

# **SOLAPUR UNIVERSITY, SOLAPUR**



**Faculty of Science**

**Syllabus**

**B.Sc.-III Biotechnology**

**Choice Based Credit System (CBCS)**

**Semester-V & VI**

**With effect from June-2018**

**Solapur University, Solapur, Faculty of Science**  
**Choice Based Credit System (CBCS): (w.e.f. 2018-19)**  
**Structure for B. Sc-III**

| Subject/<br>Core<br>Course         | Name and Type of the<br>Paper                             |              | No. of<br>papers/<br>Practical | Hrs/week  |    |           | Total<br>Marks<br>Per<br>Paper | UA         | CA         | Credits   |
|------------------------------------|---|--------------|--------------------------------|-----------|----|-----------|--------------------------------|------------|------------|-----------|
|                                    | Type  | Name         |                                | L         | T  | P         |                                |            |            |           |
| <b>Class :</b>                     | <b>B.Sc.- III Semester - V</b>                            |              |                                |           |    |           |                                |            |            |           |
|                                    | <b>Ability<br/>Enhanceme<br/>Nt<br/>Course(AE<br/>CC)</b> | English      | Paper-III                      | 4         |    |           | 100                            | 70         | 30         | 4         |
|                                    | <b>Core</b>   | Subject      | BT 301                         | 3         | -- | --        | 100                            | 70         | 30         | 3         |
|                                    | <b>Core</b>   |              | BT 302                         | 3         | -- | --        | 100                            | 70         | 30         | 3         |
|                                    | <b>Core</b>   |              | BT 303                         | 3         | -- | --        | 100                            | 70         | 30         | 3         |
|                                    | <b>DSE-1</b>  | Subject      | BT 304                         | 3         | -- | --        | 100                            | 70         | 30         | 3         |
|                                    | <b>DSE-2</b>  |              | BT 304                         | 3         | -- | --        | 100                            | 70         | 30         | 3         |
| <b>Grand<br/>Total</b>             |   |              |                                | <b>16</b> | -- | --        | <b>500</b>                     | <b>350</b> | <b>150</b> | <b>12</b> |
| <b>Class :</b>                     | <b>B.Sc.- III Semester - VI</b>                           |              |                                |           |    |           |                                |            |            |           |
|                                    | <b>Ability<br/>Enhanceme<br/>Nt<br/>Course(AE<br/>CC)</b> | English      | Paper-IV                       | 4         |    |           | 100                            | 70         | 30         | 4         |
|                                    | <b>Core</b>   | Subject      | BT 305                         | 3         | -- | --        | 100                            | 70         | 30         | 3         |
|                                    | <b>Core</b>   |              | BT 306                         | 3         | -- | --        | 100                            | 70         | 30         | 3         |
|                                    | <b>Core</b>   |              | BT 307                         | 3         | -- | --        | 100                            | 70         | 30         | 3         |
|                                    | <b>DSE-1</b>  | Subject      | BT 308                         | 3         | -- | --        | 100                            | 70         | 30         | 3         |
|                                    | <b>DSE-2</b>  |              | BT 308                         | 3         | -- | --        | 100                            | 70         | 30         | 3         |
| <b>Total<br/>(Theory)</b>          |   |              |                                | <b>16</b> | -- | --        | <b>500</b>                     | <b>350</b> | <b>150</b> | <b>12</b> |
|                                    | <b>Core</b>   | Subject      | Practical VIII                 | --        | -- | 5         | 100                            | 70         | 30         | 5         |
|                                    | <b>Core</b>   | Subject      | Practical IX                   | --        | -- | 5         | 100                            | 70         | 30         | 5         |
|                                    | <b>DSE</b>  | Subject      | Practical X                    | --        | -- | 5         | 100                            | 70         | 30         | 5         |
|                                    | <b>Core</b>   | Project Work | Practical XI                   | --        | -- | 5         | 100                            | 70         | 30         | 5         |
| <b>Total<br/>(Practicals<br/>)</b> |   |              |                                |           |    | <b>20</b> | <b>400</b>                     | <b>280</b> | <b>120</b> | <b>20</b> |
| <b>Grand<br/>Total</b>             |   |              |                                | <b>16</b> |    | <b>20</b> | <b>900</b>                     | <b>630</b> | <b>270</b> | <b>44</b> |

- Core Subjects- Chemistry/Physics/Electronics/Computer Science/Mathematics/Statistics/Botany/Zoology/Microbiology/Geology
- Discipline Specific Elective (DSE) Paper-The Subject will be specific as per the chosen core subjects.

### Summary of the Structure of B.Sc. Programme as per CBCS pattern

| Class            | Semester | Marks-Theory | Credits-Theory | Marks-Practical | Credits-Practicals | Total - credits |
|------------------|----------|--------------|----------------|-----------------|--------------------|-----------------|
| <b>B.Sc.-I</b>   | I        | 900          | 20             | -               | -                  | 20              |
|                  | II       | 900          | 20             | 400             | 16                 | 36              |
| <b>B.Sc.-II</b>  | III      | 600          | 18             | -               | -                  | 18              |
|                  | IV       | 700          | 18             | 600             | 24                 | 42              |
| <b>B.Sc.-III</b> | V        | 500          | 12             | -               | -                  | 12              |
|                  | VI       | 500          | 12             | 400             | 20                 | 32              |
| <b>Total</b>     |          | <b>4100</b>  | <b>100</b>     | <b>1400</b>     | <b>60</b>          | <b>160</b>      |

#### B.Sc. Programme :

- Total Marks : Theory + Practicals = 4100 + 1400 = 5500
  - Credits : Theory + Practicals = 100 + 60 = 160
  - Numbers of Papers Theory: Ability Enhancement Course(AECC) : 05  
Theory: Discipline Specific Elective Paper (DSE) : 02  
Theory: Core Course (CC) : 34
- Total : Theory Papers : 41**
- Practical: Core Course (CC) : 14**

#### Abbreviations:

- **L**: Lectures
- **T**: Tutorials
- **P**: Practicals
- **UA** : University Assessment
- **CA** : College Assessment
- **CC**: Core Course
- **AEC** : Ability Enhancement Course
- **DSE** : Discipline Specific Elective Paper

#### Important Note:

1. Board of Studies in the respective subject may design the curriculum/syllabus of one additional paper of the same Number (Paper –XII) as DSE Paper, so that students can opt any one of these two papers for semester –V. Similarly, the students can opt for one DSE paper (Paper-XVI) for Semester- VI.
2. The Credits for the practicals are changed as per the number of Hours per week.
3. For B.Sc.-I, Sem -I and II. Papers of each subject are divided as per previous pattern to give more weightage and to reduce the stress of the students.
4. Combined passing for B. Sc.- II Practicals ( Practical – II & III)
5. Combined passing for B. Sc-III Practicals (Practical – IV-VIII)
6. The 30 marks of College level Assessment (CA) may be distributed as 15 Marks for Internal Test and 15 Marks for Home Assignment/seminars/Viva/industrial visit/Group discussion etc.

**SOLAPUR UNIVERSITY, SOLAPUR**  
**Faculty of Science**  
**Choice Based Credit System (CBCS)**  
**(w.e.f. June 2018)**

•**Title of the Course:** B.Sc. Part-III

•**Subject:** Biotechnology

•**Choice Based Credit System CBCS**

With the view to ensure worldwide recognition, acceptability, horizontal as well as vertical mobility for students completing undergraduate degree, Solapur University has implemented Choice Based Credit System (CBCS) of Evaluation at Undergraduate level. Credit is a numerical value that indicates students work load (Lectures, Lab work, Seminar, Tutorials, Field work etc.) to complete a course unit. In most of the universities 15 contact hours constitute one credit. The contact hours are transformed into credits. As per present norms, there are 3 contact hours per paper (subject) per week which works out to be 45 contact hours per paper (subject) per semester.

In Solapur University, for B.Sc.-III Biotechnology, there are 5 papers in each semester out of which 4 papers choice will be given to student in **DSE** and Compulsory English. For B.Sc.-III Biotechnology, there are 3 contact hours per paper (subject) per week for each paper and Compulsory English carry 4 contact hours per week. Therefore, total contact hours per week are 16. Each paper has 45 contact hours, which are transformed into 3 credits. Moreover, the grading system of evaluation is introduced for B.Sc. course wherein process of Continuous Internal Evaluation is ensured. The candidate has to appear for Internal Evaluation of 30 marks and University Evaluation for 70 marks. It is 70+30 pattern of evaluation. It is applicable for theory and practical as well. The details regarding this evaluation system are as under.

