S. S. Jain Subodh P. G. College, Jaipur
(AUTONOMOUS)

SYLLABUS
(Three Year Undergraduate Programme)

B.Sc. Biotechnology

I to VI Semester examination 2025-28

SCHEME OF EXAMINATION AND COURSES OF STUDY

FACULTY OF SCIENCE

(As per NEP 2020)

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Contents:

1. Eligibility:

10+2 with 48% from Rajasthan Board / CBSE from Rajasthan state and 60% for CBSE or any other equivalent recognized Board from other state in Science Stream with Physics, Chemistry and Biology.

2. Scheme of Examination

Sr. No.	Paper	ESE	CIA	Total
1.	Theory	70%	30%	100%
2.	Practical	60%	40%	100%

Each theory paper syllabus is divided into four units. Each theory paper 3 hours duration. Each Practical /Lab work 4 hours duration

The number of papers and the maximum marks for each paper/ practical shall be shown in the syllabus for the paper concerned. It will be necessary for a candidate to pass in theory part as well as practical part of a subject separately.

Note: Maximum marks for a theory paper is 100 marks which include 70 marks for ESE and 30 marks for internal assessment.

Mark distribution in question paper:
The question paper (EoSE - End of Semester Examination) will consist of two parts A & B
Part - A: 14 Marks
Part A will be compulsory having 10 very short answer-type questions (with a limit of 20 words) of two marks each and candidate can attempt any seven questions.
Part - B: 56 Marks
Part B of the question paper shall be divided into four units comprising question number 2-5. There will be one question from each unit with internal choice. Each question will carry 14 marks.

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Skill Enhancement Courses (SEC)

Credits: 2

Classes per week: 2

Maximum Marks: 50

EoSE: 35

CIA:15

Examination will be of one hour.

Question paper will have multiple choice questions (35 in number).

Each question will be of **1 Mark each.**

Examination will be conducted on **OMR sheet.**

Name of proposed SEC from the upcoming session 2025-26.

Semester I: 101 Computer Fundamentals/104 Business Communication Skills

Semester II: 208 Introduction to Cyber Security/ 105 Effective Communication Skills

Semester III: 120 Disaster Management/ 109 Finance for everyone

Semester IV: 201 Environmental Management/ 220 Use of Chemicals in Daily Life

Semester VI: Logical and Critical Thinking

Or

108 Quantitative Aptitude and Data Interpretation

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Value added Course (VAC)

Credits: 2

Maximum Marks: 50

Classes per week: 2

EoSE: 35

CIA:15

Examination will be of **one hour.**

Question paper will have multiple choice questions **(35 in number).**

Each question will be of **1 Mark each.**

Examination will be conducted on **OMR sheet.**

Name of proposed VAC from the upcoming session 2025-26.

S.No.	Course Code	Course Name
First Year (Semester I and Semester II)		
1.	VAC-51F-101/ VAC-52F-101	Anandam-I
2.	VAC-51T-102/ VAC-52T-102	Digital Enhancement
3.	VAC-51T-103/ VAC-52T-103	Understanding Indian society & Culture
4.	VAC-51T-104/ VAC-52T-104	Nutrition for Health and Fitness
5.	VAC-51T-105/ VAC-52T-105	Geriatric Wellness and Care
6.	VAC-51T-106	National Cadet Corps (NCC)-I (Semester I)
7.	VAC-51T-107/ VAC-52T-107	Indian value system
8.	VAC-51T-108	National Service Scheme (NSS)-I (Semester-I)
9.	VAC-51T-109/ VAC-52T-109	Financial Literacy
10.	VAC-52T-110	National Cadet Corps (NCC)-I (Semester II)
11.	VAC-52T-111	National Service Scheme (NSS)-II (Semester-II)
12.	VAC-51T-112/ VAC-52T-112	Environmental studies
Second Year (Semester III and Semester IV)		
1.	VAC-63F-201/VAC-64F-201	Anandam-II
2.	VAC-63F-203/VAC-64F-203	Traditional & modern medicine systems for Evereyday health solutions
3.	VAC-63F-204	National Service Scheme (NSS)-III (Semester-III)
4.	VAC-64F-205	National Service Scheme (NSS)-IV (Semester-IV)
5.	VAC-63F-206	National Cadet Corps (NCC)-III (Semester III)
6.	VAC-64F-207	National Cadet Corps (NCC)-IV (Semester IV)
7.	VAC-63T-208/VAC-64T-208	Content writing
8.	VAC-63T-209/VAC-64T-209	Cyber Law and Ethics
9.	VAC-63T-210/VAC-64T-210	Electoral Literacy

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Multidisciplinary Course (MDC)

Credits: 4
Classes per week: 4

Maximum Marks: 100
EoSE: 70
CIA: 30

Examination will be of **three hours.**

The question paper (EoSE-End of Semester Examination) will consist of two parts A & B.

Part A: 14 Marks

Part A will be compulsory having 10 very short answer-type questions (with a limit of 20 words) of two marks each and candidate can attempt any seven questions.

Part B: 56 Marks

Part B of the question paper shall be divided into four units comprising question number 2-5. There will be one question from each unit with internal choice. Each question will carry 14 marks.

MDC will run in Semester III, IV and V.

