Department of Biotechnology
Mohanlal Sukhadia University
Udaipur, Rajasthan

M.Sc. (CBCS) Biotechnology
Syllabus as per the National Education Policy

M.Sc. (CBCS) Biotechnology: Course Structure													
Level	**Sem**	**Course Type**	**Course Code**	**Course Title**	**Delivery Type**			**Total Hours**	**Credit**	**Total Credit**	**Internal Assessment**	**EoS Exam**	**M.M.**	**Remarks**
					L	T	P							
8	I	DCC	BIO8000T	IMMUNOLOGY AND ENZYMOLOGY	L	T	-	60	4	24	20	80	100	
			BIO8001T	CELL BIOLOGY AND MOLECULAR GENETICS	L	T	-	60	4		20	80	100	
			BIO8002T	FUNDAMENTALS OF MICROBIOLOGY	L	T	-	60	4		20	80	100	
			BIO8003T	BIOMOLECULES AND METABOLISM	L	T	-	60	4		20	80	100	
			BIO8004P	IMMUNOLOGY AND CELL BIOLOGY LAB	-	-	P	120	4		20	80	100	
			BIO8005P	MICROBIOLOGY AND BIOMOLECULES LAB	-	-	P	120	4		20	80	100	
	II	DCC	BIO8006T	MOLECULAR BIOLOGY	L	T	-	60	4	24	20	80	100	
			BIO8007T	RECOMBINANT DNA TECHNOLOGY AND ITS APPLICATIONS	L	T	-	60	4		20	80	100	
			BIO8008T	ANIMAL BIOTECHNOLOGY	L	T	-	60	4		20	80	100	

			BIO8009P	MOLECULAR BIOLOGY AND RDT LAB	-	-	P	120	4		20	80	100	
			BIO8010P	ANIMAL AND PLANT BIOTECHNOLOGY LAB	-	-	P	120	4		20	80	100	
		GEC	BIO810XT	0. BIOINFORMATICS AND BIOSTATISTICS 1. BIOSAFETY, BIOETHICS AND IPR 2. 3.	L	T	-	60	4		20	80	100	
Exit with PG Diploma in Biotechnology														
9	III	DCC	BIO9011T	FERMENTATION TECHNOLOGY	L	T	-	60	4	24	20	80	100	
			BIO9012T	PLANT BIOTECHNOLOGY	L	T	-	60	4		20	80	100	
		DSE	BIO910YT	4. FOOD AND DAIRY BIOTECHNOLOGY 5. ENVIRONMENTAL BIOTECHNOLOGY 6. 7.	L	T	-	60	4		20	80	100	
			BIO911ZT	8. MEDICAL BIOTECHNOLOGY AND CANCER CELL BIOLOGY 9. AGRICULTURE BIOTECHNOLOGY 10. 11.	L	T	-	60	4		20	80	100	

			BIO912UP	12. FOOD FERMENTATION AND MEDICAL BIOTECHNOLOGY LAB 13. ENVIRONMENT AND AGRICULTURE BIOTECHNOLOGY LAB 14. 15.	-	-	P	120	4		20	80	100	
		GEC	BIO913VP	16. INSTRUMENTATION AND ANALYTICAL TECHNIQUES LAB 17. APPLICATION OF BIOINFORMATICS IN BIOLOGICAL SCIENCES LAB 18. 19.	-	-	P	120	4		20	80	100	-
	IV		BIO914XS	MAJOR RESEARCH PROJECT/INDUSTRIAL TRAINING	-	-	-	600	24	24	120	480	600	@ 30hr/week
	Exit with PG Degree in Biotechnology													

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M.Sc. (CBCS) Biotechnology

Total Seats: 30

(Seats with normal fees: 8, Self Finance Seats: 22)

Eligibility: B.Sc. with a minimum of 48% marks. Candidates from outside the state of Rajasthan should possess a minimum of 60% marks to seek admission.