•**Conversion of marks into Grades:**

A table for the conversion of the marks obtained by a student in each paper (out of 100) to grade and grade point is as given below:

| Sr. No. | Range of Marks | Grade | Grade Point                       |
|---------|----------------|-------|-----------------------------------|
| 1       | 80-100         | O     | 10                                |
| 2       | 70-80          | A+    | 9                                 |
| 3       | 60-69          | A     | 8                                 |
| 4       | 55-59          | B+    | 7                                 |
| 5       | 50-54          | B     | 6                                 |
| 6       | 45-49          | C+    | 5                                 |
| 7       | 40-44          | C     | 4                                 |
| 8       | <39            | FC    | 0( Failed in Term Exam)           |
| 9       | <39            | FR    | 0( Failed in Internal Assessment) |

**1. Grade Point Average at the end of the Semester (SGPA)**

$$SGPA = \frac{(G_1 \times C_1) + (G_2 \times C_2) + \dots}{\sum C_i}$$

( $\sum C_i$  = The total number of credits offered by the student during a semester)

**2. Cumulative Grade Point Average (CGPA)**

$$CGPA = \frac{(G_1 \times C_1) + (G_2 \times C_2) + \dots}{\sum C_i}$$

( $\sum C_i$  = The total number of credits offered by the student upto and including the semester for which CGPA is calculated.)

### 3. Final Grade Point Average (FGPA)

It will be calculated in the similar manner for the total number of credits offered for the completion of the said course.

Where:  $C_i$  = Credits allocated for the  $i^{\text{th}}$  course.

$G_i$  = Grade point scored in the  $i^{\text{th}}$  paper (subject)

### 4. Conversion of average grade points into grades:

| SGPA/CGPA/FGPA | Letter Grade |
|----------------|--------------|
| 9.5 – 10       | O            |
| 8.5 – 9.49     | A+           |
| 7.5 – 8.49     | A            |
| 6.5 – 7.49     | B+           |
| 5.5 – 6.49     | B            |
| 4.5 – 5.49     | C+           |
| 4.0 – 4.49     | C            |
| <3.99          | FC / F       |
|                | FR           |

### Syllabus Structure:

1. The University follows semester system.
2. An academic year shall consist of two semesters.
3. Each B.Sc. course shall consist of three years i.e. six semesters.
4. B.Sc. Part-III Biotechnology shall consist of two semesters: Semester V and Semester VI.

In semester V and VI, there will be a total of five out of which four papers of 100 marks for each semester with compulsory English.

The scheme of evaluation of performance of candidates shall be based on University assessment as well as College internal assessment as given below. For B.Sc. Part-III Biotechnology semester V & VI the internal assessment will be based on Unit tests, Tutorials, Home assignment, Viva, Group discussion, attitude, sincerity, attendance, student seminars etc. as given below. Practical course examination of 100 marks for each paper shall be conducted at the end of VI<sup>th</sup> semester. The practical examination of 100 marks shall also consist of 70 marks for University practical assessment and project work and 30 marks for college internal assessment.

For University practical examination both the examiners will be External and will be appointed by the University. The internal practical assessment shall be done as per scheme given below.

### 6. Scheme of Evaluation:

As per the norms of the grading system of evaluation, out of 100 marks, the candidate has to appear for college internal assessment (CA) of 30 marks and external evaluation, University Assessment (UA) of 70 marks. The respective B.O.S. may decide the nature of college internal assessment after referring to scheme given below or may be used as it is.

## **Semester – V**

### **Theory: (100 marks)**

University Examination (70 marks): No. of theory papers: 5 (1English + 4 Subjects)

### **Internal Continuous Assessment: (30 marks)**

The 30 marks of College level Assessment (CA) may be distributed as 15 Marks for Internal Test and 15 Marks for Home Assignment/seminars/Viva/ Group discussion etc.

## **Semester –VI**

### **Theory: (100 marks)**

University Examination (70 marks): No. of theory papers: 5 (1English + 4 Subjects)

### **Internal Continuous Assessment: (30 marks)**

The 30 marks of College level Assessment (CA) may be distributed as 15 Marks for Internal Test and 15 Marks for Home Assignment/seminars/Viva/Group discussion etc.

### **Practical Examination: (100 marks)**

University Examination (70 marks): No. of practical course 4 [(3+1 Project Work (50M) +visit report(10M) +review article (10M) or research paper publication)(10M)]

### **Internal Continuous Assessment: (30 marks)**

Scheme of marking: 30 marks – Internal test on any four practicals

(For practical course XI CA for 30 marks ( 20 marks for ppt presentation+ 10 marks for internal continuous assessment\*\*).)

\*\*Weightages for Lab. Journal /performance/attendance/sketching of diagrams related to syllabus (A4 Size) / original print of photography with details will be taken into consideration)

In addition, the students shall have to complete a project work on a topic chosen by him/her in consultation with the project coordinator. The project report should be submitted before practical examination and presented at the time of practical examination. This project work carries 50 marks.

Thus the course shall be of total 1400 marks including English.

## **7. Passing Standard:**

The student has to secure a minimum of 4.0 grade points (Grade C) in each paper. A student who secure less than 4.0 grade point (39% or less marks, Grade FC/FR) will be declared fail in that paper and shall be required to reappear for respective paper. A student who failed in University Examination (theory) and passed in internal assessment of a same paper shall be given FC Grade. Such student will have to reappear for University Examination only. A student who fails in internal assessment and passed in University examination (theory) shall be given FR Grade. Such student will have to reappear for both University examination as well as internal assessment. In case of Annual pattern/old semester pattern students/candidates from the mark scheme the candidates shall appear for the same 70 marks of external examination and his performance shall be scaled to 100 marks.

**8. ATKT** Candidate passed in all papers except 6 (six) papers combined together of semester III and IV of B.Sc. Part-II Biotechnology examination and clearly passed in B.Sc. Part-I-Biotechnology shall be permitted to enter upon the course of Semester V of B.Sc. III Biotechnology.

**SOLAPUR UNIVERSITY, SOLAPUR**  
Faculty of Science, CBCS Structure for B.Sc. - III Biotechnology

**Theory - Semester V**

| Paper No.                        | Title of Paper                                 | Hrs/Week |   |   | Paper Marks | UA  | CA  | Credits |
|----------------------------------|--|----------|---|---|-------------|-----|-----|---------|
|                                  |  | L        | T | P |             |     |     |         |
| Ability Enhancement Course(AECC) | Compulsory English (Paper III)                 | 4        | - | - | 100         | 70  | 30  | 4       |
| Core-BT 301                      | Plant Development                              | 3        | - | - | 100         | 70  | 30  | 3       |
| Core- BT 302                     | Fermentation Technology                        | 3        | - | - | 100         | 70  | 30  | 3       |
| Core- BT 303                     | Tools and Techniques                           | 3        | - | - | 100         | 70  | 30  | 3       |
| DSE- BT 304-A                    | Recent Trends in Biotechnology                 | 3        | - | - | 100         | 70  | 30  | 3       |
| DSE- BT 304-B                    | Introduction to Biotechnology based Industries | 3        | - | - | 100         | 70  | 30  | 3       |
| Total                            |  | 12       | - | - | 500         | 350 | 150 | 12      |

**Theory - Semester VI**

| Paper No.                        | Title of Paper                              | Hrs/Week |   |   | Paper Marks | UA  | CA  | Credits |
|----------------------------------|---|----------|---|---|-------------|-----|-----|---------|
|                                  |   | L        | T | P |             |     |     |         |
| Ability Enhancement Course(AECC) | Compulsory English(Paper IV)                | 4        | - | - | 100         | 70  | 30  | 3       |
| Core-BT 305                      | Animal Development                          | 3        | - | - | 100         | 70  | 30  | 3       |
| Core- BT 306                     | Food and Dairy Technology                   | 3        | - | - | 100         | 70  | 30  | 3       |
| Core- BT 307                     | Bioinformatics and Nanotechnology           | 3        | - | - | 100         | 70  | 30  | 3       |
| DSE- BT 308-A                    | Applications of Biotechnology               | 3        | - | - | 100         | 70  | 30  | 3       |
| DSE- BT 308-B                    | Quality Standard Practices in Biotechnology | 3        | - | - | 100         | 70  | 30  | 3       |
| Total                            |   | 12       | - | - | 500         | 350 | 150 | 12      |

