Biotechnology in B.Sc. Program: Semester wise course types, Course codes, Course title, Delivery type, Workload, Credits, Marks of Examination, and Remarks if any.

Level	Semester	Course Type	Course Code	Course Title	Delivery Type			Total Hours	Credit	Total Credit	Internal Assessment	EoS Exam	M.M.	Remarks
					L	T	P							
5	I	DCC	BIO5000T	Biotechnology-I : Basic Microbiology and Techniques	L	T	-	60	4	6	20	80	100	
			BIO5000P	Biotechnology Lab-I: Basic Microbiology and Techniques	-	-	P	60	2		20	80	100	
		AECC			L	-	-	30	2	2	20	80	100	
	II	DCC	BIO5001T	Biotechnology-II: Animal Biotechnology	L	T	-	60	4	6	20	80	100	
			BIO5001P	Biotechnology Lab-II: Animal Biotechnology	-	-	P	60	2		20	80	100	
		AECC	AES5201T		L	-	-	30	2	2	20	80	100	
Exit with Certificate in Science (After 4 more credits in SEC)														
6	III	DCC	BIO6002T	Biotechnology-III: Plant Biotechnology	L	T	-	60	4	6	20	80	100	
			BIO6002P	Biotechnology Lab-III: Plant Biotechnology	-	-	P	60	2		20	80	100	
		SEC		Communicative English	L	-	-	30	2	2	10	40	50	
	IV	DCC	BIO6003T	Biotechnology-IV: Recombinant DNA Technology	L	T	-	60	4	6	20	80	100	
			BIO6003P	Biotechnology Lab-IV: Recombinant DNA Technology	-	-	P	60	2		20	80	100	
		SEC	SES6300T	Bioinformatics	-	-	T	30	2	2	20	80	100	
Exit with Diploma in Science														

7	V	DSE	BIO7100T	1.Environmental Biotechnology	L	T	-	60	4	6	20	80	100	
			BIO7100P	1. Elective BIO. Lab-1: Environmental Biotechnology Lab	-	-	P	60	2		20	80	100	
		DSE	BIO7101T	2.Immunology and Enzyme Technology 3. 4. 5.	L	T	-	60	4		20	80	100	
		DSE	BIO7101P	2. Elective BIO. Lab-2: Immunology and Enzyme Technology Lab 3. 4. 5.	-	-	P	60	2		20	80	100	
		SEC	SES7301P	Basics of Instrumentation	-	-	P	60	2	2	20	80	100	
	VI	DSE	BIO7105T	5.Microbial Technology	L	T	-	60	4	6	20	80	100	
			BIO7105P	5. Elective BIO. Lab-1: Microbial Technology Lab	-	-	P	60	2		20	80	100	
		DSE	BIO7106T	6.Agriculture Biotechnology 7. 8.	L	T	-	60	4		20	80	100	
		DSE	BIO7106P	6. Elective BIO. Lab-2: Agriculture Biotechnology 7. 8.	-	-	P	60	2		20	80	100	
		SEC	SES7302P	Microbial cultivation	-	-	P	60	2	2	20	80	100	

				techniques										
Exit with Graduation Degree in Science (B.Sc.)														

B.Sc. (CBCS) Biotechnology

Total Seats: 60

(All Seats are Self Finance Seats)

Eligibility:

Those students who passed 10+2 school examination (Biology Group) with a minimum of 48% marks. The candidates from outside the state of Rajasthan should possess a minimum of 60% marks to seek admission. Candidates with Agriculture / Horticulture / Biotechnology or any other relevant life sciences subject at 10+2 level will also be considered, provided that they also had Chemistry as an optional subject at 10+2 level.

Note: B.Sc. with Biotechnology course is being offered in combination with Botany and Chemistry. The syllabus for Botany and Chemistry will be adopted from the respective departments.

B. Sc. BIOTECHNOLOGY SEMESTER–I (2023-24)

DCC Course (BIO5000T)

Code of the course: BIO5000T

Title of the course: Biotechnology-I: Basic Microbiology and Techniques

Level of the Course: NHEQF Level 4.5

Credit of the Course: 4

Type of the Course: Discipline Centric Compulsory (DCC) Course for Biotechnology Discipline/Subject

Delivery Type of the Course: Sixty (40 Lectures + 20 tutorial and diagnostic assessment)

Prerequisites:

(1) Life science courses of Central Board of Secondary Education or equivalent.

Objectives of the Course:

The course aims to strengthen the conceptual knowledge of basic microbiology learn at School level and lay foundation for further learning of the subject through first course on Basic Microbiology and techniques which is a prerequisite for higher courses in Biotechnology.

Course Outcome:

The student after reading the course will be able to describe general structure of prokaryotic and eukaryotic cell, general structure and diseases caused by microorganisms. Understand the basic principles of sterilization, preparation of media and techniques of cultivation of microorganisms.

Syllabus:

DCC Course (BIO5000T)

Biotechnology-I: Basic Microbiology and Techniques (Theory)

(Credit: 4; Hours: 60)

Unit 1 **12 Credit hours**

Comparison of prokaryotic and eukaryotic cells; general characteristics of microorganisms, Kingdom and Domain classification system, Ultra structure of bacteria: Cell size, shape and arrangement, Cell envelope; cell wall composition, flagella, pilli, cytoplasm, mesosomes, nucleoids and plasmids.

Unit 2 **12 Credit hours**

Virology – virus classification, general features, structure, reproduction; lytic and lysogenic life cycles. Transmission of plant and animal viruses and diseases caused by them. Mycoplasma, Viroids, and prions: general features and diseases caused by them.

Unit 3 **12 Credit hours**

Nutritional requirements of microorganisms -Macronutrients, micronutrients and growth factors. Nutritional types; Autotrophs and heterotrophs, phototrophs and chemotrophs. Culture media: Components of media, synthetic or defined media, complex media, enriched media, selective media and differential media.

Unit 4 **12 Credit hours**

Sterilization-Physical methods: moist heat sterilization; boiling, pasteurization, tyndallization, autoclaving. Dry heat sterilization- Incineration and hot air oven, Filtration- membrane filter and laminar air flows, Radiation- Ionizing radiation and non-ionizing radiation. Chemical methods: Alcohol, aldehydes, phenols, quaternary ammonium compounds and sterilizing gases.

Unit 5 **12 Credit hours**

Pure culture isolation: Streaking, serial dilution and plating methods; cultivation, physical conditions for growth; temperature, pH and oxygen, maintenance and preservation of pure cultures; cultivation of anaerobic bacteria. Morphological and cultural characterization, types of staining.

Recommended Books:

1. Tortora GJ, Funke BR, and Case C.L. (2004). Microbiology: An Introduction. 4th edition. Pearson Education.
2. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T. Brown Publishers.
3. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education limited.
4. Madigan MT, Martinko JM and Parker J. (2009). Brock Biology of Microorganisms. 12th edition. Pearson/Benjamin Cummings.
5. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
6. Dubey, R.C. and Maheshwari, D.K. A Text Book of Microbiology. S. Chand and Company.
7. Prescott, H. and Klein. 2000. Microbiology. McGraw Hill.

E-Resources

1. https://www.khanacademy.org/

2. https://unacademy.com/

3. https://swayam.gov.in/

4. https://hstalks.com/

5. https://nptel.ac.in/courses

B. Sc. BIOTECHNOLOGY SEMESTER–I (2023-24)

DCC Course (BIO5000P)

Code of the course: BIO5000P

Title of the course: Biotechnology Lab-I: Basic Microbiology and Techniques

Level of the Course: NHEQF Level 4.5

Credit of the Course: 2

Type of the Course: Discipline Centric Compulsory (DCC) Course for Biotechnology Discipline/Subject

Delivery Type of the Course: Lecture and practical 40+20=60. The 40 lectures for the hands on experiments, observations and record of the data, 10 hours for the experiment, instruments demonstration, lab practices and 10 hours on diagnostic assessment, formative assessment, subject/class activity, problem solving.

Prerequisites:

(1) Life science courses of Central Board of Secondary Education or equivalent.

Objectives of the Course:

The course aims to strengthen the practical knowledge of basic microbiology learn at School level and lay foundation for further learning of the subject through first course on Basic Microbiology and techniques which is a prerequisite for higher courses in Biotechnology.

Course Outcome:

Upon completion of this course, the students will able to:

1. Collect data and update the experimental process insistently.
2. Assess the procedure and outcomes of an experiment qualitatively and quantitatively.