(A) Candidate should have studied any two of the following subjects for at least two years at the under graduate level: Botany, Zoology, Chemistry, Microbiology, Biochemistry and Biotechnology.

or

(B) Candidates with B.Sc. in Life Sciences disciplines (Biotechnology, Genetics, Microbiology, Biochemistry, Biomedical Science, Genetic engineering, Genetics, Agriculture, Biosciences, Food Science, Food Technology, Forensic Science, B. Pharma, BDS, B.Sc. Nursing, BMLT and other relevant subjects) are also eligible for admission.

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SYLLABUS

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

DCC Course (BIO8000T)

Code of the course: BIO8000T

Title of the course: IMMUNOLOGY AND ENZYMOLOGY

Level of the Course: NHEQF Level 6.0

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 Undergraduate level or equivalent.

Objectives of the Course:

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

Course Outcome:

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

- Understand the role of the immune system, its organization and function.
- Develop immunological concepts and methods to diagnose immune disorders.
- Learn the mechanism of action and kinetics of enzyme.

Syllabus:

DCC Course (BIO8000T)

IMMUNOLOGY AND ENZYMOLOGY (THEORY)
(Credits: 4, Hour: 60)

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UNIT I **Credit hours: 12**

Innate and acquired immunity, clonal nature of the immune response. Immune system: primary lymphoid organs, secondary lymphoid organs. Cells of the immune system: B-lymphocytes, T-lymphocytes, Macrophages, Natural killer, Lymphokine activated killer cells. Haptens and adjuants. Nature of antigens, Antibody: types structure and function, Abzymes, Antigen-antibody reactions.

UNIT II **Credit hours: 12**

Antigen processing and presentation. Major histocompatibility Complex, complement system. Regulation of the immune response, activation of B and T-lymphocytes, cytokines, T-cell regulation, MHC restriction, Immunological tolerance. Hybridoma technology and monoclonal and polyclonal antibodies. Autoimmunity, Hypersensitivity reactions and Organ transplantation.

UNIT III **Credit hours: 12**

Classification of Enzymes, Mechanism of Enzyme Action; Concept of active site and energetics of enzyme substrate complex formation; Specifically of enzyme action; Kinetics of single substrate reactions; turnover number; estimation of Michaelis-Menten parameters, multi-substrate reactions-mechanism and kinetics; Types of inhibition-kinetic models; Substrate and Product Inhibition; Allosteric regulation of enzyme; Deactivation kinetics.

UNIT IV **Credit hours: 12**

Physical and Chemical methods used for cell disintegration. Enzyme fractionation by precipitation (using temperature, salt, solvent, pH, chemicals), Liquid-liquid extraction, ionic exchange, Gel Chromatography, Affinity chromatograhy and other special purification methods. Isozymes, Coenzymes, Ribozymes.

UNIT V **Credit hours: 12**

Physical and Chemical techniques for enzyme immobilization-adsorption, matrix entrapment, encapsulation, cross linking, covalent binding. Advantages and disadvantages of different immobilization techniques, overview of application of immobilized enzyme systems. Enzyme crystallization techniques. Commercial applications of enzymes in food, pharmaceutical and other industries.

Recommended Books

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1. Harvey W. Blanch, Douglas S. Clark, “Biochemical Engineering”, marcel Dekker, Inc.
2. James M. Lee, “Biochemical Engineering”, PHI, USA.
3. James, E. Bailey & David F. Ollis, “Biochemical Engineering fundamentals”, McGraw-Hill.
4. Wiseman, “Enzyme Biotechnology”’ Ellis Horwood Pub.
5. Kuby, J. “Immunology”. W. H. Freeman and Company.
6. Roitt, Brostoff, Male and Mosby, Immunology.
7. Palmer, T. Understanding Enzymes.
8. Coleman, R.M. Fundamental Immunology. 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**

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

DCC Course (BIO8001T)

Code of the course: BIO8001T

Title of the course: CELL BIOLOGY AND MOLECULAR GENETICS

Level of the Course: NHEQF Level 6.0

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 Undergraduate level or equivalent.