Name of proposed MDC from the upcoming session 2025-26

1. **English**

Basics of English Grammar and Composition	English	III
Basics of English Grammar and Composition	English	IV
Basics of English Grammar and Composition	English	V

2. **History**

Historical Evolution of Indian Society	History	III
Historical Trends in Indian culture	History	IV
Historical Methods and Historiography	History	V

3. **Business Administration**

Business communication skills	BBA	III
E-commerce	BBA	IV
Trade Unions and Industrial Relations	BBA	V

4. **Botany**

Introduction of Botany	Botany	III
Plants and Human health	Botany	IV
Biodiversity Conservation and Ecotourism	Botany	V

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5. Psychology

Basics of Psychology-I	Psychology	III
Basics of Psychology-II	Psychology	IV
Personality Development	Psychology	V

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B. Sc. (Bio) Biotechnology

3. Semester Structure: The details of the courses with title assigned are as given below.

Duration: 6 Semesters (3 Years)

Semester–I	Name of Paper	Credits	Total Credits
Paper I -	Biotechniques and Microbial world	4	6
Lab-	Practicals Based on Theory Papers	2	
Semester –II			
Paper I-	Cell Biology and Genetics	4	6
Lab-:	Practicals Based on Theory Papers	2	
Semester III			
Paper I-	Plant and Animal Biotechnology	4	6
Lab-	Practicals Based on Theory Papers	2	
Semester IV			
Paper I-	Immunology and Medical Biotechnology	4	6
Lab-	Practicals Based on Theory Papers	2	
Semester V			
Paper I A(E)	RDT and Industrial Biotechnology	4	6
Paper I B(E)	Cellular Biophysics and Biochemistry	4	
Lab-	Practical's Based on Elective Papers	2	
Semester VI			
Paper I A(E)	Biosafety, Bioethics and IPR in Biotechnology	4	6
Paper I B(E)	Bioinformatics and Nanotechnology	4	
Lab-	Practical's Based on Elective Paper	2	

***Students have to choose any one elective paper out of two in fifth and sixth semester.**
****Department will offer theory elective papers for the students based on options submitted by the students and availability of Faculty to teach the course.**

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4. Programme Specific Outcomes:

By the end of the course, a student should be able to:

1. Students develop global competencies in the area of basic and applied biological sciences.
2. Enhancing the subject knowledge of students by using traditional and modern ICT based teaching methods and learning by doing.
3. To enrich students' knowledge and train them in various branches of Biotechnology such as genetics, molecular biology, biochemistry, immunology, fermentation technology, environmental biotechnology and tissue culture techniques.
4. To groom the students to meet futuristic challenges and national interests
5. To bestow the students with all the research skills required to work independently
6. To develop scientific temperament and social responsibilities in the students.
7. To inculcate nature care by imparting knowledge of advance modern techniques
8. As Biotechnology is an interdisciplinary course, empower the students to acquire technological knowhow by connecting disciplinary and interdisciplinary aspects of biotechnology.
9. Acquire knowledge in students of biotechnology enabling their applications in industry and research.

Course Outcomes:

1. Graduates will have a deep and comprehensive understanding of core biotechnology concepts, including molecular biology, genetics, bioinformatics, and bioprocessing.
2. Graduates will be proficient in designing, conducting, analyzing complex biotechnological experiments, using advanced laboratory techniques and tools.
3. Graduates will be adept at applying biotechnological methods to solve real-world problems in healthcare, agriculture, environment, and industry.
4. Graduates will have hands-on experience and technical expertise in genetic engineering, recombinant DNA technology, cell culture, and other modern biotechnological practices.

5. Course Details:

- The syllabus has also been framed in such a way that the basic skills of subject are taught to the students, and everyone might not need to go for higher studies and the scope of securing a job after graduation will increase BSc Biotechnology Admissions are mainly done on the basis of merit list.
- The BSc Biotechnology Courses are offered in Full Time Education.
- The syllabus of BSc in Biotechnology includes subjects like Biophysics & Instrumentation, Bioinformatics, Cell Structure & Dynamics, Principles of Microbiology, Molecular Genetics, etc.
- The different Job profiles after completion of the degree are Biotech Analyst, BioChemist, Research scientist and many more.
- Also, it is being recommended that the Project Work and Industrial Tour/ Institute visit is compulsory for all the students as per their respective semester curriculum.

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S.S. Jain Subodh PG College (Autonomous), Jaipur

DEPARTMENT OF BIOTECHNOLOGY

Model Paper

B.Sc. (Pass / Hon.), Sem. - …. , Biotechnology

External Practical Examination - ……..

Paper Name -

Batch -

Time Duration - 4 Hours

Max. Marks -30

Date -

Q.1 Major Exercise - 7 Marks

Q.2 Minor Exercise - 5 Marks

Q.3 Spotting (i) to (iv) 4x2 = 8 Marks

(i)

(ii)

(iii)

(iv)

Q.4 Viva-Voce - 5 Marks

Q.5 Practical Record - 5 Marks

Internal Examiner

External Examiner

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S.S. Jain Subodh PG College (Autonomous), Jaipur

DEPARTMENT OF BIOTECHNOLOGY

Model Paper

B.Sc. (Pass / Hon.), Sem.- .... , Biotechnology

Internal Practical Examination -.....

Paper Name -

Batch -

Max. Marks-20

Time Duration - 1 Hour

Date -

Attempt Any Two Questions.

Q.1 10 Marks

Q.2 10 Marks

Q.3 10 Marks

Internal Examiner

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Semester I

Paper: Biotechniques and Microbial World

1 credit -25 Marks

4 credit- 100 Marks

Question paper: 70 Marks

Internal Assessment: 30 Marks

80 Hrs. (6 hrs/week)

Course objective: This course introduces fundamental techniques in biotechnology and microbiology, focusing on microscopy, centrifugation, chromatography, electrophoresis, and spectroscopy. It covers microbial diversity, structure, growth, metabolism, and reproduction, along with methods of cultivation and preservation. The course also highlights the role of microorganisms in water and food microbiology, laying a strong foundation for further studies in biotechnology.

Unit I

Microscopy- Principles, types and applications of Microscopy. Bright field, Dark-field, fluorescent microscopy, Electron Microscope. Procedure for Preparation of Slides for microscopic study.

Centrifugation: Definition of centrifugation v/s sedimentation. Centrifuge: Principle, Parts, Types (Low, high and ultra-centrifuge), and their Applications.

Unit II

Chromatography: General principle of chromatographic separation. Principle, Instrumentation and applications of Paper Chromatography and Thin Layer Chromatography.

Electrophoresis: Basic principle and types of electrophoresis. Factors affecting electrophoretic migration, Technique and uses of Agarose gel electrophoresis.

Spectroscopy- Principle and applications of colorimeter and spectrophotometer, Beer-Lambert law. Light absorption and transmission.