3. Extend the scope of an experiment if or not results are as per expectation
4. Communicate the process and outcomes of an experiment.
5. Perform an experiment collaboratively and ethically

Syllabus:

DCC Course (BIO5000P)

Biotechnology Lab-I: Basic Microbiology and Techniques (Practical)

(Credit: 2; Hours: 60)

1. Determine quantitatively the number of cells in the given yeast suspension using Neubauer's chamber.
2. Calibrate the ocular micrometer and determine the size of given microscopic structure at 10X and 40X magnification.
3. Prepare suitable smear of the given bacterial cultures and identify them using Gram stain.
4. Prepare suitable smear of the given bacterial culture and demonstrate the presence of bacterial endospores using spore staining.
5. Perform the monochrome staining procedure to identify the morphological shape of bacterial cells.
6. Perform the negative staining procedure to compare morphological shapes and arrangement of bacterial cells using nigrosin stain.
7. Demonstrate the streak/spread/pour plate technique for isolation of bacteria from given sample.
8. Determine the cultural characteristics of the given bacterial colonies.

Any other experiment can be designed to demonstrate the concepts and phenomenon related to the paper.

SPOTS:

1. TMV
2. pH meter
3. Hot air oven
4. Bacteriophage
5. Filter sterilization unit
6. Laminar air flow bench
7. Compound Microscope
8. Diseased specimen - Citrus canker

   -Yellow vein mosaic of bhindi

Recommended Books:

1. K.R. Aneja (2007) Experiments in Microbiology, Plant pathology and Biotechnology, 4th Edition, New Age International (P) Limited Publishers.
2. R.C. Dubey and D.K. Maheshwari (2012) Practical Microbiology, 3rd Edition, S. Chand and Company Ltd.
3. Online Virtual Labs

Scheme of the Examination:

1. Major Exercise	20 Marks
2. Minor Exercise	15 Marks
3. Minor Exercise	15 Marks
4. Spots	2 x 5 = 10 Marks
5. Viva-voce	10 Marks
6. Record	10 Marks

B. Sc. BIOTECHNOLOGY SEMESTER–I (2023-24)

AECC 1

B.Sc. BIOTECHNOLOGY SEMESTER–II (2023-24)

DCC Course (BIO5001T)

Code of the course: BIO5001T

Title of the course: Biotechnology-II: Animal Biotechnology

Level of the Course: NHEQF Level 4.5

Credit of the Course: 4

Type of the Course: Discipline Centric Compulsory (DCC) Course for Biotechnology Discipline/Subject

Delivery Type of the Course: Sixty (40 Lectures + 20 tutorial and diagnostic assessment)

Prerequisites:

(1) Life science courses of Central Board of Secondary Education or equivalent.

Objectives of the Course:

The course aims to strengthen the conceptual knowledge related to animal biotechnology learn at School level and lay foundation for further learning of the subject through this course on Animal Biotechnology which is a prerequisite for higher courses in Biotechnology.

Course Outcome:

Upon completion of this course, the students will able to illustrate the techniques, procedure and growth patterns of animal cell culture and understand the structure of animal genes and genomes. Understand basic principles and techniques in genetic manipulation and genetic engineering. Understand gene transfer technologies for animals and animal cell lines, Understand the techniques and problems both technical and ethical in animal cloning.

Syllabus:

DCC Course (BIO5001T)

Biotechnology II: Animal Biotechnology (Theory)

(Credit: 4; Hours: 60)

Unit-I **12 Credit hours**

Animal cell culture: History, techniques, methods, culture media (natural and artificial media). Balanced salt solutions and simple growth medium: composition, types and preparation. Role of CO_2, serum and Growth factors in culture media. Serum and protein-free defined media and their applications.

Unit-II **12 Credit hours**

Primary cultures, Secondary cultures. anchorage dependent growth, non-anchorage dependent cells and their growth. Characterization of cultured cells. test of viability, cytotoxicity and measurement of growth.

Unit-III **12 Credit hours**

Animal cell lines: origin, characteristics, nomenclature and maintenance. Transformed animal cells and cell lines, measurement of cell death (apoptosis). Stem cell cultures, scaling-up of animal cell cultures and production of recombinant gene products.

Unit-IV **12 Credit hours**

Organ culture: various techniques, applications and limitations. Whole embryo culture, transfection of animal cells: selectable markers, HAT selection, Somatic cell fusion, hybridoma technology and production of monoclonal antibodies.

Unit-V **12 Credit hours**

Growth kinetics of cells in culture, Applications of animal cell culture. Three-dimensional culture and tissue engineering (artificial skin and artificial cartilage), In vitro fertilization in humans, super ovulation, embryo transfer in humans and livestock.

Recommended Books:

1. Masters, J. Animal Cell Culture. Panima.
2. Freshney, I. Culture of Animal Cell. John Wiley.
3. Martin, C. (Ed). Animal Cell Culture Techniques. Springer.
4. Mather and Barnes. (Ed). Methods in Cell Biology. Vol. 5-7, Animal Cell Culture Method. Academic Press.
5. Paul, J. Animal Tissue Culture.
6. Butler, M. and Dawson, M. Lab Fax : Cell Culture. Bios Scientific Publications.

E-Resources

1. https://www.khanacademy.org/

2. https://unacademy.com/

3. https://swayam.gov.in/

4. https://hstalks.com/

5. https://nptel.ac.in/courses

B.Sc. BIOTECHNOLOGY SEMESTER–II (2023-24)

DCC Course (BIO5001P)

Code of the course: BIO5001P

Title of the course: Biotechnology Lab-II: Animal Biotechnology (Practical)

Level of the Course: NHEQF Level 4.5

Credit of the Course: 2

Type of the Course: Discipline Centric Compulsory (DCC) Course for Biotechnology Discipline/Subject

Delivery Type of the Course: Lecture and practical 40+20=60. The 40 lectures for the hands on experiments, observations and record of the data, 10 hours for the experiment, instruments demonstration, lab practices and 10 hours on diagnostic assessment, formative assessment, subject/class activity, problem solving.

Prerequisites:

(1) Life science courses of Central Board of Secondary Education or equivalent.

Objectives of the Course:

The course aims to strengthen the practical knowledge related to animal biotechnology learn at School level and lay foundation for further learning of the subject through this course on Animal Biotechnology which is a prerequisite for higher courses in Biotechnology.

Course Outcome:

Upon completion of this course, the students will able to:

1. Collect data and update the experimental process insistently.
2. Assess the procedure and outcomes of an experiment qualitatively and quantitatively.

3. Extend the scope of an experiment if or not results are as per expectation
4. Communicate the process and outcomes of an experiment.
5. Perform an experiment collaboratively and ethically

Syllabus:

DCC Course (BIO5001P)

Biotechnology Lab-II: Animal Biotechnology (Practical)

(Credit: 2; Hours: 60)

1. Prepare single cell suspension of the given animal tissue.
2. Demonstrate the process of lymphocyte separation from blood.
3. Quantify the total number of cells in given suspension.
4. Quantify the total viable cells in given suspension.
5. Perform the mechanical disaggregation of the given tissue and separate the cells.
6. Demonstrate the watch glass method technique for organ culture.
7. Prepare 100 ml Dulbecco's phosphate buffer saline solution A for animal tissue culture.
8. Prepare 100 ml HBSS medium containing 1 gml-1 D-glucose for animal cell culture (pH 6.5).

Any other experiment can be designed to demonstrate the concepts and phenomenon related to the paper.

SPOTS:

1. pH meter
2. Defined media
3. Syringe filter
4. CO2 incubator
5. Trypan blue dye
6. Microwave oven
7. Phenol red indicator
8. Inverted microscope

Recommended Books:

1. Freshney, R. I. (2015). Culture of animal cells: a manual of basic technique and specialized applications. John Wiley & Sons.
2. Online Virtual Labs

Scheme of the Examination:

1.	Major Exercise	20 Marks
2.	Minor Exercise	15 Marks
3.	Minor Exercise	15 Marks
4.	Spots	2 x 5 = 10 Marks
5.	Viva-voce	10 Marks
6.	Record	10 Marks

B.Sc. BIOTECHNOLOGY SEMESTER–II (2023-24)

AECC 2

B. Sc. BIOTECHNOLOGY SEMESTER–III (2023-24)

DCC Course (BIO6002T)

Code of the course: BIO6002T

Title of the course: Plant Biotechnology

Level of the Course: NHEQF Level 5

Credit of the Course: 4

Type of the Course: Discipline Centric Compulsory (DCC) Course for Biotechnology Discipline/Subject

Delivery Type of the Course: Sixty (40 Lectures + 20 tutorial and diagnostic assessment)

Prerequisites:

(1) Life science courses of Central Board of Secondary Education or equivalent.