Objectives of the Course:

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

Course Outcome:

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

- Get a strong foundation on the basic unit of life and functions of cell
- Understand genetics and related modern DNA technology for disease diagnostics and therapy.

Syllabus:

DCC Course (BIO8001T)

CELL BIOLOGY AND MOLECULAR GENETICS (THEORY)
(Credits: 4, Hour: 60)

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Unit I **Credit hours: 12**

Comparison of prokaryotic and eukaryotic cells, cell wall, ultrastructure of plasma membrane, Nucleus: nuclear membrane, nucleolus and nuclear pore complex, Cytoskeletal elements, Mitochondria and chloroplast- structure and evolution, Mitochondria and male sterility, Lysosomes, Peroxisomes, glyoxysomes, Sub cellular organisms: Viruses and Prions.

Unit II **Credit hours: 12**

Cell-Cell Interactions: General principles of cell to cell communication, Cell Signaling: Signaling via G- Protein- linked cell surface receptors and via enzyme- linked cell surface receptors; Cell cycle events, regulation of cell division: cyclins, cyclin-dependent kinases, control of cell division in multicellular organisms; Transport across biomembrane, endocytosis and exocytosis.

Unit III **Credit hours: 12**

Mendelian genetics – Laws of inheritance; Gene interaction: modification of mendelian ratios; Linkage and crossing over, linkage map; Tetrad analysis; Chromatin; structure, types organization and chemistry of the chromosome. C-value paradox, Nuclear dyes and their application in staining of chromosomes. Polytene, Lambrush and B-chromosomes.

Unit IV **Credit hours: 12**

Genetic recombination at molecular level (Holliday model). Role of RecA protein in recombination, Mutation: spontaneous and induced mutations, Physical and chemical mutagenesis. Numerical and structural changes in chromosomes, Karyotyping, Pedigree analysis; Sex-linked inheritance: sex limited and sex influenced inheritance, Conceptual basis: Mechanism of sex determination in plants and animals.

Unit V **Credit hours: 12**

Transposons: Types, structure, properties and their significance. Mechanism of transposition, transposon mutagenesis. Integrons, Insertion sequences (IS), Composite transposons. Replicative and non replicative transpositions. Role of transposase and resolvase. Examples of Transposable elements, Retrotransposon.

Recommended Books

1. Alberts, B., Bray, D. Lewis, J., Raff, M., Roberts, K. and Watson, J.D. 1999. Molecular

Biology of Cell. Garland Publishing Co. New York, USA.

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2 Gasque, E. Manual of Laboratory experiments in cell Biology. W.C. Wilson Public.

3. Robertis, E.D.P., Robertis, E.M.F. Cell and Molelcular Biology. Sauder College Publication.

4. Beeker, W.M. The world of the cell. Pearson Education.

5. Karp, G. Cell and Molecular Biology. John Willey and sons.

6. Lodish and Baltimore. Molecular Cell Biology. W.H. Freeman and Co.

7. Snustad, D.P. and Simmons, M.J. 2000. Principles of genetics. John Wiley and Sons.

8. Russel, P.J. 1998. Genetics. The Benjamin/Cumming Publishing Co.

9.Gardner et al. Principles of Genetics. John Wiley

10. Griffiths et al. An Introduction to Genetic Analysis Freeman.

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

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

DCC Course (BIO8002T)

Code of the course: BIO8002T

Title of the course: FUNDAMENTALS OF MICROBIOLOGY

Level of the Course: NHEQF Level 6.0

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 Undergraduate level or equivalent.

Objectives of the Course:

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

Course Outcome:

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

- Throws light on types of microorganisms in and around humans
- Understanding on the concept of culturing microbes, sterilization techniques and estimating number of microbes in given sample.