**Practical Annual**

| Paper No.  | Title of Paper         | Hrs/Week |   |    | Paper Marks | UA  | CA  | Credits |
|--|------------------------|----------|---|----|-------------|-----|-----|---------|
|  |                        | L        | T | P  |             |     |     |         |
| Paper-Core-BT 301<br>Paper-Core BT 303<br>Paper-Core BT-305  | Laboratory Course VIII | -        | - | 5  | 100         | 70  | 30  | 3       |
| Paper-Core-BT-302<br>Paper-Core-BT-306<br>Paper- Core-BT-307   | Laboratory Course IX   | -        | - | 5  | 100         | 70  | 30  | 3       |
| Paper-DSE- BT 304-A<br><b>OR</b><br>Paper-DSE-BT-304-B<br><b>and</b><br>Paper-DSE- BT-308-A<br><b>OR</b><br>Paper-DSE-BT-308-B | Laboratory Course X    | -        | - | 5  | 100         | 70  | 30  | 3       |
| Project Work   | Laboratory Course XI   | -        | - | 5  | 100         | 70  | 30  | 3       |
| Total  |                        | -        | - | 20 | 400         | 280 | 120 | 12      |

**Abbreviations:**

L: Lectures

T: Tutorials

P: Practicals

UA: University Assessment by End Semester Examination

CA: College Assessment by Internal Continuous Examination

UA: University Assessment: - University Theory paper shall be of 70 marks

CA: College Assessment:- The internal examination for theory and practical course

PW: Project Work



## SEMESTER-V

| <b>Paper- Core-BT 301- Plant Development<br/>[Credits -3, Total Lectures-45]</b> |   |                 |
|--|---|-----------------|
| <b>Unit</b>  | <b>Content</b>  | <b>Lectures</b> |
| <b>I</b>   | <p><b>Gametophyte, Pollination and Fertilization in plants:</b><br/>           Plant reproductive organs: Plant morphology and floral characteristics, <b>Male gametophyte:</b> pollen development and gene expression, male sterility, sperm Dimorphism, Anther and Pollen structure. <b>Female gametophytes:</b> types of embryo sacs, structure of embryo sac cells, structure of the pistil <b>Mechanism of pollination and fertilization:</b> Pollination (pollen-pistil interaction, pollen-stigma interaction, vectors involved in pollination), Fertilization (pollen tube growth and guidance, pollen storage, pollen embryos. double fertilization, <i>in vitro</i> fertilization), sporophytic and gametophytic self-incompatibility (cytological, biochemical and molecular aspects), Hybrid seed production.</p> | <b>12</b>       |
| <b>II</b>  | <p><b>Seed development and fruit growth:</b><br/>           Endosperm development during early, maturation and desiccation stages, embryogenesis, ultrastructure and nuclear cytology, cell lineage during late embryo development, storage proteins of endosperm and embryo, embryo culture, dynamics of fruit growth, biochemistry and molecular biology of fruit maturation. Apomixes: Diplospory, apospory, causes, consequences and significance of Apomixes. Polyembryony: Classification causes, experimental induction and practical importance.</p>  | <b>09</b>       |
| <b>III</b>   | <p><b>Plant patterning:</b><br/>           Model of plant development – <i>Arabidopsis thaliana</i>. Root and shoot and floral patterning – 1. Introduction 2. Classification. 3. Theories of structural development. Diversity with respect to cell fusion and somatic cell genetics.</p>  | <b>07</b>       |
| <b>IV</b>  | <p><b>Phytohormones and Plant Tissue development:</b><br/> <b>Mode of action of phytohormone</b> – Auxins, Gibberellins, Cytokinins, Abscisic acid (ABA), ethylene, Florigen hormone. <b>Plant Tissue development</b>-Cell growth and development, cell wall development and role of cytoskeleton, patterns of development in primary xylem and phloem, development of stomata, periderm development, quiescent center and its role in development of primary tissues in lateral root development, leaf development.</p>  | <b>08</b>       |
| <b>V</b>   | <p><b>Technologies based on plant development:</b><br/> <b>Seed technology:</b> technology and its importance; production processing and testing of seeds of crop plants; seed storage, seed certification, role of National Seeds Corporation (NSC) in production; <b>Importance and Production of secondary metabolites</b> - Alkaloids, Carbohydrates, proteins, Amino acids, Glycosides, Flavonoids, Terpenoids, Steroids, Carotenoids, Tannins, Resins, Sugar, Anthraquinone, Phenol, Saponin, Quinine, Catechin, Coumarin.</p>  | <b>09</b>       |

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|--|---|--|
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|  | <p><b>References:</b></p> <ol style="list-style-type: none"> <li>1. Dubey, R.C, “A Textbook of Biotechnology”, S. Chand &amp; Company, New Delhi</li> <li>2. R.C. Sobati, “Basics of Bio-technology”, Vishal Publishing</li> <li>3. Bhojwani and Bhatnagar, “Plant Embryology”.</li> <li>4. Cole, A.J. 1969. “Numerical Taxonomy”. Academic Press, London.</li> <li>5. Davis, P.H. and Heywood, V.M. 1973. “Principles of Angiosperm Taxonomy”. Robert E. Kereiger Publ. New York.</li> <li>6. Harrison, H.J. 1971. “New Concepts in Flowering Plant Taxonomy”. Heiman Ednl. Books. Ltd., London.</li> <li>7. Radford, A.E. 1986. “Fundamentals of Plant Systematics”, Harper &amp; Row Publ. USA.</li> <li>8. Woodland, D.W. 1991. “Contemporary Plant Systematics”. Prentice Hall, New Jersey</li> <li>9. Klaus Kalthoff. Analysis of Biological development.</li> <li>10. H. S. Chawala, Plant biotechnology.</li> <li>11. Plant secondary metabolites, Harindar P.S. Makkar et al. 2007</li> <li>12. Principles of seed sciences and technology, Text book by Lawrence O. Copeland and M. B. McDonald</li> <li>13. Seed technology by Agrawal Rattan lal, Oxford and IBH publishing 1995</li> </ol> |  |

| <b>Paper- Core-BT 302- Fermentation Technology</b><br><b>[Credits -3, Total Lectures-45]</b> |  |                 |
|--|--|-----------------|
| <b>Unit</b>  | <b>Content</b>   | <b>Lectures</b> |
| <b>I</b>   | <b>Bioreactors/fermenters and media:</b><br>Introduction, Basic functions of a fermenter, Components of a typical fermenter, Operation of the fermenter. Fermentation Media: Introduction, Characteristics of an ideal fermentation medium, raw materials used, Types of Fermentation media, media sterilization, inoculum media, screening for fermentation media. Inoculum preparation. Microbial growth Kinetics. | <b>10</b>       |
| <b>II</b>  | <b>Screening:</b><br>Introduction, Primary and secondary screening. Strain Improvement. Preservation and maintenance of industrial strains, Culture Collection Centers for Microorganisms, Scale up of fermentation. Detection and assay of fermentation products: Physical- chemical assays, Biological assays.   | <b>11</b>       |
| <b>III</b>   | <b>Types of Fermentations:</b><br>(Introduction, Advantages and Limitations, Basic aspects of Process Biotechnology, Fermentor Design , Industrial applications and process of): Batch fermentation, Continuous Fermentation, Submerged , Solid state Fermentations, Anaerobic Fermentations   | <b>06</b>       |
| <b>IV</b>  | <b>Downstream processes:</b><br>Solid-liquid separation, coagulation and Flocculation, Filtration, Centrifugation, Disintegration methods, Precipitation, Solvent extraction, Distillation, Purification by Chromatographic Techniques, Product Formulation. Fermentation economics. Application of computer in fermentation technology.   | <b>12</b>       |
| <b>V</b>   | <b>Microbial production of industrial products:</b><br>(Micro-organisms involved, production media, fermentation conditions, product recovery and applications of):Citric acid, Ethanol, Penicillin, Vitamin B12, amylase, bioinsecticide ( <i>Bacillusthuriensis</i> ).   | <b>06</b>       |