Objectives of the Course:

The course aims to strengthen the conceptual knowledge related to plant biotechnology learn at School level and lay foundation for further learning of the subject through this course on Plant Biotechnology which is a prerequisite for higher courses in Biotechnology.

Course Outcome:

Upon completion of this course, the students will able to learn the principles and technical advances behind the in vitro culture of plant cells and rDNA techniques, Students will learn the applications of plant transformation for improving the productivity and performance of plants under biotic and abiotic stresses, Students will understand the use of antisense technologies for improvement of crop plants.

Syllabus:

DCC Course (BIO6002T)

Biotechnology-III: Plant Biotechnology (Theory)

(Credit: 4; Hours: 60)

Unit-I **12 Credit hours**

Plant tissue culture- History, contribution of Indian Scientists. Concept of cellular totipotency and differentiation, laboratory facilities and supplies, asepsis and methods of sterilization. Culture medium- composition and methods of preparation. Role of plant growth regulators, vitamins and other adjuvants.

Unit-II **12 Credit hours**

Pathways of micropropagation- axillary bud proliferation, adventitious shoot bud proliferation, Callus organogenesis, Somatic embryogenesis, Steps of micropropagation-management of donor plants, culture establishment, shoot multiplication, rooting, hardening and acclimatization.

Unit-III **12 Credit hours**

Protoplast isolation, culture and Somatic hybridization, production of haploids -Anther and pollen culture, ovary culture. Embryo and endosperm culture. Embryo rescue. Production of synthetic seeds.

Unit-IV **12 Credit hours**

In vitro fertilization, Methods of cryopreservation for germplasm conservation. Somaclonal and gametoclonal variation. Meristem tip culture for elimination of viruses in plants. Commercialization of plant tissue culture- Global scenario and plant tissue culture industries in India.

Unit-V **12 Credit hours**

Cell culture and in vitro production of secondary metabolites. Important alkaloids and factors affecting their production. Hairy root culture, elicitation and biotransformation, Bioreactors – their types, construction and use in secondary metabolite production.

Recommended Books:

1. Robert Smith. Plant tissue culture : Techniques and Experiments. South Asia Edition.
2. Gamborg and Phillip. Plant Cell, Tissue and Organ Culture. Narosa.
3. Dixon and Gonzales. Plant Cell Culture. Panima.
4. Narayanswamy. Plant Cell and Tissue Culture. McGraw Hill.
5. Bhojwani, S.S. and Rajdan, M.K. Plant Tissue Culture: Theory and Practices a revised Edition. Elsevier.
6. Razdan, M.K. Introduction to plant tissue culture. Oxford & IBH Publishers.
7. Chawla, H.S. Introduction to Plant Biotechnology. Oxford & IBH Publishers.
8. Dey, K.K. Plant Tissue Culture.

E-Resources

1. https://www.khanacademy.org/

2. https://unacademy.com/

3. https://swayam.gov.in/

4. https://hstalks.com/

5. https://nptel.ac.in/courses

B. Sc. BIOTECHNOLOGY SEMESTER–III (2023-24)

DCC Course (BIO6002P)

Code of the course: BIO6002P

Title of the course: Biotechnology Lab-III: Plant Biotechnology (Practical)

Level of the Course: NHEQF Level 5

Credit of the Course: 2

Type of the Course: Discipline Centric Compulsory (DCC) Course for Biotechnology Discipline/Subject

Delivery Type of the Course: Lecture and practical 40+20=60. The 40 lectures for the hands on experiments, observations and record of the data, 10 hours for the experiment, instruments demonstration, lab practices and 10 hours on diagnostic assessment, formative assessment, subject/class activity, problem solving.

Prerequisites:

(1) Life science courses of Central Board of Secondary Education or equivalent.

Objectives of the Course:

The course aims to strengthen the practical knowledge related to plant biotechnology learn at School level and lay foundation for further learning of the subject through this course on Plant Biotechnology which is a prerequisite for higher courses in Biotechnology.

Course Outcome:

Upon completion of this course, the students will able to:

1. Collect data and update the experimental process insistently.
2. Assess the procedure and outcomes of an experiment qualitatively and quantitatively.

3. Extend the scope of an experiment if or not results are as per expectation
4. Communicate the process and outcomes of an experiment.
5. Perform an experiment collaboratively and ethically

Syllabus:

DCC Course (BIO6002P)

Biotechnology Lab-III: Plant Biotechnology (Practical)

(Credit: 2; Hours: 60)

1. Preparation of stock solution of MS (Murashige and Skoog, 1962) basal medium and plant growth regulator stocks.
2. Prepare various types of explants and inoculate from the aseptically (in vitro) raised plants.
3. Describe the characteristics of callus on the basis of the following parameters: (a) Color and texture (b) Fresh weight and Dry weight (c) Cell viability test (TTC assay)
4. To provide an introduction to the technique of seed immobilization.
5. Sterilize and inoculate the given seeds for in vitro seed germination on MS media.
6. Prepare, sterilize and inoculate explants (seeds) for callus induction.
7. Prepare suitable media for in vitro shoot multiplication of given material and inoculate shoots for multiplication
8. Prepare, sterilize and inoculate the nodal explants on suitable media for establishment of in vitro shoot cultures.

Any other experiment can be designed to demonstrate the concepts and phenomenon related to the paper.

SPOTS:

1. Lux Meter
2. Membrane Filter
3. Hair Hygrometer
4. Plant Growth Chamber

5. Stages of micro propagation
6. Questions based on chemicals and stomatal characteristics.
    a. Q1: How does 70% alcohol kills bacteria?
    b. Q2: What is the function of sodium hypochlorite?
    c. Q3: How mercuric chloride kills microbes?
    d. Q4: What factors affect the number of stomata on a leaf?
    e. Q5: What control the opening and closing of stomata?
    f. Q6: Why do stomata closes at night?

Recommended Books:

1. Bhojwani, S. S., & Razdan, M. K. (2003). Plant tissue culture: theory and practice. Elsevier.
2. Chawla, H.S. Introduction to Plant Biotechnology. Oxford & IBH Publishers.
3. Online Virtual Labs

Scheme of the Examination:

1.	Major Exercise	20 Marks
2.	Minor Exercise	15 Marks
3.	Minor Exercise	15 Marks
4.	Spots	2 x 5 = 10 Marks
5.	Viva-voce	10 Marks
6.	Record	10 Marks

B. Sc. BIOTECHNOLOGY SEMESTER–III (2023-24)

SEC Course

Communicative English

Code of the course:

Title of the course: Communicative English

Level of the Course: NHEQF Level 5

Credit of the Course: 2

Type of the Course: Skill Enhancement Course (SEC) Course for all Discipline/Subject

Delivery Type of the Course: Thirty hours Lecture

Prerequisites:

(1) Courses of Central Board of Secondary Education or equivalent.

Objectives of the Course:

The purpose of this course is to introduce students to the theory, fundamentals and tools of communication and to develop in them vital communication skills which should be integral to personal, social and professional interactions. One of the critical links among human beings and an important thread that binds society together is the ability to share thoughts, emotions and ideas through various means of communication: both verbal and non-verbal. In the context of rapid globalization and increasing recognition of social and cultural pluralities, the significance of clear and effective communication has substantially enhanced.

Course Outcome:

Upon completion of this course, the students will able to learn the basic language and improve communication skills.

Syllabus:

SEC Course

Communicative English (Theory)

(Credit: 2; Hours: 30)

B. Sc. BIOTECHNOLOGY SEMESTER–IV (2023-24)

DCC Course (BIO6003T)

Code of the course: BIO6003T

Title of the course: Recombinant DNA Technology

Level of the Course: NHEQF Level 5

Credit of the Course: 4

Type of the Course: Discipline Centric Compulsory (DCC) Course for Biotechnology Discipline/Subject

Delivery Type of the Course: Sixty (40 Lectures + 20 tutorial and diagnostic assessment)

Prerequisites:

(1) Life science courses of Central Board of Secondary Education or equivalent.

