1586031805.
8. Rhodes Gale.Crystallography Made Crystal Clear, Third Edition: A Guide for Users of Macromolecular Models. Publisher: USA, Academic Press 2000 ISBN: 0125870728.
9. Branden ,Tooze John. Introduction to Protein Structure. Publisher: New York, Garland Publishing Inc. 1999. ISBN: 0815323050. • Hill H.A.O. Sadler P.J., A.J. Ed. Metal Sites in Proteins and Models Redox Centres Publisher: New York, Springer 1999. ISBN: 3540655564. •
10. Sternberg Michael J. E. Protein Structure Prediction: A Practical Approach. Publisher: USA, Oxford University Press. 1997. ISBN: 0199634953.
11. Fasman G.D. Prediction of Protein Structure and the Principles of Protein Conformation. Publisher: New York, Plenum Press. 1989 ISBN: 0306431319. •
12. Creighton T. E. Editor. Protein Structure: A Practical Approach. Publisher: IRL Press at Oxford University Press. 1989. ISBN: 0199630011.

**Rajarshi Shahu Mahavidyalaya (Autonomous), Latur**
**CHOICE BASED CREDIT SYSTEM**
**B.Sc. Biotechnology (Semester Pattern)**
**VI Semester**

**Course Title: Lab course XXIII** **Course Code: U-LAC-737**
**Marks: 50** **Credit: 03**

---

**Learning Objectives:**

- Student will be aware about three-dimensional structures analysis
- Student will know the computational approaches for structure analysis
- Student will be able to acquire knowledge of various algorithms & methods for structure prediction

**Course outcome:**

- Understanding of structural organization of Biomolecules
- The computational approaches and its utilization for analysis
- The concept will be utilized for further research in the field of Advances in Biological science

**Practical:**

1 Studies of Protein Data Bank
2 Studies of Nucleic Acid Databank
3. Visualization of structures (SWISS-PDB Viewer, Discovery Studio)
4. Calculation of structural parameters of Proteins & Ramachandran Plot
5. Calculation of structural parameters of DNA & RNA
6 Calculation of structural parameters of Carbohydrates and Lipids
7 Understanding Macromolecular interactions through visualization & structure analysis Protein – Protein Protein – Nucleic acids Protein – carbohydrates
8 Understanding assemblies of biomolecules through visualization: Ribosome, Nucleosome, & Viral particles find chain breaks in polypeptides
9 To detect presence of non-bonded interactions o Write codes for computation of dihedral angles (3) o Write code for 4th atom fixing
10 Prediction of Secondary structures of proteins using various methods and computation of prediction accuracies

**Rajarshi Shahu Mahavidyalaya (Autonomous), Latur**
**CHOICE BASED CREDIT SYSTEM**
**B. Sc. Biotechnology (Semester Pattern)**
**VI Semester**

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

---

**Learning Objective:**

- Students will be more aware about the Biomolecules and nutrition
- Student will be more methodical and practical about the technies for analysis
- Student will be enabling to understand the basic and medical aspects Biomolecules

**Course outcome:**

- Understands the concept of Biomolecules and its utilization
- Students will acquire the knowledge about structure and its classification

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

**Biomolecules**

Biomolecules Proteins: Functions of proteins, Polymer of amino acids, Classification of amino acids, Chemistry of amino acids: Ionization of amino acid side chains, Configuration, zwitterion, reactions of amino acids, titration of amino acid, Isoelectric pH. Protein structure: Primary structure and peptide bond formation, Secondary structure, secondary repeats Tertiary and Quaternary structure (eg. Hemoglobin). Protein denaturation and renaturation.

**Unit-II:** **(13 L)**

**Vitamin**

Vitamins: Classification, Structure and Biochemical functions of fat soluble and water-soluble Vitamins. Coenzymes: Thiamine, Riboflavin, Niacin, Coenzyme A, lipoic acid, Folic acid and

**Unit-III:** **(13 L)**

**Enzyme**

Enzymes: General properties & classification of enzymes Biocatalyst, Active site, Specificity, Energy of activation, Reaction Rate. Rate law for enzyme catalyzed reaction Enzyme units, specific activity, turnover number. Lock and key, Induced fit hypothesis.