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|--|---|--|
|  |   |  |
|  | <p><b>Reference:</b></p> <ol style="list-style-type: none"> <li>1. Casida L. E. (1991). Industrial Microbiology, New Age international Ltd.</li> <li>2. Crueger W. and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.</li> <li>3. Patel A. H. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.</li> <li>4. Stanbury P. F, Whitaker A. and Hall S. J. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.</li> <li>5. Pepler H.J., Perlman D. (2004). Microbial technology-Fermentation Technology, second edition, Volume I and II, Academic Press.</li> <li>6. H. A. Modi (2009): Fermentation Technology Vol. I And Vol. II, Pointer Publishers</li> <li>7. Fermentation Microbiology and Biotechnology (2012): E.M.T. Mansi, C. F. A. Bryce, B. Dahhou &amp; other third edition, CRC press</li> </ol> |  |

| <b>Paper- Core-BT 303- Tools and Techniques<br/>[Credits -3, Total Lectures-45]</b> |  |                 |
|---|--|-----------------|
| <b>Unit</b>   | <b>Content</b>   | <b>Lectures</b> |
| <b>I</b>  | <b>Introduction and Basics of Genetic Engineering:</b><br><b>Genetic Engineering:</b> Introduction, milestones and scope, <b>Basic Techniques:</b> Electrophoresis- Agarose gel electrophoresis, SDS- PAGE, Isoelectrofocussing, Pulse Field Gel Electrophoresis (PFGE), High Voltage Electrophoresis (HVE), <b>Blotting techniques:</b> Southern blotting, Northern Blotting, Western Blotting, principles of autoradiography.  | <b>08</b>       |
| <b>II</b>   | <b>Enzymes in Genetic Engineering:</b><br>Exonucleases (Exonuclease I, III and $\lambda$ ), Endonucleases (S1nuclease, Mung bean nuclease, DNase1, Ribonuclease H), Restriction endonuclease (Type I, II, III), DNA polymerases (Polymerase I, klenow fragments, Taq), RNA polymerases (E. coli RNA polymerases, SP-6 RNA polymerases, T <sub>7</sub> - RNA polymerases ), Reverse transcriptases (AMV Reverse transcriptase, M-Mul V Reverse transcriptase), Ligases (E. coli DNA Ligase, T <sub>4</sub> - DNA Ligase, T <sub>4</sub> - RNA Ligase), Alkaline phosphatases, Terminal deoxy nucleotidyl transferase, Kinases (T <sub>4</sub> – Poly Nucleotide kinase, T <sub>4</sub> – Poly Nucleotide kinase phosphatase free) | <b>12</b>       |
| <b>III</b>  | <b>Vectors in Genetic Engineering:</b><br>Plasmids (pSC101, pBR322, pUC), Phages ( $\lambda$ insertion vector and $\lambda$ replacement vector) Cosmids, Phagemids (pBluescript II KS(+/-), pTZ19R/pTZ19U), BAC, Shuttle vectors, plants (Caulimo viruses and Tobamo viruses), animals (SV40) and yeast (YIp, YEp, YCp), YAC, Selection and screening of recombinants: Direct screening, Blue – White screening, Colony hybridization, Immunological screening.  | <b>09</b>       |
| <b>IV</b>   | <b>DNA Transfer techniques:</b><br>DNA transfer techniques: Transformation, Transfection and Transduction, <b>Cloning in Prokaryotes and Eukaryotes:</b> 1.Methods of direct transformation: PEG mediated, microinjection, particle bombardment, electroporation, Liposome mediated, Calcium phosphate. 2. Methods of indirect transformation: Agrobacterium mediated gene transfer techniques.  | <b>08</b>       |
| <b>V</b>  | <b>Advance techniques in Genetic Engineering:</b><br>Probes: Genomic DNA probes, cDNA probes, synthetic oligonucleotide probes, RNA probes, methods of labeling probes. Molecular markers: DNA Foot-Printing, DNA Fingerprinting (RFLP, RAPD, AFLP), Chromosome walking, PCR (Reverse transcriptase PCR, Anchored PCR, Inverse PCR), Methods of DNA sequencing: Maxam's and Gilbert's method, Sanger's dideoxy method, Automated DNA sequencing.   | <b>08</b>       |

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|  | <p><b>References:</b></p> <ol style="list-style-type: none"> <li>1. An Introduction to Genetic Engineering, 2nd Edition, Desmond S.T. Nicholl, Cambridge University Press (2006).</li> <li>2. Molecular Biotechnology: Principles and Applications of Recombinant DNA, 3rd Edition, B.R. Glick and J.J. Pasternak, ASM Press (2007)</li> <li>3. Principles of Gene Manipulation and Genomics, 7th Edition, S.B. Primrose and R.M. Twyman, Blackwell Publishing (2006)</li> <li>4. Molecular Biotechnology, 2nd Edition, S.B. Primrose, Panima Publishing (2001)</li> <li>5. Introduction to Biotechnology, Low Price Edition, W.J. Thieman and M.A. Palladino, Peaeson Education (2007)</li> <li>6. Genetic Engineering : Principles And Practice, Sandhya Mitra, Macmillan India (1996)</li> <li>7. Genetic Engineering: Principles and Methods, Setlow J.K., Kluwer Academic Publishers. (2000)</li> <li>8. Genetic Engineering, Yount L., Gale Group (2002)</li> <li>9. Molecular Cloning: A Laboratory Manual (Volume - I, II &amp; III) Sambrook J., D.W. Russell, Cold Spring Harbor Laboratory Press (2001)</li> <li>10. Gene Cloning and DNA Analysis: An Introduction, 4th edition, Brown T. A., Blackwell Science Inc (2001)</li> <li>11. Recombinant DNA: Genes and Genomes - A Short Course, 3rd Edition, James D</li> </ol> |  |

| <b>Paper- DSE- BT 304-A- Recent Trends in Biotechnology<br/>[Credits -3, Total Lectures-45]</b> |   |                 |
|---|---|-----------------|
| <b>Unit</b>   | <b>Content</b>  | <b>Lectures</b> |
| <b>I</b>  | <b>Environmental impact assessment:</b><br>i) Components of EIA: Air, Water, Biological environment, land, noise<br>ii) Environmental monitoring: chemical, biological, radiological, microbiological<br>iii) Sampling methods: random, continuous or semicontinuous, remote sensing  | <b>06</b>       |
| <b>II</b>   | <b>Environmental Remedies:</b><br>i) Bioremediation, <i>Ex-situ</i> and <i>In-situ</i> bioremediation;<br>ii) Phytoremediation and wetland system<br>iii) Bioaugmentation & biofiltration; Bioleaching of ores<br>iv) Industrial waste biotreatment technologies: sugar and distillery, textile, paper and pulp, biomedical waste   | <b>06</b>       |
| <b>III</b>  | <b>Recent trends in Biosciences</b><br>i) Molecular pharming e.g. alkaloids, therapeutic proteins, edible vaccines; Integration of genetic engineering in agriculture e.g. chloroplast engineering<br>ii) Regenerative medicine-Tissue engineering and stem cell technology<br>iii) Immobilization of cells and enzymes; Support or Carrier, its properties; Methods of immobilizations– Carrier binding, Cross-linking, Entrapment; Industrial applications of immobilization..      | <b>11</b>       |
| <b>IV</b>   | <b>Recent trends in metabolomics</b><br>i) Strategy & applications of enzyme engineering,<br>ii) Introduction to metabolic engineering<br>iii) Cloning and over expression of heterologous genes<br>iv) Analysis of metabolic network [metabolic flux analysis, metabolic control analysis (MCA), flux control coefficient from transient metabolite, top down MCA],<br>v) Pathway synthesis, Implementation changes, analysis of changes<br>vi) Limitations of metabolic engineering | <b>12</b>       |
| <b>V</b>  | <b>Recent trends in clinical biotechnology</b><br>i) Principles of clinical biochemical analysis<br>ii) Clinical measurements-Importance of laboratory tests in clinical medicine, liver and renal function test<br>iii) Biochemical aids to clinical diagnosis Human disease and drug Therapy  | <b>10</b>       |

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|  | <p><b>References:</b></p> <ol style="list-style-type: none"> <li>1. Hans-Joachim Jordening, Josef Winter, “Environmental Biotechnology: Concepts and applications”, Willey Interscience, A John Willey &amp; Sons, INC., Publication.</li> <li>2. U. Satyanarayan, U Chakrapani “Biotechnology”, Books and allied Private LTD</li> <li>3. Introduction to Biotechnology, 2<sup>nd</sup> Edition, W. J. Thieman and M. A. Palladino, Pearson Publishers.</li> <li>4. Biotechnology: Principles and applications, S. C. Rastogi, Narosa Publishing House (2007)</li> <li>5. R. C. Dubey, “A Text book of Biotechnology”, S. Chand &amp; Company LTD.</li> <li>6. B. D. Singh, “Biotechnology”, Kalyani Publishers.</li> <li>7. Harper’s Illustrated Biochemistry, 29<sup>th</sup> Edition, R. K. Murray, D. A. Bender, P. J. Kennelly, V. W. Rodwell and P. A. Weil, McGraw Hill Publications.</li> <li>8. Principles and Techniques of Biochemistry and Molecular Biology, 7<sup>th</sup> Edition, Keith Wilson and John Walker, Cambridge University Press.</li> </ol> |  |