Objectives of the Course:

The course aims to strengthen the conceptual knowledge related to genetic engineering learn at School level and lay foundation for further learning of the subject through this course on Recombinant DNA Technology which is a prerequisite for higher courses in Biotechnology.

Course Outcome:

Upon completion of this course, the students will able to outline the concept and techniques used in genetic engineering and gene cloning, understand about the different enzymes and vectors used in recombinant DNA technology, learn the techniques used to isolate bio molecules and the principles behind various hybridization and screening techniques.

Syllabus:

DCC Course (BIO6003T)

Biotechnology-IV: Recombinant DNA Technology (Theory)

(Credit: 4; Hours: 60)

Unit-I **12 Credit hours**

Genetic Engineering : definition, scope and importance, molecular tools for genetic engineering. Restriction endonucleases- types, nomenclature, recognition sequences, cleavage pattern. Vectors – general characteristics of vectors, desirable characters such as size, ori site, selection/ markers gene, restriction sites and MCS, cloning and expression vectors.

Unit-II **12 Credit hours**

Plasmid vectors: pBR-322, pUC vectors, Ti-plasmid,. M13 derived pUC vectors, bacteriophage λ vectors, cosmids, YAC and BAC. Creation of recombinant DNA: cloning and selection of individual gene. Transformation techniques: preparation of competent cells of bacteria, physical and chemical methods of gene tranfer in plant and animal cells.

Unit-III **12 Credit hours**

Genomic library and cDNA library, reverse transcriptase, Colony hybridization, screening by DNA hybridization, labelling of DNA, RNA and proteins: use of radioactive isotopes, non-radioactive labelling, relative advantages, in vivo labelling, nick translation, random primer labelling, autoradiography. Blotting techniques southern,northern, western and eastern.

Unit-IV **12 Credit hours**

Protein profiling: SDS PAGE, 2D gel electrophoresis and its significance, gel retardation assay, T-DNA and transposon mediated gene tagging, chloroplast transformation and its utility, DNA microarray.

Unit-V **12 Credit hours**

Antisense RNA technology, Ribozyme: biochemistry, hammerhead, hair pin and other ribozymes, strategies for designing ribozymes, application of antisense and ribozyme technologies.

Recommended Books:

1. Christopher, H.Gene cloning and Manipulation. Cambridge University, Press.
2. Nicholl, D.S.T. An introduction to genetic engineering. Cambridge University Press.
3. Sambrook, Russell and Maniatis. Molecular Cloning : A Laboratory Manual (Vol. I, II and III). Cold Spring Harber Laboratory.
4. Glover, D.M. and Hames, B.D. DNA Cloning : A practical approach. IRL Press. Oxford.
5. Brown, T.A. Gene cloning. Blackwell Publisher.
6. Kreuzar, H. and Massey, A. Recombinant DNA technology. A.S.M. Press, Washington.
7. Llibelli, Lanza and Campbell. Principles of Cloning. Academic Press.

E-Resources

1. https://www.khanacademy.org/

2. https://unacademy.com/

3. https://swayam.gov.in/

4. https://hstalks.com/

5. https://nptel.ac.in/courses

B. Sc. BIOTECHNOLOGY SEMESTER–IV (2023-24)

DCC Course (BIO6003P)

Code of the course: BIO6003P

Title of the course: Biotechnology Lab-IV: Recombinant DNA Technology (Practical)

Level of the Course: NHEQF Level 5

Credit of the Course: 2

Type of the Course: Discipline Centric Compulsory (DCC) Course for Biotechnology Discipline/Subject

Delivery Type of the Course: Lecture and practical 40+20=60. The 40 lectures for the hands on experiments, observations and record of the data, 10 hours for the experiment, instruments demonstration, lab practices and 10 hours on diagnostic assessment, formative assessment, subject/class activity, problem solving.

Prerequisites:

(1) Life science courses of Central Board of Secondary Education or equivalent.

Objectives of the Course:

The course aims to strengthen the practical knowledge related to genetic engineering learn at School level and lay foundation for further learning of the subject through this course on Recombinant DNA Technology which is a prerequisite for higher courses in Biotechnology.

Course Outcome:

Upon completion of this course, the students will able to:

1. Collect data and update the experimental process insistently.
2. Assess the procedure and outcomes of an experiment qualitatively and quantitatively.

3. Extend the scope of an experiment if or not results are as per expectation
4. Communicate the process and outcomes of an experiment.
5. Perform an experiment collaboratively and ethically

Syllabus:

DCC Course (BIO6003P)

Biotechnology Lab-IV: Recombinant DNA Technology (Practical)

(Credit: 2; Hours: 60)

1. Demonstrate the loading of given DNA sample to perform agarose gel electrophoresis.
2. Perform agarose gel electrophoresis to study the effect of varying agarose concentration on the mobility of the DNA.
3. Demonstrate the effect of varying voltage on mobility of given DNA samples by Agarose gel electrophoresis.
4. To perform restriction digestion of a given DNA sample and visualize it using agarose gel electrophoresis.
5. Determine the extent of polymorphism in given DNA profile using Jaccard's Coefficient.
6. Quantify the size of unknown DNA comparing with known DNA by semi- logarithmic graph.
7. Study the relation between the quantity and intensity of the given DNA sample using spot assay.
8. To estimate the quantity and purity of the DNA sample by using UV-VIS Spectroscopy.

Any other experiment can be designed to demonstrate the concepts and phenomenon related to the paper.

SPOTS:

1. SDS-PAGE
2. PCR machine
3. UV transilluminator

4. Electrophoretic apparatus
5. Gel Documentation System
6. Questions based on molecular biology
7. Questions based on solution preparations
8. Role of chemicals: SDS, Chloroform, Isopropanol, NaCl, Lysozyme

Recommended Books:

1. Green, M. R., & Sambrook, J. (2012). Molecular cloning. A Laboratory Manual 4th.
2. Schleif, R. F., & Wensink, P. C. (2012). Practical methods in molecular biology. Springer Science & Business Media.
3. Online Virtual Labs

Scheme of the Examination:

1.	Major Exercise	20 Marks
2.	Minor Exercise	15 Marks
3.	Minor Exercise	15 Marks
4.	Spots	2 x 5 = 10 Marks
5.	Viva-voce	10 Marks
6.	Record	10 Marks

B. Sc. BIOTECHNOLOGY SEMESTER–IV (2023-24)

SEC Course (SES6300T)

Code of the course: SES6300T

Title of the course: Bioinformatics

Level of the Course: NHEQF Level 5

Credit of the Course: 2

Type of the Course: Skill Enhancement Course (SEC) Course for Biotechnology Discipline/Subject

Delivery Type of the Course: Thirty hours Lecture

Prerequisites:

(1) Life science courses of Central Board of Secondary Education or equivalent.

Objectives of the Course:

The course aims to strengthen the conceptual knowledge related to basic applications of mathematics and computer science learn at School level and lay foundation for further learning of the subject through this course on bioinformatics which is a prerequisite for higher courses in Biotechnology.

Course Outcome:

Upon completion of this course, the students will able to gain knowledge and awareness of the basic principles and concepts of biology, computer science and mathematics, existing software effectively to extract information from large databases and to use this information in computer modeling.

Syllabus:

SEC Course (SES6300T)

Bioinformatics (Theory)

(Credit: 2; Hours: 30)

Unit 1: Introduction to Bioinformatics **6 Credit hours**

Introduction, Branches of Bioinformatics, Aim, Scope and Research areas of Bioinformatics. Structural Bioinformatics in Drug Discovery, Quantitative structure-activity relationship (QSAR) techniques in Drug Design, Microbial genome applications, Crop improvement.

Unit 2: Databases in Bioinformatics **6 Credit hours**

Introduction, Biological Databases, Classification format of Biological Databases, Biological Database Retrieval System.

Unit 3 : Biological Sequence Databases **6 Credit hours**

National Center for Biotechnology Information (NCBI): Tools and Databases of NCBI, Database Retrieval Tool, Sequence Submission to NCBI, Basic local alignment search tool (BLAST), Nucleotide Database, Protein Database, Gene Expression Database. Protein Information Resource (PIR): About PIR, Resources of PIR, Databases of PIR, Data Retrieval in PIR. Swiss-Prot: Introduction and Salient Features.