Syllabus:

DCC Course (BIO8002T)

FUNDAMENTALS OF MICROBIOLOGY (THEORY)

(Credits: 4, Hour: 60)

Unit-I **Credit hours: 12**

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History, introduction and scope of Microbiology. Types of microorganisms, their general characteristics and significance. Kingdom and domain system of classification, Bacterial nomenclature and taxonomy. Bergey's manual of systematic bacteriology.

Unit-II **Credit hours: 12**

Archaea: General characters, classification, economic and ecological significance: differences and similarities with bacteria. Virus: Structural organization, classification, multiplication and transmission. Mycoplasma, General characters, reproduction and transmission. Some important diseases caused by viruses and mycoplasma.

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Unit-III **Credit hours: 12**

Bacteria: Ultrastructure, Morphological types, arrangement, Structure and function of Capsule, Cell membrane, flagella and pili. Cell wall: types, structural organization, Significance of LPS and role in pathogenicity. Nucleoid, Plasmids and Bacterial endospores. Applications of bacteria as probiotics and in bioremediation. Some important diseases caused by the bacteria.

Unit-IV **Credit hours: 12**

Physical and chemical methods of sterilization. Isolation and development of pure culture. Techniques of microbial culture, Anaerobic culture. Nutritional requirement for growth, Physical requirements for growth. Culture media; types, composition, preparation. Enumeration of microbes.

Unit V **Credit hours: 12**

Principles of Staining, Nature of dyes and types of staining; Maintaining and preservation of cultures, Selective culture methods, Characterization and identification of microbes based on morphology, cultural physiological and biochemical characteristics, serology and molecular methods of identification.

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.

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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

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

DCC Course (BIO8003T)

Code of the course: BIO8003T

Title of the course: BIOMOLECULES AND METABOLISM

Level of the Course: NHEQF Level 6.0

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 Undergraduate level or equivalent.

Objectives of the Course:

The course aims to strengthen the conceptual knowledge of biochemistry learn at School level and lay foundation for further learning of the subject through the course biomolecules and metabolism which is a prerequisite for higher courses in Biotechnology.

Course Outcome:

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

- Understand salient features of biomolecules in the organization of life.
- Helps the students in appreciating the integrated approach of interrelated pathways of catabolism and anabolism.

Syllabus:

DCC Course (BIO8003T)

BIOMOLECULES AND METABOLISM (THEORY)

(Credits: 4, Hour: 60)

Unit –I **Credit hours: 12**

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Bioenergetics: entropy, enthalpy, Gibbs free energy concept, Laws of thermodynamics. Acids and Bases, redox potential, Ioninzation of water, weak acids, and weak bases, pH and Buffers, Henderson and Hasselbach equation, pKa, pKb.

Unit- II **Credit hours: 12**

Carbohydrates: classification, structure, properties and functions. Glycolysis, TCA, HMP, and PPP; Gluconeogenesis, Glycogenesis, Glycogenolysis. Electron transport mechanism (chemi-osmotic theroy), Mechanism of ATP synthesis, Energy rich molecules.

Unit -III **Credit hours: 12**

Lipids: classification, structure, properties and functions of fatty acids, triacylglycerols, phospholipids, sterols and terpenes, Conjugated lipids - lipoproteins. ketone bodies, Lipids with specific biological functions, micelles and liposomes. Biosynthesis of saturated and unsaturated fatty acids, β-oxidation.

Unit -IV **Credit hours: 12**

Amino acids: general properties and biosynthesis, Transamination, Deamination, Decarboxylation; glutamine and glutamic acid pathway, urea cycle, uric acid biosynthesis. pI of amino acids, Protein structure (primary, secondary, tertiary and quaternary). Ramachandran plot. Protein turnover, Vitamins and Co- enzyme (biological and biochemical functions).

