



### **CRITERIA 1.1.3**

Different UG And PG Programme, Sample of Courses With Highlight On Ethics / Gender / Human Values / Environment And Sustainability Aspects Is Presented.

### **Programme: B.Sc Biotechnology**

1. ETHICS



2. GENDER



3. HUMAN VALUES



4. ENVIRONMENT AND SUSTAINIBILITY



**Program outcomes, Program specific  
outcomes and Course outcomes**

**For**  
**B.Sc. Biotechnology Syllabus**  
**(2022 onwards)**



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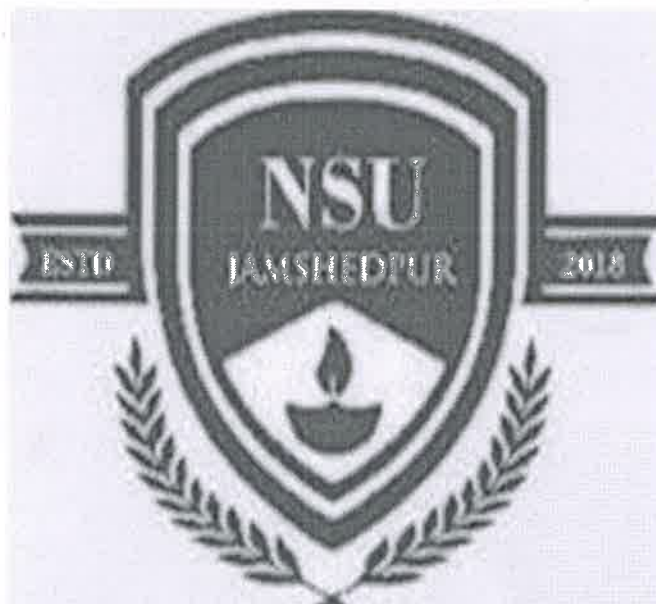
Head  
Department of Bio-Technology  
Netaji Subhas University

**School of Biotechnology**  
**Netaji Subhas University**

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Dean Academics  
Netaji Subhas University  
Jamshedpur, Jharkhand

**NETAJI SUBHAS UNIVERSITY**

**JAMSHEDPUR**



**B.SC BIOTECHNOLOGY**

**SYLLABUS**

**2022 ONWARDS**





**NETAJISUBHASUNIVERSITY**  
**DEPARTMENT OF BIOTECHNOLOGY**

**Vision:** Provide in graduates equipped with excellent the critical knowledge and practical skills and promoting scientific research and community service.

**Mission**

To provide students a unique and multidisciplinary learning experience that will foster the young minds to develop as a researcher, entrepreneur etc. •

To enhance academic and industrial collaborative research initiatives for the development of biotechnological, food and therapeutic products.

- To emphasize an equip the students towards innovative industrial and research updates.
- To serve the society with out most commitment, integrity, enthusiasm, and dedication.



## Programme Outcome:POs

|       |                                                                                                                                                                                                                                                      |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| PO-1  | Understand and inculcate the ability to apply, update, extend and to develop deep knowledge through flexible, research intensive programed signed to meet the current demand of academia and industry.                                               |
| PO-2: | Demonstrate professional integrity and ethical attitude with awareness of global and national competencies and think about the social entailment of their work, especially its impact on safety, health and environment for sustainable development. |
| PO-3  | Apply the acquired practical skills and broad biotechnological training in product, process and inculcate leadership qualities for innovative entrepreneurship to meet the societal demands.                                                         |
| PO-4  | Ability to design and conduct experiments, as well as to analyze and interpret scientific data.                                                                                                                                                      |
| PO-5  | Awareness of contemporary issues that can be mitigated or supported through life science knowhow and biotechnology skills.                                                                                                                           |
| PO-6  | Equipped with laboratory skills in biotechnology.                                                                                                                                                                                                    |
| PO-7  | Ability to integrate technologies through an inter-disciplinary learning habit.                                                                                                                                                                      |
| PO-8  | Demonstrate an independent thinking ability.<br>Ability to communicate effectively.                                                                                                                                                                  |



## Programme Specific Outcome-PSOs

**PSO-1** To teach the application of biotechnology skills in core and related fields, such as molecular and microbiology, immunology and genetic engineering, fermentation and bioprocess, enzyme and food technology, and bioinformatics.

**PSO-2:** To foster students' scientific curiosity and give them the ideas and research methodologies they need for a future in biotechnology.

**PSO-3:** To meet industry and academic demands by providing students with comprehensive, practical oriented knowledge in a variety of biotechnology thrust areas.

**PSO4:** To demonstrate proficiency in applying technical concepts to biological systems by demonstrating a working knowledge of advanced biological sciences.

**PSO5:** In order to solve biotechnological challenges, one must be adept at using sophisticated biological concepts and methods.

**PSO6:** Researching complicated issues in biotechnology and related fields by designing, executing, analyzing, and interpreting data.

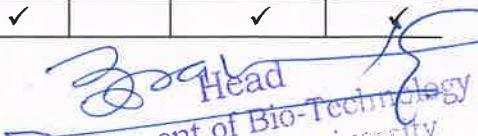




| Semester | Course Code | Name of Course                                     | PE<br>(Professional ethics) | G<br>(Gender) | HV<br>(human value) | ES<br>(environmental sustainability) |
|----------|-------------|----------------------------------------------------|-----------------------------|---------------|---------------------|--------------------------------------|
| I        | BSC101      | Biotechnology-I (Cell biology)                     |                             |               | ✓                   | ✓                                    |
|          | BSC102      | Pharma Chemistry-I<br>OR<br>Computer Science-I     | ✓                           |               |                     | ✓                                    |
|          | BSC 103     | Animal Physiology                                  |                             |               | ✓                   | ✓                                    |
|          | BSC104      | Communicative English                              | ✓                           |               | ✓                   | ✓                                    |
|          |             |                                                    |                             |               |                     |                                      |
| II       | BSC 201     | Biotechnology-II(Micro biology)                    |                             |               | ✓                   | ✓                                    |
|          | BSC 202     | Pharma Chemistry-II<br>OR<br>Computer Science-II   |                             |               |                     | ✓                                    |
|          | BSC 203     | Plant Physiology                                   |                             |               | ✓                   | ✓                                    |
|          | BSC 204     | English Language-II                                | ✓                           |               |                     |                                      |
|          |             |                                                    |                             |               |                     |                                      |
| III      | BSC 301     | Biotechnology-III(Biophysics and biochemistry )    |                             |               |                     | ✓                                    |
|          | BSC 302     | Pharma Chemistry-III<br>OR<br>Computer Science-III | ✓                           |               | ✓                   | ✓                                    |
|          | BSC 303     | Environmental Studies-I                            | ✓                           |               | ✓                   | ✓                                    |
|          | BSC 304     | Entrepreneurship Development-I                     | ✓                           |               | ✓                   |                                      |
|          |             |                                                    |                             |               |                     |                                      |
| IV       | BSC 401     | Biotechnology-IV(bioinstrumentation)               |                             |               | ✓                   | ✓                                    |
|          | BSC 402     | Pharma Chemistry-IV<br>OR<br>Computer Science-IV   | ✓                           |               | ✓                   | ✓                                    |
|          | BSC403      | Environmental Studies-II                           | ✓                           |               | ✓                   | ✓                                    |
|          | BSC 404     | Entrepreneurship Development-II                    | ✓                           |               | ✓                   | ✓                                    |
|          |             |                                                    |                             |               |                     |                                      |
| V        | BSC 501     | Biotechnology-V(genetic engineering)               |                             |               | ✓                   | ✓                                    |
|          | BSC 502     | Pharma Chemistry-V                                 | ✓                           |               | ✓                   | ✓                                    |

  
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**Head**  
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|    |         |                                                           |   |  |   |   |
|----|---------|-----------------------------------------------------------|---|--|---|---|
|    |         | OR<br>Computer Science-V                                  |   |  |   |   |
|    | BSC 503 | Biotechnology Forensics Science                           | ✓ |  | ✓ | ✓ |
|    | BSC504  | Intellectual property rights (IPR)                        | ✓ |  | ✓ | ✓ |
|    |         |                                                           |   |  |   |   |
| VI | BSC 601 | Biotechnology-VI(applied<br>biotechnology)                |   |  |   | ✓ |
|    | BSC 602 | Pharma Chemistry-VI OR<br>Computer Science-VI             | ✓ |  | ✓ | ✓ |
|    | BSC603  | Project(Biotechnology)                                    | ✓ |  | ✓ | ✓ |
|    | BSC604  | Project(Pharma Chemistry) OR<br>Project(Computer Science) | ✓ |  | ✓ | ✓ |
|    |         |                                                           |   |  |   |   |

*Shome*  
**Dean Academics**  
 Netaji Subhas University  
 Ranchi, Jharkhand



*[Signature]*  
**Head**  
 Department of Bio-Technology  
 Netaji Subhas University



## **NetajiSubhasUniversity**

### **Syllabusfor3-YearsB.Sc.(Honours)Biotechnology**

#### **SEMESTER I**

| S.No | Code    | Subject                                                   | Credit    | ExaminationMarksDetail |               |           |            |
|------|---------|-----------------------------------------------------------|-----------|------------------------|---------------|-----------|------------|
|      |         |                                                           |           | External Exam          | Internal Exam | Practical | Total      |
| 1    | BSC101  | Biotechnology-I                                           | 4         | 40                     | 10            | -         | 50         |
| 2    | BSC102  | PharmaChemistry-I<br>OR<br>ComputerScience-I              | 4         | 40                     | 10            | -         | 50         |
| 3    | BSC103  | AnimalPhysiology                                          | 4         | 40                     | 10            | -         | 50         |
| 4    | BSC101P | Biotechnology-I<br>Practical                              | 2         | -                      | -             | 50        | 50         |
| 5    | BSC102P | Pharma chemistryI<br>OR<br>Computerscience-I<br>Practical | 2         | -                      | -             | 50        | 50         |
| 6    | BSC103P | AnimalPhysiology<br>Practical                             | 2         | -                      | -             | 50        | 50         |
| 7    | BSC104  | EnglishLanguage-I                                         | 4         | 40                     | 10            | -         | 50         |
|      |         | <b>Total</b>                                              | <b>22</b> |                        |               |           | <b>350</b> |





## **NetajiSubhasUniversity**

### **Syllabusfor3-YearsB.Sc.(Honours)Biotechnology**

#### **Semester-II**

| S.No | Code    | Subject                                                     | Credit    | ExaminationMarksDetail |               |           |            |
|------|---------|-------------------------------------------------------------|-----------|------------------------|---------------|-----------|------------|
|      |         |                                                             |           | External Exam          | Internal Exam | Practical | Total      |
| 1    | BSC201  | Biotechnology-II                                            | 4         | 40                     | 10            | -         | 50         |
| 2    | BSC202  | PharmaChemistry-II<br>OR<br>ComputerScience-II              | 4         | 40                     | 10            | -         | 50         |
| 3    | BSC203  | PlantPhysiology                                             | 4         | 40                     | 10            | -         | 50         |
| 4    | BSC201P | BiotechnologyII<br>Practical                                | 2         | -                      | -             | 50        | 50         |
| 5    | BSC202P | PharmaChemistry-II<br>OR<br>ComputerScience-II<br>Practical | 2         | -                      | -             | 50        | 50         |
| 6    | BSC203P | PlantPhysiologyPractical                                    | 2         | -                      | -             | 50        | 50         |
|      | BSC204  | EnglishLanguage-II                                          | 4         | 40                     | 10            | -         | 50         |
|      |         | <b>Total</b>                                                | <b>22</b> |                        |               |           | <b>350</b> |





## Netaji Subhas University

### Syllabus for 3-Years B.Sc. (Honours) Biotechnology

#### SEMESTER III

| S.No. | Code    | Subject                                                         | Credit    | Examination Marks Detail |               |           |            |
|-------|---------|-----------------------------------------------------------------|-----------|--------------------------|---------------|-----------|------------|
|       |         |                                                                 |           | External Exam            | Internal Exam | Practical | Total      |
| 1     | BSC301  | Biotechnology-III                                               | 4         | 40                       | 10            |           | 50         |
| 2     | BSC302  | Pharma Chemistry-III<br>OR<br>Computer Science-III              | 4         | 40                       | 10            |           | 50         |
| 3     | BSC303  | Environmental Studies-I                                         | 4         | 40                       | 10            | -         | 50         |
| 4     | BSC304  | Entrepreneurship<br>Development-I                               | 4         | 40                       | 10            | -         | 50         |
| 5     | BSC301P | Biotechnology-III<br>Practical                                  | 2         | -                        | -             | 50        | 50         |
| 6     | BSC302P | Pharma Chemistry-III<br>OR<br>Computer Science-III<br>Practical | 2         | -                        | -             | 50        | 50         |
|       |         | <b>Total</b>                                                    | <b>20</b> |                          |               |           | <b>300</b> |





## **Netaji Subhas University**

### **Syllabus for 3-Years B.Sc. (Honours) Biotechnology**

#### **SEMESTER IV**

| S.No | Code    | Subject                                                       | Credit    | Examination Marks Detail |               |           |            |
|------|---------|---------------------------------------------------------------|-----------|--------------------------|---------------|-----------|------------|
|      |         |                                                               |           | External Exam            | Internal Exam | Practical | Total      |
| 1    | BSC401  | Biotechnology-IV                                              | 4         | 40                       | 10            |           | 50         |
| 2    | BSC402  | Pharma Chemistry-IV<br>OR<br>Computer Science-IV              | 4         | 40                       | 10            |           | 50         |
| 3    | BSC403  | Environmental Studies-II                                      | 4         | 40                       | 10            | -         | 50         |
| 4    | BSC404  | Entrepreneurship<br>Development-II                            | 4         | 40                       | 10            | -         | 50         |
| 5    | BSC401P | Biotechnology-IV Practical                                    | 2         | -                        | -             | 50        | 50         |
| 6    | BSC402P | Pharma Chemistry-IV<br>OR<br>Computer Science-IV<br>Practical | 2         | -                        | -             | 50        | 50         |
|      |         | <b>Total</b>                                                  | <b>20</b> |                          |               |           | <b>300</b> |





## **NetajiSubhasUniversity**

### **Syllabusfor3-YearsB.Sc.(Honours)Biotechnology**

#### **SEMESTERV**

| S.No. | Code    | Subject                                                  | Credit    | ExaminationMarksDetail |               |           |            |
|-------|---------|----------------------------------------------------------|-----------|------------------------|---------------|-----------|------------|
|       |         |                                                          |           | External Exam          | Internal Exam | Practical | Total      |
| 1     | BSC501  | Biotechnology-V                                          | 4         | 40                     | 10            | -         | 50         |
| 2     | BSC502  | PharmaChemistry-V<br>OR<br>ComputerScience-V             | 4         | 40                     | 10            | -         | 50         |
| 3     | BSC503  | BiotechnologyForensics<br>Science                        | 4         | 40                     | 10            | -         | 50         |
| 4     | BSC504  | Intellectualproperty<br>rights (IPR)                     | 4         | 40                     | 10            | -         | 50         |
| 5     | BSC501P | Biotechnology-V<br>Practical                             | 2         |                        |               | 50        | 50         |
| 6     | BSC502P | PharmaChemistry-V<br>OR<br>ComputerScienceV<br>Practical | 2         |                        |               | 50        | 50         |
|       |         | <b>Total</b>                                             | <b>20</b> |                        |               |           | <b>300</b> |





## NetajiSubhasUniversity

### Syllabus for 3-Years B.Sc. (Honours) Biotechnology

#### Semester-VI

| S.No. | Code    | Subject                                                     | Credit    | Examination Marks Detail |               |           |            |
|-------|---------|-------------------------------------------------------------|-----------|--------------------------|---------------|-----------|------------|
|       |         |                                                             |           | External Exam            | Internal Exam | Practical | Total      |
| 1     | BSC601  | Biotechnology-VI                                            | 4         | 40                       | 10            | -         | 50         |
| 2     | BSC602  | PharmaChemistry-VI<br>OR<br>ComputerScience-VI              | 4         | 40                       | 10            | -         | 50         |
| 3     | BSC603  | Project(Biotechnology)                                      | 10        | -                        | -             | -         | 100        |
| 4     | BSC604  | Project(PharmaChemistry)<br>OR<br>Project(ComputerScience)  | 10        | -                        | -             | -         | 100        |
| 5     | BSC601P | Biotechnology-VI Practical                                  | 2         | -                        | -             | 50        | 50         |
| 6     | BSC602P | PharmaChemistry-VI<br>OR<br>ComputerScience-VI<br>Practical | 2         | -                        | -             | 50        | 50         |
|       |         | <b>Total</b>                                                | <b>32</b> |                          |               |           | <b>400</b> |







## **B.SC BIOTECHNOLOGY**

### **Course Outcomes Of BSC 101 Cell Biology**

Upon successful completion of the **Cell Biology** course, students will be able to:

1. *Explain Cell Structure and Function*
  - Identify and describe the differences between prokaryotic and eukaryotic cells, their organelles, and their specific functions.
2. *Understand Molecular Composition of Cells*
  - Demonstrate knowledge of biomolecules (proteins, lipids, carbohydrates, and nucleic acids) and their roles in cellular activities.
3. *Analyze Cellular Processes and Metabolism*
  - Explain membrane transport mechanisms, enzyme functions, energy metabolism (cellular respiration, photosynthesis), and homeostasis.
4. *Comprehend Genetic and Molecular Basis of Life*
  - Describe DNA replication, gene expression, transcription, and translation, and understand their regulation.
5. *Understand Cell Cycle and Division*
  - Explain the stages of the cell cycle, mitosis, meiosis, and apoptosis, and their significance in growth and development.