Unit 4: Sequence Alignments **6 Credit hours**

Introduction, Concept of Alignment, Multiple Sequence Alignment (MSA), MSA by CLUSTALW, Scoring Matrices, Per cent Accepted Mutation (PAM), Blocks of Amino Acid Substitution Matrix (BLOSUM).

Unit 5: Molecular Phylogeny **6 Credit hours**

Methods of Phylogeny, Software for Phylogenetic Analyses, Consistency of Molecular Phylogenetic Prediction.

Recommended Books:

1. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.
2. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell.
3. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. II Edition. Benjamin Cummin
4. Xinong J. Essential Bioinformatics, Cambridge University Press.
5. Mount D.W. Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor Laboratory Press.
6. Sharma V., Munjal A., Shanker A. A Text Book of Bioinformatics. Rastogi Publications.

E-Resources

1. https://www.khanacademy.org/

2. https://unacademy.com/

3. https://swayam.gov.in/

4. https://hstalks.com/

5. https://nptel.ac.in/courses

B. Sc. BIOTECHNOLOGY SEMESTER–V (2023-24)

DSE Course (BIO7100T)

Code of the course: BIO7100T

Title of the course: Environmental Biotechnology

Level of the Course: NHEQF Level 5.5

Credit of the Course: 4

Type of the Course: Discipline Specific Elective (DSE) Course for Biotechnology Discipline/Subject

Delivery Type of the Course: Sixty (40 Lectures + 20 tutorial and diagnostic assessment)

Prerequisites:

(1) Life science courses of Central Board of Secondary Education or equivalent.

Objectives of the Course:

The course aims to strengthen the conceptual knowledge related to Environmental science learn at School level and lay foundation for further learning of the subject through this course on Environmental Biotechnology which is a prerequisite for higher courses in Biotechnology.

Course Outcome:

Upon completion of this course, the students will able to describe factors leading to Environmental degradation, describe different types of biotechnological applications or means through which environmental problems can be solved, explain principles and major processes of bioremediation and phytoremediation, Identify and formulate strategies for the conservation of environment through biotechnological means to achieve goals of sustainable management under the given legislative measures.

Syllabus:

DSE Course (BIO7100T)

Environmental Biotechnology (Theory)

(Credit: 4; Hours: 60)

Unit-I **12 Credit hours**

Natural resources: Energy resources (renewable and non-renewable), conventional and non-conventional sources of energy, forest resources, fish resources, water resources. Conservation of natural resources- ex situ and in situ conservation strategies, wildlife management,

Unit – II **12 Credit hours**

Waste water and its treatment- small scale and large scale sewage treatment, BOD and COD. Ground water remediation, water softening, water demineralization, desalination, ion-exchange and reverse osmosis, disinfection of water; ozonation and chemo-sterilization of water.

Unit – III **12 Credit hours**

Solid waste and their treatment- organic compost and process of composting, vermi-culture technology. Microbial degradation of xenobiotics, microorganism in abatement of heavy metal pollution, aeromicrobiology: aeroallergens and aeroallergy.

Unit – IV **12 Credit hours**

Biogas, biogas production- Solubilization, acetogenesis and methanogenesis, mechanism of methane formation. Microbes and their genetic engineering for degradation of pollutants.

Unit – V **12 Credit hours**

Application of microbes -biofertilizer, biopesticides, microbial leaching, biomining, biohydrometallurgy and biomineralization. Principles and applications of biosensors for detection of pollutants, Oil spills- Causes and recovery, use of super bugs for removal of oil spills.

Recommended Books:

1. Mooray Moo-Young. (Eds). Comprehensive Biotechnology (Vol. I, II, III) Pergamon Press, England.
2. Metcalf and Eddy. Waste water engineering treatment and uses. McGraw Hill.
3. Jogdand, S.N. Environmental Biotechnology. Himalaya Publication House.
4. De, A.K. Environmental Chemistry. Wiley Eastern Ltd.
5. Abbasi and Abbasi. Renewable Energy Sources and their environmental impact. Prentice Hall of India, Pvt. Ltd.
6. Chatterji, A.K. Introduction to Environmental Biotechnology. Prentice Hall of India.
7. Thakur, I. S. Text Book of Environmental Biotechnology. I. K. International Publisher, New Delhi.
8. Mohapatra, P. K. Text Book of Environmental Biotechnology. I. K. International Publisher, New Delhi.

E-Resources

1. https://www.khanacademy.org/

2. https://unacademy.com/

3. https://swayam.gov.in/

4. https://hstalks.com/

5. https://nptel.ac.in/courses

B. Sc. BIOTECHNOLOGY SEMESTER–V (2023-24)

DSE Course (BIO7100P)

Code of the course: BIO7100P

Title of the course: Elective BIO. Lab-1: Environmental Biotechnology Lab (Practical)

Level of the Course: NHEQF Level 5.5

Credit of the Course: 2

Type of the Course: Discipline Specific Elective (DSE) Course for Biotechnology Discipline/Subject

Delivery Type of the Course: Lecture and practical 40+20=60. The 40 lectures for the hands on experiments, observations and record of the data, 10 hours for the experiment, instruments demonstration, lab practices and 10 hours on diagnostic assessment, formative assessment, subject/class activity, problem solving.

Prerequisites:

(1) Life science courses of Central Board of Secondary Education or equivalent.

Objectives of the Course:

The course aims to strengthen the practical knowledge related to Environmental science learn at School level and lay foundation for further learning of the subject through this course on Environmental Biotechnology which is a prerequisite for higher courses in Biotechnology.

Course Outcome:

Upon completion of this course, the students will able to:

1. Collect data and update the experimental process insistently.
2. Assess the procedure and outcomes of an experiment qualitatively and quantitatively.

3. Extend the scope of an experiment if or not results are as per expectation
4. Communicate the process and outcomes of an experiment.
5. Perform an experiment collaboratively and ethically

Syllabus:

DSE Course (BIO7100P)

Elective BIO. Lab-1: Environmental Biotechnology Lab (Practical)

(Credit: 2; Hours: 60)

1. Determine chemical oxygen demand (COD) of given water sample.
2. Determine biological oxygen demand (BOD) of given sewage sample.
3. Determine dissolved oxygen (DO) of given water sample.
4. Determine the total dissolved solids (TDS) in given water sample.
5. Isolate and identify E.coli from the given sewage sample.
6. Determine total hardness of the given water sample.
7. Determine total alkalinityin given water sample.
8. Determine the chlorine content of given water sample.

Any other experiment can be designed to demonstrate the concepts and phenomenon related to the paper.

SPOTS:

1. TDS meter
2. Desiccator
3. Water bath
4. Aeroallergens
5. BOD Incubator
6. Water softening
7. Reverse osmosis system
8. Diagram showing Biogas plant

Recommended Books:

1. Patra, J. K., Das, G., Das, S. K., & Thatoi, H. (2020). A Practical Guide to Environmental Biotechnology. Springer.

2. K.R. Aneja (2007) Experiments in Microbiology, Plant pathology and Biotechnology, 4th Edition, New Age International (P) Limited Publishers.

3. Online virtual labs

Scheme of the Examination:

1.	Major Exercise	20 Marks
2.	Minor Exercise	15 Marks
3.	Minor Exercise	15 Marks
4.	Spots	2 x 5 = 10 Marks
5.	Viva-voce	10 Marks
6.	Record	10 Marks

B. Sc. BIOTECHNOLOGY SEMESTER–V (2023-24)

DSE Course (BIO7101T)

Code of the course: BIO7101T

Title of the course: Immunology and Enzyme Technology

Level of the Course: NHEQF Level 5.5

Credit of the Course: 4

Type of the Course: Discipline Specific Elective (DSE) Course for Biotechnology Discipline/Subject

Delivery Type of the Course: Sixty (40 Lectures + 20 tutorial and diagnostic assessment)

Prerequisites:

(1) Life science courses of Central Board of Secondary Education or equivalent.

Objectives of the Course:

The course aims to strengthen the conceptual knowledge related to Immunology and Enzyme biology learn at School level and lay foundation for further learning of the subject through this course on Immunology and Enzyme Technology which is a prerequisite for higher courses in Biotechnology.