Unit -V **Credit hours: 12**

Experimental evidence for nucleic acids as genetic material. Secondary structure of DNA, Watson and Crick model of DNA. A, B and Z forms of DNA, Tm and its relation to GC content Chemical and enzymatic degradation of nucleic acids. Nucleic Acids: Structure of nucleoside, nucleotide. De novo and salvage pathways of nucleotide synthesis

Recommended Books

1. Voet and Voet. 2000. Biochemistry. John Wiley.

2. Lehninger. 2000. Principles of Biochemistry. CBS Publishers.

3. Stryer, L. 2002. Biochemistry. W.H. Freeman.

4. Harper. 2003. Biochemistry. McGraw-Hill.

5. Zubay. 1995. Biochemistry. Brown Publishers.

6. Trehan, K. Biochemistry. Wiley Eastern Publications.

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7. Jain, J.L. Fundamentals of Biochemistry. S. Chand and Company.

8. Deb, A.C. Fundamental of Biochemistry.

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**

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M. Sc. (CBCS) Biotechnology Semester-I (2023-24)

DCC COURSE- Immunology and Cell Biology Lab (BIO8004P)

Code of the course: BIO8004P

Title of the course: Immunology and Cell Biology Lab

Level of the Course: NHEQF Level 6.0

Credit of the Course: 4

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

Delivery Type of the Course: Lecture and practical 80+40=120. The 80 lectures for the hands on experiments, observations and record of the data, 20 hours for the experiment, instruments demonstration, lab practices and 20 hours on diagnostic assessment, formative assessment, subject/class activity, problem solving.

Prerequisites:

(1) Life science courses of Undergraduate level or equivalent.

Objectives of the Course:

The course aims to strengthen the practical knowledge of basic immunology and cell biology learn at college level and lay foundation for further learning of the subject which is a prerequisite for higher courses in Biotechnology.

Learning 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

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Syllabus:

Students are required to complete at least eight experiments.

1. To perform the sandwich Dot ELISA test for antigen.
2. Perform the Ouchterlony double diffusion procedure to determine the time value of thetest antiserum.
3. To determine the concentration of unknown antigen in the given sample using radial immunodiffusion (RID)
4. To prepare blood film and observe various type of blood cells.
5. To determine the blood group and Rh factor
6. To study the formation of haemin crystals.
7. Determination of alpha amylase activity by DNS method.
8. Indirect estimation of lactate dehydrogenase using yeast.
9. Prepare a temporary mount of given flower bud of onion and observe any one stage of meiosis.
10. Prepare a temporary mount of given onion root tip sample and observe any one stage of mitosis.
11. Prepare a karyotype from the given mitotic complement and derive the chromosome formula.
12. Demonstrate the presence of Barr body in your own buccal smear.
13. Prepare a temporary mount of buccal epithelium and localize the mitochondria using vital stain.
14. Prepare a temporary mount of buccal epithelium and localize the golgi body using vital stain.
15. Isolate the chloroplast from the give plant material.
16. Exercises based on genetics.

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

SPOTS:

1. Blood groups
2. Haemoglobinometer
3. Haemocytometer
4. Water bath
5. Photographs of abnormal karyotyping: Turner syndrome, Klienfelter syndrome, Down syndrome, Patau syndrome
6. Sides of mitosis and meiosis
7. Photographs of cell organelles: Chloroplast, RER, Golgi complex, Secondary lysosomes, Mitochondria, Nucleus.

Recommended Books:

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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 Examination:

1. Major Exercise I	15 Marks
2. Major Exercise II	15Marks
3. Minor Exercise I	10 Marks
4. Minor Exercise II	10 Marks
5. Spots	2X5=10 Marks
6. Viva-voce	10 Marks
7. Record	10 Marks

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M. Sc. (CBCS) Biotechnology Semester-I (2023-24)

DCC COURSE- Microbiology and Biomolecules Lab (BIO8005P)

Code of the course: BIO8005P

Title of the course: Microbiology and Biomolecules Lab

Level of the Course: NHEQF Level 6.0

Credit of the Course: 4

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

Delivery Type of the Course: Lecture and practical 80+40=120. The 80 lectures for the hands on experiments, observations and record of the data, 20 hours for the experiment, instruments demonstration, lab practices and 20 hours on diagnostic assessment, formative assessment, subject/class activity, problem solving.