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### **Course Outcomes of BSC103 Animal Physiology**

Upon successful completion of the **Animal Physiology** course, students will be able to:



1. *Explain the Principles of Animal Physiology*
  - Describe the fundamental physiological processes that regulate homeostasis and maintain life functions in animals.
2. *Understand Organ System Functions*
  - Identify and explain the structure and function of major organ systems, including circulatory, respiratory, digestive, excretory, nervous, endocrine, and reproductive systems.
3. *Analyze Neurophysiological and Endocrine Mechanisms*
  - Explain how the nervous and endocrine systems coordinate body functions through neural signaling and hormonal regulation.
  -
4. *Describe Energy Metabolism and Nutrient Utilization*
  - Understand metabolic pathways, thermoregulation, and the physiological mechanisms of digestion and absorption.
5. *Explain Circulatory and Respiratory Processes*
  - Analyze the transport of gases, blood circulation, and adaptations of the cardiovascular and respiratory systems to different environments.
6. *Understand Muscle Physiology and Movement*
  - Describe the mechanisms of muscle contraction, biomechanics, and the role of the skeletal and muscular systems in locomotion.

## **Course Outcomes of**

### **Microbiology**

Upon successful completion of the **Microbiology** course, students will be able to:

1. *Explain the Fundamentals of Microbiology*
  - Describe the history, scope, and significance of microbiology in various fields, including medicine, industry, and environmental sciences.
2. *Classify and Characterize Microorganisms*
  - Identify and differentiate between major microbial groups such as bacteria, viruses, fungi, protozoa, and algae based on their structure, function, and classification.
3. *Understand Microbial Structure and Physiology*
  - Explain the cellular organization, morphology, growth requirements, and metabolic pathways of different microorganisms.
4. *Demonstrate Knowledge of Microbial Growth and Control*
  - Apply knowledge of microbial growth kinetics, culture methods, sterilization, and disinfection techniques in laboratory and industrial settings.



### 5. *Analyze Microbial Metabolism and Genetics*

- Understand microbial enzymatic processes, metabolic pathways, gene expression, mutations, and genetic engineering applications.

## Course Outcomes of **Biostatistics and Bioinformatics**

Upon successful completion of the **Biostatistics and Bioinformatics** course, students will be able to:

### Biostatistics Outcomes:

1. *Understand and Apply Basic Statistical Concepts*
  - Explain key statistical principles and their relevance in biological and medical research.
2. *Perform Data Collection and Experimental Design*
  - Design experiments, collect biological data, and apply appropriate statistical methods for analysis.
3. *Apply Descriptive and Inferential Statistical Methods*
  - Use measures of central tendency, variability, probability distributions, hypothesis testing, and confidence intervals in biological studies.
  - Conduct correlation and regression analysis to study relationships in biological datasets.

### Bioinformatics Outcomes:

1. *Understand the Fundamentals of Bioinformatics*
  - Explain the importance of computational tools in genomics, proteomics, and systems biology.
2. *Use Biological Databases for Sequence Analysis*
  - Retrieve and analyze genetic and protein sequences using databases such as GenBank, UniProt, and EMBL.
3. *Perform Sequence Alignment and Phylogenetic Analysis*
  - Apply bioinformatics tools like BLAST, ClustalW, and MEGA for molecular sequence comparisons.
4. *Analyze Genomic and Proteomic Data Using Computational Tools*
  - Use software for gene prediction, protein structure modeling, and



functional annotation.

### Course Outcomes of

#### Environmental Science (EVS)

Upon successful completion of the **Environmental Science** course, students will be able to:

1. *Understand the Fundamentals of Environmental Science*
  - Explain key environmental concepts, ecosystems, and the importance of biodiversity conservation.
2. *Analyze Natural Resources and Their Sustainable Use*
  - Assess the utilization and conservation of resources like air, water, soil, forests, and minerals.
3. *Identify and Evaluate Environmental Pollution*
  - Recognize sources, impacts, and control measures for air, water, soil, and noise pollution.
4. *Assess Climate Change and Global Environmental Issues*
  - Understand the causes and consequences of global warming, ozone depletion, and deforestation.
5. *Apply Waste Management and Sustainable Practices*
  - Implement techniques such as recycling, composting, and waste treatment for environmental sustainability

### Course Outcomes of

#### Entrepreneurship

Upon successful completion of the **Entrepreneurship** course, students will be able to:

1. *Demonstrate an Understanding of Entrepreneurship Concepts*
  - Explain the role of entrepreneurship in economic growth and business development.
2. *Develop an Entrepreneurial Mindset*
  - Apply creativity, innovation, risk-taking, and problem-solving skills in business decision-making.
3. *Identify and Evaluate Business Opportunities*
  - Conduct market research and feasibility analysis to identify potential business ventures.
4. *Create a Business Plan and Strategy*
  - Develop a structured business plan, including financial projections, marketing strategies, and operational plans.



5. *Understand Financial and Funding Aspects*

- Identify sources of funding, manage financial resources, and create effective financial strategies for startups.

Course Outcomes of

**Molecular Biology**

Upon successful completion of the **Molecular Biology** course, students will be able to:

1. *Understand the Structure and Function of Biomolecules*
  - Explain the roles of DNA, RNA, and proteins in cellular and molecular processes.
2. *Analyze DNA Replication, Repair, and Recombination Mechanisms*
  - Describe the molecular mechanisms of DNA synthesis, mutation repair, and genetic recombination.
3. *Explain Gene Expression and Regulation*
  - Understand transcription, translation, and regulatory pathways controlling gene expression in prokaryotic and eukaryotic cells.
4. *Explore Molecular Mechanisms of Genetic Control*
  - Analyze epigenetic modifications, operon systems, and gene silencing mechanisms.
5. *Understand Protein Synthesis and Post-Translational Modifications*
  - Describe the function of ribosomes, tRNA, chaperones, and protein-folding pathways.

Course Outcomes of

**Forensic Science**

Upon successful completion of the **Forensic Science** course, students will be able to:

1. *Demonstrate an Understanding of Forensic Science Principles*
  - Explain the role, history, and significance of forensic science in criminal investigations and the legal system.
2. *Apply Crime Scene Investigation Techniques*
  - Utilize proper methods for crime scene documentation, evidence collection, and preservation.



3. *Analyze Physical and Biological Evidence*
  - Identify and interpret fingerprints, bloodstains, DNA, hair, and fiber evidence using forensic techniques.
4. *Examine Forensic Toxicology and Drug Analysis*
  - Detect and analyze drugs, poisons, and toxins in biological samples.
5. *Utilize DNA Profiling for Identification*
  - Apply molecular biology techniques such as PCR and STR analysis for forensic identification.

Course Outcomes of

### **Intellectual Property Rights (IPR)**

Upon successful completion of the **Intellectual Property Rights (IPR)** course, students will be able to:

1. *Demonstrate an Understanding of Intellectual Property (IP) Concepts*
  - Explain the significance of IPR in protecting innovations, creativity, and business assets.
2. *Differentiate Various Types of Intellectual Property*
  - Identify and describe patents, copyrights, trademarks, trade secrets, geographical indications, and industrial designs.
3. *Apply Patent Laws and Filing Procedures*
  - Understand the process of patent filing, examination, grant, and maintenance at national and international levels.
4. *Analyze Copyright Protection and Fair Use Policies*
  - Explain the legal aspects of copyright protection in literary, artistic, and digital works.
5. *Understand Trademark Laws and Brand Protection Strategies*
  - Evaluate the importance of trademarks and their role in brand identity and business growth.

Course Outcomes of

### **Applied Biotechnology**

Upon successful completion of the **Applied Biotechnology** course, students will be able to:



1. *Demonstrate an Understanding of Biotechnology Principles*
  - Explain the fundamental concepts and applications of biotechnology in various fields.
2. *Apply Genetic Engineering and Recombinant DNA Technology*
  - Utilize gene cloning, vector systems, and genome editing techniques like CRISPR for biotechnological advancements.
3. *Analyze the Role of Biotechnology in Healthcare*
  - Evaluate the development and application of biopharmaceuticals, vaccines, gene therapy, and molecular diagnostics.
4. *Utilize Biotechnology for Agricultural Improvement*
  - Explain the benefits of genetically modified organisms (GMOs), biofertilizers, and pest-resistant crops.
5. *Implement Industrial Biotechnology and Bioprocessing Techniques*
  - Apply fermentation, enzyme engineering, and biomanufacturing techniques for industrial applications.

Head  
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# **BSC-101–BIOTECHNOLOGY-I**

## **CELLSTRUCTURE&BIOLOGY**

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**MAX.MARKS:40+10**

**No.ofLecturesperWeek:02Hours**

**TOTALLECTURES:32**

**TheQuestionPaperwillcontainquestionsequallydistributedinallUnits.TheInternalChoice will be given in all Questions.**

ThecourseobjectivesofCellBiology

1. Understanding CellStructure&Function
  - Learnabout prokaryoticandeukaryoticcells,theirorganelles, andtheirspecificfunctions.
2. MolecularCompositionofCells
  - Studythebiomolecules(proteins,lipids,carbohydrates,andnucleicacids)that makeupthecell and their roles.
3. CellularProcesses&Metabolism
  - Explorecellsignaling,membranetransport,energyproduction(cellularrespiration, photosynthesis), and enzyme functions.
4. GeneticandMolecular BasisofLife
  - UnderstandDNAreplication,transcription,translation,andgeneexpressionregulation.
5. CellCycle&Division
  - Learnaboutmitosis,meiosis,andthe mechanismsthatregulatecellproliferationandapoptosis.

|                                                                                                                                                                                                                                                                                                                                                   |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b><u>Unit-I</u></b>                                                                                                                                                                                                                                                                                                                              |
| Cell Structure & Theory, Structure of prokaryotic cell, Eubacteria and Archaeobacteria. Size, shape and arrangement of bacterial cells. Gram's positive and Gram's negative cells. Structure of Eukaryotic cell, plant cells, animal cells. Difference between prokaryotic and eukaryotic cells.                                                  |
| <b><u>Unit-II</u></b>                                                                                                                                                                                                                                                                                                                             |
| Structure and function of bacterial cell — flagella, pill, Cell wall, cytoplasmic membrane, nuclear region, mesosomes, ribosomes, vacuoles.<br><br>Structure and function of eukaryotic cell — Cell wall, cell membrane, mitochondria, chloroplast, endoplasmic reticulum, Golgi bodies, nucleus, cytoskeleton, microbodies, Centriole, Lysosome. |
| <b><u>Unit-III</u></b>                                                                                                                                                                                                                                                                                                                            |
| Cell cycle and cell division—mitosis, meiosis. Anomalies in cell division and associated diseases. Cell synchrony, Cell-cell interactions.                                                                                                                                                                                                        |
| <b><u>Unit-IV</u></b>                                                                                                                                                                                                                                                                                                                             |
| <b>Transport Process:</b> Cell Membrane: Models of membrane structure, Membrane proteins and their properties, Membrane carbohydrates and their roles. Transport across membranes—active and passive diffusion, mechanisms.                                                                                                                       |
| <b><u>Unit-V</u></b>                                                                                                                                                                                                                                                                                                                              |
| Introduction to Necrosis, Senescence, Apoptosis—Programmed cell death. Mechanism of Apoptosis, Intrinsic & Extrinsic pathways of cell death, Apoptosis in relation to Cancer, Oncogenes — Types of cancer.                                                                                                                                        |

#### BOOKS:

1. Molecular Biology of the cell, 2002: Albert's et al
2. The cell: A molecular approach: J.M. Cooper
3. Cell biology: P.S. Verma and V.K. Agarwal
4. Cell and Molecular Biology: P.K. Gupta
5. Experiments in Biotechnology: Nigohjkar and Nigohjkar
6. A practical book of Molecular Biology and Immunology; 2017: P.K. Singh et al

# BIOTECHNOLOGY-IPRACTICALS

MAX.MARKS:50

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## No.ofLaboratoryperWeek:06Hours

1. Tostudytheplantcellstructureusingvariousplantmaterials.
2. TostudymicrobialcellbyMonochromestainsandGramstaining.
3. Toprepareandstudythedifferentstagesofmitosisandmeiosis.
4. Prepareslideforstudyofstomata.
5. Studyofpermanentslideslikecelldivision,prokaryoticandeukaryoticcells,Musclesand Nerve cells, T.S. ofstomata.
6. Tostudytheanimalcellstructureusingcheekcells.
7. Histochemicallocalizationofflagellin.
8. Viablecellcountingusinghaematocytometer.
9. Measurementofcellbylightmicroscope:-Calibrationofocularmicrometer,findingout average cellsize
10. SeparationofcelltypesfrombloodbyTLC/differentialcounting.
11. Methodsofcelllysis:ruptureosmotic/chemical/enzymatic.

## CourseOutcomesofCellBiology

Uponsuccessfulcompletionofthe**CellBiology**course,studentswill beableto:

1. **ExplainCellStructureand Function**
  - Identifyanddescribethedifferencesbetweenprokaryoticandeukaryoticcells,theirorganelles,andtheir specific functions.
2. **UnderstandMolecularComposition ofCells**
  - Demonstrateknowledgeofbiomolecules(proteins,lipids,carbohydrates,andnucleicacids)andtheirroles in cellular activities.
3. **AnalyzeCellularProcessesandMetabolism**
  - Explainmembranetransportmechanisms,enzymefunctions,energymetabolism(cellularrespiration, photosynthesis), and homeostasis.
4. **Comprehend GeneticandMolecularBasisofLife**
  - DescribeDNAreplication,geneexpression,transcription,andtranslation,andunderstandtheirregulation.
5. **UnderstandCellCycle andDivision**
  - Explainthestagesofthecellcycle, mitosis, meiosis, andapoptosis, andtheir significanceingrowthand development.