Unit III

History and Evolution of Microbiology and Microbial diversity: Microbial phylogeny and Classification of micro-organisms on the basis of nutrition. Morphology and cell structure of major groups of microorganisms e.g. Bacteria, Fungi, and Viruses.

Cultivation and Maintenance of microorganisms: Culture media composition types and their functions. Media Preparation and sterilisation. Different methods of microbes isolation (Streak plate, pour plate spread plate method), Preservation of micro-organisms.

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Unit IV

Microbial growth, metabolism and reproduction: Growth curve, Generation time, synchronous growth, measurement of growth and factors affecting growth of bacteria. Microbial metabolism and reproduction.

Water and Food Microbiology: Bacterial pollutants of water, coliforms and non-coliforms. Sewage composition and its treatment. Important microorganism in food Microbiology: Yeasts, bacteria. Preservation of various types of foods.

Suggested Readings:

1. Walker J. M. and Ging old, E.B. (1983). Molecular Biology & Biotechnology (Indian Edition) Royal Society of Chemistry U.K.
2. Boyer, R.F. (2000). Modern Experimental Biochemistry, 3rd Edition, Prentice Edition. Wiley-Inter science, USA.
3. Friefelder, D.M. (1983). Physical Biochemistry: Applications to Biochemistry Hall publishers, USA.
4. P.Palanivelu and M.Salihu. (2009). Analytical Biochemistry and Separation and Molecular Biology. 2nd Revised edition. W. H. Freeman, USA.
5. Upadhyay and Upadhyay Nath. (2009). Biophysical Chemistry, Principles and Techniques. Himalaya Publishing House.
6. Wilson and Walkar. (2000). A Biologist Guide to Principles and Techniques of Practical Biochemistry, 5th Edition, Cambridge University Press, UK.
7. Madigan MT, Martinko JM and Parker J. (2009). Brock Biology of Microorganisms. 12th edition. Pearson/Benjamin Cummings.
8. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
9. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.
10. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9 th edition. Pearson Education.

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Lab Practical Based on Theory papers

Maximum practical Marks = 50 marks
Internal marks = 30 Marks
External marks = 20 Marks
60 Hours

Course objective: The objective of a "Biotechniques and Microbial World" practical course is to equip students with the fundamental knowledge and practical skills necessary to work with microorganisms in a biotechnology context. This includes understanding microbial diversity, cultivation, identification, and applying various biotechnological techniques to harness their potential for various applications.

1. To study the principle and applications of important laboratory instruments (weighing balance, hot air oven, autoclave, LAF, hot plate, pH meter, and water bath) used in the biotechnology laboratory.
2. Organization and working of optical microscopes: (Dissecting and Compound Microscope.)
3. Separation of amino acids by paper chromatography.
4. Separation of plant pigment by TLC.
5. Demonstrate the basic principle of centrifugation.
6. Preparation of nutrient agar and broth media & sterilization methods.
7. Perform the technique of Serial dilution.
8. Perform the different types of culture methods (pour plating, spreading, streaking).
9. Isolation of micro-organisms from different sources (air, water and soil)
10. Perform the Different types of staining methods: simple staining, Gram staining, acid fast staining

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Semester II

Paper: Cell Biology and Genetics

1 credit -25 Marks
4 credit- 100 Marks
Question paper: 70 Marks
Internal Assessment: 30 Marks
80 Hrs. (6 hrs/week)

Course objective: This course aims to provide foundational knowledge of cell structure, function, and genetic mechanisms. It covers the ultrastructure of prokaryotic and eukaryotic cells, chromosomes, cell cycle regulation, DNA replication, transcription, and gene expression. Students will learn classical and molecular genetics, Mendelian inheritance, chromosomal alterations, and mutation concepts, preparing them for advanced studies in cell and molecular biology.

Unit I

Cell and cell organelles: Ultra-structure of prokaryotic and eukaryotic cell, Structure and functions of cytoskeleton structures (microtubules, microfilaments and intermediate filaments). Structural organization and functions of plasma membrane and cell wall.

Chromosomes: Morphology and structural organization, Centromere, Euchromatin and Heterochromatin. Special type of chromosomes: Salivary gland and Lamp brush chromosomes.

Unit II

Cell cycle: An overview of cell cycle, components of cell cycle control system, cell division (Mitosis and meiosis).

DNA structure, replication and transcription: DNA as genetic material, Structure, types and functions of DNA, Replication of DNA in prokaryotes and eukaryotes. RNA structure types and their functions. Transcription in prokaryotes: Prokaryotic RNA polymerase, promoter, initiation, elongation and termination.

Unit III

Concept and organization of genetic material in bacteria, plant and animal (*E. coli, Arabidopsis thaliana, Coenorhabditis elegans*) as a model organism.

Concept of Gene: Allele, multiple alleles, pseudo alleles and complement test. Cytogenetic: Human karyotype, Banding techniques, Human genetic diseases. Pedigree analysis.

Unit IV

Mendelian principles and laws of inheritance: Law of dominance, segregation, independent assortment, co-dominance and incomplete dominance and pleiotropy. Back cross and Test cross.

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Structural and numerical alterations of chromosome: Deletion, Inversion, Duplication, Translocation. Ploidy and their genetic implications. Mutation: (Spontaneous and Induced) Mutagens. Biochemical basis of mutation.

Suggested Reading:

1. Cooper, G. M. and Hausman, R. E. (2009). The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
2. De Robertis, E. D. P. and De Robertis, E. M. F. (2006). Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
3. Alberts, B. (2015). Molecular Biology of the Cell (6th ed.). W.W. Norton & Company
4. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
5. Gardener E.J, Simmons M.J and Snustad , D.P.(2005). Principles of Genetics–John Wiley& Sons Publications.
6. Concepts of Genetics by Klug, Cummings, Spencer, and O'Brien
7. Genetics: A Conceptual Approach by Benjamin A. Pierce
8. Lewin, B. (2014). Lewin's Genes XI (11th ed.). Jones & Bartlett Learning.