| <b>Paper- DSE- BT 304-B- Introduction to Biotechnology based Industries<br/>[Credits -3, Total Lectures-45]</b> |  |                 |
|---|--|-----------------|
| <b>Unit</b>   | <b>Content</b>   | <b>Lectures</b> |
| <b>I</b>  | <p><b>General Structure &amp; organization of Biotechnology Industry:</b><br/> Departments &amp; their responsibilities (Administrator &amp; Human Resources (HR), Store &amp; Purchase, Production unit -Upstream, Downstream processing, Finishing, packaging. Quality Assurance, Quality control &amp; Testing, Dispatch &amp; marketing, Research &amp; Development etc.)<br/> Hierarchy of Personals (CEO, Directors, Managers, Officers, Attendants, Workers etc.)</p>   | <b>07</b>       |
| <b>II</b>   | <p><b>Industrial terminologies and concepts</b><br/> <b>GMP:</b> Definition, GMP principles, GMP guidelines according to personnel's, Raw materials and their storage, seed lot and cell banks, premises and equipments-clean rooms, <b>Validation programs</b>-equipments (V- model), cleaning (Cleaning samples- Rinse method &amp; Swab method), process etc.), Aseptic simulation, Deviation &amp; Corrective action and preventive action (CAPA).<br/> <b>Batch Manufacturing Record (Definition and importance)</b><br/> <b>SOPs:</b> Definition, Structure of SOP, Importance of SOP<br/> <b>Industrial Safety :</b> Definitions, Objectives, Types.</p>  | <b>10</b>       |
| <b>III</b>  | <p><b>Various Regulatory authorities: Introduction to regulatory authorities, their Location, Establishment, Roles and responsibilities)</b><br/> <b>International authorities:</b><br/> World Health Organization (WHO), US- Food Drug Administration, World Trade Organization (WTO), International Conference on Harmonization (ICH), World Intellectual Property Organization (WIPO), Environmental Protection Agency (EPA)<br/> <b>Indian authorities: (Location, Establishment, Roles and responsibilities):</b><br/> Central Drug Standard Control Organization (CDSCO), Ministry of Health &amp; Family Welfare (MHFW), Indian Indian Pharmacopoeia Commission (IPC), Food Safety and Standards Authority of India (FSSAI), International Organization for Standardization (ISO), Indian Council of Agriculture Research (ICAR), Ethics Committees in India.</p> | <b>10</b>       |

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| <p><b>IV</b></p> | <p><b>Types of Biotech Industries based on products : ( Introduction to industry Production and applications)</b></p> <p><b>Pharmaceutical and Bio-medical industries:</b> Active pharmaceutical ingredients, Probiotics, Biotherapeutic proteins &amp; peptides, Biosimilars etc.</p> <p><b>Paper and Pulp industries:</b> Paper</p> <p><b>Distilleries &amp; Beverages:</b> spirit and fruit beverages</p> <p><b>Animal Husbandry and veterinary medicines:</b> Dairy product &amp; veterinary vaccine.</p> <p><b>Agriculture Industry:</b> Bio-fertilizer, bio-inoculants, plant tissue culture</p> <p><b>Bioengineering &amp; Equipment Design:</b> Radiation therapy &amp; any Surgical device.</p> <p><b>Nanotechnology and Genetics based industries:</b> Nanozymes &amp; any gene products.</p> <p><b>Bio-informatics:</b> Medical coding, Bio IT.</p> <p><b>List of Biotechnology based companies in India.</b></p>  | <p><b>09</b></p> |
| <p><b>V</b></p>  | <p><b>Council of Scientific and Industrial Research (CSIR) and extension institutes:</b> Organisation, establishment, Introduction to Research, development and activities, CSIR pride in Biology and Biotechnology, Various institutes working in India, Laboratory wise-core competence, ongoing projects, fellowships, scholarships and training.</p> <p><b>DBT – Organisation, establishment, Introduction to Research,development and activities, JRF, DBT-Research Associateship (DBT – RA), Khorana Program for Scholars etc.</b></p> <p><b>National and International fellowships, scholarships forBiotechnology students:</b></p> <p><b>New Zealand Commonwealth Scholarships For M.Sc. &amp; Ph. D. Candidates:</b> Swarup Bhatnagar Prize for Science and Technology, India Prime Minister Research Fellowship (PMRF) Scheme, India Arturo Falaschi ICGEB PhD Fellowship Programmes (National andinternational)STARS – Supporting Talented PhD Research CharlesUniversity in Prague,Czech Republic.<b>Simons-NCBS / iTHEMS-IKEN Joint Postdoctoral Fellowship, India</b></p> | <p><b>09</b></p> |

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|  | <p><b>References:</b></p> <ol style="list-style-type: none"> <li>1. Deborah Kioy (2008): Good laboratory practice training manual for the trainer, WHO</li> <li>2. H. A. Modi (2009): Fermentation Technology Vol. I And Vol. II, Pointer Publishers</li> <li>3. Anthony Meager (1999): Gene therapy applications technology and regulations from laboratory to clinic. John Wiley &amp; Son's pvt Ltd.</li> <li>4. WHO (1999): Medical device regulations</li> <li>5. WHO (2016): Good Regulatory practices: Guide lines for national regulatory authorities Medical products</li> <li>6. H. J. Pepler and D. Perlman (Editors), Microbial Technology, Vol. II: Fermentation Technology (2nd Edition).</li> <li>7. Singh Gajendra (2005) Drug Regulatory Affairs Paper back</li> </ol> |  |

## SEMESTER-VI

| <b>Paper- Core-BT 305- Animal Development<br/>[Credits -3, Total Lectures-45]</b> |  |                 |
|---|--|-----------------|
| <b>Unit</b>   | <b>Content</b>   | <b>Lectures</b> |
| <b>I</b>  | <p><b>History and Scope</b><br/>           Definition, Scope, History and Introduction to Developmental Biology, Theories in Developmental Biology: Preformation theories, Theory of epigenesis, Baer's law, Biogenetic law, Germplasm theory of Weismann, Mosaic theory of Roux, Regulative theory of Driesch, Gradient theory of Child and Organizers theory of Spemann.</p>   | <b>06</b>       |
| <b>II</b>   | <p><b>Gametogenesis</b><br/>           Origin of primordial Germ cells in mammals, Male Gonad, Spermatogenesis: spermatids formation, spermiogenesis, Biochemical changes in spermatogenesis, Control of spermatogenesis, morphology of mature sperm. Discharge and Transportation of Gametes: Semination and sperm transport, Mechanism of semination, sperm discharge, transport of sperms, sperm viability, artificial insemination. Female Gonad: Compact and Saccular ovaries, Eggs and Oogenesis: introduction, Oogenesis in insects and mammals. Functions of ovarian tissues during growth phases. Ovulation: organs of ovulation and transportation in vertebrates, Time and regulation of ovulation.</p> | <b>12</b>       |
| <b>III</b>  | <p><b>Fertilization and Cleavage</b><br/>           Fertilization: Basic requirements and mechanism of fertilization, encounter of spermatozoa and ova, capacitation and contact, Acrosome reaction and penetration, activation of ovum, migration of pronuclei and amphimixis, post-fertilization changes in egg cytoplasm, mono- and polyspermic fertilization. IVF- Process &amp; applications, Cleavage: cells involved, planes, patterns and rate of cleavage, influence of yolk, egg organization, cytokinesis in the cleavage, laws of cleavage, chemical changes during cleavage.</p>  | <b>10</b>       |
| <b>IV</b>   | <p><b>Morulation, Blastulation, Fate maps, Gastrulation</b><br/>           Morulation, Blastulation in Centrolecithal egg, Blastulation in Isolecithal, microlecithal, Telolecithal, polylecithal egg. Construction of fate maps by natural and artificial marking. Gastrulation: general process, Epibolic and Embolic morphogenetic movement, General metabolism, hormonal action and gene activation during gastrulation.</p>   | <b>09</b>       |
| <b>V</b>  | <p><b>Development in Model Organisms and Development genetics</b><br/>           Introduction to Regeneration in microbes, protozoa, invertebrates and vertebrates. Introduction to Malignancy, Aging, Metamorphosis, Asexual reproduction and parthenogenesis. Concepts in development genetics: Potency, commitment, specification, induction, competence, determination and differentiation. Environmental regulation of animal development.</p>  | <b>08</b>       |