[illegible]

# BSC-102–ANIMALPHYSIOLOGY

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**MAX.MARKS:40+10**

**No.ofLecturesperWeek:02Hours**

**TheQuestionPaperwillcontainquestionsequallydistributedinallUnits.TheInternalChoicewill be given in all Questions.**

## **CourseObjectivesofAnimalPhysiology**

The**AnimalPhysiology**courseaimstoprovidestudentswithafundamentalunderstandingofthephysiological processes that regulate and maintain life in animals. The key objectives include:

1. **UnderstandtheFundamentalPrinciplesofAnimalPhysiology**
  - Learnthebasicconceptsofhomeostasis,biologicalregulation, andphysiologicaladaptationsindifferent animal species.
2. **ExploretheStructureandFunctionofOrganSystems**
  - Studytheanatomyandphysiologyofmajor organsystems,includingcirculatory,respiratory, digestive, excretory, nervous, endocrine, and reproductive systems.
3. **AnalyzeNeurophysiologyandEndocrineRegulation**
  - Understandthefunctionsofthenervoussystem,signaltransmission, andhormonalcontrolmechanismsin animals.
4. **ComprehendEnergyMetabolismandNutrientUtilization**
  - Learnhowanimalsgenerateandutilizeenergy,includingmetabolicpathways, thermoregulation, and nutrient absorption.
5. **ExamineCirculatoryandRespiratorySystems**
  - Studythemechanismsofoxygentransport,bloodcirculation, gasexchange, andadaptationstodifferent environmental conditions.

|                                                                                                                                                                                                    |                          |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| <b><u>Unit-I</u></b>                                                                                                                                                                               | <b><u>12Lectures</u></b> |
| <b>Digestion</b><br>Digestion: Definition and types (extra and intracellular digestion); Digestion, absorption and assimilation of Carbohydrates.                                                  |                          |
| <b><u>Unit-II</u></b>                                                                                                                                                                              | <b><u>12Lectures</u></b> |
| <b>Respiration</b><br>Definition of Respiration and Respiratory mechanisms – External, Internal and cellular. Respiratory Pigments; Transport of oxygen, Oxygen dissociation curves. Bohr's effect |                          |
| <b><u>Unit-III</u></b>                                                                                                                                                                             | <b><u>14Lectures</u></b> |
| <b>Circulation:</b><br>Types of circulation – Open and Closed circulation; Blood and its types and function                                                                                        |                          |
| <b><u>Unit-IV</u></b>                                                                                                                                                                              | <b><u>12Lectures</u></b> |
| <b>Excretion</b><br>Definition; Classification (Ammonotelic, Uricotelic, Ureotelic), Structure and function of Nephron                                                                             |                          |
| <b><u>Unit-V</u></b>                                                                                                                                                                               | <b><u>14Lectures</u></b> |
| <b>Endocrine System</b><br>Endocrine glands – Structure, secretions and functions of Pituitary, Thyroid, Parathyroid, Adrenal glands and Pancreas                                                  |                          |

#### BOOKS:

1. Hughes, G.M. Comparative Physiology of vertebrate respiration (1963) Cambridge.
2. Guyton and Hall (2001) textbook of medical physiology.
3. Schmidt–Neilson, K (2002) Animal physiology, Adaptation and environment
4. Cell and Molecular Biology: P.K. Gupta
5. Webster, R. Neurotransmitters, drugs and brain function.
6. A practical book of Molecular Biology and Immunology; 2017: P.K. Singh et al

## BIOTECHNOLOGY-IPRACTICALS

**MAX.MARKS:50**

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**No.ofLaboratoryperWeek:06Hours**

1. Qualitative tests for identification of carbohydrates.
2. Qualitative tests for identification of proteins
3. Qualitative tests for identification of lipids
4. Qualitative tests for identification of ammonia.
5. Qualitative tests for identification of urea
6. Estimation of Haemoglobin by Sahl's method.
7. Estimation of total protein by Lowry's method
8. Blood Test

### Course Outcomes of Animal Physiology

Upon successful completion of the **Animal Physiology** course, students will be able to:

1. **Explain the Principles of Animal Physiology**
  - Describe the fundamental physiological processes that regulate homeostasis and maintain life functions in animals.
2. **Understand Organ System Functions**
  - Identify and explain the structure and function of major organ systems, including circulatory, respiratory, digestive, excretory, nervous, endocrine, and reproductive systems.
3. **Analyze Neurophysiological and Endocrine Mechanisms**
  - Explain how the nervous and endocrine systems coordinate body functions through neural signaling and hormonal regulation.
  -
4. **Describe Energy Metabolism and Nutrient Utilization**
  - Understand metabolic pathways, thermoregulation, and the physiological mechanisms of digestion and absorption.
5. **Explain Circulatory and Respiratory Processes**
  - Analyze the transport of gases, blood circulation, and adaptations of the cardiovascular and respiratory systems to different environments.
6. **Understand Muscle Physiology and Movement**
  - Describe the mechanisms of muscle contraction, biomechanics, and the role of the skeletal and muscular systems in locomotion.

[illegible]

# BSC-201–BIOTECHNOLOGY-II MICROBIOLOGY

MAX.MARKS:40+10

TOTALLECTURES:32

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The Question Paper will contain questions equally distributed in all Units. The Internal Choice will be given in all Questions.

## Course Objectives of Microbiology

The **Microbiology** course aims to provide students with a fundamental understanding of microorganisms, their structure, function, and roles in health, industry, and the environment. The key objectives include:

1. **Understand the Fundamentals of Microbiology**
  - Learn the history, scope, and importance of microbiology in various fields.
2. **Classify and Describe Microorganisms**
  - Study the characteristics, classification, and diversity of bacteria, viruses, fungi, protozoa, and algae.
3. **Explain Microbial Structure and Function**
  - Understand the cellular organization, physiology, and reproduction of microorganisms.
4. **Understand Microbial Growth and Control**
  - Learn about microbial growth conditions, culture techniques, and methods for controlling microbial populations.
5. **Explore Microbial Metabolism and Genetics**
  - Study metabolic pathways, enzyme functions, microbial genetics, and gene expression regulation.

|                                                                                                                                                                                                                                                                                          |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Unit-I</b>                                                                                                                                                                                                                                                                            |
| Introduction of Microbiology History, Applications & Status of Microbiology in India. Classification of Microorganisms - General Features, systems of Classification.                                                                                                                    |
| <b>Unit-II</b>                                                                                                                                                                                                                                                                           |
| Structure and Diversity of Bacteria & Virus, Microbes in extreme environment. Nutritional requirement of microbes.<br>Bacteriology: Morphology and ultra-structure of bacteria and its morphological types, Archaeobacteria.                                                             |
| <b>Unit-III</b>                                                                                                                                                                                                                                                                          |
| Various methods of staining: Simple, Gram staining, Endospore staining and capsule staining.                                                                                                                                                                                             |
| <b>Unit-IV</b>                                                                                                                                                                                                                                                                           |
| Microbial growth—mathematical expression of growth, growth curve, factors affecting growth. Quantification of microbial growth. Control of microorganisms-physical & chemical, Evaluation of chemical disinfectants-tube dilution test, agar diffusion test and phenol- coefficient.     |
| <b>Unit-V</b>                                                                                                                                                                                                                                                                            |
| Microbial Nutrition and metabolism- Microbial Metabolism- Concept of Anabolism & catabolism processes. Nitrogen Fixation- Types and mechanisms, Microbial disease in plants & Animals (Only General concept).<br>Fermentation Process—Fermenter & its microbes of industrial importance. |

#### BOOKS:

1. Textbook of Microbiology: Prescott
2. Textbook of Microbiology: Pelczar, Pelczar and Chan
3. Textbook of Microbiology: RCDubey and DK Maheshwari
4. General Microbiology Vol. I and II: Powar and Dhagniwala
5. Experiments in Biotechnology: Nigohjkar and Nigohjkar
6. Experiments in microbiology, plant pathology and Biotechnology: KR Aneja
7. Microbiology; A practical approach: Bhavesh Patel

# BIOTECHNOLOGY-IIPRACTICALS

## BIOTECHNOLOGY-IIPRACTICALS

MAX.MARKS:50

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### No.ofLaboratoryperWeek:06Hours

1. Aseptic techniques, Cleaning of glassware, Preparation of cotton plugging and sterilization.
2. Isolation of Microbes from Air, Water and Soil.
3. Dilution and plating by pour plate, Spread Plate Methods.
4. Staining Method—Gram Staining, Endospore Staining, Fungal Staining, Algal staining.
5. Identification of Bacteria based on staining, shape and size.
6. Antibiotic Sensitivity of Microbes by the Use of Antibiotic Discs.
7. Isolation and Identification of a aquatic Fungus from Local water body.
8. Isolation and Characterisation of green algae from Natural habitats.
9. Measurement of water and soil, pH.

### Course Outcomes of Microbiology

Upon successful completion of the **Microbiology** course, students will be able to:

1. **Explain the Fundamentals of Microbiology**
  - Describe the history, scope, and significance of microbiology in various fields, including medicine, industry, and environmental sciences.
2. **Classify and Characterize Microorganisms**
  - Identify and differentiate between major microbial groups such as bacteria, viruses, fungi, protozoa, and algae based on their structure, function, and classification.
3. **Understand Microbial Structure and Physiology**
  - Explain the cellular organization, morphology, growth requirements, and metabolic pathways of different microorganisms.
4. **Demonstrate Knowledge of Microbial Growth and Control**
  - Apply knowledge of microbial growth kinetics, culture methods, sterilization, and disinfection techniques in laboratory and industrial settings.
5. **Analyze Microbial Metabolism and Genetics**
  - Understand microbial enzymatic processes, metabolic pathways, gene expression, mutations, and genetic engineering applications.

[illegible]

## **BSC-202–PLANTPHYSIOLOGY**

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**MAX.MARKS:40+10**

**No.ofLecturesperWeek:02Hours**

**TheQuestionPaperwillcontainquestionsequallydistributedinallUnits.TheInternalChoicewill be given in all Questions.**

### **CourseObjectivesofPlantPhysiology**

The**Plant Physiology**courseaimstoprovidestudentswithacomprehensiveunderstandingofthefunctionaland physiological processes in plants. The key objectives include:

1. **UnderstandtheFundamentalConceptsofPlantPhysiology**
  - Learnthebasicprinciplesofplantstructure,function,andgrowthprocesses.
2. **ExplorePlantWaterRelationsandMineralNutrition**
  - Studythemechanismsof water uptake, transport,transpiration, andtheroleofessentialnutrientsinplant growth and metabolism.
3. **AnalyzePhotosynthesisandRespiration**
  - Understandthebiochemicalpathwaysofphotosynthesis,respiration,andtheirsignificanceinenergy production and plant metabolism.
4. **ExaminePlant GrowthandDevelopment**
  - Studyplanthormones,growthregulators,photoperiodism,seedgermination,andfloweringmechanisms.
5. **UnderstandTransportMechanismsin Plants**
  - Learnaboutphloemandxylemtransport,translocationof nutrients,andsource-sinkrelationships.
6. **StudyStressPhysiologyand Adaptations**
  - Analyzeplantresponsestoabiotic(drought, salinity,temperature)andbiotic(pathogens, herbivores) stresses.

|                                                                                                                                                        |                   |
|--------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| <b>Unit-I</b>                                                                                                                                          | <b>14Lectures</b> |
| <b>Plant waterrelations, Diffusion, Osmosis, Water transport mechanisms, Transpiration and Stomatal physiology.</b>                                    |                   |
| <b>Unit-II</b>                                                                                                                                         | <b>12Lectures</b> |
| <b>Minerals Nutrition in plants: types and function and deficiency disease.</b>                                                                        |                   |
| <b>Unit-III</b>                                                                                                                                        | <b>14Lectures</b> |
| <b>Photosynthesis and General concept of photosynthesis, photosynthesis pigment, C<sub>2</sub>, Calvin cycle, C<sub>4</sub> cycle and CAM pathway.</b> |                   |
| <b>Unit-IV</b>                                                                                                                                         | <b>12Lectures</b> |
| <b>Respiration: Photooxidation of water, glycolysis, TCA cycle and ATP synthesis.</b>                                                                  |                   |
| <b>Unit-V</b>                                                                                                                                          | <b>12Lectures</b> |
| <b>Plant growth regulators: Definition, Types (Auxins, Cytokinins, Gibberellins, Ethylene &amp; ABA) and Application.</b>                              |                   |
|                                                                                                                                                        |                   |

#### BOOKS:

1. Textbook of plant pathology Agrios, Academic Press London.
2. Plant physiology, Delvin, Yan Nostrand Reinhold comp. New York.
3. Textbook of various adaptation of plants, Jones A. D And will bins.
4. Lyndon, R. F 1990 Plant development, The cellular basis
5. Tayal M. S 1996 Plant anatomy. Rastogi publication, Meerut.

# BIOTECHNOLOGY-IIPRACTICALS

# BIOTECHNOLOGY-I PRACTICALS

**MAX.MARKS:50**

No.ofLaboratoryperWeek:06Hours

1. To perform Osmosis, and Diffusion
2. To measure Transpiration rate
3. To measure chlorophyll contents of plant Leaves
4. To study various diseases in plants
5. To study different plant growth regulators

## CourseOutcomesofPlantPhysiology

Upon successful completion of the **Plant Physiology** course, students will be able to:

1. **Explain the Fundamental Principles of Plant Physiology**
  - Demonstrate an understanding of plant structure, function, and physiological processes.
2. **Understand Plant-Water Relations and Mineral Nutrition**
  - Describe water absorption, transpiration, nutrient uptake, and their roles in plant growth and metabolism.
3. **Analyze Photosynthesis and Respiration**
  - Explain the biochemical pathways of photosynthesis and respiration and their significance in energy production.
4. **Describe Plant Growth and Development Mechanisms**
  - Understand the role of plant hormones, photoperiodism, and environmental factors in regulating plant growth.
5. **Explain Transport Mechanisms in Plants**
  - Analyze how water, nutrients, and organic substances are transported through xylem and phloem.

[illegible]

## **BSC-301–BIOTECHNOLOGY-III BIOPHYSICS AND BIOCHEMISTRY**

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**MAX. MARKS: 40+10**

**No. of Lectures per Week: 02 Hours**

**The Question Paper will contain questions equally distributed in all Units. The Internal Choice will be given in all Questions.**

### **Course Objectives of Biophysics and Biochemistry**

The **Biophysics and Biochemistry** course aims to provide students with a fundamental understanding of the physical and chemical principles governing biological systems. The key objectives include:

#### **Biophysics Objectives:**

1. **Understand the Physical Basis of Biological Processes**
  - Learn how principles of physics, such as thermodynamics, fluid mechanics, and electromagnetism, apply to biological systems.
2. **Explore Biomolecular Interactions**
  - Study the physical forces governing protein folding, enzyme activity, and molecular recognition.
3. **Analyze Biomechanics and Bioenergetics**
  - Understand the physical principles behind muscle contraction, cellular motility, and energy transformations in biological systems.

#### **Biochemistry Objectives:**

6. **Understand the Structure and Function of Biomolecules**
  - Learn about proteins, nucleic acids, carbohydrates, and lipids and their role in cellular processes.
7. **Explore Enzyme Kinetics and Metabolism**
  - Study enzyme mechanisms, metabolic pathways, and energy production in biological systems.

|                                                                                                                                                                                                                                                                                                                                                                                                             |                          |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| <b><u>Unit-I</u></b>                                                                                                                                                                                                                                                                                                                                                                                        | <b><u>12Lectures</u></b> |
| <b>Thermodynamics:</b> Thermodynamic System, Equilibrium, Thermodynamic laws and their applications. Different types of processes, Thermodynamic variables and Entropy.                                                                                                                                                                                                                                     |                          |
| <b><u>Unit-II</u></b>                                                                                                                                                                                                                                                                                                                                                                                       | <b><u>12Lectures</u></b> |
| <b>General Biophysical methods:</b> Measurement of pH, Radioactive labeling & counting, Autoradiography. Diffusion, Sedimentation, Osmosis.                                                                                                                                                                                                                                                                 |                          |
| <b><u>Unit-III</u></b>                                                                                                                                                                                                                                                                                                                                                                                      | <b><u>14Lectures</u></b> |
| Fundamentals of Biochemistry: Biochemistry as molecular logic of living beings.. Chemical elements, structure of atoms, molecules and chemical bonds. Ionic, covalent, coordinate and hydrogen bonds. Structure, function and properties of water, Water as a universal solvent, Acids, bases and salts, pH and buffers.                                                                                    |                          |
| <b><u>Unit-IV</u></b>                                                                                                                                                                                                                                                                                                                                                                                       | <b><u>12Lectures</u></b> |
| <b>Biomolecules:</b> Introduction and occurrence, classification, properties, importance of carbohydrate, lipids, proteins, amino acids and nucleic acids and various types of RNA's.                                                                                                                                                                                                                       |                          |
| <b><u>Unit-V</u></b>                                                                                                                                                                                                                                                                                                                                                                                        | <b><u>14Lectures</u></b> |
| Enzymes: Structure, classification and function - Active site. Energy of activation, transition state hypothesis, lock and key hypothesis, induced fit hypothesis. Concept of $K_m$ - Michaelis-Menten equation. Various types of enzyme inhibition. Introduction to Allosteric Enzymes. Definition of holoenzyme, Apoenzyme. Coenzyme, cofactor, prosthetic group and their examples. Concept of ribozyme. |                          |

#### BOOKS:

1. Principles of Biochemistry Lehninger, Nelson & Cox.
2. Biochemistry, Voet & Voet
3. Biochemistry, Berg & Stryer
4. Textbook of Biochemistry, S.P. Singh
5. Molecular Biology of the Cell, Bruce Alberts
6. Textbook of Biochemistry, U. Satyanarayana
7. Experiments in Biotechnology: Nigohjkar and Nigohjkar

## BIOTECHNOLOGY-III PRACTICALS

**MAX. MARKS: 50**

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**No. of Laboratory per Week: 06 Hours**

1. Principles and working knowledge of instruments like Colorimeter, pH meter, Centrifuge, Spectrophotometer, Microscope etc.
2. Qualitative analysis of Carbohydrates, Proteins and Lipids.
3. Quantitative estimation of Protein by Folin-Lowry method.
4. Quantitative estimation of sugar by Nelson Smogyi's method.
5. Determination of enzyme activity by amylase.
6. Study the effect of pH on enzyme activity.
7. Study the effect of temperature on enzyme activity.
8. Separation of amino acids by TLC
9. Separation of leaf pigments by Paper chromatography.
10. Estimation of hemoglobin.
11. RBC counting by haematocytometer.
12. WBC counting by Differential/ or total cell count.
13. Measurement of bleeding and clotting time.