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Lab Practical Based on Theory papers

Maximum practical Marks = 50 marks
Internal marks = 30 Marks
External marks = 20 Marks
60 Hours

Course objective: Cell Biology and Genetics practical courses aim to equip students with a solid understanding of cell structure, function, and heredity. Key objectives include mastering microscopy techniques, learning cell division processes, and applying genetic principles to solve problems. Students will also gain practical experience with genetic experiments and analysis.

1. To observe and distinguish between prokaryotic and eukaryotic cells using curd and onion peel or cheek cells.
2. Observation of chromosomes at different stages of mitosis using onion root tip
3. Observation of chromosomes at different stages of meiosis using Flower bud.
4. Preparation of polytene chromosomes from *Drosophila* salivary gland.
5. Explanation of Structure of RNA and DNA by charts and model.
6. Extract DNA from onion, banana, or blood sample using salt-detergent-alcohol method.
7. Demonstrate the Mendel's law of Genetics-Mono and Dihybrid crosses.
8. Rearing morphology of Drosophila (mutant types identification)
9. Observation of Genetic model organisms (*Arabidopsis thaliana* and *Coenorrabditis elegans*)- By Permanent slides
10. Identification of Barr body from blood cells

*** Any other practical exercise as per theory syllabus.**

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Semester III

PAPER: Plant and Animal Biotechnology

Max. Marks: 100
Internal marks = 70 Marks
External marks = 30 Marks
60 Hrs. (4 hrs/week)

Objective of Course: This course teaches organization and expression of animal genome and animal and Plant tissue culture, Students learn about transgenic animal, plants their application in pharmaceutical and agriculture industry.

Unit-I

Plant Tissue culture: Introduction to Plant tissue culture, Definition, History and Applications of plant Tissue culture. Culture media composition, types, preparation and sterilisation. Growth factors and laboratory facilities. Methods of explant sterilisation and inoculation.

Unit-II

Various techniques of plant cell and tissue culture, Callus and suspension culture: Initiation and maintenance of callus and suspension culture. Tissue and micro-propagation, callus formation, regeneration, production of haploids, protoplast culture and somatic hybridization. Production of transgenic plants and their applications: Improving agronomic traits – genetic manipulation of plants for salt resistance, herbicide resistance, fungi and virus resistance.

Unit-III

Introduction to animal tissue culture: Definition, history, terminology and Applications of animal tissue culture. Different types of Animal Culture media (Natural & Artificial) and their composition, growth factors and laboratory facilities. Method of media preparation and sterilisation.

Unit–IV

Culture methods: Animal selection, cervical dislocation, tissue disaggregation, homogenate preparation and culture. Primary culture, Secondary culture and cell lines. Maintenance and preservation of cell lines in the laboratory. Transgenic animals: Introduction, method and application of transgenic animals. Production of transgenic animal.

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Suggested Readings:

1. Dubey R. C., (2018). A Text Book of Biotechnology. S. Chand & Co Ltd, NewDelhi.
2. Gangal S., (2010). Animal Tissue culture. Second edition. University Press (India)
3. PvtLtd. Hyderabad.
4. Ranga, M. (2006). Animal Bioteclmology, Studam publishers.
5. Sasidhara, R. (2006). Animal Biotechnology, MJP Publishers.
6. Satya and Das (2005). Essential Biotechnology for students. Pee Pee Publishers.
7. New Delhi
8. Shivangi Mathur (2012). Animal cell and tissue culture. Agrobios Publisher, India
9. Chawla,(2003).IntroductiontoPlantBiotechnology(2edn)OxfordandIBH Publishers
10. Chrispeel M.J, Sadava D.E,(1994). Revised edition, Plants,
11. Genesand Agriculture, Jones and Barlett Publication, Boston.
12. R.KeshavaChandranandK.V.Peter.(2008). Plant Biotechnology.Firstedition.
13. University Press (India) Pvt. Ltd, Hyderabad.
14. R.C.Dubey, (2006). A TextBookof Biotechnology. S.Ch and & Co Ltd, New Delhi.
15. Ramawat K.G,(2003).PlantBiotechnology,S.ChandandCo,Edition 2

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Practials Based on Theory Papers

Maximum practical Marks = 50 marks
Internal marks = 30 Marks
External marks = 20 Marks
60 Hours

Objective of Course: The course objectives for Plant and Animal Biotechnology practicals are to provide hands-on experience with plant tissue culture and animal cell culture, understand fundamental concepts like genetic transformation and molecular techniques for plant/animal improvement, and gain practical skills in these methods to solve real-world problems in agriculture and medicine. Key objectives include developing skills in plant and animal genetic manipulation, understanding the applications of these technologies, and familiarizing students with instrumentation and procedures used in the biotechnology industry.

1. Preparation of animal cell culture media.
2. Preparation & sterilization of balanced salt solution
3. Disaggregation of tissues by enzymatic and mechanical method (Demo).
4. Viability test and cell counting.
5. Isolation of genetic DNA from animal tissue.
6. Preparation of MS media.
7. Establishment of shoot tip culture using MS medium
8. Isolation of protoplasts using enzymatic method **or** mechanical method.
9. Establishment and maintenance of somatic embryogenesis (Demo).
10. Preparation of synthetic seeds (Entrapment method).

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Semester IV

PAPER: IMMUNOLOGY AND MEDICAL BIOTECHNOLOGY

Max. Marks: 100
Internal marks = 70 Marks
External marks = 30 Marks
60 Hrs. (4 hrs/week)

Objective of Course: Students should be able to: Gain fundamental knowledge of immunology: include study of the tissues, cells and molecules involved in host defence mechanisms. The students will be able to demonstrate the use of biotechnology in solving various medical problems.

Unit-I

Immune system, Historical perspective and terminologies, innate immune response and its role in protection, Adaptive immune response. Humoral and cell mediate immunity. Cells and organs of the immune system (primary and secondary lymphoid organ).