Course Outcome:

Upon completion of this course, the students will able to describe fundamental definition of immunity, immunesystem and immune responses, explain different types of immunity and the cellular components involved in the process of immune response, Describe the process of cell-mediated, humeral immunity and other immunity types, Illustrate major principles of antigen-antibody interactions and their role in diagnostic and therapeutic applications, Describe enzymes, enzyme actions and mode of enzyme actions, Illustrate about different types enzymes' classification, Describe principles of major enzymatic reaction occurring in the cells, Identify the relationship between enzyme actions and different cellular processes of metabolism and others.

Syllabus:

DSE Course (BIO7101T)

Immunology and Enzyme Technology (Theory)

(Credit: 4; Hours: 60)

Unit-I **12 Credit hours**

Immune system and immunity; history of immunology; innate and acquired immunity; structure, composition and functions of cells involved in immune system: T cells, B-cells, macrophages, eosinophils, neutrophils, mast cells and natural killer Cells. Structure, composition and functions of Organs involved in immune system: thymus gland, bone marrow, spleen and lymph nodes.

Unit-II **12 Credit hours**

Antigens – structure and properties, types (iso and alloantigens), haptens, adjuvants; antigen specificity. Immunoglobulins – structure, heterogeneity, types and subtypes, properties (physico-chemical and biological). complement – structure, components, properties and functions of complement; complement pathways and biological consequences of complement activation.

Unit-III **12 Credit hours**

Antigen antibody reactions – agglutination, precipitation, complement fixation, immunofluorescence, immuneoelectrophoresis, Applications of these methods in diagnosis of microbial infections. Major histocompatibility complex – structure and functions of MHC.

Unit-IV **12 Credit hours**

History and introduction to enzymes, Classification of enzymes, IUBMB system of nomenclature, E.C. numbers, Introduction to coenzyme, cofactors and prosthetic groups. Enzyme kinetics (Michaelis-Menten laws), importance and determination of V_{max} and K_m values, catalytic mechanisms of enzymes, acid-base, covalent, metal ion and electrostatic catalysis.

Unit-V **12 Credit hours**

Regulation of enzyme activity: metabolic compartmentation, covalent modification, feedback regulation. Enzyme inhibition: competitive and non competitive. Multienzyme complexes: structure and significance. Isolation and purification of enzymes: salt precipitation, gel filteration, ion exchange and affinity chromatography.

Recommended Books:

1. CoicoR, Sunshine, BenjaminE.Immunology : A short course. John Wiley and Sons.
2. Roitt, Brostoff, Male and Mosby. Immunology.
3. Kuby et al. Immunology. W.H. Freeman and Company.
4. Rao, C.V. An Introduction to Immunology. NarosaPub. House.
5. Coleman, R.M. Fundamental Immunology. McGraw Hill.
6. Paul, W.E. Fundamentals of Immunology. Raven Press New York
7. Palmer, T. Understanding Enzymes.
8. Price and Stevenson. Fundamentals of Enzymology. OxfordUniversity Press.
9. Dixon and Webb. The Enzymes. Academic Press, London.
10. Foster, F.L. The nature of Enzymology. John Wiley and Sons

E-Resources

1. https://www.khanacademy.org/

2. https://unacademy.com/

3. https://swayam.gov.in/

4. https://hstalks.com/

5. https://nptel.ac.in/courses

B. Sc. BIOTECHNOLOGY SEMESTER–V (2023-24)

DSE Course (BIO7101P)

Code of the course: BIO7101P

Title of the course: Elective BIO. Lab-2: Immunology and Enzyme Technology Lab (Practical)

Level of the Course: NHEQF Level 5.5

Credit of the Course: 2

Type of the Course: Discipline Specific Elective (DSE) Course for Biotechnology Discipline/Subject

Delivery Type of the Course: Lecture and practical 40+20=60. The 40 lectures for the hands on experiments, observations and record of the data, 10 hours for the experiment, instruments demonstration, lab practices and 10 hours on diagnostic assessment, formative assessment, subject/class activity, problem solving.

Prerequisites:

(1) Life science courses of Central Board of Secondary Education or equivalent.

Objectives of the Course:

The course aims to strengthen the practical knowledge related to Immunology and Enzyme biology learn at School level and lay foundation for further learning of the subject through this course on Immunology and Enzyme Technology which is a prerequisite for higher courses in Biotechnology.

Course Outcome:

Upon completion of this course, the students will able to:

1. Collect data and update the experimental process insistently.

2. Assess the procedure and outcomes of an experiment qualitatively and quantitatively.
3. Extend the scope of an experiment if or not results are as per expectation
4. Communicate the process and outcomes of an experiment.
5. Perform an experiment collaboratively and ethically

Syllabus:

DSE Course (BIO7101P)

Elective BIO. Lab-2: Immunology and Enzyme Technology Lab (Practical)

(Credit: 2; Hours: 60)

1. Prepare stained blood film and identify different types of blood cells. Draw well labeled diagram of cells observed.
2. Enumerate the total RBC counting in your own blood.
3. Determine the blood group of your own blood.
4. Demonstrate the haemolysis and crenation in RBCs.
5. Prepare a slide of blood showing the formation of haemin crystals. Write the procedure and make the diagram of the crystals seen.
6. Determine the clotting time of your own blood.
7. Demonstrate the enzyme activity of peroxidase in given sample.
8. Demonstrate the enzyme activity of dehydrogenase in given sample.

Any other experiment can be designed to demonstrate the concepts and phenomenon related to the paper.

SPOTS:

1. Alloantigens
2. Macrophages
3. Heamocytometer
4. Slide of blood cells
5. Heamoglobinometer

6. Multienzyme complexes
7. Blood group detection kit
8. Major histocompatibility complex

Recommended Books:

1. Andreas Hofmann, Samuel Clokie (2018). Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology. 8th edition. Cambridge University Press
2. Frank C. Hay & Olwyn M.R. Westwood (2002). Practical Immunology. Blackwell Science Ltd
3. Online Virtual Labs

Scheme of the Examination:

1. Major Exercise	20 Marks
2. Minor Exercise	15 Marks
3. Minor Exercise	15 Marks
4. Spots	2 x 5 = 10 Marks
5. Viva-voce	10 Marks
6. Record	10 Marks

B. Sc. BIOTECHNOLOGY SEMESTER–V (2023-24)

SEC Course (SES7301P)

Code of the course: SES7301P

Title of the course: Basics of Instrumentation

Level of the Course: NHEQF Level 5.5

Credit of the Course: 2

Type of the Course: Skill Enhancement Course (SEC) Course for all Discipline/Subject

Delivery Type of the Course: Lecture and practical 40+20=60. The 40 lectures for the hands on experiments, observations and record of the data, 10 hours for the experiment, instruments demonstration, lab practices and 10 hours on diagnostic assessment, formative assessment, subject/class activity, problem solving.

Prerequisites:

(1) Life science courses of Central Board of Secondary Education or equivalent.

Objectives of the Course:

The course aims to strengthen the practical knowledge related to basic biological techniques learn at School level and lay foundation for further learning of the subject through this course on Basics of Instrumentations which is a prerequisite for higher courses in Biotechnology. This course will teach the various instrumentations that are used in the analytical laboratories. The students have the basic knowledge on the practical, operation and function of analytical instruments.

Course Outcome:

1. Collect data and update the experimental process insistently.
2. Assess the procedure and outcomes of an experiment qualitatively and quantitatively.

3. Extend the scope of an experiment if or not results are as per expectation
4. Communicate the process and outcomes of an experiment.
5. Perform an experiment collaboratively and ethically

Syllabus:

SEC Course (SES7301P)

Basics of Instrumentation (Practical)

(Credit: 2; Hours: 30)

1. Verification of Lambert – Beer 's law for KMnO4 using spectrophotometer.
2. Extract and separate pigments from Curcuma longa using Thin Layer Chromatography and calculate their Rf values.
3. Evaluate the effectiveness of moist heat sterilization using linear streak method.
4. Evaluate the effectiveness of dry heat sterilization using linear streak method.
5. Demonstrate the effectiveness of ultra violet radiations using linear streak method.
6. Evaluate the effectiveness of alcohol as a skin antiseptic using thumb impression method.
7. Evaluate the antiseptics (Tincture of iodine and 70% Isopropyl alcohol) by filter paper disk method.
8. Extract and separate photosynthetic pigments by paper chromatography and calculate their Rf values.

Any other experiment can be designed to demonstrate the concepts and phenomenon related to the paper.