### **Course Outcomes of Biophysics and Biochemistry**

Upon successful completion of the **Biophysics and Biochemistry** course, students will be able to:

#### **Biophysics Outcomes:**

1. **Understand the Physical Principles Governing Biological Systems**
  - Explain the application of physics concepts (thermodynamics, fluid dynamics, and electromagnetism) in biological processes.
2. **Analyze Biomolecular Structures and Interactions**
  - Understand the principles of molecular interactions, including protein folding, enzyme kinetics, and ligand binding.
3. **Explain Biomechanics and Bioenergetics**
  - Describe the physical forces involved in muscle contraction, cell motility, and energy transformation in biological systems.

#### **Biochemistry Outcomes:**

6. **Explain Biomolecular Structure and Function**
  - Describe the chemical properties, structure, and biological roles of proteins, nucleic acids, carbohydrates, and lipids.
7. **Understand Enzyme Mechanisms and Metabolism**
  - Explain enzyme kinetics, catalytic mechanisms, and metabolic pathways, including glycolysis, TCA cycle, and oxidative phosphorylation.

[illegible]

# BSC-302–EnvironmentalStudies-I

MAX.MARKS:50

No.ofLecturesperWeek:02Hours

TheQuestionPaperwillcontainquestionsequallydistributedinallUnits.TheInternalChoicewill be given in all Questions.

## CourseObjectivesofEnvironmentalScience

TheEnvironmentalSciencecourseaimstoprovidestudentswithacomprehensiveunderstandingofthe environment, ecological processes, and human impact on natural systems. The key objectives include:

1. **UnderstandtheFundamentalsofEnvironmentalScience**
  - Learnthebasicprinciples,scope,andimportanceofenvironmentalscienceinsustainabilityand conservation.
2. **ExploreEcosystemStructureand Function**
  - Studyecologicalinteractions,biodiversity,foodchains,andenergyflowinecosystems.
3. **AnalyzeNaturalResourcesand TheirManagement**
  - Understandtheuse,conservation,andustainablemanagementofair,water,soil,forests,andminerals.
4. **ExamineEnvironmentalPollutionandItsImpact**
  - Studythecauses,effects,andcontrolmeasuresforair,water,soil,andnoisepollution.
5. **UnderstandClimateChangeandGlobalEnvironmentalIssues**
  - Learnaboutgreenhousegases, globalwarming, ozonedepletion,andstrategiesfor climatechange mitigation.

|                                                                                                                                                                                                                                                                                                                                   |                   |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| <u>Unit-I</u>                                                                                                                                                                                                                                                                                                                     | <u>12Lectures</u> |
| MultidisciplinarynatureofenvironmentalstudiesDefinition,scopeandimportance.                                                                                                                                                                                                                                                       |                   |
| <u>Unit-II</u>                                                                                                                                                                                                                                                                                                                    | <u>12Lectures</u> |
| NaturalResources:Renewableandnon-renewableresources,Naturalresourcesandassociated problems.a)Forestresources,b)Waterresources,c)Mineralresources, d)Foodresources,e) Energyresourcesf)Landresources.                                                                                                                              |                   |
| <u>Unit-III</u>                                                                                                                                                                                                                                                                                                                   | <u>14Lectures</u> |
| Ecosystems:Conceptofanecosystem,Structureandfunctionofanecosystem,Producers,consumersanddecomposers, Energy flowin the ecosystem.                                                                                                                                                                                                 |                   |
| <u>Unit-IV</u>                                                                                                                                                                                                                                                                                                                    | <u>12Lectures</u> |
| Foodchains,foodwebsandecologicalpyramids.Characteristicfeaturesandfunctionofthefollowing ecosystem: a. Forest ecosystem , b. Grassland ecosystemc. Desert ecosystemd. Aquatic ecosystems                                                                                                                                          |                   |
| <u>Unit-V</u>                                                                                                                                                                                                                                                                                                                     | <u>14Lectures</u> |
| Biodiversity: - Introduction- definition, genetic, species and ecosystem. Importance of Biodiversity. BiogeographicalclassificationofIndia.Indiaasamega-diversitynation.Hot-spotsofbiodiversity.Threats tobiodiversity,EndangeredandendemicspeciesofIndia.Conservationofbiodiversity:In- situandEx-situconservationofbiodiversity |                   |

## Books:

1. Basu, M. and Xavier, S., Fundamentals of Environmental Studies, Cambridge University Press, 2016.
2. Mitra, A. K. and Chakraborty, R., Introduction to Environmental Studies, Book Syndicate, 2016.
3. Enger, E. and Smith, B., Environmental Science: A Study of Interrelationships, Publisher: McGraw-Hill Higher Education; 12th edition, 2010

## Course Outcomes of Environmental Science (EVS)

Upon successful completion of the **Environmental Science** course, students will be able to:

1. **Understand Environmental Concepts and Ecosystem Functions**
  - Explain the fundamental principles of environmental science, ecosystem dynamics, and biodiversity conservation.
2. **Analyze Natural Resources and Their Sustainable Use**
  - Demonstrate knowledge of resource management strategies for water, air, soil, forests, and minerals.
3. **Evaluate Environmental Pollution and Its Control Measures**
  - Identify different types of pollution, their sources, and effective solutions for environmental protection.
4. **Understand Climate Change and Global Environmental Issues**
  - Analyze the causes and impacts of climate change, global warming, ozone depletion, and biodiversity loss.
5. **Apply Waste Management and Sustainable Practices**
  - Implement concepts of waste reduction, recycling, and proper disposal methods to promote sustainability.

[illegible]

# BSC-303–ENTREPRENEURSHIPDEVELOPMENT-I

MAX.MARKS:50

No.ofLecturesperWeek:02Hours

TheQuestionPaperwillcontainquestionsequallydistributedinallUnits.TheInternalChoicewill be given in all Questions.

## CourseObjectivesofEntrepreneurship

The**Entrepreneurship**courseaimstoequipstudentswiththeknowledge, skills,and mindset requiredtostart, manage, and grow a successful business. The key objectives include:

1. **UnderstandtheFundamentalsofEntrepreneurship**
  - Learnthedefinition,scope,andimportanceofentrepreneurshipineconomicdevelopment.
2. **ExploreEntrepreneurialMindsetandCharacteristics**
  - Developcreativity,innovation,risk-takingability,andproblem-solvingskillsessentialforentrepreneurs.
3. **IdentifyBusinessOpportunitiesandMarket Research**
  - Learnhowtoanalyzemarkettrends,identifybusinessopportunities,andconductfeasibilitystudies.
4. **UnderstandBusinessPlanningandStrategy**
  - Developabusiness model,draftabusinessplan,andformulatestrategiesforbusinesssuccess.
5. **Learn AboutFundingandFinancialManagement**
  - Understandsourcesoffunding,financialplanning,budgeting,andresourcemanagementforstartups.
6. **ExploreLegaland EthicalAspectsofEntrepreneurship**
  - Gainknowledgeofbusinesslaws,taxation,intellectualpropertyrights,andethicalbusiness practices.

| 08Lectures                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Entrepreneurship Development — Concept and importance , Function of Enterprisar ,Goal determination - Problems Challenges and solutions. Project Proposal — need andObjects — Nature of organisation, Production Management, Financial Management , Marketing Management , Consumer Management . Role ofregulatory InstitutionsRoleof developmentorganisations,selfemploymentoriented schemes.MajorMotivesInfluencing anEntrepreneur–AchievementMotivationTraining,SelfRating,Business Games. |

## TEXTBOOKS:

DonaldFKuratko,

1. “Entrepreneurship–Theory, Process and Practice”, 9th Edition, Cengage Learning, 2014.

Khanka.S.S.,

2. “Entrepreneurial Development” S.Chand & Co.Ltd., Ram Nagar, New Delhi, 2013

## Course Outcomes of Entrepreneurship

Upon successful completion of the **Entrepreneurship** course, students will be able to:

1. **Demonstrate an Understanding of Entrepreneurship Concepts**
  - Explain the role of entrepreneurship in economic growth and business development.
2. **Develop an Entrepreneurial Mindset**
  - Apply creativity, innovation, risk-taking, and problem-solving skills in business decision-making.
3. **Identify and Evaluate Business Opportunities**
  - Conduct market research and feasibility analysis to identify potential business ventures.
4. **Create a Business Plan and Strategy**
  - Develop a structured business plan, including financial projections, marketing strategies, and operational plans.
5. **Understand Financial and Funding Aspects**
  - Identify sources of funding, manage financial resources, and create effective financial strategies for startups.

[illegible]

## **BSC-401–BIOTECHNOLOGY-IV**

### **BIOINSTRUMENTATION,BIOSTATISTICSANDBIOINFORMATIES**

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**MAX.MARKS:40+10**

**No.ofLecturesperWeek:02Hours**

**TheQuestionPaperwillcontainquestionsequallydistributedinallUnits.TheInternalChoice will be given in all Questions.**

#### **CourseObjectivesofBiostatisticsandBioinformatics**

The **BiostatisticsandBioinformatics** course aims to provide students with a fundamental understanding of statistical methods and computational tools used in biological and biomedical research. The key objectives include:

##### **BiostatisticsObjectives:**

1. **UnderstandtheBasicsofBiostatistics**
  - Learn statistical concepts, data types, and their applications in biological research.
2. **DevelopSkillsin Data Collectionand Analysis**
  - Understand experimental design, sampling methods, and data interpretation in life sciences.
3. **ApplyDescriptiveandInferentialStatisticalMethods**
  - Learn measures of central tendency, dispersion, hypothesis testing, and probability distributions.

##### **BioinformaticsObjectives:**

6. **Understand thePrinciplesofBioinformatics**
  - Learn the role of bioinformatics in genomics, proteomics, and systems biology.
7. **AnalyzeBiologicalDatabasesand SequenceAlignment**
  - Study DNA, RNA, and protein sequence analysis using tools like BLAST, FASTA, and multiple sequence alignment.
8. **LearnComputationalMethodsforGeneand ProteinAnalysis**
  - Understand phylogenetic analysis, motif discovery, and structural bioinformatics applications.

|                                                                                                                                                                                                                                                                                   |                   |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| <b>Unit-I</b>                                                                                                                                                                                                                                                                     | <b>14Lectures</b> |
| Microscopy—Light,Phasecontrast,fluorescenceandElectronmicroscopy.Centrifugationtechnique.<br>Principlestypes&separationof biologicalmolecules.                                                                                                                                    |                   |
| <b>Unit-II</b>                                                                                                                                                                                                                                                                    | <b>12Lectures</b> |
| ChromatographyandElectrophoresis<br>Chromatography:Principlesandapplications,Principleandapplicationofelectrophoresis.<br>Agarosegelelectrophoresis.Blotting:Southern,WesternandNorthernBlotting.                                                                                 |                   |
| <b>Unit-III</b>                                                                                                                                                                                                                                                                   | <b>10Lectures</b> |
| Spectrophotometry-PrincipleandApplicationUVandVisibleSpectrophotometry,ColorimetryRadio and<br>Non radio labeling, Autoradiography                                                                                                                                                |                   |
| <b>Unit-IV</b>                                                                                                                                                                                                                                                                    | <b>12Lectures</b> |
| <b>Biostatistics</b> -Introduction,Scope,applicationanduseofstatisticcollectionandclassificationofdata<br>summarizationandpresentationofdata.Arithmeticmean,median,standarddeviation.<br>Probability,definition.Randomvariableanditsdistribution.Binomialprobabilitydistribution. |                   |
| <b>Unit-V</b>                                                                                                                                                                                                                                                                     | <b>16Lectures</b> |
| <b>BasicBioinformatics</b> :IntroductiontoInternet,SearchEngines(Google,Yahoo,Entrez/etc)<br><b>BiologicalDatabases</b> :Sequencedatabases(EMBL.GenBank,DDBJ.UNIPROT.TrEMBL).                                                                                                     |                   |

## BOOKS:

1. BioinformaticsC.V.S.Murthy
2. ThetextbookofBioinformatics,Sharma,MunjalAndShankar
3. BasicBioinformatics,S.Ignacimuthu,S.J.
4. Biostatistics,B.Prasad
5. Biostatistics,P.NArora

## Course Outcomes of Biostatistics and Bioinformatics

Upon successful completion of the **Biostatistics and Bioinformatics** course, students will be able to:

## BiostatisticsOutcomes:

- 1. Understand and Apply Basic Statistical Concepts**
  - Explain key statistical principles and their relevance in biological and medical research.
- 2. Perform Data Collection and Experimental Design**
  - Design experiments, collect biological data, and apply appropriate statistical methods for analysis.
- 3. Apply Descriptive and Inferential Statistical Methods**
  - Use measures of central tendency, variability, probability distributions, hypothesis testing, and confidence intervals in biological studies.
  - Conduct correlation and regression analysis to study relationships in biological datasets.

### BioinformaticsOutcomes:

6. **Understand the Fundamentals of Bioinformatics**
  - Explain the importance of computational tools in genomics, proteomics, and systems biology.
7. **Use Biological Databases for Sequence Analysis**
  - Retrieve and analyze genetic and protein sequences using databases such as GenBank, UniProt, and EMBL.
8. **Perform Sequence Alignment and Phylogenetic Analysis**
  - Apply bioinformatic tools like BLAST, ClustalW, and MEGA for molecular sequence comparisons.
9. **Analyze Genomic and Proteomic Data Using Computational Tools**
  - Use software for gene prediction, protein structure modeling, and functional annotation.
10. **Apply Machine Learning and AI in Bioinformatics**

[illegible]

## **BIOTECHNOLOGY-IV PRACTICALS**

**MAX. MARKS: 50**

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**No. of Laboratory per Week: 06 Hours**

1. Separation of amino acids by TLC
2. Separation of leaf pigments by Paper chromatography.
3. Estimation of hemoglobin.
4. RBC counting by haematocytometer.
5. WBC counting by Differential/ or total cell count.
6. Measurement of bleeding and clotting time.
7. Measurement of Hemin Crystals.
8. Estimation of beta carotene in carrots.
9. Estimation of ascorbic acid in lemon juice.
10. Determination of iodine number of fat sample.
11. Determination of phosphorus content in plant material (Colorimetric method).
12. Computer Input and Output devices
13. Prepare a Marksheet of your class Subjects
14. Prepare a bar chart, pie chart for analysis of Election Result.
15. Exercise based on power point presentation.
16. Design a presentation illustrating insertion of pictures, word art & clip art
17. Use MS Word to insert a table into document.
18. Problem based on Mean, Median, Mode.
19. Hardy Weinberg Law applied on Population Genetics.
20. Problem based on Probability.
21. Exercise based on standard Deviation.
22. Biological data resources and data retrieval

## BSC-402–Environmental Studies-II

MAX.MARKS:50

No.ofLecturesperWeek:02Hours

TheQuestionPaperwillcontainquestionsequallydistributedinallUnits.TheInternalChoicewill be given in all Questions.