Unit-II

Structure, Function and classification of immunoglobulins. Antigen- antibody reactions, agglutination and precipitation. Major Histocompatibility Complex, Structure, types and function of MHC. Diseases related to immune system. Transplantation immunology: Graft rejection, Evidences and mechanism, prevention of graft rejection and Immunosuppressive drugs

Unit-III

Introduction to Medical Biotechnology. Difference between medical and general biotechnology. Importance of biotechnology in healthcare and medicine. Vaccines and Medicines: How vaccines are made using biotechnology. Examples: insulin production using bacteria. Introduction to antibiotics and their biotech production.

Unit-IV

Biotechnology and Human Health: Genetic diseases and inherited conditions. Simple idea of gene therapy (fixing faulty genes). How biotechnology helps in early disease detection

Bacterial and Viral Diseases-Epidemiology, Pathogenicity, laboratory diagnosis, prevention and control of the following disease. Tuberculosis, Typhoid, Chickenpox and COVID 19.

Gene therapy – ex-vivo and in-vivo gene therapy; somatic and germline gene therapy.

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Suggested Readings:

1. Kuby,RA, Goldsby,ThomasJ.Kindt,Barbara,A.Osborne,(2006).“Immunology” 6thEdition, Freeman.

2. Janewayetal.(2012)“Immunobiology”4thEdition,CurrentBiology Publications.

3. Paul,(2012)“FundamentalofImmunology,4thedition”,LippencottRaven

4.Roitt I.(2017).EssentialImmunology.WileyBlackwell,LondonU.K.

6. Pelczar,M.J.,Chan,E.C.S.KreigandNR(2001).“Microbiology”McGrawHillEducation;5 edition. Noida, Uttarpradesh, India.

7. Satyanarayana, U.(2008). Biotechnology, BooksandAllied (p) Ltd, Kolkata. PratibhaNallari, V.VenugopalRao (2010). Medical Biotechnology. Publisher Oxford Press

8. Glick and Pasternak (2010). Molecular Biotechnology.ASM Press, USA

9. Rimoin D. *et. al*., (2013).Principles and Practice of Medical Genetics, I, II, III Volumes by AEH Edts. Emery

10. Work and Work (2009). Laboratory Techniques in Biochemistry and Molecular Biology. Elsevier Science.

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Practicals Based on Theory Paper

Maximum practical Marks = 50 marks
Internal marks = 30 Marks
External marks = 20 Marks
60 Hours

Objective of Course: A course objective for a practical class in Immunology and Medical Biotechnology is to develop proficiency in core laboratory techniques and procedures used in research, diagnostics, and industry. It bridges theoretical knowledge with hands-on application, preparing students for roles in clinical, pharmaceutical, and academic settings.

1. Study different organs of immune system by permanent slides.
2. Determine the blood group types and Rh factor of a blood sample.
3. Study the immune diffusion technique by Single Radial Immun-diffusion.
4. Study the reaction pattern of an antigen with a set of antibodies by Ouchterlony Double Diffusion method.
5. Perform the technique of Dot ELISA for the detection of an antigen.
6. Demonstrate the antibiotic resistance by bacteria.
7. Perform the widal test to detect the typhoid.
8. Study of Covid 19, Tuberculosis and Chickenpox.
9. Study of viral born disease and symptoms.
10. Identify any to fungal and bacterial born disease.

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Semester V

ELECTIVE I A -PAPER: RDT AND INDUSTRIAL BIOTECHNOLOGY

Max. Marks: 100
Internal marks = 70 Marks
External marks = 30 Marks
60 Hrs. (4 hrs/week)

Course Objective: Student of this course have knowledge on gene manipulation, gene expression, etc which prepares them for further studies in the area of genetic engineering and to provide fundamental insights to exploit enzymes and microbes for the manufacturing of products which have a huge industrial significance for the purpose of producing goods and services.

Unit–I

Introduction and Procedure of RDT. Recombinant DNA Tool: Enzymes used in genetic engineering: Exonucleases, endonucleases - nuclease, restriction endonucleases, ligases, polymerases, reverse transcriptase, terminal deoxynucleotidyltransferases. Application of r-DNA technology in various fields.

Unit–II

Introduction, process and applications of gene cloning. Biology, structure and functions of cloning vectors: Plasmids, cosmids, Agrobacterium tumifaciens. PCR technique and its applications. Transposons: Definition, types and classification with mechanism.

Unit–III

Fundamentals of Industrial Biotechnology: Introduction to Industrial Biotechnology. Definition, scope, and importance. Microbial Diversity and Strain Selection: Industrially important microorganisms (bacteria, fungi,). Isolation, screening, and maintenance of industrial strains. Improvement of microbial strains (mutation, recombination, genetic engineering).

Unit IV

Industrial Fermentation Technology: Introduction, Types of fermentation: batch, continuous. Fermenters: design, operation and types. Media formulation, Sterilization aeration, and agitation techniques. Production of Ginger wine and grapes wine by fermentation.

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Suggested Readings:

1. Brown T. A., (2008). Genomes. 3rd Edition. New York: Garland Publishing Co. New York: Garland Science.
2. Dubey. R. C. A (2018) Text Book of Biotechnology. S. Chand & Co Ltd, New Delhi.
3. Primrose, S. B. and Twyman, R. M., (2006). Principles of Gene Manipulation and Genomics - 7th Edition. Blackwell Publishing Company.
4. Satyanarayana, U. (2008). Biotechnology, Books and Allied (P) Ltd .Kolkata
5. Tvan, R. S. (1997). Recombinant gene expression protocols. Human Press Inc., Tokiwa.
6. KunLY.(2006).MicrobialBiotechnology.World Scientific.
7. Ponmurugan, P., Ramasubramanian, N., and Fredimoses. (2012). Experimental Procedures in Bioprocess technology and Downstream processing. Anjana Book House, Chennai.
8. Primrose SB.(2001). MolecularBiotechnology.Panima.
9. Satyanarayana.U, 2008. Biotechnology,BooksandAllied(p)Ltd. Kolkata.
10. HuffnagleGB & WernickS. (2007). TheProbioticsRevolution: The Definitive Guide to Safe, Natural Health. Bantam Books.

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Practical based on Theory Paper.