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|  | <p><b>References:</b></p> <ol style="list-style-type: none"> <li>1. An Introduction to Embryology 1981, Balinsky B.L., Saunders College, Philadelphia.</li> <li>2. Developmental Biology; Patterns/Principles/Problems, 1982, Saunders J. W. Collier MacMillan, Publishers, London.</li> <li>3. Developmental Biology, 1997, 3rd Edition, Gilbert S.F. Saunder Associates Inc. U.S.A.</li> <li>4. Developmental Biology, 1992 3rd edition, Browder L.W. Erickson C.A. &amp;Williams, R.J. Saunders College, Publications, London.</li> <li>5. A Text Book of Embryology, Dr. Puranik P. G., S. Chand &amp; Co.</li> <li>6. Klaus Kalthoff. Analysis of Biological development.</li> <li>7. Development of Chick embryo, 1972, Lillie.</li> <li>8. Developmental Biology, 1991, 3rd Edition, Sinaur Associates, Inc. U.S.A.</li> <li>9. A Text Book of Embryology (Developmental Biology) Dr. N. Arumugam, Saras Publication, Kanyakumari.</li> <li>10. Chordate Embryology, P.S. Verma and V.K. Agarwal S. Chand and Company LTD., New Delhi.</li> <li>11. Chordate embryology and histology, S. Chands Simplified Course, S. Chand and Company Ltd.</li> <li>12. Developmental Biology, 1984, Browder L.W., Saunders College Publications, U.S.A.</li> </ol> |  |

| <b>Paper- Core-BT 306- Food and Dairy Technology<br/>[Credits -3, Total Lectures-45]</b> |   |                 |
|--|---|-----------------|
| <b>Unit</b>  | <b>Content</b>  | <b>Lectures</b> |
| <b>I</b>   | <b>Food Microbiology:</b> Chemical and physical properties of food affecting Microbial growth (intrinsic and extrinsic factors). Microbial spoilage of different food products-cereals and cereal products, sugar and sugar products, vegetables and fruits, meat and meat products, eggs and poultry, fish and sea products. General methods of food preservation: Asepsis, use of high temperatures, use of low temperatures, drying, food additives, radiation   | <b>12</b>       |
| <b>II</b>  | <b>Dairy plant design and milk microbiology:</b> Dairy plant design, construction, Materials and utilization.<br><br>Milk - Definition, composition and constituents of milk, Normal flora of milk, Microbial spoilage of different milk products. Pasteurization of milk - Methods of Pasteurization – LTH, HTST, and UHT. Phosphatase test for determination of efficiency of Pasteurization.   | <b>12</b>       |
| <b>III</b>   | <b>Methods for the Microbiological examination of foods:</b> Indicator organisms, Direct Examination, Cultural techniques, Enumeration method standard plate counts, Most Probable Number Counts, Dye reduction tests-MBRT, Resazurin Test, Rapid methods for detection of Specific organisms and Toxins- Immunological methods, DNA/RNA methodology  | <b>08</b>       |
| <b>IV</b>  | <b>Nutritional value &amp; analysis of food:</b> Introduction, significance nutritional labeling, effect of processing, storage and marketing on nutrient retention, methods of nutrient analysis.  | <b>07</b>       |
| <b>V</b>   | <b>Fermented dairy and other food Products-</b><br>Yoghurt, Cheese, Sauerkraut, Beer, Vinegar, Bread, Pickles.  | <b>06</b>       |
|  | <b>References:</b><br>1. Food Microbiology (1995)-Adams M.R. and Moss, M.O., New Age International Limited.<br>2. Food Microbiology –Frazier, W.C., Westhoff, D.C. IVedition, Tata McGraw Hill Publisher.<br>3. Industrial Microbiology by A. H. Patel, Mac Millan India Pvt. Ltd.<br>4. Modern Food Microbiology VI <sup>th</sup> edition- James M Jay. An Aspen publication.<br>5. Applied Dairy Microbiology –Elmer Marth and James Steele 2 <sup>nd</sup> edition, publisher Marcel Dekker<br>6. Microbial Technology Volume II- Pepller and Perlman, Academic Press<br>7.Modern Food Microbiology (2018)-K. R. Aneja, MEDTECH publishers<br>8. Food Microbiology (1995)-Adams M. and Dick M., second edition, MEDTECH publishers<br>9.Quality control for the food industry (2017) -Amihud Kramer and Bernard Twigg, Volume II 3 <sup>rd</sup> edition, MEDTECH publishers<br>10. Dairy and food products for engineering (2018)-Arthur W. Farrall. second edition, MEDTECH publishers |                 |

|  | 11.Basics in Food microbiology (1998)-George I. Banwart 2 <sup>nd</sup> edition CBC publishers and distributors   |                 |
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| <b>Paper- Core-BT 307- Bioinformatics and Nanotechnology<br/>[Credits -3, Total Lectures-45]</b> |   |                 |
| <b>Unit</b>  | <b>Content</b>  | <b>Lectures</b> |
| <b>I</b>   | <b>Introduction to Bioinformatics</b><br>History – concept; brief history and introduction to bioinformatics Need of bioinformatics, branches of bioinformatics, Nomenclature and code letters of DNA and protein sequences, scope and applications of bioinformatics various fields of life sciences. Introduction to search engine Entrez.  | <b>06</b>       |
| <b>II</b>  | <b>Biological Databases [Introductory only]</b><br>Nucleic acid sequence databases: EMBL, DDBJ, GenBank; Primary Protein sequence databases:- PIR, MIPS, Swiss – PROT, TrEMBL, NRL – 3D; Composite Protein sequence databases: - NRDB, OWL, MIPSx, SWISS-PROT + TrEMBL; Secondary Protein databases: - PROSITE, Pfam, Structure classification databases: - SCOP, CATH, PDBsum, Structural Databases: - PDB, NDB, MMDB. Introduction to NCBI literature databases.  | <b>09</b>       |
| <b>III</b>   | <b>Sequence Analysis and Tools</b><br>Sequence Alignments – Global and Local alignments methods (only strategy required no detail algorithm), Pairwise and Multiple sequence alignments. Tools for alignment– BLAST, FASTA, CLUSTALX. Introduction to phylogenetics. Aspects of protein structure prediction.   | <b>08</b>       |
| <b>IV</b>  | <b>Nanotechnology</b><br>Introduction, fundamental science behind nanotechnology (electron, atoms and ions, molecules, metals), Classification of nanomaterials, bionanomaterials, Properties of the nanomaterials,; Applications in – Drug delivery, Electronics, Pharmaceuticals , Cosmetics, sensors and biosensors, cleaning environment (for heavy metal & Bioremediation).  | <b>10</b>       |
| <b>V</b>   | <b>Synthesis Methods &amp; Characterization techniques for nanomaterials</b><br>Types of Synthesis: Introduction to Physical, Chemicals, Biological and hybrid methods of Nanomaterial synthesis. Tools for measuring nanostructures – Scanning probe instruments, spectroscopy, electrochemistry, electron microscopy. Tools to make nanostructures – Nanoscale lithography, dip pen lithography, E-beam lithography, nanosphere liftoff lithography, molecular synthesis, self assembly, nanoscale crystal growth, polymerization, nanobricks and building blocks. Tools to imagine nanoscale behaviors. NanoCAD. | <b>12</b>       |

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|  | <p><b>References:</b></p> <ol style="list-style-type: none"> <li>1. C.S.C. Murthy, “Bioinformatics”, Himalaya Publishing House, Mumbai.</li> <li>2. S. Ignacimuthu, S.J., “Basic Bioinformatics”, Narosa Publication House, PVT., LTD.</li> <li>3. R. Sunderlingam, V. Kumaresan, “Bioinformatics”, Saras Publication.</li> <li>4. Attwood and Pary Smith, “Introduction to bioinformatics”, Pearson Publication.</li> <li>5. R. C. Dubey, “Biotechnology”, S. Chand Publication &amp; Company LTD.</li> <li>6. Mark Ratner, Daniel Ratner, “Nanotechnology, A Gentle introduction to the next big idea”, Pearson Publication</li> <li>7. Charles P. <i>et al.</i>, “Introduction to Nanotechnology”, Willey Interscience, A John Willey &amp; Sons, INC., Publication.</li> <li>8. Sulbha Kulkarni, “Nanotechnology: Principles and Practices”.U. Satyanarayan, U Chakrapani “Biochemistry”, Books and allied Private LTD</li> <li>9. V. Sree Krishna, “Bioethics and Biosafety in Biotechnology”, New Age International Publishers.</li> <li>10. Richard D Dart, “Medical Toxicology”, 3rd Ed. Pippincott Williams &amp; Wilkins</li> <li>11. Ernest Hodgson, “A textbook of Modern Toxicology”, Willey Interscience, A John Willey &amp; Sons, INC., Publication.</li> <li>12. Hans-Joachim Jordening, Josef Winter, “Environmental Biotechnology: Concepts and applications”, Willey Interscience, A John Willey &amp; Sons, INC., Publication.</li> </ol> |  |
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| <b>Paper- DSE- BT 308-A- Applications of Biotechnology<br/>[Credits -3, Total Lectures-45]</b> |  |                 |
|--|--|-----------------|
| <b>Unit</b>  | <b>Content</b>   | <b>Lectures</b> |
| <b>I</b>   | <b>Genetic Engineering in Environment:</b> Microbial degradation of Xenobiotics, Genetic engineering of Biodegradative pathways (manipulation by transfer of plasmids- e.g. superbug and gene alteration- e.g. 4-ethylbenzoate), Phytoremediation- Engineering microbial strains that facilitate growth, Utilization of starch and sugars (Production of fructose and alcohol, Silage fermentation), Utilization of cellulose: components of lignocelluloses.  | <b>10</b>       |
| <b>II</b>  | <b>Genetic Engineering in Microbes:</b> Microbial biosynthesis of Rubber, Engineering <i>Xanthomonas</i> for Xanthan Gum production, Engineered Lactic Acid Bacteria for production of Interleukine-10 (against Ulcerative colitis and Crohn disease), Microbial insecticides - Engineering of <i>B. thuringiensis</i> Toxin Genes for Synthesis during Vegetative Growth.   | <b>10</b>       |
| <b>III</b>   | <b>Genetic Engineering in Plants:</b> Insect-resistant plants (e.g. <i>Bacillus thuringiensis</i> protoxin), Herbicide-resistant plants (e.g. glyphosate, dicamba), Development of salt stress tolerant plants (e.g. salt tolerant tobacco and <i>A. thaliana</i> ), Senescence - tolerant plants (fruit ripening and flower wilting- e.g. FlavrSavr), Modification of plant nutritional contents (Amino acids and Iron), Modification of food plant taste (Sweetness), plant as bioreactor for polymers, plants as edible vaccines. | <b>10</b>       |
| <b>IV</b>  | <b>Genetic Engineering in Animals:</b> Transgenic animals (transgenic mice model for Alzheimer disease), Transgenic livestock (e.g. for improved milk quality), <b>Nucleic acid as Therapeutic agents:</b> Antisense RNA, Antisense oligonucleotides, chimeric RNA-DNA molecules, Interfering RNA, Gene therapy for cystic fibrosis.   | <b>08</b>       |
| <b>V</b>   | <b>Genetic Engineering for Industrially important products:</b> increasing enzyme activity of Tyrosyl-tRNA synthetase, increasing enzyme stability and specificity of tissue plasminogen activator, altering multiple properties in subtilisin. Synthesis of Human Interferon and Growth hormone.  | <b>07</b>       |