### CourseObjectivesofEnvironmentalScience

TheEnvironmentalSciencecourseaimstoprovidestudents witha comprehensiveunderstandingofthe environment, ecological processes, and human impact on natural systems. The key objectives include:

1. **ExploreWasteManagementandSustainablePractices**
  - a. Studysolidwastedisposal,wastewatertreatment, andrecyclingtechniquetopromotesustainability.
2. **AnalyzeEnvironmentalLawsandPolicies**
  - a. Understandnationalandinternationalenvironmentallaws,treaties,andpoliciesforenvironmental protection.
3. **ExamineHumanPopulationandEnvironmentalImpact**
  - a. Studypopulationgrowth,urbanization,andtheireffectsonnaturalresourcesandecosystems.
4. **UnderstandRenewableEnergy andConservationStrategies**
  - a. Explorealternativeenergysourcessuchassolar,wind,andbioenergyforsustainabledevelopment.
5. **ApplyEnvironmentalScienceConceptstoReal-WorldProblems**

|                                                                                                                                                                                                                        |                          |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| <b><u>Unit-I</u></b>                                                                                                                                                                                                   | <b><u>12Lectures</u></b> |
| Environmentalpollution:types,causes,effectsandcontrols;Air,water,soilandnoise pollution.                                                                                                                               |                          |
| <b><u>Unit-II</u></b>                                                                                                                                                                                                  | <b><u>12Lectures</u></b> |
| Climatechange,global warming,ozonelayerdepletion,acidrainandimpactsonhuman communitiesandagriculture.                                                                                                                  |                          |
| <b><u>Unit-III</u></b>                                                                                                                                                                                                 | <b><u>14Lectures</u></b> |
| Solidwaste management:Controlmeasuresofurbanandindustrialwaste,special referencee-waste,Biomedicalwaste.                                                                                                               |                          |
| <b><u>Unit-IV</u></b>                                                                                                                                                                                                  | <b><u>12Lectures</u></b> |
| HumanPopulationandtheEnvironment:populationgrowth,populationexplosion,FamilyWelfare Programme.                                                                                                                         |                          |
| <b><u>Unit-V</u></b>                                                                                                                                                                                                   | <b><u>14Lectures</u></b> |
| • EnvironmentalLaws:TheEnvironment(Protection)Act,1986;TheAir(Preventionand ControlofPollution)Act,1981;TheWater(PreventionandControlofPollution)Act1974; Forest(Conservation)Act,1980;• ThewildlifeProtectionAct,1972 |                          |

### Books:

- Basu, M. and Xavier, S., *Fundamentals of Environmental Studies*, Cambridge University Press, 2016.
- Mitra, A. K. and Chakraborty, R., *Introduction to Environmental Studies*, Book Syndicate, 2016.
- Enger, E. and Smith, B., *Environmental Science: A Study of Interrelationships*, Publisher: McGraw-Hill Higher Education; 12th edition, 2010

## Course Outcomes of Environmental Science (EVS)

Upon successful completion of the **Environmental Science** course, students will be able to:

1. **Understand the Fundamentalsof Environmental Science**
  - Explainkey environmental concepts, ecosystems, and the importance of biodiversity conservation.
2. **Analyze Natural Resources and Their Sustainable Use**
  - Assess the utilization and conservation of resources like air, water, soil, forests, and minerals.
3. **Identify and Evaluate Environmental Pollution**
  - Recognizesources, impacts, and control measures for air, water, soil, and noise pollution.
4. **Assess Climate Change and Global Environmental Issues**
  - Understand the causes and consequences of global warming, ozone depletion, and deforestation.
5. **Apply Waste Management and Sustainable Practices**
  - Implementtechniques such as recycling, composting, and waste treatment for environmental sustainability.

[illegible]

## BSC-403–ENTREPRENEURSHIP DEVELOPMENT-II

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**MAX.MARKS:50**

**No.of Lectures per Week:02 Hours**

**The Question Paper will contain questions equally distributed in all Units. The Internal Choice will be given in all Questions.**

### **Course Objectives of Entrepreneurship**

The **Entrepreneurship** course aims to equip students with the knowledge, skills, and mindset required to start, manage, and grow a successful business. The key objectives include:

1. **Understand the Fundamentals of Entrepreneurship**
  - Learn the definition, scope, and importance of entrepreneurship in economic development.
2. **Explore Entrepreneurial Mindset and Characteristics**
  - Develop creativity, innovation, risk-taking ability, and problem-solving skills essential for entrepreneurs.
3. **Identify Business Opportunities and Market Research**
  - Learn how to analyze market trends, identify business opportunities, and conduct feasibility studies.
4. **Understand Business Planning and Strategy**
  - Develop a business model, draft a business plan, and formulate strategies for business success.
5. **Learn About Funding and Financial Management**

- Need–Sources of Finance, Term Loans, Capital Structure,
- Financial Institution, Financial Management for Project—Financial institution and their role,
- Capital estimation and arrangement. Cost and price determination and accounting management.
- Problem of entrepreneur—Problem relating Capital,
- Problem relating Registration, administration problem and how to overcome from above problems.
- Sickness in small Business—Concept, Magnitude, Causes and Consequences

### **TEXTBOOKS:**

- Donald F. Kuratko, “Entrepreneurship—Theory, Process and Practice”, 9th Edition, Cengage Learning, 2014.
- Khanka, S.S., “Entrepreneurial Development” S. Chand & Co. Ltd., Ram Nagar, New Delhi, 2013.

## Course Outcomes of Entrepreneurship

Upon successful completion of the **Entrepreneurship** course, students will be able to:

1. **Demonstrate Understanding of Entrepreneurship Concepts**
  - Explain the role of entrepreneurship in economic growth and business development.
2. **Develop an Entrepreneurial Mindset**
  - Apply creativity, innovation, risk-taking, and problem-solving skills in business decision-making.
3. **Identify and Evaluate Business Opportunities**
  - Conduct market research and feasibility analysis to identify potential business ventures.
4. **Create a Business Plan and Strategy**
  - Develop a structured business plan, including financial projections, marketing strategies, and operational plans.
5. **Understand Financial and Funding Aspects**
  - Identify sources of funding, manage financial resources, and create effective financial strategies for startups.

[illegible]

## **BSC-501–BIOTECHNOLOGY-V: MOLECULAR BIOLOGY AND GENETIC ENGINEERING**

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**MAX. MARKS: 40+10**

**No. of Lectures per Week: 02 Hours**

**The Question Paper will contain questions equally distributed in all Units. The Internal Choice will be given in all Questions.**

### **Course Objectives of Molecular Biology**

The **Molecular Biology** course aims to provide students with a deep understanding of the molecular mechanisms that govern cellular processes, gene regulation, and biomolecular interactions. The key objectives include:

1. **Understand the Molecular Basis of Life**
  - Learn the structure and function of DNA, RNA, and proteins and their roles in cellular processes.
2. **Explore DNA Replication, Repair, and Recombination**
  - Study the molecular mechanisms of DNA replication, mutation repair pathways, and genetic recombination.
3. **Understand Gene Expression and Regulation**
  - Analyze the processes of transcription, translation, and post-transcriptional modifications in prokaryotes and eukaryotes.
4. **Examine Molecular Mechanisms of Genetic Control**
  - Explore epigenetic modifications, operon systems, and regulatory proteins involved in gene expression.
5. **Analyze Protein Synthesis and Post-Translational Modifications**
  - Study the molecular machinery of ribosomes, tRNA, and protein folding pathways.

|                                                                                                                                                                                                                                                                                                                                                                                                         |                          |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| <b><u>Unit-I</u></b>                                                                                                                                                                                                                                                                                                                                                                                    | <b><u>12Lectures</u></b> |
| DNA and RNA, Chemical Structure, Types and Properties, Experimental Proof of DNA as genetic material. DNA Replication. Types, Experimental proof of semi conservative replication, Replicon-Concept. Proteins and enzymes involved in replication in prokaryotes and eukaryotes, Modes of DNA replication. Unidirectional, Bidirectional, Types of DNA replication. Y shaped, rolling circle mechanism. |                          |
| <b><u>Unit-II</u></b>                                                                                                                                                                                                                                                                                                                                                                                   | <b><u>12Lectures</u></b> |
| Eukaryotic chromosomal organization, Euchromatin, Heterochromatin. Chromatin structure. Nucleosomes, histone and non-histone proteins, histone modifications.                                                                                                                                                                                                                                           |                          |
| <b><u>Unit-III</u></b>                                                                                                                                                                                                                                                                                                                                                                                  | <b><u>14Lectures</u></b> |
| Origin of life: Classical experiments and current concepts. Evolution of biological macromolecules, Evolution of early forms, Mendelian genetics: Mendel's Law, Chromosomal basis of heredity, Chromosomal analysis, allelic variation, dominance. Linkage and crossing over.                                                                                                                           |                          |
| <b><u>Unit-IV</u></b>                                                                                                                                                                                                                                                                                                                                                                                   | <b><u>12Lectures</u></b> |
| Introduction to Recombinant DNA technology, Scope & importance. Gene cloning using PCR, Introduction to Restriction endonuclease, DNA transfer techniques, Vectors and their types: Plasmids, Phagemids, Cosmids                                                                                                                                                                                        |                          |
| <b><u>Unit-V</u></b>                                                                                                                                                                                                                                                                                                                                                                                    | <b><u>14Lectures</u></b> |
| Plasmids Types Properties and cloning vectors. Mutation, Types of mutations; Point mutation (Base pair change, frameshift, deletion). Transcription, translation in prokaryotes and eukaryotes. Operon Concept (lac and trp).                                                                                                                                                                           |                          |

#### BOOKS:

- Molecular Biology of the cell, 2002: Albert's et al
- The cell: A molecular approach: J.M. Cooper
- Cell biology: P.S. Verma and V.K. Agarwal
- Cell and Molecular Biology: P.K. Gupta
- Experiments in Biotechnology: Nigohjkar and Nigohjkar
- A practical book of Molecular Biology and Immunology; 2017: P.K. Singh et al

## Course Outcomes of Molecular Biology

Upon successful completion of the **Molecular Biology** course, students will be able to:

- 1. Understand the Structure and Function of Biomolecules**
  - Explain the roles of DNA, RNA, and proteins in cellular and molecular processes.
- 2. Analyze DNA Replication, Repair, and Recombination Mechanisms**
  - Describe the molecular mechanisms of DNA synthesis, mutation repair, and genetic recombination.
- 3. Explain Gene Expression and Regulation**
  - Understand transcription, translation, and regulatory pathways controlling gene expression in prokaryotic and eukaryotic cells.
- 4. Explore Molecular Mechanisms of Genetic Control**
  - Analyze epigenetic modifications, operon systems, and gene silencing mechanisms.
- 5. Understand Protein Synthesis and Post-Translational Modifications**
  - Describe the function of ribosomes, tRNA, chaperones, and protein-folding pathways.

[illegible]

## BIOTECHNOLOGY-V PRACTICALS

**MAX. MARKS: 50**

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**No. of Laboratory per Week: 06 Hours**

1. Chromosomal DNA isolation from Plant cells.
2. Chromosomal DNA isolation from Animal cells.
3. Genomic DNA isolation from Micro-Organisms.
4. Analysis of isolated DNA by Agarose gel electrophoresis.
5. Spectrophotometric analysis of DNA and DNA melting.
6. UV as a physical mutagen
7. Gradient Plate Technique
8. Estimation of DNA using diphenylamine method.
9. Estimation of RNA using orcinol method.
10. Isolation of RNA from Yeast.
11. Isolation of plasmid DNA from bacteria.
12. Effect of UV radiation on microbial cell
13. Demonstration of repair mechanism in microbes.
14. Bacteriophage **and** determination of latent period of infection
15. Isolation of total RNA from Plant tissue by SDS phenol method.
16. Elution of DNA from agarose gel band.
17. Transformation in E-coli cell.
18. Growth of plant tissue into undifferentiated mass of callus.
19. Preparation of animal cell culture media.
20. Separation and culture of lymphocyte from blood.
21. Demonstration of fermentor.
22. Preparation of wine.
23. Extraction of citric acid from *A. spargilluv*.
24. Production of ethanol by yeast.
25. Demonstration of PCR.

# BSC-502–BIOTECHNOLOGYFORFORENSICSSCIENCE

**MAX.MARKS:50**

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**No.ofLecturesperWeek:02Hours**

**TheQuestionPaperwillcontainquestionsequallydistributedinallUnits.TheInternal Choice will be given in all Questions.**

## CourseObjectivesofForensicScience

The**ForensicScience**courseaimstoprovidestudentswitha fundamentalunderstandingofscientificprinciples and techniques used in crime investigation and legal proceedings. The key objectives include:

1. **UnderstandtheBasicsofForensicScience**
  - Learnthehistory,scope, andsignificanceofforensicscienceincriminalinvestigations.
2. **ExploreCrimeSceneInvestigationTechniques**
  - Studyproceduresforcrimescenedocumentation,evidencecollection,andpreservation.
3. **AnalyzePhysicaland BiologicalEvidence**
  - Learntechniquesforanalyzingfingerprints,bloodstains,DNA,hair,fibers,andothertraceevidence.
4. **UnderstandForensicToxicologyandDrugAnalysis**
  - Studythedetectionandeffectsofdrugs,poisons,andalcoholincriminalcases.
5. **LearnForensicDNAProfilingandGeneticAnalysis**
  - UnderstandtheroleofDNAsequencing,PCR,andSTRanalysis inidentifyingindividual

## Syllabus

- |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"><li>• BasicofForensicScience:Introduction,Definition,need,significationandscope of ForensicScience.</li><li>• Principles of Forensic Science, multi professional and multi personal aspects of forensicscience.</li><li>• DomainsinForensicScience:Forensic<b>Biology</b>,ForensicMedicine,ForensicToxicology, Forensic Osteology and Odontology, Forensic Anthropology, Wild life Forensic, DNA profiling, Computer Forensicetc.</li><li>• EthicalissueinForensicScience</li><li>• OrganizationsetupofForensicScienceLaboratory</li></ul> |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

## CourseOutcomesofForensicScience

Upon successful completion of the **Forensic Science** course, students will be able to:

- 1. Demonstrate Understanding of Forensic Science Principles**
  - Explain the role, history, and significance of forensic science in criminal investigations and the legal system.
- 2. Apply Crime Scene Investigation Techniques**
  - Utilize proper methods for crime scene documentation, evidence collection, and preservation.
- 3. Analyze Physical and Biological Evidence**
  - Identify and interpret fingerprints, bloodstains, DNA, hair, and fiber evidence using forensic techniques.
- 4. Examine Forensic Toxicology and Drug Analysis**
  - Detect and analyze drugs, poisons, and toxins in biological samples.
- 5. Utilize DNA Profiling for Identification**
  - Apply molecular biology techniques such as PCR and STR analysis for forensic identification.

[illegible]

## **BSC-503–IntellectualPropertyRights**

**MAX.MARKS:50**

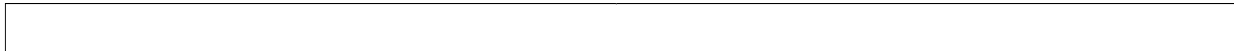
**No.ofLecturesperWeek:02Hours**

**TheQuestionPaperwillcontainquestionsequallydistributedinallUnits.TheInternalChoicewill be given in all Questions.**

### **CourseObjectivesofIntellectualPropertyRights(IPR)**

The**IntellectualPropertyRights(IPR)** courseaimstoprovidestudentswithacomprehensiveunderstandingof intellectualproperty laws, their significance, and their application in various fields. The key objectives include:

1. **UnderstandtheFundamentalsofIntellectualProperty(IP)**
  - Learntheconcept,history,andimportanceofintellectualpropertyrightsinnovationandbusiness.
2. **ExploreDifferent TypesofIntellectualProperty**
  - Studypatents,copyrights,trademarks,tradesecrets,geographicalindications,andindustrialdesigns.
3. **ExaminePatent LawsandFiling Procedures**
  - Understandtheprocessofpatentapplication,examination,andgrantatnationalandinternationallevels.
4. **AnalyzeCopyright LawsandProtectionMechanisms**
  - Learnaboutcopyrightpolicies,fairuse,andprotectionofliterary,artistic,anddigitalworks.
5. **UnderstandTrademarkRegistration andBrand Protection**
  - Exploresignificanceoftrademarks,theirregistrationprocess,andinfringementissues.