Max. Marks: 50

60 Hrs. (4 hrs/week)

Internal marks = 30 Marks

External marks = 20 Marks

Course Objective: The primary course objective for RDT (presumably "Recombinant DNA Technology") and Industrial Biotechnology practicals is to provide students with hands-on experience in essential techniques, enabling them to apply theoretical knowledge of genetic engineering, cell culture, fermentation, and downstream processing to develop practical solutions in industrial, medical, and agricultural fields.

1. DNA isolation From Bacterial Cell.
2. Perform the restriction Digestion.
3. Plasmid Isolation from bacterial cell.
4. Perform DNA Ligation process.
5. Demonstration of PCR technique with the help of thermocycler.
6. Isolation of Industrial important microorganisms (bacteria & fungus) from the natural sources.
7. Production of grapes wine.
8. Production of ginger wine.
9. Sauerkraut production.
10. Production of citric acid using Aspergillusby batch culture techniques.

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Semester-V

ELECTIVE I B – Cellular Biophysics and Biochemistry

Max. Marks: 100

Internal marks = 70 Marks

External marks = 30 Marks

60 Hrs. (4 hrs/week)

Course Objective:

To introduce the chemical and physical principles governing cellular processes, with emphasis on biomolecular structure, metabolism, and signal transduction. The course aims to build foundational knowledge in biochemistry and biophysics relevant to biotechnology.

Unit I

Molecular Foundations of Biochemistry: Structure and properties of water, pH, buffers, and their biological relevance. Overview of biomolecules: carbohydrates, lipids, proteins, nucleic acids. Structure–function relationship in proteins: primary to quaternary levels

Enzymes: classification, kinetics (Michaelis-Menten), inhibition, coenzymes

Unit II

Metabolism and Bioenergetics: Bioenergetics: laws of thermodynamics, ATP as energy currency. Carbohydrate metabolism: glycolysis, TCA cycle, oxidative phosphorylation.

Lipid metabolism: β-oxidation, ketone bodies. Protein and amino acid metabolism: deamination, urea cycle

Unit III

Biophysical Principles of Cellular Function: Diffusion, osmosis, and membrane transport mechanisms. Ion channels, membrane potential, and electrophysiology basics. Bioenergetics of membranes: proton gradients and chemiosmosis. Biophysical techniques: spectroscopy (UV, fluorescence), calorimetry, X-ray diffraction

Unit IV

Signal Transduction and Molecular Interactions: Basics of cell signaling: ligands, receptors, second messengers. G-proteins, tyrosine kinases, and intracellular signaling pathways. Molecular interactions: hydrogen bonds, ionic bonds, Van der Waals forces. Techniques in biochemistry and biophysics: chromatography, electrophoresis, centrifugation.

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Suggested Readings

1. Lehninger Principles of Biochemistry – Nelson & Cox
2. Biochemistry – Lubert Stryer
3. Biophysical Chemistry – Upadhyay, Upadhyay, & Nath
4. Molecular Cell Biology – Lodish *et al.*
5. Physical Biochemistry – David Freifelder
6. Biochemistry and Molecular Biology – William H. Elliott & Daphne C. Elliott

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Practicals Based on Elective Theory paper

Max. Marks: 50

60 Hrs. (4 hrs/week)

Internal marks = 30 Marks

External marks = 20 Marks

Course Objective:

To develop basic laboratory skills in biochemical analysis and biophysical techniques, enabling students to analyse biomolecules and understand enzyme kinetics and membrane transport.

1. Preparation and standardization of buffers (e.g., phosphate buffer)
2. Determination of protein concentration.using Biuret and Lowry methods
3. Estimation of reducing sugars using DNS method
4. Thin Layer Chromatography (TLC) of amino acids or sugars
5. Separation of proteins by SDS-PAGE
6. Determination of enzyme activity (e.g., amylase, urease)
7. Effect of pH and temperature on enzyme activity
8. Spectrophotometric analysis of biomolecules (proteins, nucleic acids)
9. Demonstration of osmosis and diffusion using dialysis tubing
10. Determination of saponification value or acid value of lipids

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Semester VI

ELECTIVE I A -PAPER: Biosafety, Bioethics and IPR in Biotechnology

Max. Marks: 100
Internal marks = 70 Marks
External marks = 30 Marks
60 Hrs. (4 hrs/week)

Objective of Course:
To enable students to understand principles and practices of bioethics, biosafety, and intellectual property rights in biotechnology, with emphasis on Indian and international perspectives, regulatory frameworks, innovation management, and entrepreneurship.

UNIT 1

Principles of bioethics, ethical issues in biotechnology research and applications, ethics of genetic engineering, stem cells, GM crops, and clinical trials, legal and socioeconomic impact of biotechnology, public education national and international biosafety regulations, rDNA safety guidelines, levels of containment (BL1–BL4).

UNIT 2

Concept and importance of IPR in life sciences, types of IPR: patents, copyrights, trademarks, geographical indications, trade secrets, TRIPS agreement and WTO, international Conventions, Indian Patent Act 1970 and amendments, patent filing procedure in India, patent claims

UNIT 3

Chemical and biological hazards in research laboratories, laboratory biosafety practices, transport and handling of GMOs and infectious agents, bioterrorism and biosecurity issues, research integrity and responsible conduct of research, plagiarism.

UNIT 4

Basics of bioentrepreneurship, stages in setting up a biotech enterprise, market research and product development in biotechnology, case studies of successful biotech startups in India and abroad.

Suggested Readings:

1. Aneja. K.R. (2007). Laboratory Manual of Microbiology and Biotechnology, New Age
2. International Publisher.
3. Goel And Parashar (2013). IPR, Biosafety and Bioethics. Pearson Education India
4. Nambisan, P. (2017). An Introduction to Ethical, Safety and Intellectual Property Rights
5. Issues in Biotechnology, Academic Press.
6. Joshi R. (2007). Biosafety and Bioethics. Isha Book Publisher.
7. Sateesh M.K. (2010). Bioethics and Biosafety, I. K. International Pvt Ltd.
8. Sree Krishna V. (2007). Bioethics and Biosafety in Biotechnology, New Age international publishers.