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|  | <p><b>References:</b></p> <ol style="list-style-type: none"> <li>1. Molecular Biotechnology: Principles and Applications of Recombinant DNA, 3<sup>rd</sup> Edition, B.R.Glick and J.J. Pasternak, ASM Press (2007).</li> <li>2. An Introduction to Genetic Engineering, 2<sup>nd</sup> Edition, Desmond S.T. Nicholl, CambridgeUniversity Press (2006).</li> <li>3. Principles of Gene Manipulation and Genomics, 7<sup>th</sup> Edition, S.B. Primrose and R.M. Twyman,Blackwell Publishing (2006)</li> <li>Molecular Biotechnology, 2<sup>nd</sup> Edition, S.B. Primrose, Panima Publishing (2001).</li> <li>4.Introduction toBiotechnology, Low Price Edition, W.J. Thieman and M.A Palladino, Peaeson Education (2007).</li> <li>Genetic Engineering : Principles And Practice, SandhyaMitra, Macmillan India (1996).</li> <li>5.Genetic Engineering: Principles and Methods, Setlow J.K., Kluwer Academic Publishers. (2000).</li> <li>6.Genetic Engineering, Yount L., Gale Group (2002).</li> <li>7.Gene Cloning and DNA Analysis: An Introduction, 4<sup>th</sup> edition, Brown T. 8.A., Blackwell ScienceInc (2001).</li> <li>9. Recombinant DNA: Genes and Genomes - A Short Course, 3<sup>rd</sup> Edition, James D. Watson,James, Richard M. Myers,Amy A. Caudy, Jan A. Witkowski, W. H. Freeman (2006).</li> </ol> |  |

| <b>Paper- DSE- BT 308-B- Quality Standard Practices in Biotechnology<br/>[Credits -3, Total Lectures-45]</b> |   |                 |
|--|---|-----------------|
| <b>Unit</b>  | <b>Content</b>  | <b>Lectures</b> |
| <b>I</b>   | Drinking Water Quality: Definition, Purpose, Packaged drinking water-safety, health benefits, international standards, water for food production and processing, Occurrence of pathogens, Verification of microbial safety and quality, Methods of detection of fecal indicator bacteria, Treatment-achievability, Chlorination, Ozonation, Filtration, Aeration, Chemical coagulation, Activated carbon adsorption, Ion exchange, Membrane processes, Chemical hazards in drinking-water, Derivation of chemical guideline values, Approaches taken, Threshold chemicals, Non-threshold chemicals, Provisional guideline values. | <b>11</b>       |
| <b>II</b>  | Milk and Dairy products: Define-milk, desserts, ice cream butter, cheese, curd, Brief Introduction to NCIMS, PMO, DMO, SSCC, EML, MMSR, FDCA, Testing of Milk and Milk Products- SPC, DMC, Cryoscope, antibiotic screening test, PI-SPC, DMSCC, ADV, LPC, Thermoturic spore count, fat content, TSC.  | <b>11</b>       |
| <b>III</b>   | Food Safety: Good Hygienic Practices (GHP)-Objectives, Scope & Use, Key aspects of Hygiene Control systems etc., Food safety Management Systems- HACCP-seven principles, applications, HACCP based SOPs by USDA, Food Safety Management System- ISO 22000-Key elements of ISO 22000, What does ISO 22000 bring to the HACCP Method, Why to use ISO 22000, Quality Management System- ISO 9001- Introduction, Clauses, Documentation structure, Quality Manual, Mandatory Procedures, SOPs, Formats and Records etc.   | <b>10</b>       |
| <b>IV</b>  | Pharmaceutical products: WHO Good Manufacturing Practices GMP: Definition, Introduction, Sterile pharmaceutical products, Biological products, Investigational pharmaceutical products for clinical trials in humans, The manufacture of herbal medicines.  | <b>07</b>       |
| <b>V</b>   | Quality Control Procedures For Stem Cell Lines: Introduction, The Cell Banking Principle, Cell Characterization, Viability, Karyology, Identity Testing, Confirmation of Species of Origin, DNA Profiling for Cell-Specific Identification, Antibody Markers, Gene Expression, Pluripotency, Sterility, Mycoplasma Testing, Other Microbial Contaminants and Potential Biohazards, Quality Control of Culture Conditions, Reagents, and   | <b>06</b>       |

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|--|--|--|
|  | Media, Some Points for Consideration in the Use of Class II Biosafety.   |  |
|  | <p><b>References:</b></p> <ol style="list-style-type: none"> <li>1. Food safety and standards (food products standards and food additives) regulations, 2011</li> <li>2. Food safety and standards authority of India expert group on milk and milk products base working paper on strategy and action plan for ensuring safety of milk and milk Products prepared by national dairy development board Anand</li> <li>3. Applied dairy microbiology 2<sup>nd</sup> ed, Elmer H. Marth James L. Steele, Marcel Dekker, inc.</li> <li>4. Modern food microbiology 7<sup>th</sup> ed, Jay, Loessner and Golden, springer</li> <li>5. Training manual for food safety regulators, vol ii – food safety regulations &amp; food safety management 2010</li> <li>6. Quality assurance of pharmaceuticals a compendium of guidelines and related materials <i>volume 2, 2nd updated edition</i> good manufacturing practices and inspection, WHO</li> <li>7. Culture of human stem cells, R. Ian Freshney, Glyn N. Stacey, Jonathan M. Auerbach, Wiley-Interscience a John Wiley &amp; Sons, inc., publication</li> <li>8. <i>Indian standard</i> drinking water-specification (<i>second revision</i>) ics 13.060.20, © bis 2012 Bureau of Indian Standards</li> <li>9. Q7 good manufacturing practice guidance for active pharmaceutical ingredients guidance for industry, U.S. Department of Health and Human services, Food and Drug Administration, Center for Drug Evaluation and Research (CDER), Center for Biologics Evaluation and Research (CBER) September 2016 ICH Revision 1</li> <li>10. Quality control for the food industry (2017) -Amihud Kramer and Bernard Twigg, Volume II 3<sup>rd</sup> edition ,MEDTECH publishers.</li> </ol> |  |

**PRACTICAL ANNUAL**  
**Practical Course – VIII**

**Paper-Core-BT 301: Plant Development**

1. Study of style and stigma
2. Pollen germination in *In-situ* condition
3. Study of pollen viability by T.T.C. or Acetocarmine test
4. Collection of seed and storage of seeds for seed bank
5. Study of floral patterning in any suitable flower.
6. To study types of ovules (by permanent slides )
7. To study male gametophytes (by permanent slides)
8. Effect of heavy metals on mitosis and study of mitotic index.
9. Production of artificial seed.
10. Seed inoculation with rhizobia
11. Testing of nodulation ability by rhizobia
12. Qualitative Analysis of Nitrogen, Trepenoide, Phenolic containing secondary metabolites from plant extract.