- Introduction to Intellectual Property, Copyright, Related Rights,
- Types of Intellectual Property and legislations covering IPR in India: - Patents, Copyrights, Trademark.
- Industrial design and Trade secrets.
- Protection of plant varieties and Farmers' Right Act, Methods of protection of plant and plant products,
- Essentialities of plant protection.
- Classification of patents by WIPO, Categories of Patent Special Patents, Patenting Biological products

## Course Outcomes of Intellectual Property Rights (IPR)

Upon successful completion of the **Intellectual Property Rights (IPR)** course, students will be able to:

1. **Demonstrate an Understanding of Intellectual Property (IP) Concepts**
  - Explain the significance of IPR in protecting innovations, creativity, and business assets.
2. **Differentiate Various Types of Intellectual Property**
  - Identify and describe patents, copyrights, trademarks, trade secrets, geographical indications, and industrial designs.
3. **Apply Patent Laws and Filing Procedures**
  - Understand the process of patent filing, examination, grant, and maintenance at national and international levels.
4. **Analyze Copyright Protection and Fair Use Policies**
  - Explain the legal aspects of copyright protection in literary, artistic, and digital works.
5. **Understand Trademark Laws and Brand Protection Strategies**
  - Evaluate the importance of trademarks and their role in brand identity and business growth.

[illegible]

# BSC-601–BIOTECHNOLOGY-VI

## APPLIEDBIOTECHNOLOGY

**MAX.MARKS:40+10**

**No.ofLecturesperWeek:02Hours**

**TheQuestionPaperwillcontainquestionsequallydistributedinallUnits.TheInternalChoice will be given in all Questions.**

### CourseObjectivesofAppliedBiotechnology

1. **UnderstandtheFundamentalsofBiotechnology**
  - Learnthebasicconcepts, tools,andtechniquesusedinmodernbiotechnology.
2. **ExploreGeneticEngineering andRecombinantDNA Technology**
  - Studygenecloning,vectorsystems,geneexpression,andCRISPR-basedgenomeediting.
3. **AnalyzeApplicationsofBiotechnology inHealthcare**
  - Understandthedevelopmentofbiopharmaceuticals,genetherapy,vaccines,andpersonalizedmedicine.
4. **ExamineAgriculturalBiotechnologyandCropImprovement**
  - Learnaboutgeneticallymodifiedorganisms(GMOs),biofertilizers,andpest-resistantcrops.
5. **StudyIndustrialBiotechnologyandBioprocessingTechniques**

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                   |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| <b>Unit-I</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>14Lectures</b> |
| FoodMicrobiology-Microbialcontamination&Spoilage,Foodpreservation. <b>IndustrialProductionof Penicillin..</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                |                   |
| <b>Unit-II</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>12Lectures</b> |
| Introductiontoplanttissueculture,Nutritionalrequirements,In vitroculture.Singlecellculture, Antherculture,Ovuleculture,Somaticembryogenesis,OrganogenesisProtoplastculture,Somatic hybridization, <b>Genetic manipulation of plants using Agrobacterium tumefaciens</b>                                                                                                                                                                                                                                                                                      |                   |
| <b>Unit-III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>10Lectures</b> |
| Immunity- Innate and Acquired, Cells of Immune system, Vaccines and its types .Antigens- Propertiesandtypes. Immunoglobulin-Structure,typesand functions.,PrimaryandSecondary response, HistoryEquipmentandmaterialsforanimalcellculturetechnology. Physicalrequirementfor animal cell and their growth curve inculture.<br><br><b>Applications of animal biotechnology: Methods of Transfection and cell fusion of animal cells, Selectablemarkers,HATselection,Transgenicanimals,Stemcellculture.,Bioreactorsforlargescale production of animal cells.</b> |                   |
| <b>Unit-IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>12Lectures</b> |
| FermentationTechnology,Primaryand Secondary.ScreeningandStrainImprovement. Industrial Sterilization process, Scale-up and Harvest andRecovery. Typesoffermentation— batch,continuousandfed batchprocess.Basicdesignofafermenterand factors affecting fermentation, design.Types offermenters.                                                                                                                                                                                                                                                                |                   |
| <b>Unit-V</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>16Lectures</b> |
| Environment:Basicconcept,Significance,Environmentalpollution,Assessmentofwaterquality, Treatmentofwaste-water— <b>Primary,secondaryandtertiarytreatment. Biofertilizers - Nitrogenfixers,PSB,Mycorrhizaand VAM</b>                                                                                                                                                                                                                                                                                                                                           |                   |

## BOOKS:

1. MolecularBiologyofthecell,2002:Albert'setal
2. Thecell:Amolecularapproach:J.M.Cooper
3. Cellbiology:P.S.VermaandV.K.Agarval
4. CellandMolecularBiology:P.K.Gupta
5. ExperimentsinBiotechnology:NighojkarandNighojkar
6. ApracticalbookofMolecularBiologyandImmunology;2017:P.K.Singhetal

## Course Outcomes of Applied Biotechnology

Upon successful completion of the **Applied Biotechnology** course, students will be able to:

1. **Demonstrate an Understanding of Biotechnology Principles**
  - Explain the fundamental concepts and applications of biotechnology in various fields.
2. **Apply Genetic Engineering and Recombinant DNA Technology**
  - Utilize gene cloning, vector systems, and genome editing techniques like CRISPR for biotechnological advancements.
3. **Analyze the Role of Biotechnology in Healthcare**
  - Evaluate the development and application of biopharmaceuticals, vaccines, gene therapy, and molecular diagnostics.
4. **Utilize Biotechnology for Agricultural Improvement**
  - Explain the benefits of genetically modified organisms (GMOs), biofertilizers, and pest-resistant crops.
5. **Implement Industrial Biotechnology and Bioprocessing Techniques**
  - Apply fermentation, enzyme engineering, and biomanufacturing techniques for industrial applications.

[illegible]

## BIOTECHNOLOGY-VIPRACTICALS

**MAX.MARKS:50**

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**No.ofLaboratoryperWeek:06Hours**

1. EffectofUVradiationonmicrobialcell
2. Demonstrationofrepairmechanism*in*microbes.
3. Bacteriophage**and**determinationoflatentperiodofinfection
4. ElutionofDNAfromagarosegelband.
5. TransformationinE-colicell.
6. Growthofplanttissueintoundifferentiatedmassofcallus.
7. Preparationofanimalcellculturemedia.
8. Separationandcultureoflymphocytefromblood.
9. Demonstrationofferment.
10. Preparationofwine.
11. DemonstrationofPCR.

# **BSC-201:INFORMATIONTECHNOLOGYANDAPPLICATION**

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## **IntroductiontoComputers**

Introduction, Characteristics of computers, Evolution of computers, Generation of Computers, ClassificationofComputers,TheComputerSystem,ApplicationsofComputers.

## **Input/OutputdevicesandMemory**

Introduction, Keyboard, Pointing Devices, Speech Recognition, Digital Camera, Scanners, Optical Scanners.ClassificationofOutput,Printers,Plotters,ComputerOutputMicrofilm (COM), Monitors, Audio Output, Projectors. Random Access Memory(RAM), Types ofRAM,Read Only Memory(ROM),TypesofROM.ClassificationofSecondaryStorageDevices.

## **SoftwareConcepts**

Introduction to Software, Relationship between Software and Hardware, System Software, ApplicationSoftwareanditstypes,UtilitySoftware,Algorithm,Flowchart,Program,and Pseudocode(P-Code).FeaturesofaGoodProgrammingLanguage.

## **DataCommunicationandComputerNetwork**

Introduction, Data Communication, Transmission Media, Multiplexing, Switching, Computer Network,NetworkTopologies,CommunicationProtocols,Networkdevices.

WorldWideWeb,Hypertext,UniformResourceLocator,WebBrowsers,IPAddress,DomainName, Internet Services Providers, Internet Security,Internet Requirements, Web Search Engine, Net Surfing, InternetServices

**MS-Office**–MS-Word,MS-Excel,Ms-PowerPoint.

## **TextBooks:**

1. V.Rajaraman,FundamentalsOfComputers,3rdEdition,PHIPublications
2. NasibS.Gill,EssentialsofComputer&NetworkTechnology,KhannaPublications.
3. DeepakBharihoke,FundamentalsofInformationTechnology,ExcelBooks.

## **ReferenceBook:**

1. RajaramanV.–FundamentalofComputers,PrenticeHallofIndiaPvt.Ltd.,NewDelhi–2nd edition,1996.

## BSC-202:PROGRAMMING IN C

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**Fundamentals of C:** History of Programming language. Identifier and keywords - data types - constants-Variables-Declarations-Expressions-Statements-Arithmetic,Unary,Relational andlogical,AssignmentandConditionalOperators-Libraryfunctions.SimpleCprograms- Flowofcontrol-if,if-else,while,do-while,forloop,Nestedcontrolstructures-Switch,break and continue, goto statements-Commaoperator.

**Functions-**Definition-prototypes–types-Passingarguments–Recursionanditstypes-Storage Classes-Automatic,External,Static,GlobalandRegisterVariables.

**Arrays-**DefiningandProcessing -Passingarraystofunctions -Multi-dimensionarrays-Arraysand Strings.

**Structuresandunions-**Userdefineddatatypes-Passingstructurestofunctions-Self-referentialstructures- Unions - Bit wise operations.

**Pointers-**Declarations-Passingpointerstofunctions-OperationonPointers-PointerandArrays.

**Files:**FileHandlinginCUsingFilePointers,Openafileusingthefunctionfopen(),Closeafileusingthefunctionfclose(),InputandOutputusingfilepointers,CharacterInputand Outputin Files,StringInput/OutputFunctions,FormattedInput/OutputFunctions,Block Input/OutputFunctions,SequentialVsRandomAccessFiles,PositioningtheFilePointer.

### **TextBook:**

1. E.BalaguruSwamy-ANSICProgrammingLanguage,2ndEdition,PHI,1988.
2. KanetkarY.,LetusC,BPBPub.,NewDelhi,1999.
3. ReemaThareja-ProgramminginC

### **ReferenceBook:**

1. H.Schildt,C:TheCompleteReference,4thEdition,TMHEdition,2000.
2. ByronGotfried–CProgramming;OxfordUniversityPress

## BSC-203:DATASTRUCTUREUSINGC

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PrimitiveandCompositeDataTypes,TimeandSpaceComplexityofAlgorithms,StackandPrimitive  
OperationonStack.Applications-Infix,Postfix,PrefixandRecursion.Queues, Primitive  
OperationsonQueues,CircularQueue,DeQueueandPriorityQueue.

**Linked List:** BasicOperation on Linked List, Circular Linked List,Doubly Linked List, Linked  
RepresentationofStackandQueue,ApplicationofLinkedList.

**Trees:** Basic Terminology, Binary Trees, Tree Representation as Array and Linked List, Basic  
OperationonBinaryTree,TraversalofBinaryTree–InOrder,Preorder,PostOrder,Application  
ofBinaryTree,ThreadedBinaryTree,B-TreeandHeightBalanceTree(AVL).

**Sorting&Searching:** SequentialSearch,BinarySearch,InsertionSort,SelectionSort,Quick  
Sort,BubbleSort,HeapSort,andComparisonofSortingMethods.

**Graph:** Introduction to Graphs, Definition, Terminology, Directed, Undirected, Weighted Graph,  
Representation of Graphs, Graph Traversal – Depth First and Breadth First, Spanning Trees,  
MinimumSpanningTrees,ShortestPathAlgorithm.

### TextBook:

1. ExpertDataStructurewith‘C’ByR.BPatel(KhannaBookPublishingCo.(P))
2. DatastructureByLipschutz(TataMcGrawHill)
3. DataStructureByYashvantKanitkar(BPB)

### ReferenceBook:

1. AnIntroductiontoDataStructureswithApplications,ByJean-PaulTremblay,Paul  
G.Sarerson (Tata McGrawHill)
2. DataStructureUsingCandC++ByYedidyahlangsam,MosheJ.Augenstein,AroraM.  
Tenenbaum (Prentice- HallIndia)

## BSC-204OBJECTORIENTEDPROGRAMMINGUSINGJAVA

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**Introduction to java:** evolution, features, comparison with C and C++; Java program structure; tokens, keywords, constants, variables, data types, type casting, statements, Operators and Expression; Conditional Statements and Loop Statements.

**Class:** syntax, instance variable, class variables, methods, constructors, overloading of constructors and methods. Arrays, Strings and Vectors.

**Inheritance:** types of inheritance, use of super, method overriding, final class, abstract class, wrapper classes. Interface, Packages and visibility controls.

**Errors and Exceptions:** Types of errors, Exception classes, Exception handling in java, use of try, catch, finally, throw and throws. Taking user input, Command line arguments.

**Multithreaded Programming:** Creating Threads, Lifecycle of thread, Thread priority, Thread synchronization, Inter-thread communication, implementing the Runnable Interface;

**Applet:** Applet Life Cycle, Applet Tag, Adding Applet to HTML File; Passing Parameters to Applets, Getting Input From User. **AWT :** AWT Classes, Working With Frame Windows, Working With Graphics, Working With Colour, Adding And Removing Controls, Responding To Controls, Labels, Buttons, Checkbox, Checkbox Group, Choice Control, Lists, Text Field, Text Area. Menus, Dialog Box, Handling Events.

### Text Book:

1. Java: A Beginner's Guide, Sixth Edition: A Beginner's Guide by Herbert Schildt, McGraw-Hill Osborne Media
2. Programming in Java By E. Balagurusamy (TMH)
3. JAVA 2 programming Black Book By Steven Holzner et al. (Dreamtech Press)

### Reference Book:

1. The Complete reference Java Ninth Edition By Herbert Schildt (Tata McGraw Hill)
2. Core Java Volume I--Fundamentals (9th Edition) by Cay S. Horstmann, Gary Cornell, Prentice Hall

## **BSC-205:DATABASEMANAGEMENTSYSTEM**

Introduction: Characteristics of database approach, Advantages, Database system architecture, Overview of different types of Data Models and data independence, Schemas and instances, Databaselanguagesandinterfaces; E-R Model: Entities, Attributes, keys, Relationships, Roles, Dependencies, E-R Diagram.

Introduction to Relational model, Constraints: Domain, Key, Entity integrity, Referential integrity; Keys: Primary, Super, Candidate, Foreign; Relational algebra: select, project, union, intersection, crossproduct, different types of join operations.

SQL: Data Types, statements: select, insert, update, delete, create, alter, drop; views, SQL algebraic operations; Stored procedures: Advantages, Variables, creating and calling procedures, if and case statements, loops, Functions, Triggers.

Normalization: Definition, Functional dependencies and inference rules, 1NF, 2NF, and 3NF; Transactions processing: Definition, desirable properties of transactions, serial and non-serial schedules, concept of serializability, conflict-serializable schedules.

Concurrency Control: Two-phase locking techniques, dealing with Deadlock and starvation, deadlock prevention protocols, basic timestamp ordering algorithm; Overview of database recovery techniques; concept of data warehousing.

### **TextBook:**

1. Database System Concepts By Korth, Silberschatz, Sudarshan (Mcgraw Hill)
2. An Introduction to Database Systems By Bipin C. Desai (Galgotia Publication.)
3. SQL, PL/SQL Programming By Ivan Bayross (BPB)
4. Commercial Application Development Using Oracle Developer 2000 By Ivan Bayross (BPB)

### **ReferenceBook:**

1. Fundamentals of Database Systems, Ramez A. Elmasri, Shamkant Navathe, 5<sup>th</sup> Ed (Pearson)

## BSC-206:PYTHONPROGRAMMING

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OverviewofProgramming:StructureofaPythonProgram,PythonInterpreter,UsingPythonascalculator, Python shell, Indentation. Atoms, Identifiers and keywords, Literals, Strings,Operators(Arithmetic operator,Relationaloperator,LogicalorBooleanoperator,Assignment,Operator,Ternaryoperator, Bitwiseoperator,IncrementorDecrementoperator).

Creating Python Programs: Input and Output Statements, Control statements (Branching,Looping, Conditional Statement, Exit function, Difference between break, continue), Defining Functions, defaultarguments, ErrorsandExceptions.

IterationandRecursion:Conditional execution, Alternative execution,Nested conditionals,The return statement, Recursion, Stackdiagramsfor recursive functions, Multipleassignment, The while statement, Implementing 2-Dmatrices.

StringsandLists:Stringasacompounddatatype,Length,Traversalandtheforloop,String slices,Stringcomparison,Loopingandcounting,Listvalues,Accessingelements,Listlength, Listmembership,Listsandforloops,Listoperations,Listdeletion.Cloninglists,Nestedlists.