Prerequisites:

(1) Life science courses of Undergraduate level or equivalent.

Objectives of the Course:

The course aims to strengthen the practical knowledge of basic microbiology and biochemistry learn at college level and lay foundation for further learning of the subject which is a prerequisite for higher courses in Biotechnology.

Learning 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

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Syllabus:

Students are required to complete at least eight experiments.

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
3. Perform the Gram staining procedure for the given bacterial sample.
4. Perform the negative staining procedure to study the morphology and arrangement of bacterial cells.
5. Perform the spore staining procedure for the given bacterial sample to observe the bacterial spores.
6. Determine the carbohydrate fermentation pattern of given bacterial sample (*Bacillus subtilis)*
7. Determine the ability of given bacterial cultures (*Bacillus subtilis)* to reduce nitrate to nitrite bynitrate reduction method.
8. Determine the ability of given bacterial cultures (*Bacillus subtilis* and *E.coli)* to excrete hydrolytic extracellular enzyme capable of degrading starch.
9. Isolation and identification of *E. coli* on EMB agar.
10. Enumerate the bacteria in the given food sample by standard plate count.
11. Determination of protein content by Bradford assay in the given sample using spectrophotometer.
12. Extract and quantify the total phenol content in given plant sample using the Folin-Ciocalteu method.
13. Determination of chlorophyll a and b in the given plant sample spectrophotometrically.
14. Determination of ABTS radical scavenging activity using spectrophotometer.
15. Qualitative determination of lipids in the given sample using Sudan test.
16. Qualitative estimation of carbohydrates in the given sample using different methods.
17. Qualitative estimation of protein content in the given sample using Biuret and Xanthoproteic test.
18. Determine the saponification value of given fat sample.

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

SPOTS:

1. Slides (Negative staining, Gram staining and spore staining)
2. Biochemical tests (Catalase test, Oxidase test)
3. Cultural characteristics
4. Photomicrographs (TMV, bacteriophage)
5. Specimen of diseased plants (Citrus canker, Yellow vein mosaic of bhindi
6. Glycolysis
7. Kreb's cycle

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8. Urea cycle
9. Calculation of the solutions (Molar, Molal, Normal and ppm)
10. Bradford's reagent
11. Folin-Ciocalteu
12. Henderson–Hasselbalch equation
13. Chemiosmotic hypothesis

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. Rajendiran, S., & Dhiman, P. (2019). Biochemistry Practical Manual-E-Book. Elsevier Health Sciences.
4. Online Virtual Labs

Scheme of Examination:

1. Major Exercise I	15 Marks
2. Major Exercise II	15Marks
3. Minor Exercise I	10 Marks
4. Minor Exercise II	10 Marks
5. Spots	2X5=10 Marks
6. Viva-voce	10 Marks
7. Record	10 Marks

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

DCC Course (BIO8006T)

Code of the course: BIO8006T

Title of the course: MOLECULAR BIOLOGY

Level of the Course: NHEQF Level 6.0

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 Undergraduate level or equivalent.

Objectives of the Course:

The course aims to strengthen the conceptual knowledge of molecular biology learn at college level and lay foundation for further learning of the subject through the course on Molecular biology which is a prerequisite for higher courses in Biotechnology.

Course Outcome:

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

- Learn fundamental molecular principles of genetics.
- Understand relationship between phenotype and genotype in human genetic traits.
- Describe the basics of genetic mapping and understand how gene expression is regulated.

Syllabus:

DCC Course (BIO8006T)

MOLECULAR BIOLOGY (THEORY)

(Credits: 4, Hour: 60)

Unit –I **Credit hours: 12**

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Eukaryotic and prokaryotic genetic materials: Structure, chemical composition, organization; Molecular mechanism of DNA synthesis, RNA primer for DNA synthesis, Enzymes and proteins associated with DNA replication, repetitive DNA. DNA repair: photo reactivation, excision repair, post replication repair, SOS repair.