SPOTS:

1. Instruments
    a) Autoclave
    b) Hot air oven
    c) Incubator
    d) Laminar air flow bench
    e) Spectrophotometer

f) Centrifuge

g) pH meter

2. Microscopy (principle and applications of Light, phase contrast, SEM,TEM)

Recommended Books:

1. Andreas Hofmann, Samuel Clokie (2018). Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology. 8th edition. Cambridge University Press

2. K.R. Aneja (2007) Experiments in Microbiology, Plant pathology and Biotechnology, 4th Edition, New Age International (P) Limited Publishers.

3. Online virtual labs

Scheme of the Examination:

1.	Major Exercise	20 Marks
2.	Minor Exercise	15 Marks
3.	Minor Exercise	15 Marks
4.	Spots	2 x 5 = 10 Marks
5.	Viva-voce	10 Marks
6.	Record	10 Marks

B. Sc. BIOTECHNOLOGY SEMESTER–VI (2023-24)

DSE Course (BIO7105T)

Code of the course: BIO7105T

Title of the course: Microbial Technology

Level of the Course: NHEQF Level 5.5

Credit of the Course: 4

Type of the Course: Discipline Specific Elective (DSE) Course for Biotechnology Discipline/Subject

Delivery Type of the Course: Sixty (40 Lectures + 20 tutorial and diagnostic assessment)

Prerequisites:

(1) Life science courses of Central Board of Secondary Education or equivalent.

Objectives of the Course:

The course aims to strengthen the conceptual knowledge related to Applied Microbiology learn at School level and lay foundation for further learning of the subject through this course on Microbial Technology which is a prerequisite for higher courses in Biotechnology.

Course Outcome:

Upon completion of this course, the students will able to throw light on the application of biological and engineering principles in microbial, mammalian, and biological/biochemical systems. Students will gain knowledge on concept of culturing and maintaining industrially important microbes. of significance and activities of microorganisms in food. Students are expected to be able to design a food fermentation process.

Syllabus:

DSE Course (BIO7105T)

Microbial Technology (Theory)

(Credit: 4; Hours: 60)

Unit-I **12 Credit hours**

Introduction to industrial biotechnology, basic principles of fermentation technology, Types of fermentation – solid state, submerged, batch and continuous fermentation. Fermentation media – natural and synthetic media; molasses, corn-steep liquor, sulphite waste liquor, whey, yeast extract and protein hydrolysates.

Unit-II **12 Credit hours**

Fermenters and bioreactors – construction, design and operation, continuous stirred tank, airlift, packed bed, fluidized bed and bubble column bioreactor. Measurement and control of fermentation parameters - pH, temperature, dissolved oxygen, foaming and aeration.

Unit-III **12 Credit hours**

Downstream processing: Cell disruption, filtration, centrifugation, solvent extraction, precipitation, lyophilization and spray drying. Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes (glucose isomerase and penicillin acylase).

Unit-IV **12 Credit hours**

Microbial production of industrial products (micro-organisms involved, media, fermentation conditions, downstream processing and uses); Citric acid, ethanol, penicillin, glutamic acid, Vitamin B12 Enzymes (amylase, protease, lipase).

Unit-V **12 Credit hours**

Microbial foods – Single Cell Proteins (SCP), Single Cell Oils (SCO); Techniques of mass culture of Algae-spirulina; Microbial polysaccharides and polyesters; production of xanthan gum and polyhydroxyalkaloides.

Recommended Books:

1. Waites, Morgan, Rockey. Industrial Microbiology. Blackwell Science.
2. Saha, B.D. Fermentation Biotechnology. American Chemical Society.
3. Demain and Davies . Industrial Microbiology and Biotechnology. A.S.M. Press Washington.
4. Glazer, A.N. and Nikaido, H. Microbial Biotechnology : Principle and application of applied microbiology. W.H.Freeman and com.
5. Stanbary, Whitaker and Hall. Principles of Fermentation Technology.
6. Shuler and Kargi. Bioprocess Engineering. Pearson.
7. Mukherji, K.G. Microbial Technology. APH. Pub. Corp.
8. Ray. Fundamental Food Microbiology. CBH Pub.
9. Bell, Neaves and Williams. Food Microbiology and Laboratory Practice. Panima.

E-Resources

1. https://www.khanacademy.org/

2. https://unacademy.com/

3. https://swayam.gov.in/

4. https://hstalks.com/

5. https://nptel.ac.in/courses

B. Sc. BIOTECHNOLOGY SEMESTER–VI (2023-24)

DSE Course (BIO7105P)

Code of the course: BIO7105P

Title of the course: Elective BIO. Lab-1: Microbial Technology Lab (Practical)

Level of the Course: NHEQF Level 5.5

Credit of the Course: 2

Type of the Course: Discipline Specific Elective (DSE) Course for Biotechnology Discipline/Subject

Delivery Type of the Course: Lecture and practical 40+20=60. The 40 lectures for the hands on experiments, observations and record of the data, 10 hours for the experiment, instruments demonstration, lab practices and 10 hours on diagnostic assessment, formative assessment, subject/class activity, problem solving.

Prerequisites:

(1) Life science courses of Central Board of Secondary Education or equivalent.

Objectives of the Course:

The course aims to strengthen the practical knowledge related to Applied Microbiology learn at School level and lay foundation for further learning of the subject through this course on Microbial Technology which is a prerequisite for higher courses in Biotechnology.

Course Outcome:

1. Collect data and update the experimental process insistently.
2. Assess the procedure and outcomes of an experiment qualitatively and quantitatively.
3. Extend the scope of an experiment if or not results are as per expectation

4. Communicate the process and outcomes of an experiment.
5. Perform an experiment collaboratively and ethically

Syllabus:

DSE Course (BIO7105P)

Elective BIO. Lab-1: Microbial Technology Lab (Practical)

(Credit: 2; Hours: 60)

1. Perform the negative staining of given the bacterial sample to study morphology and arrangement of bacterial cells
2. To determine the esculin hydrolysis activity for lactobacilli
3. Determine the carbohydrate fermentation pattern of given bacterial sample.
4. To determine the citrate utilization activity of the given bacteria.
5. Perform the Voges–Proskauer test for the given lactobacilli.
6. Isolation of yeast on Sabouraud agar.
7. Determination of titrable acidity of the fermented juice.
8. Identify the acid producing lactobacilli using BCP supplemented MRS medium.

Any other experiment can be designed to demonstrate the concepts and phenomenon related to the paper.

SPOTS:

1. Cell disruption
2. Negative staining
3. Single Cell Proteins
4. Colony characteristics of yeast
5. Wet mount preparation of yeast
6. Fermented stirred tank bioreactor
7. Composition of MRS, Sabouraud agar
8. Production of Alcohol, Citric acid, Penicillin

Recommended Books:

1. K.R. Aneja (2007) Experiments in Microbiology, Plant pathology and Biotechnology, 4th Edition, New Age International (P) Limited Publishers.
2. R.C. Dubey and D.K. Maheshwari (2012) Practical Microbiology, 3rd Edition, S. Chand and Company Ltd.
3. Online Virtual Labs

Scheme of the Examination:

1.	Major Exercise	20 Marks
2.	Minor Exercise	15 Marks
3.	Minor Exercise	15 Marks
4.	Spots	2 x 5 = 10 Marks
5.	Viva-voce	10 Marks
6.	Record	10 Marks

B. Sc. BIOTECHNOLOGY SEMESTER–VI (2023-24)

DSE Course (BIO7106T)

Code of the course: BIO7106T

Title of the course: Agriculture Biotechnology

Level of the Course: NHEQF Level 5.5

Credit of the Course: 4

Type of the Course: Discipline Specific Elective (DSE) Course for Biotechnology Discipline/Subject

Delivery Type of the Course: Sixty (40 Lectures + 20 tutorial and diagnostic assessment)

Prerequisites:

(1) Life science courses of Central Board of Secondary Education or equivalent.

Objectives of the Course:

The course aims to strengthen the conceptual knowledge related to Agriculture technology learn at School level and lay foundation for further learning of the subject through this course on Agriculture Biotechnology which is a prerequisite for higher courses in Biotechnology.

Course Outcome:

This course presents the application of biotechnology in agricultural goals. To make the student to understood usage of Plant products and their utilization in Biotechnology. On successful completion of the subject, the student should have understood: Crop development, Callus culture, Biotechnological applications of plants, the principles, practices and applications of plant biotechnology, plant tissue culture, plant genomics, genetic transformation and molecular breeding of plants.