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Practicals Based on Theory Elective I A

Max. Marks: 50
60 Hrs. (4 hrs/week)
Internal marks = 30 Marks
External marks = 20 Marks

Objective of Course: The primary objective of a practical course on Biosafety, Bioethics, and IPR in Biotechnology is to equip students with the hands-on skills, knowledge, and ethical awareness needed to conduct research and development responsibly. This involves applying regulatory guidelines, assessing risks, and managing intellectual property in a laboratory or industrial setting

1. Demonstrate the Process of Patent Filing.
2. List of Document to be enclosed with Application.
3. Planning of establishing a hypothetical biotechnology industry in India.
4. A case study on clinical trials of drugs in India with emphasis on ethical issues.
5. Demonstration of Innovation And Enterpreneureship.
6. Explain the laboratory biosafety practices.
7. Demonstrate transport and handling of GMOs and infectious agents.
8. Demonstrate the research plagiarism in writing a research paper /Thesis/ patent filing.
9. Case study of successful biotech startup in India.
10. Case study of successful biotech startup in abroad.

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Paper Elective I B (E): Bioinformatics and Nanotechnology

Max. Marks: 100

Internal marks = 70 Marks

External marks = 30 Marks

60 Hrs. (4 hrs/week)

Objective of Course: This paper introduces to student's concepts in bioinformatics and Nanotechnology. The student will be able to apply basic principles of biology, computer science and mathematics to address complex biological problems.

Unit-I

Introduction to Bioinformatics: Definition, introduction, application and scopes of Bioinformatics. Biological Databases and Sequence analysis introduction, Primary Databases: Primary Sequence database. Databanks–Gen Bank, PubMed. BLAST, UNIPORT, OMIM and NCBI.

Unit-II

Sequence Alignment: Introduction to sequence alignment and its applications. Pair wise sequence alignment: Concept of global and local alignment. Molecular Structure Databases: Protein Data Bank (PDB), Multiple sequence alignment, Uses of multiple sequence alignment. Introduction and application of microarray in relation to Biotechnology.

Unit-III

Elementary Idea about Nano-biotechnology– Concepts, definitions, prospects. Nanoparticles – size, shape, properties. Bionanoparticles – nanostarch, nanocomposites–dendrimers. Hot–Dotnanoparticles.Applications of nanobiotechnology in medicine.

Unit-IV

Biological synthesis of Nanoparticles: Concept of reducing and capping agents, introduction to biomolecules as reducing and capping agents- Bacteria, and plants. Advantages and applications of biologically synthesized nanomaterials.Introduction about Nanochips and Biosensors.

Suggested Readings:

1. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.

2. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition.WileyBlackwell.

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3. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. II Edition. Benjamin Cummings.

4. Introduction to nanoscience and nanotechnology, CRC Press, Tylor and Francis Group, Boca Raton, G. L. Hornyak, H. F. Tibbals, J. Dutta and J J. Moore.

5. Introductory Nanoscience: Physical and Chemical Concepts, CRC Press, Tylor and Francis Group, Boca Raton, M. Kuno.

6. Brown, T.A (1996). Gene cloning and DNA analysis Blackwell science, Osney Mead, Oxford.

7. Chouhan R. (2018). Molecular Biology and Biotechnology. Second edition.CBH Publication, Jaipur

8. Dubey, R. C. (2007). A textbook of Biotechnology, S.Chand& Company Ltd. New Delhi.

9. Gupta P.K: (2004). Biotechnology and Genomics, Rastogi publication, Meerut

10. Satyanarayana. U, (2008),.Biotechnology, Books and Allied (p) Ltd

11. Singh, B. D (2004). Biotechnology, Kalyani Publishers, New Delhi.

12. Charles P. Poole.Jr. and Frank J. Owens (2006). Introduction to Nanotechnology.

13. Sharma, Munjal and Shanker: A Text Book of Bioinformatics.

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Practical's Based on Elective I B

Max. Marks: 50

60 Hrs. (4 hrs/week)
Internal marks = 30 Marks
External marks = 20 Marks

Objective of Course: Students will learn about model and simulate the interaction of nanoparticles with biological systems, such as proteins or cell membranes, to predict their potential therapeutic or toxic effects.

1. Study of Important Bioinformatics Websites
2. Searching of Biological Literature Using Search Engines
3. Find the any Protein in NCBI and retrieve the sequence and save it in computer.
4. Homology Searching by Using BLAST Tool).
5. Preparation of FASTA Format for Given Sequence
6. Multiple Sequence alignment
7. Study the 3D Protein Structure Prediction
8. Prediction of different features of a functional group.
9. Study of structure of protein by Cn3D/rasmol.
10. More practical can add on the basis of theory.

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Department of Biotechnology
Value Added Courses
Session 2023-24

1. Course Title: Entrepreneurship in Biotechnology

Course Objective: This course introduces the principles and practices of entrepreneurship in the biotechnology industry, including business planning, financing, marketing, and intellectual property management.

Course Duration: 15 hours

Examination Scheme: The examination will consist of a written exam that will test the student's understanding of the course material. The exam will include multiple-choice questions, short answer questions, and essay questions.

Unit -I

Entrepreneurship and Financing Strategies:

Introduction to Entrepreneurship in Biotechnology. Definition and scope of Biotech entrepreneurship. Historical development of biotech entrepreneurship. Role of Biotech entrepreneurship in modern Biotech industry. Market Analysis and Business Planning. Market analysis and identification of opportunities. Business planning process and key components. Competitive analysis and differentiation Funding and Financing Strategies. Funding sources for biotech start-ups. Financing strategies and considerations. Venture capital and angel investing. Regulatory affairs and compliance. Regulatory requirements for biotech products.

Unit II

Product Development and Sales Strategies:

Product Development and Commercialization. Product development process and key components. Regulatory requirements for Biotech Product. Manufacturing and supply chain management. Pricing and reimbursement strategies. Sales and marketing strategies for Biotech products. Market segmentation and targeting. Branding and advertising. Leadership and Team Building. Leadership principles and practices. Team building and management strategies. Corporate culture and values.