Object Oriented Programming: Introduction to Classes, Objects and Methods, Standard Libraries. Overview of stacks andqueues.

### TextBooks:

1. T.Budd,ExploringPython,TMH,1stEd,2011
2. Introductiontocomputationandprogrammingpython,byJohnGuttag,MITPress.
3. LearningPython,LutzandAscher,O'Reillypublications

### WebResources:

1. [http://files.swaroopch.com/python/byte\\_of\\_python.pdf](http://files.swaroopch.com/python/byte_of_python.pdf)
2. <https://www.cs.uky.edu/~keen/115/Haltermanpythonbook.pdf>
3. <http://greenteapress.com/thinkpython/thinkpython.pdf>
4. [Pythontutorials:https://docs.python.org/3/tutorial/index.html](https://docs.python.org/3/tutorial/index.html)

# BSC-301–PHARMACHEMISTRY-I

## INORGANIC CHEMISTRY

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### Scope:

This subject deals with the monographs of inorganic drugs and pharmaceuticals. General discussion on the following inorganic compounds including important physical and chemical properties, medicinal and pharmaceutical uses and storage conditions.

### Unit-I

**Impurities in pharmaceutical substances:** History of Pharmacopoeia, Sources and types of impurities, principle involved in the limit test for Chloride, Sulphate, Iron, Arsenic, Lead and Heavy metals,

**Acids, Bases and Buffers:** Acid-base theories, Buffer equations and buffer capacity in general, buffers in pharmaceutical systems, preparation, stability, buffered isotonic solutions, measurements of tonicity, calculations and methods of adjusting isotonicity. Boric acid, Ammonium hydroxide, Hydrochloric acid and official buffers.

### UNIT-II

#### Gastrointestinal agents

Acidifiers: Ammonium chloride and Dil. HCl

Antacid: Ideal properties of antacids, combinations of antacids, Sodium Bicarbonate, Aluminum hydroxide gel, Magnesium hydroxide mixture, Aluminum phosphate, Calcium carbonate, Combinations of antacid preparations.

Cathartics: Magnesium sulphate, Sodium potassium tartrate

#### Topical agents

Antimicrobials & Astringents: Mechanism, classification, Potassium permanganate, Hydrogen peroxide, Chlorinated lime, Iodine and its preparations, Borax, Silver nitrate, Ammoniated mercury, Mercuric oxide, Zinc Sulphate, Potash Alum

### **UNIT III**

#### **Major extra and intracellular electrolytes**

Functions of major physiological ions, Electrolytes used in the replacement therapy: Sodium chloride & its preparation, Potassium chloride, Calcium gluconate, Sodium lactate injection, Potassium citrate and Oral Rehydration Salt (ORS), Physiological acid base balance.

### **UNIT IV**

#### **Expectorants & Emetics**

Potassium iodide, Ammonium chloride, Copper sulphate, Antimony potassium tartrate

#### **Haematinics**

Ferrous sulphate, Ferrous gluconate

#### **Poison and Antidote**

Sodium thiosulphate, Activated charcoal, Sodium nitrite

### **UNIT V**

#### **Radiopharmaceuticals**

Radioactivity, Measurement of radioactivity, Properties of  $\alpha$ ,  $\beta$ ,  $\gamma$  radiations, Half life, radioisotopes and study of radio isotopes - Sodium iodide I131 , Storage conditions, precautions & pharmaceutical application of radioactive substances. Radioopaque contrast media - Barium sulfate.

### **PRACTICAL**

1. Limit test for Chloride, Sulfate, Arsenic, Iron and Heavy metals.
2. Identification tests for inorganic compounds particularly drugs and pharmaceuticals.
3. Estimation of Fe(II) ions by titrating it with  $K_2Cr_2O_7$ .
4. Estimation of Cu(II) ions iodometrically using  $Na_2S_2O_3$ .
5. Estimation of sodium carbonate and sodium bicarbonate present in a mixture.

#### **Recommended Books**

6. Inorganic pharmaceutical chemistry, Anand & Chatwal.
7. Vogel's Quantitative Chemical Analysis, A.I. Vogel, Prentice Hall, 6th Edition.
8. J.D. Lee: A new Concise Inorganic Chemistry, E.L.B.S.
9. F.A. Cotton & G. Wilkinson: Basic Inorganic Chemistry, John Wiley.
10. Douglas, McDaniel and Alexander: Concepts and Models in Inorganic Chemistry, John Wiley

# **BSC-302–PHARMACHEMISTRY-II**

## **BIO-CHEMISTRY&METABOLISM**

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### **Unit-I**

Amino acid & Proteins: Structure and properties of Amino acids, Types of Proteins and their Classification, Forces stabilizing protein structure and shape. Different levels of structural organization of proteins, Fibrous and globular proteins. Carbohydrates: Structure, Function and properties of Monosaccharides, Disaccharides and Polysaccharides. **Homo & Heteropolysaccharides, Mucopolysaccharides, Bacterial cell wall polysaccharides, Glycoproteins and their biological functions.**

### **UNIT-II**

Lipids: Structure and functions Classification, nomenclature and properties of fatty acids, essential fatty acids. Phospholipids, Sphingolipids, Glycolipids, Cerebrosides, Gangliosides, Prostaglandins, Cholesterol.

### **UNIT-III**

Nucleic acids: Structure and functions: Physical & chemical properties of Nucleic acids, Nucleosides & Nucleotides, Purines & Pyrimidines. **Biologically important nucleotides, Double helical model of DNA structure and forces responsible for A, B & Z DNA.**

### **UNIT-IV**

Enzymes: Nomenclature and classification of Enzymes, **Holoenzyme, apoenzyme, Cofactors, coenzyme, prosthetic groups, Enzyme activity, Specific activity, Common feature of active sites, Enzyme specificity.**

### **UNIT-V**

Carbohydrates Metabolism: Reactions, energetic and regulation. Glycolysis: Fate of pyruvate under aerobic and anaerobic conditions. Pentose phosphate pathway and its significance, Gluconeogenesis, Glycogenolysis and glycogen synthesis. TCA cycle, Electron transport chain, Oxidative phosphorylation, Beta-oxidation of fatty acids.

## **PRACTICAL**

1. To study activities of any enzyme under optimum conditions.
2. To study the effect of pH, temperature on the activity of salivary amylase enzyme.
3. Determination of pH optima, temperature optima,  $K_m$  value,  $V_{max}$  value, Effect of inhibitor (Inorganic phosphate) on the enzyme activity.
4. Estimation of blood by glucose oxidase method. item Principles of Colorimetry: (i) Verification of Beers Lambert's law, estimation of protein. (ii) To study relation between absorbance and % transmission.
5. Preparation of buffers.
6. Separation of Amino acids by paper chromatography.
7. Qualitative tests for Carbohydrates and lipids.
8. Qualitative estimation of proteins.

## **Recommended Books**

1. Nelson, D.L., Cox, M.M. (2004) Lehninger Principles of Biochemistry, 4th Edition, W.H. Freeman and Company, New York, USA.
2. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H. Freeman and Co.
3. Harper's Illustrated Biochemistry (Harper's Biochemistry) by Robert K. Murray, Darryl K. Granner, Peter A. Mayes, and Victor W. Rodwell.
4. Fundamentals of Biochemistry. Life at the molecular level (Fourth Edition) by Donald Voet, Judith G. Voet and Charlotte W. Pratt. Wiley 2010.
5. Biophysical Chemistry, Principles & Techniques—Upadhyay, Upadhyay & Nath—Himalaya Publ.
6. Biochemistry, 4th edition by U.S. Satyanarayana and U. Chakrapani, Elsevier India

# BSC-303–PHARMACHEMISTRY-III

## ORGANICCHEMISTRY

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### Unit-I

#### **AtomicStructure**

Review of: Bohrs theoryanditslimitations, dual behaviour of matter andradiation, de-Broglies relation,Heisenberg Uncertaintyprinciple.Hydrogenatomspectra.Quantummechanics. Radial and angularpartsofthehydrogenicwavefunctions(atomicorbitals)andtheirvariationsfor1s,2s, 2p, 3s,3pand 3d orbitals(Only graphical representation). Significance ofquantum numbers. Spin quantumnumber(s)and magnetic spin quantumnumber(ms).Rulesfor filling electronsin various orbitals,Electronicconfigurationsoftheatoms.Stabilityofhalf-filledandcompletelyfilled orbitals,conceptofexchangeenergy.Relativeenergiesofatomicorbitals.

### Unit-

#### **IIChemicalandMolecularStructure**

IonicBonding:General characteristicsofionicbonding.Energy considerationsin ionicbonding, lattice energyand solvation energy and their importance in the context of stability and solubilityof ionic compounds.Statement of Born-Land equation for calculation of lattice energy, Born- Haber cycleanditsapplications, polarizingpowerandpolarizability.Fajansrules,ioniccharacter in covalent compounds, dipole moment .Covalent bonding: VB Approach: Shapes of some inorganicmoleculesandionsonthebasis ofVSEPRandhybridization with suitable examplesof linear, trigonalplanar,squareplanar,tetrahedral,trigonalbipyramidalandoctahedral arrangements. Concept of resonance and resonating structures in various inorganic and organiccompounds.

## **Unit-**

### **III Fundamentals of Organic Chemistry**

Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis. Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals. Strength of organic acids and bases. Aromaticity: Huckel's rule.

## **Unit-**

### **IV Stereochemistry**

Conformations with respect to ethane, butane and cyclohexane. Fischer representations. Concept of chirality (upto two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Mesocompounds). D and L; cis-trans nomenclature. Racemic modification and resolution of a racemic mixture.

## **Unit-**

### **V Aliphatic Hydrocarbons**

Preparations & reactions Alkanes: (Upto 5 Carbons). Preparation: Catalytic hydrogenation, Wurtz reaction, Kolbess synthesis, from Grignard reagent. Reactions: Free radical Substitution: Halogenation. Alkenes: (Upto 5 Carbons) Preparation: Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) Birch reduction. Reactions: cis-addition (alk.  $\text{KMnO}_4$ ) and trans-addition (bromine), Markownikoff's and anti-Markownikoff's rule, Hydration, Ozonolysis, Alkynes: (Upto 5 Carbons) Preparation: Acetylene from  $\text{CaC}_2$  and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides. Reactions: formation of metal acetylides, addition of bromine and alkaline  $\text{KMnO}_4$ , ozonolysis.

## **PRACTICAL**

1. Detection of extra elements (N, S, Cl, Br, I) in inorganic compounds (containing up to two extra elements).
2. Experiments involving laboratory techniques - Recrystallization, Steam distillation.

## **Recommended Books**

1. Vogel's Qualitative Inorganic Analysis, A.I. Vogel, Prentice Hall, 7th Edition.
2. Vogel's Quantitative Chemical Analysis, A.I. Vogel, Prentice Hall, 6th Edition.
3. Textbook of Practical Organic Chemistry, A.I. Vogel, Prentice Hall, 5th edition.
4. Practical Organic Chemistry, F.G. Mann & B.C. Saunders, Orient Longman, 1960.

# BSC-304–PHARMACHEMISTRY-IV

## PHARMACEUTICAL ANALYSIS

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### Scope

This course deals with the fundamentals of analytical chemistry and principles of electrochemical analysis of drugs.

### Unit-I

#### a) **Pharmaceutical analysis:** Definition and scope

- i) Different techniques of analysis
- ii) Methods of expressing concentration
- iii) Primary and secondary standards.
- iv) Preparation and standardization of various molar and normal solutions - Oxalic acid, sodium hydroxide, hydrochloric acid, sodium thiosulphate, sulphuric acid, potassium permanganate and ceric ammonium sulphate
- v) **Errors:** Sources of errors, types of errors, methods of minimizing errors, accuracy, precision and significant figures.

### UNIT-II

#### **Acid base titration**

Theories of acid base indicators, classification of acid base titrations and theory involved in titration of strong, weak, and very weak acids and bases neutralization curves.

#### **Nonaqueous titration**

Solvents, acidimetry and alkalimetry titration and, estimation of Sodium benzoate and Ephedrine HCl

### **UNIT-III**

#### **Complexometric titration**

Classification, metal ion indicators, masking and demasking reagents, estimation of Magnesium sulphate, and calcium gluconate.

#### **Gravimetry**

Principle and steps involved in gravimetric analysis. Purity of the precipitate: co-precipitation and post precipitation, Estimation of barium sulphate. Basic Principles, methods and application of diazotization titration

### **UNIT-IV**

#### **Redox titrations**

- (a) Concepts of oxidation and reduction
- (b) Types of redox titrations (Principles and applications) Cerimetry, Iodimetry, Iodometry, Bromatometry, Dichrometry, and Titration with potassium iodate.

### **UNIT-V**

#### **Electrochemical methods of analysis**

##### **Conductometry**

Introduction, Conductivity cell, Conductometric titrations, applications

##### **Potentiometry**

Electrochemical cell, construction and working of reference (Standard hydrogen, silver chloride electrode and calomel electrode) and indicator electrodes (metal electrodes and glass electrode), methods to determine endpoint of potentiometric titration and applications.

##### **Polarography**

Principle, Ilkovic equation, construction and working of dropping mercury electrode and rotating platinum electrode, applications.

## **PRACTICAL**

### **I. Preparation and standardization of**

- (1) Sodium hydroxide
- (2) Sulphuric acid
- (3) Sodium thiosulfate
- (4) Potassium permanganate
- (5) Cerium ammonium sulphate

### **II. Assay of the following compounds along with Standardization of Titrant**

- (1) Ammonium chloride by acid-base titration
- (2) Ferrous sulphate by Cerimetry
- (3) Copper sulphate by Iodometry
- (4) Calcium gluconate by complexometry
- (5) Hydrogen peroxide by Permanganometry

## **Recommended Books**

1. A.H. Beckett & J.B. Stenlake's, Practical Pharmaceutical Chemistry Vol I & II, Stahlone Press of University of London
2. A.I. Vogel, Text Book of Quantitative Inorganic analysis
3. P. Gundu Rao, Inorganic Pharmaceutical Chemistry
4. Bentley and Driver's Textbook of Pharmaceutical Chemistry
5. John H. Kennedy, Analytical chemistry principles

# BSC-305–PHARMACHEMISTRY-V

## PHARMACEUTICAL QUALITY ASSURANCE

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### Scope

This course deals with the various aspects of quality control and quality assurance aspects of pharmaceutical industries. It deals with the important aspects like cGMP, QC tests, documentation, quality certifications and regulatory affairs.

### UNIT-I

#### Quality Assurance and Quality Management concepts

Definition and concept of Quality control, Quality assurance and GMP

#### Total Quality Management (TQM)

Definition, elements, philosophies

#### ICH Guidelines

Purpose, participants, process of harmonization, Brief overview of QSEM, with special emphasis on Q-series guidelines, ICH stability testing guidelines

#### Quality by design (QbD)

Definition, overview, elements of QbD program, tools

#### ISO 9000 & ISO 14000

Overview, Benefits, Elements, steps for registration

### UNIT-II

#### Organization and personnel

Personnel responsibilities, training, hygiene and personal records.

#### Premises

Design, construction and plant layout, maintenance, sanitation, environmental control, utilities and maintenance of sterile areas, control of contamination.

#### Equipments and raw materials

Equipment selection, purchase specifications, maintenance, purchase specifications and maintenance of stores for raw materials.

### **UNIT-III**

#### **QualityControl**

Qualitycontroltestforcontainers,rubberclosuresandsecondarypackingmaterials.

#### **GoodLaboratoryPractices**

General Provisions, Organization and Personnel, Facilities, Equipment, Testing Facilities Operation, Test and Control Articles, Protocol for Conduct of a Nonclinical LaboratoryStudy, RecordsandReports,DisqualificationofTestingFacilities.

### **UNIT-IV**

#### **Complaints**

Complaintsandevaluationofcomplaints,Handlingofreturngood,recallingandwastedisposal.

#### **Documentmaintenanceinpharmaceuticalindustry**

Batch Formula Record, Master FormulaRecord, SOP,Qualityaudit,QualityReviewand Qualitydocumentation,Reportsanddocuments,distributionrecords.

### **UNIT-V**

#### **CalibrationandValidation**

Introduction, definition and general principles of calibration, qualification and validation, importanceandscopeofvalidation,typesofvalidation,validationmasterplan.Calibrationof pH meter, Qualification of UV-Visible spectrophotometer, General principles of Analytical method Validation.