**Paper-Core-BT 303: Tools and Techniques**

1. Isolation of genomic DNA from yeast and its quantification.
- 2 Isolation of Plasmid DNA from yeast/bacteria and its quantification.
- 3 Construction of restriction map of plasmid DNA
- 4 Calculation of molecular weight of digested DNA
- 5 DNA amplification by PCR
- 6 Preparation of single stranded DNA template

**Paper-Core-BT-305: Animal Development**

- 1 Study of different types of sperms by smear technique- Frog, Hen, Rat and Human
- 2 Sperm motility test
- 3 Study of different types of eggs - Insects, Amphioxus, Frog and Hens egg.
- 4 Study of Cleavage, Blastula and Gastrula –Frog and Hen (Slide/ICT)
- 5 Temporary / Permanent preparation of Chick embryos.
- 6 To estimate oxygen consumption in aquatic animal in relation to temperature.
- 7 Study Teratogenic effect on development of Frog / Chick embryo
- 8 Preparation of temporary slide to study histology by microtomy technique.
- 9 Study of histopathological permanent slides of different types of cancer
- 10 Study of dissection of Rat/Frog to observe reproductive system. (By ICT)

## Practical Course – IX

### **Paper-Core-BT-302: Fermentation Technology**

1. Introduction to laboratory Fermentor
2. Screening of Antibiotic producing microorganisms from soil by crowded plate technique
3. Biological assay of antibiotic by paper disc method
4. Production, recovery and assay of citric acid by *Aspergillus niger*.
5. Production, recovery and assay of amylase
6. Isolation of spoilage microorganisms from spoiled vegetables/fruits
7. Isolation of lipolytic microorganisms from butter.
8. Isolation of lactic acid bacteria from the curd sample.
9. Assay of growth factor (Vitamin)
10. Determination of thermal death time (TDT) of given bacterial culture
11. Determination of thermal death point (TDP) of given bacterial culture
12. Quantification of Vitamin C (ascorbic acid) in given food sample

### **Paper-Core- BT-306: Food and Dairy Technology**

1. Antibiotics screening test of milk
2. Direct microscopic somatic cell count (DMSCC) of milk
3. Determine Acid degree value (ADV) of milk
4. Determine Laboratory pasteurization count (LPC) of pasteurized milk
5. Study dead stock register for maintaining records of consumables
6. Determine colony forming units in lab using settle plate method
7. Determine the efficiency of autoclave using *B. subtilis* spore method
8. Determine the viability of animal cells using dye method
9. Enumeration of bacteria in milk by Standard Plate Count
10. Qualitative analysis of milk sample by Methylene Blue Reduction Time Test
11. Determination of efficiency of pasteurization of milk by alkaline phosphatase test.
12. Production of sauerkraut by microorganisms
13. Estimation of milk sugar by Benedict's method.

### **Paper- Core-BT-307:Bioinformatics and Nanotechnology**

1. Searching for literature at NCBI
2. Retrieving of gene sequence from GenBank
3. Retrieving of gene sequence through SRS
4. Performing sequence similarity by BLAST
5. Performing sequence similarity by FASTA
6. Determining phylogenetic tree from CLUSTALx

7. Synthesis of ZnO nanoparticles
8. Synthesis of Silver nanoparticles

### **Practical Course – X**

#### **Paper-DSE- BT 304-A: Recent Trends in Biotechnology**

1. Reporter gene assay ( $\beta$ - Gal)
2. Estimation of COD from water sample
3. Estimation of BOD from water sample
4. Isolation of lac mutants by replica plate technique
5. Estimation pesticides from soil/water/food samples
6. Liver function test- estimation of SGPT
7. Liver function test -estimation of SGOT

### **OR**

#### **Paper-DSE- BT 304-B: Introduction to Biotechnology based Industries**

1. Study dead stock register for maintaining records of consumables
2. Determine colony forming units in lab using settle plate method
3. Study Karyology of animal cells
4. Prepare SOPs for handling of laboratory instruments (any five)
5. Prepare safety notes for working in pharmaceutical laboratories
6. Determine the efficiency of autoclave using B. subtilis spore method
7. Determine the efficiency of laminar air flow
8. Determine the viability of animal cells using dye method
9. Study Visit to industrially/research interested areas are compulsory. A report of one of the visits is to be submitted at the time of practical examination. Precaution should be taken as per the guidelines of Higher education in safeguard of students at the time of excursion.

### **AND**

#### **Paper-DSE-BT-308-A: Applications of Biotechnology**

1. Restriction mapping of DNA
2. Ligation theory and ligation of DNA
3. Isolation of RNA from bacteria and its estimation.
4. Study of Southern blotting
5. Study of Northern blotting
6. Silver nitrate staining of DNA

### **OR**

#### **Paper-DSE-BT-308-B: Quality Standard Practices in Biotechnology**

1. MPN of packaged drinking water
2. Presumptive test for Fecal contamination of water
3. Confirmative test for Fecal Contamination of water (Using selective medium or elevated temp test)
4. Detection of food adulteration in wheat flour / milk and milk products
5. Perform to determine limit test of lead/chloride/iron/heavy metals/arsenic from

pharmaceutical products

6. Determine the concentration of chlorine in water and waste water
7. Sterility testing of injectables by different methods
8. Microscopic analysis of powdered crude drugs
9. Determination of Rhizobium/Azotobacter count in biofertilizer by using MPN technique
10. Determination of Minimum inhibitory concentration of antibiotic against testmicroorganism by tube-dilution technique.
11. Production of wine from any fruit.
12. Production of Bioinsecticides by using *B.thuringensis*
13. Study Visit to industrially/research interested areas are compulsory. A report of one of the visits is to be submitted at the time of practical examination. Precaution should be taken as per the guidelines of Higher education in safeguard of students at the time of excursion.

### **Practical Course – XI: Project Work**

The project report is to be prepared by the student on the subjects in consultation with the Project coordinator in the year. The project work is carried out in group of maximum 4-5 students or individually. The coordinator will guide the students in selecting the topic of the project, working of the experiments, results of the same and writing the report. The report shall be signed by the coordinator and shall be submitted to the University at the time of the University Practical examination of B.Sc. Part III. The student should visit any place of Biotechnological interest (Pharmaceutical industry, Dairy, Research institutes, Food processing industry, Botanical or Zoological place etc.) and submit the report of their visit at the time of practical examination in practical course No. XI: Project Work. The visit report should be duly certified by the Head of the Department. For this visit 10 marks are allotted in Practical Course No. XI: .Project Work.

**And**

Review article on any topic prepared by individual student in consultation with project guide will be submitted at the time of university practical examination whichever signed by project guide and head of the department. **(10 mark)**

**Or**

One national or international research publication in any one of the UGC approved journal **( 10 mark)**

**Note:**

1. Kindly note that during field visits students shall observe only animals and make record of the observations without disturbing natural habitat nor kill the animals. Students should be told about the importance of biodiversity and conservation;
2. Students are encouraged to prepare and submit a concise report of the excursion;
3. Report on multiple excursion tours may be clubbed for preparing and submitting report at the time of final examination will be allowed;



4. Reduce or avoid the use of plastic files during submission of reports / projects as a ecofriendly method.

### **EQUIVALENCE**

| <b>Paper</b> | <b>OLD CGPA</b>                   | <b>Sem</b> | <b>Paper</b> | <b>NEW CBCS</b>                   | <b>Sem</b> |
|--------------|-----------------------------------|------------|--------------|-----------------------------------|------------|
| 21           | Plant Development                 | <b>V</b>   | BT 301       | Plant Development                 | <b>V</b>   |
| 22           | Animal Development                | <b>V</b>   | BT 305       | Animal Development                | <b>VI</b>  |
| 23           | Bioinformatics and Nanotechnology | <b>V</b>   | BT 307       | Bioinformatics and Nanotechnology | <b>VI</b>  |
| 24           | Recent Trends in Biotechnology    | <b>V</b>   | BT 304-A     | Recent Trends in Biotechnology    | <b>V</b>   |
| 25           | Tools and Techniques              | <b>VI</b>  | BT 303       | Tools and Techniques              | <b>V</b>   |
| 26           | Applications                      | <b>VI</b>  | BT 308-A     | Applications of Biotechnology     | <b>VI</b>  |
| 27           | Fermentation Technology           | <b>VI</b>  | BT 302       | Fermentation Technology           | <b>V</b>   |
| 28           | Food and Dairy Technology         | <b>VI</b>  | BT 306       | Food and Dairy Technology         | <b>VI</b>  |