Suggested reading:

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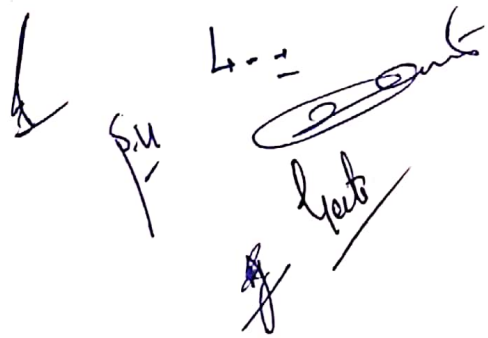
1. "Entrepreneurship in Biotechnology: Managing for Growth from Start-Up to Initial Public Offering" by Martin Grossmann (2003).
2. "Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies" by Craig Shimasaki (2014).
3. "Biotechnology Operations: Principles and Practices" by John M. Centanni and Michael J. Roy (2016).
4. "Pricing, Reimbursement and Value: The Realities of Innovative Pharmaceutical Pricing" by Richard H. Chapman (2020).



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2. Course Title: Bioinformatics

Course objectives: This course introduces the principles and applications of bioinformatics, including data analysis, database management, and computer programming in biological research.

Course Duration: 15 hours

Unit -I

Introduction to Bioinformatics. Definition and scope of bioinformatics. Historical development of bioinformatics. Role of bioinformatics in modern biology research. Molecular Biology and Genetics Basics for Bioinformatics. Nucleic acids, proteins, and their properties. DNA sequencing technologies. Biological Databases and Data Retrieval. Types of biological databases. Sequence and structure databases. Gene expression and proteomics databases. Retrieval and analysis of data from databases.

Unit II

Sequence Alignment and Phylogenetic Analysis. Sequence alignment algorithms and tools. Multiple sequence alignment and applications. Phylogenetic analysis and tree-building methods. Applications of phylogenetic analysis. Genome Assembly and Annotation. Genome sequencing technologies. Genome assembly algorithms and tools. Gene prediction and annotation. Genome-scale analysis and applications. Transcriptomic and Gene Expression Analysis. RNA sequencing technologies.

Suggested Readings:

1. "Bioinformatics: Sequence and Genome Analysis" by David W. Mount (2004).
2. "Introduction to Bioinformatics" by Arthur M. Lesk (2019).
3. "Bioinformatics and Functional Genomics" by Jonathan Pevsner (2015).
4. "Essential Bioinformatics" by Jin Xiong (2006).

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3. Course Title: Clinical Trials Management

Course Objective: This course provides an overview of the management and conduct of clinical trials, including study design, protocol development, ethical considerations, data collection and analysis, regulatory requirements, and project management.

Course Duration: 15 hours

Unit I

Clinical Trials and Protocol development process:

Introduction to Clinical Trials. Definition and types of clinical trials. Historical development of clinical trials. Ethical and legal considerations in clinical trials. Study Design and Protocol Development. Study design principles and considerations. Protocol development process and key components. Risk assessment and management. Regulatory requirements for clinical Trials. Regulatory agencies and their roles. Investigational New Drug (IND) application process. Institutional Review Board (IRB) requirements. Good Clinical Practice (GCP) guidelines.

Unit II

Data Collection and Statistical Analysis:

Study Monitoring and Data Collection. Study monitoring and site management. Data collection and management strategies. Quality control and assurance. Statistical Analysis and Reporting. Statistical analysis methods and software. Clinical Trial Management and Project Planning. Project management principles and techniques. Budget planning and management. Contract negotiations and vendor management.

Suggested reading:

1. "Fundamentals of Clinical Trials" by Lawrence M. Friedman, Curt D. Furberg, David L. DeMets, and David M. Reboussin (2015).
2. "Design and Analysis of Clinical Trials: Concepts and Methodologies" by Shein-Chung Chow and Jen-Pei Liu (2013).
3. "Principles and Practice of Clinical Trial Medicine" by Richard Chin and Bruce Y. Lee (2008).
4. "A Concise Guide to Clinical Trials" by Allan Hackshaw (2009).

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Multidisciplinary Programme- BIOTECHNOLOGY

Introduction to Biotechnology

Credits: 4 **Max. Marks:100 (70TE+ 30TI)**

Course Learning Outcomes (CLO):

On successful completion of the course the students will gain and be able to demonstrate following knowledge:

1. Understand the concepts of biotechnology to get an insight of how biotechnology is related to other sciences and how **Bhartiya Gyan Prampra contributed in biotechnology.**
2. Gain knowledge about the scope and applications of biotechnology. Learners will get an insight of scope and applicationsof biotechnology in agriculture, environment, food, pharma, dairy and other industries. The students will be able todemonstrate the knowledge of the applications of biotechnology for sustainable development and human welfare.
3. Gain knowledge about the role of biotechnology in Bioinformatics, Nanotechnology and other allied fields.
4. Gain knowledge about intellectual property rights, risk assessments, safety guidelines and ethical issues related to biotechnology.

UNIT I

Biotechnology: Definition, different types and colors (white, red, green, blue) of biotechnology, biotechnology as an interdisciplinary pursuit, scope and future of biotechnology, Biotechnology research in India, Biotechnology in context of developing world, Role **of Bhartiya Gyan Prampra or Indian knowledge System (IKS) in biotechnology.**

Unit II

Application of biotechnology: Application of biotechnology in agriculture, dairy processing, food industry, pharmaceutical industry, forensic analysis, environment protection; waste treatment and bioremediation.

UNIT III

Biotechnology for sustainabledevelopment and human welfare. Brief about Biofuels, bioplastics, petroleum refining, bioleaching and biomining. Brief about immunology, antigens antibodies, In vitro fertilization, and embryo transfer technology.

UNIT IV

Role of biotechnology in allied fields; Bioinformatics, Nanotechnology, Biomedical microelectromechanical systems (BioMems), Biosensor. IPR, biosafety and bioethics: a brief account on intellectual property and Intellectual property rights; patent, trademark, copyright, trade secret and geographical indication.

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