Syllabus:

DSE Course (BIO7106T)

Agriculture Biotechnology (Theory)

(Credit: 4; Hours: 60)

UNIT I **12 Credit hours**

Role of micropropagation in silviculture, horticulture, agriculture, and conservation of biodiversity and threatened plant species. Somatic embryogenesis with special reference to production of synthetic seeds, Application of plant biotechnology in plant pathology with special reference to culture of obligate parasites.

UNIT-II **12 Credit hours**

Screening of germplasm and cell line selection. Application of somaclonal variation with special reference to development of disease resistant cell lines. Applications of plant biotechnology in breeding and crop improvement with special reference to production of haploids and triploids.

UNIT-III **12 Credit hours**

Role of tissue culture in genetic engineering for crop improvement – Agrobacterium mediated gene transfer in plants and development of genetically modified organisms with special reference to drought and salinity, insect and virus resistance.

UNIT-IV **12 Credit hours**

Bioreactors for production of secondary metabolites. Introduction types: stirred-tank type, air-lift type, membrane type bioreactor, packed bed reactor. Modes of culture applied in bioreactors – batch culture, fed-batch culture, semi-continuous culture, continuous culture.

UNIT-V **12 Credit hours**

Secondary products in tissue cultures – production of alkaloids, phenols, steroids, lignins, coumarins, flavonoids, anthroquinones and naphthoquinones, isoprenoids, Plant cell immobilization, gel entrapment, applications of immobilization techniques. Secondary metabolite production using immobilized cells.

Recommended Books:

1. Smyth, S. J., Phillips, P. W., & Castle, D. (Eds.). (2014). Handbook on agriculture, biotechnology and development. Edward Elgar Publishing.
2. Maddela, N. R., & García, L. C. (Eds.). (2021). Innovations in biotechnology for a sustainable future. Springer International Publishing.
3. Shan, G. (2011). Immunoassays in agricultural biotechnology. John Wiley & Sons.
4. Bhojwani, S.S. and Rajdan, M.K. Plant Tissue Culture: Theory and Practices a revised Edition. Elsevier.
5. Razdan, M.K. Introduction to plant tissue culture. Oxford & IBH Publishers.
6. Chawla, H.S. Introduction to Plant Biotechnology. Oxford & IBH Publishers.

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1. https://www.khanacademy.org/

2. https://unacademy.com/

3. https://swayam.gov.in/

4. https://hstalks.com/

5. https://nptel.ac.in/courses

B. Sc. BIOTECHNOLOGY SEMESTER–VI (2023-24)

DSE Course (BIO7106P)

Code of the course: BIO7106P

Title of the course: Elective BIO. Lab-2: Agriculture Biotechnology (Practical)

Level of the Course: NHEQF Level 5.5

Credit of the Course: 2

Type of the Course: Discipline Specific Elective (DSE) Course for Biotechnology Discipline/Subject

Delivery Type of the Course: Lecture and practical 40+20=60. The 40 lectures for the hands on experiments, observations and record of the data, 10 hours for the experiment, instruments demonstration, lab practices and 10 hours on diagnostic assessment, formative assessment, subject/class activity, problem solving.

Prerequisites:

(1) Life science courses of Central Board of Secondary Education or equivalent.

Objectives of the Course:

The course aims to strengthen the practical knowledge related to Agriculture technology learn at School level and lay foundation for further learning of the subject through this course on Agriculture Biotechnology which is a prerequisite for higher courses in Biotechnology.

Course Outcome:

1. Collect data and update the experimental process insistently.
2. Assess the procedure and outcomes of an experiment qualitatively and quantitatively.
3. Extend the scope of an experiment if or not results are as per expectation

4. Communicate the process and outcomes of an experiment.
5. Perform an experiment collaboratively and ethically

Syllabus:

DSE Course (BIO7106P)

Elective BIO. Lab-2: Agriculture Biotechnology (Practical)

(Credit: 2; Hours: 60)

1. Prepare suitable explants form the given plant material and demonstrate the process of meristem tip culture for the production of disease free plants.
2. Prepare suitable media for rooting of micro shoot and inoculate it for rooting.
3. Demonstrate the technique of micropropagation by culturing of leaf disc on suitable media.
4. To demonstrate the process of adventitious shoot bud differentiation from leaf of the given plant sample.
5. To isolate the Azotobacter species from soil sample by serial dilution method.
6. To isolate antibiotic producing bacteria from soil.
7. Isolate the fungi from the given soil sample by pour plate method
8. Identification of fungi by wet mount method.
9. Determination of phosphate solubilizing activity in given bacterial culture.

Any other experiment can be designed to demonstrate the concepts and phenomenon related to the paper.

SPOTS:

1. Bioreactors
2. Silviculture
3. Naphthoquinones
4. Genetic engineering
5. Somaclonal variation

6. Production of haploids
7. Somatic embryogenesis
8. Culture of obligate parasites

Recommended Books:

1. Bhojwani, S. S., & Razdan, M. K. (2003). Plant tissue culture: theory and practice. Elsevier.

2. K.R. Aneja (2007) Experiments in Microbiology, Plant pathology and Biotechnology, 4th Edition, New Age International (P) Limited Publishers.

3. Online Virtual Labs

Scheme of the Examination:

1. Major Exercise	20 Marks
2. Minor Exercise	15 Marks
3. Minor Exercise	15 Marks
4. Spots	2 x 5 = 10 Marks
5. Viva-voce	10 Marks
6. Record	10 Marks

B. Sc. BIOTECHNOLOGY SEMESTER–VI (2023-24)

SEC Course (SES7302P)

Code of the course: SES7302P

Title of the course: Microbial cultivation techniques

Level of the Course: NHEQF Level 5.5

Credit of the Course: 2

Type of the Course: Skill Enhancement Course (SEC) Course for Biotechnology Discipline/Subject

Delivery Type of the Course: Lecture and practical 40+20=60. The 40 lectures for the hands on experiments, observations and record of the data, 10 hours for the experiment, instruments demonstration, lab practices and 10 hours on diagnostic assessment, formative assessment, subject/class activity, problem solving.

Prerequisites:

(1) Life science courses of Central Board of Secondary Education or equivalent.

Objectives of the Course:

The course aims to strengthen the practical knowledge related to isolation and cultivations of microorganisms learn at School level and lay foundation for further learning of the subject through this course on microbial cultivation techniques which is a prerequisite for higher courses in Biotechnology.

Course Outcome:

1. Collect data and update the experimental process insistently.
2. Assess the procedure and outcomes of an experiment qualitatively and quantitatively.

3. Extend the scope of an experiment if or not results are as per expectation
4. Communicate the process and outcomes of an experiment.
5. Perform an experiment collaboratively and ethically

Syllabus:

SEC Course (SES7302P)

Microbial cultivation techniques (Practical)

(Credit: 2; Hours: 60)

1. Preparation of Nutrient agar medium and isolation of bacteria using Streak, Spread and Pour plate method.
2. To study the colony characteristics of bacteria.
3. To perform Gram staining for studying bacterial morphology.
4. To perform catalase test for bacterial identification
5. To perform carbohydrate fermentation test for biochemical identification of bacteria.
6. Preparation of Sabouraud agar for isolation of fungi and to study the colony morphology of isolated colonies.
7. To prepare wet mount of fungi for their identification.
8. To perform slant and stab culture method for storage of bacteria.

Any other experiment can be designed to demonstrate the concepts and phenomenon related to the paper.

SPOTS:

1. Stab and slant culture
2. Streaking four ways
3. Pour plate technique
4. Carbohydrate fermentation
5. Media ingredients and their role: Nutrient agar, Nutrient broth, Sabouraud agar
6. Wet mount of fungi

7. Instruments: Autoclave, Hot air oven, Laminar air flow, pH meter, Centrifuge, Spectrophotometer

Recommended Books:

1. K.R. Aneja (2007) Experiments in Microbiology, Plant pathology and Biotechnology, 4th Edition, New Age International (P) Limited Publishers.

2. R.C. Dubey and D.K. Maheshwari (2012) Practical Microbiology, 3rd Edition, S. Chand and Company Ltd.

3. Online Virtual Labs

Scheme of the Examination:

1. Major Exercise	20 Marks
2. Minor Exercise	15 Marks
3. Minor Exercise	15 Marks
4. Spots	2 x 5 = 10 Marks
5. Viva-voce	10 Marks
6. Record	10 Marks