## **Recommended Books**

1. Quality Assurance Guide by organization of Pharmaceutical Products of India.
2. Good Laboratory Practice Regulations, 2nd Edition, Sandy Weinberg Vol. 69.
3. Quality Assurance of Pharmaceuticals - A compendium of Guidelines and related materials Vol I WHO Publications.
4. A guide to Total Quality Management - Kushik Maitra and Sedhan K Ghosh
5. How to Practice GMP's - P P Sharma.
6. ISO 9000 and Total Quality Management - Sadhan K Ghosh.
7. The International Pharmacopoeia - Vol I, II, III, IV - General Methods of Analysis and Quality specification for Pharmaceutical Substances, Excipients and Dosage forms
8. Good laboratory Practices - Marcel Dekker Series
9. ICH guidelines, ISO 9000 and 14000 guidelines

# **BSC-306–PHARMACHEMISTRY-VI**

## **PHARMACEUTICAL REGULATORY SCIENCE**

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### **Scope**

This course is designed to impart the fundamental knowledge on the regulatory requirements for approval of new drugs, and drug products in regulated markets of India & other countries like US, EU, Japan, Australia, UK etc. It prepares the students to learn in detail on the regulatory requirements, documentation requirements, and registration procedures for marketing the drug products.

### **Unit I**

New Drug Discovery and development Stages of drug discovery, Drug development process, pre-clinical studies, non-clinical activities, clinical studies, Innovator and generics, Concept of generics, Generic drug product development.

### **Unit II**

Regulatory Approval Process Approval processes and timelines involved in Investigational New Drug (IND), New Drug Application (NDA), Abbreviated New Drug Application (ANDA). Change to an approved NDA / ANDA.

### **Unit III**

Registration of Indian drug product in overseas market Procedure for export of pharmaceutical products, Technical documentation, Drug Master Files (DMF), Common Technical Document (CTD), electronic Common Technical Document (eCTD), ASEAN Common Technical Document (ACTD) research.

### **Unit IV**

Clinical trials Developing clinical trial protocols, Institutional Review Board / Independent Ethics committee - formation and working procedures, Informed consent process and procedures, GCP obligations of Investigators, sponsors & Monitors, Managing and Monitoring clinical trials, Pharmacovigilance-safety monitoring in clinical trials.

## **Unit V**

Regulatory Concepts Basic terminology, guidance, guidelines, regulations, Laws and Acts, Orange book, Federal Register, Code of Federal Regulations, Purple book.

### **Recommended Books**

1. Drug Regulatory Affairs by Sachin Itkar, Dr. N. S. Vyawahare, Nirali Prakashan.
2. The Pharmaceutical Regulatory Process, Second Edition Edited by Ira R. Berry and Robert P. Martin, Drugs and the Pharmaceutical Sciences, Vol. 185. Informa Healthcare Publishers.
3. New Drug Approval Process: Accelerating Global Registrations By Richard A Guarino, MD, 5th edition, Drugs and the Pharmaceutical Sciences, Vol. 190.
4. Guidebook for drug regulatory submissions/Sandy Weinberg. By John Wiley & Sons. Inc.
5. FDA Regulatory Affairs: a guide for prescription drugs, medical devices, and biologics / edited by Douglas J. Pisano, David Mantus.
6. Generic Drug Product Development, Solid Oral Dosage forms, Leon Shargel and Isader Kaufer, Marcel Dekker series, Vol. 143
7. Clinical Trials and Human Research: A Practical Guide to Regulatory Compliance By Fay A. Rozovsky and Rodney K. Adams
8. Principles and Practices of Clinical Research, Second Edition Edited by John I. Gallin and Frederick P. Ognibene
9. Drugs: From Discovery to Approval, Second Edition By Rick Ng

**CURRICULUM ARTICULATE MATRIX:**

| CO  | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| CO1 | 2   | 2   | 3   | 0   | 2   | 2   | 3   | 0   | 1   | 0    |
| CO2 | 3   | 1   | 1   | 2   | 0   | 3   | 1   | 2   | 3   | 1    |
| CO3 | 2   | 3   | 1   | 1   | 3   | 0   | 2   | 1   | 3   | 2    |
| CO4 | 1   | 1   | 2   | 1   | 1   | 1   | 1   | 3   | 2   | 3    |
| CO5 | 1   | 2   | 1   | 1   | 3   | 2   | 1   | 1   | 1   | 1    |
|     | 1.8 | 1.8 | 1.6 | 1   | 1.8 | 1.6 | 1.6 | 1.4 | 2   | 1.4  |

| CO  | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| CO1 | 1   | 3   | 2   | 2   | 1   | 1   | 1   | 0   | 2   | 2    |
| CO2 | 2   | 0   | 1   | 1   | 0   | 2   | 2   | 2   | 1   | 1    |
| CO3 | 3   | 4   | 1   | 2   | 2   | 1   | 3   | 1   | 2   | 2    |
| CO4 | 1   | 2   | 3   | 1   | 1   | 2   | 1   | 2   | 2   | 1    |
| CO5 | 2   | 1   | 0   | 3   | 1   | 1   | 0   | 3   | 1   | 1    |
| AVR | 1.8 | 2   | 1.4 | 1.8 | 1   | 1.4 | 1.4 | 1.6 | 1.6 | 1.4  |

| CO  | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| CO1 | 1   | 3   | 1   | 1   | 1   | 1   | 1   | 0   | 2   | 2    |
| CO2 | 2   | 1   | 1   | 2   | 1   | 2   | 2   | 1   | 1   | 1    |
| CO3 | 3   | 3   | 1   | 1   | 1   | 2   | 2   | 2   | 2   | 2    |
| CO4 | 1   | 1   | 3   | 1   | 0   | 2   | 1   | 2   | 2   | 1    |
| CO5 | 1   | 1   | 0   | 3   | 2   | 1   | 0   | 3   | 1   | 1    |
| AVR | 1.6 | 1.8 | 1.4 | 1.6 | 1   | 1.6 | 1.2 | 1.6 | 1.6 | 1.4  |

| CO  | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| CO1 | 3   | 3   | 3   | 0   | 2   | 2   | 3   | 0   | 1   | 0    |
| CO2 | 2   | 2   | 1   | 2   | 0   | 3   | 1   | 2   | 3   | 1    |
| CO3 | 2   | 3   | 0   | 1   | 3   | 0   | 2   | 1   | 3   | 2    |
| CO4 | 1   | 1   | 2   | 1   | 1   | 1   | 1   | 3   | 2   | 3    |
| CO5 | 1   | 2   | 1   | 1   | 3   | 2   | 1   | 1   | 1   | 1    |
|     | 1.8 | 2.0 | 1.5 | 1   | 1.8 | 1.6 | 1.6 | 1.4 | 2   | 1.4  |

| CO  | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| CO1 | 1   | 3   | 1   | 2   | 1   | 0   | 1   | 0   | 2   | 2    |
| CO2 | 1   | 2   | 1   | 1   | 0   | 1   | 2   | 2   | 2   | 1    |

| CO  | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| CO1 | 2   | 2   | 3   | 0   | 2   | 2   | 3   | 0   | 1   | 0    |
| CO2 | 3   | 1   | 1   | 2   | 0   | 3   | 1   | 2   | 3   | 1    |
| CO3 | 2   | 3   | 1   | 1   | 3   | 0   | 2   | 1   | 3   | 2    |
| CO4 | 1   | 1   | 2   | 1   | 1   | 1   | 1   | 3   | 2   | 3    |
| CO5 | 1   | 2   | 1   | 1   | 3   | 2   | 1   | 1   | 1   | 1    |
|     | 1.8 | 1.8 | 1.6 | 1   | 1.8 | 1.6 | 1.6 | 1.4 | 2   | 1.4  |
| CO3 | 2   | 1   | 3   | 3   | 2   | 1   | 1   | 1   | 1   | 2    |
| CO4 | 1   | 1   | 1   | 1   | 1   | 2   | 1   | 2   | 1   | 1    |
| CO5 | 2   | 1   | 0   | 1   | 1   | 1   | 0   | 3   | 1   | 1    |
| AVR | 1.4 | 1.6 | 1.4 | 1.6 | 1   | 1   | 1   | 1.6 | 1.4 | 1.4  |

| CO  | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| CO1 | 2   | 1   | 2   | 1   | 1   | 1   | 1   | 0   | 2   | 2    |
| CO2 | 1   | 2   | 1   | 1   | 1   | 1   | 2   | 1   | 1   | 1    |
| CO3 | 3   | 2   | 1   | 2   | 2   | 2   | 2   | 2   | 2   | 2    |
| CO4 | 1   | 1   | 3   | 1   | 0   | 2   | 1   | 2   | 2   | 1    |
| CO5 | 1   | 1   | 0   | 3   | 2   | 1   | 0   | 3   | 1   | 1    |
| AVR | 1.6 | 1.4 | 1.4 | 1.6 | 1.2 | 1.4 | 1.2 | 1.6 | 1.6 | 1.4  |

| CO  | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| CO1 | 1   | 3   | 1   | 2   | 1   | 0   | 1   | 0   | 2   | 2    |
| CO2 | 1   | 2   | 1   | 1   | 0   | 1   | 2   | 2   | 2   | 1    |
| CO3 | 2   | 1   | 3   | 3   | 2   | 1   | 1   | 1   | 1   | 2    |
| CO4 | 1   | 1   | 1   | 1   | 1   | 2   | 1   | 2   | 1   | 1    |
| CO5 | 2   | 1   | 0   | 1   | 1   | 1   | 0   | 3   | 1   | 1    |
| AVR | 1.4 | 1.6 | 1.4 | 1.6 | 1   | 1   | 1   | 1.6 | 1.4 | 1.4  |

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|

|     |     |     |     |     |     |     |     |     |     |     |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| CO1 | 3   | 1   | 2   | 1   | 1   | 1   | 1   | 0   | 2   | 2   |
| CO2 | 1   | 2   | 2   | 2   | 1   | 0   | 2   | 1   | 1   | 1   |
| CO3 | 0   | 1   | 1   | 2   | 2   | 2   | 2   | 2   | 2   | 2   |
| CO4 | 1   | 1   | 3   | 1   | 0   | 2   | 1   | 2   | 1   | 1   |
| CO5 | 1   | 1   | 0   | 3   | 2   | 1   | 0   | 2   | 1   | 1   |
| AVR | 1.2 | 1.2 | 1.4 | 1.8 | 1.2 | 1.2 | 1.2 | 1.4 | 1.4 | 1.4 |

|     |     |     |     |     |     |     |     |     |     |      |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| CO  | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
| CO1 | 3   | 2   | 1   | 3   | 1   | 0   | 1   | 0   | 2   | 2    |
| CO2 | 3   | 3   | 3   | 1   | 0   | 2   | 2   | 2   | 2   | 2    |
| CO3 | 1   | 1   | 2   | 3   | 2   | 1   | 2   | 1   | 1   | 1    |
| CO4 | 1   | 1   | 1   | 2   | 1   | 2   | 1   | 2   | 1   | 1    |
| CO5 | 2   | 1   | 0   | 1   | 2   | 1   | 0   | 3   | 1   | 1    |
| AVR | 2   | 1.6 | 1.4 | 2   | 1.2 | 1.2 | 1.2 | 1.6 | 1.4 | 1.4  |

|     |     |     |     |     |     |     |     |     |     |      |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| CO  | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
| CO1 | 2   | 2   | 1   | 3   | 1   | 0   | 1   | 0   | 2   | 2    |
| CO2 | 3   | 2   | 3   | 2   | 0   | 2   | 2   | 2   | 2   | 2    |
| CO3 | 1   | 1   | 1   | 3   | 2   | 2   | 2   | 1   | 1   | 1    |
| CO4 | 1   | 1   | 1   | 2   | 1   | 2   | 1   | 2   | 1   | 1    |
| CO5 | 2   | 1   | 0   | 1   | 2   | 1   | 0   | 3   | 1   | 1    |
| AVR | 1.8 | 1.4 | 1.4 | 2.2 | 1.2 | 1.4 | 1.2 | 1.6 | 1.4 | 1.4  |

|     |     |     |     |     |     |     |     |     |     |      |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| CO  | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
| CO1 | 3   | 1   | 2   | 1   | 1   | 1   | 1   | 0   | 2   | 2    |
| CO2 | 1   | 2   | 2   | 2   | 2   | 0   | 2   | 1   | 1   | 1    |
| CO3 | 2   | 2   | 1   | 3   | 2   | 3   | 2   | 2   | 2   | 2    |
| CO4 | 1   | 1   | 3   | 1   | 0   | 2   | 1   | 2   | 0   | 1    |

|     |     |     |     |   |     |     |     |     |     |     |
|-----|-----|-----|-----|---|-----|-----|-----|-----|-----|-----|
| CO5 | 1   | 1   | 0   | 3 | 2   | 1   | 0   | 2   | 1   | 1   |
| AVR | 1.6 | 1.4 | 1.4 | 2 | 1.4 | 1.4 | 1.2 | 1.4 | 1.2 | 1.4 |

|     |     |     |     |     |     |     |     |     |     |      |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| CO  | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
| CO1 | 3   | 1   | 2   | 1   | 1   | 1   | 1   | 0   | 2   | 2    |
| CO2 | 2   | 2   | 2   | 2   | 2   | 0   | 2   | 1   | 1   | 1    |
| CO3 | 1   | 1   | 1   | 3   | 2   | 3   | 2   | 2   | 2   | 2    |
| CO4 | 1   | 2   | 3   | 1   | 3   | 2   | 2   | 2   | 2   | 1    |
| CO5 | 1   | 1   | 2   | 3   | 2   | 2   | 0   | 2   | 1   | 1    |
| AVR | 1.6 | 1.4 | 1.4 | 2   | 2   | 1.6 | 1.4 | 1.4 | 1.6 | 1.4  |

|     |     |     |     |     |     |     |     |     |     |      |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| CO  | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
| CO1 | 3   | 1   | 2   | 1   | 1   | 1   | 1   | 0   | 2   | 2    |
| CO2 | 2   | 2   | 2   | 2   | 2   | 0   | 2   | 1   | 1   | 1    |
| CO3 | 1   | 1   | 1   | 3   | 2   | 3   | 2   | 2   | 2   | 2    |
| CO4 | 1   | 2   | 3   | 1   | 3   | 2   | 2   | 2   | 2   | 1    |
| CO5 | 1   | 1   | 2   | 3   | 2   | 2   | 0   | 2   | 1   | 1    |
| AVR | 1.6 | 1.4 | 1.4 | 2   | 2   | 1.6 | 1.4 | 1.4 | 1.6 | 1.4  |

|     |     |     |     |     |     |     |     |     |     |      |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| CO  | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
| CO1 | 3   | 1   | 2   | 1   | 1   | 1   | 1   | 0   | 2   | 2    |
| CO2 | 2   | 2   | 2   | 2   | 2   | 0   | 2   | 1   | 1   | 1    |
| CO3 | 3   | 2   | 0   | 3   | 2   | 3   | 2   | 2   | 2   | 2    |
| CO4 | 1   | 2   | 3   | 2   | 2   | 2   | 1   | 3   | 2   | 1    |
| CO5 | 1   | 1   | 2   | 1   | 2   | 2   | 0   | 2   | 1   | 1    |
| AVR | 2   | 1.6 | 1.4 | 1.8 | 1.8 | 1.6 | 1.2 | 1.6 | 1.6 | 1.4  |

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**DSE-3WildLifeconservation&Management**

| CO  | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| CO1 | 2   | 2   | 1   | 3   | 1   | 0   | 1   | 0   | 2   | 2    |
| CO2 | 3   | 2   | 3   | 2   | 0   | 2   | 2   | 2   | 2   | 2    |
| CO3 | 1   | 1   | 2   | 3   | 2   | 2   | 2   | 3   | 2   | 1    |
| CO4 | 1   | 1   | 1   | 2   | 1   | 1   | 1   | 2   | 1   | 2    |
| CO5 | 2   | 1   | 0   | 1   | 2   | 1   | 0   | 3   | 1   | 1    |
| AVR | 1.8 | 1.4 | 1.4 | 2.2 | 1.2 | 1.2 | 1.2 | 2   | 1.6 | 1.6  |