Parameters affecting enzyme activity (temp, pH, substrate, cofactor, enzyme con.) Enzyme inhibition

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

**Nucleic acid**

Nucleic acids: Purine, Pyrimidines, Nucleosides, Nucleotides, Polynucleotide. Nucleoprotein's Covalent structure of DNA and RNA Forces stabilizing nucleic acid structure Properties of Nucleic Acid. Denaturation & renaturation of Nucleic Acids. Different forms of DNA

**Text and References:**

1. Outlines of Biochemistry: 5th Edition, (2009), Erice Conn & Paul Stumpf ; John Wiley and Sons, USA

2. Fundamentals of Biochemistry. 3rd Edition, (2008), Donald Voet& Judith Voet , John Wiley and Sons, Inc. USA

3. Principles of Biochemistry, 4th edition (1997), Jeffory Zubey, McGraw-Hill College, USA

CBCS: 2019-2020 F.Y.B.Sc. Biotechnology Savitribai Phule Pune University Page 32

4. Biochemistry:7th Edition, (2012), Jeremy Berg, Lubert Stryer, W.H.Freeman and company,NY

5. Lehninger , Principles of Biochemistry. 5th Edition (2008), David Nelson & Michael Cox, W.H. Freeman and company, NY.

6. Biochemistry. 5th Edition, (copy right 2013), Reginald Garett and Charles Grisham, Brook/Cole, Cengage Learning, Boston, USA.

7. An Introduction to Practical Biochemistry.3rd Edition, (2001), David Plummer, Tata McGraw Hill Edu.Pvt.Ltd. New Delhi, India 8. Biochemical Methods.1st , (1995), S.Sadashivam, A.Mani

8. Biochemical Methods.1st , (1995), S. Sadashivam, A. Manickam, New Age International Publishers, India

**Rajarshi Shahu Mahavidyalaya (Autonomous), Latur**
**CHOICE BASED CREDIT SYSTEM**
**B.Sc. Biotechnology (Semester Pattern)**
**VI Semester**

**Course Title: Lab Course XIV** **Course Code: U-MBC-738**
**Marks: 50** **Credit: 03**

---

**Learning Objective:**

- Students will be more aware about the techniques of separation of Biomolecules
- Student will be more methodical and practical about analysis
- Student will be enabling to understand the basic and medical aspects Biomolecules

**Course outcome:**

- Understands the concept of Biomolecules and its determination by chromatographic and spectroscopic methods
- Students will acquire the knowledge about structure and its classification

**Practicals:**

1. Safety measures in laboratories.
2. Preparation of normal and molar solutions.
3. Preparation of buffers, phosphate and acetate buffers.
4. Determination of pKa of acetic acid and glycine.
5. Qualitative tests for carbohydrates.
6. Qualitative test for lipids.
7. Qualitative test for amino acids, proteins.
8. Qualitative test for nucleic acids.
9. Separation of amino acids/ sugars/ bases by thin layer chromatography/paper chromatography.
10. Estimation of vitamin C.

**Rajarshi Shahu Mahavidyalaya (Autonomous), Latur**
**B.Sc. Biotechnology (Semester Pattern)**
**VI Semester**

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

---

**Learning objective:**

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

**Course Outcomes:**

- Describe productions steps and specific requirements for each Biofertilizers
- To make skilled manpower for Biofertilizer industry
- Course can generate opportunities of self-entrepreneurship among students

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

**Biofertilizer**

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:** **(13 L)**

**Organic farming**

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:** **(12 L)**

**Production of Biofertilizers**

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:** **(13 L)**

**Efficacy of Biofertilizers**

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

**Text & References:**

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

2. Biotechnology, Saras Publications, New Delhi. Kumaresan, V. 2005,

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

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

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

6. Biotechnology of Biofertilizers. CHIPS, Texas. Kannaiyan, S., 2003

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

**Rajarshi Shahu Mahavidyalaya (Autonomous), Latur**
**B.Sc. Biotechnology (Semester Pattern)**
**VI Semester**
**Course Title: Solid Waste Management Course Code: U-ADC-640(S)**
**Marks: 50 Credit: 02**

**Course objectives:**

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

**Learning Outcomes:**

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

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

**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

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

Lab (2): Field trip - WTE Recycling facility

**Unit-II:** **(13 L)**

**Municipal solid waste characteristics and quantities**

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

**Collection**

**Refuse collection systems**

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

**Landfills**

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

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

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

**Unit-III:** **(13 L)**

**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

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

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

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

**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

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

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

**Text & References:**

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

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

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

## 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 nanoelectronics

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.

| Sr. No. | Cross Cutting Issues | Related course |
|---|---|---|
| 1. | **Gender Sensitization** | _ |
| 2. | **Environment & Sustainability** | Environmental Studies<br>Biodiversity and Systematic<br>Solid Waste Management |
| 3. | **Human Values** | _ |
| 4. | **Professional Ethics** | Biofertilizer / Horticulture |

.