Unit -II **Credit hours: 12**

RNA: types, structure and synthesis. Transcription: Prokaryotic transcription and RNA polymerase. Eukaryotic transcription and RNA polymerases. Transcription factors and their role. Modification in RNA: 5'-CAP formation, 3'-end processing, Polyadenylation, Splicing, Editing, Nuclear export of mRNA and mRNA stability. Processing of other RNAs. Reverse transcription. Inhibitors of RNA synthesis.

Unit -III **Credit hours: 12**

Translation: Prokaryotic and Eukaryotic translation, mechanism of initiation, elongation & termination, Amino acid activation, Inhibitors, Regulation of translation, Co- & Post-translational modification of proteins such as phosphorylation, adenylation, acylation and glycosylation. Protein sorting: synthesis of secretory and membrane proteins, import into nucleus, mitochondria, chloroplast and peroxisomes.

Unit –IV **Credit hours: 12**

Regulation of gene expression in prokaryotes and eukaryotes: Transcriptional control; enzyme induction and repression, constitutive synthesis of enzymes. The operon hypothesis: genes involved in regulation- regulatory gene, promoter gene, operator gene and structural gene, role of cAMP and cAMP receptor protein (CRP) in the expression of e.g. Lac operon, Tryptophan operon. Catabolite repression. *Cis* control elements, promoters, enhancers, DNA binding motifs of transcription factors.

Unit- V **Credit hours: 12**

Principles and applications of blotting techniques: Southern, Northern, Western and Eastern blotting. Polymerase chain reaction: Types and applications. Radioactive and Non-radioactive probes. Autoradiography. DNA fingerprinting, DNA foot printing and DNA sequencing, Antisense and siRNA technology. Chromosome walking.

Recommended Books

1. Watson, J.D. Molecular Biology of Gene. Pearson Education.

2. Friefelder, D. Molecular Biology. Narosa Publishing House, New Delhi.

3. Weaver, R. Molecular Biology. McGraw Hill.

4. Lewin, B. Gene VIII. Pearson Education.

5. Lodish and Baltimore. Molecular Cell Biology. W.H. Freeman and Co.

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6. Cooper, M. The Cell – A molecular approach. Sinauer.

7. Daniel. Molecular Cell Biology. Scientific American Books.

8. Smith. Molecular Biology. Faber and Faber Publications.

9. Dabre, P.D. Introduction to (Practical) Molecular Biology. John Wiley and Sons,

E-Resources

1. **https://www.khanacademy.org/**
2. **https://unacademy.com/**
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M. Sc. BIOTECHNOLOGY SEMESTER –II (2023-24)

DCC Course (BIO8007T)

Code of the course: BIO8007T

Title of the course: RECOMBINANT DNA TECHNOLOGY AND ITS APPLICATIONS

Level of the Course: NHEQF Level 6.0

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 Undergraduate level or equivalent.

Objectives of the Course:

The course aims to strengthen the conceptual knowledge of genetic engineering learn at college level and lay foundation for further learning of the subject through the course on recombinant DNA technology and its applications which is a prerequisite for higher courses in Biotechnology.

Course Outcome

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

- Know about implementation of genetic engineering for different purposes.
- Understand the principles of genetic engineering and the vectors used in cloning, methods of introduction of gene and expression.
- Investigate the different strategies of recombinant DNA technology and resolve the problems encountered.

Syllabus:

DCC Course (BIO8007T)

RECOMBINANT DNA TECHNOLOGY AND ITS APPLICATIONS (THEORY)

(Credits: 4, Hour: 60)

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Unit I **Credit hours: 12**

Recombinant DNA Technology: History, Milestones and basic steps in Genetic Engineering. Applications of genetic enzymes in recombinant DNA technology- Exo and endonucleases, restriction endonucleases; discovery, nomenclature, types and applications, DNA ligases, polymerases, DNA modifying enzymes.

Unit II **Credit hours: 12**

General concept and principle of cloning: Cloning vectors, classification, plasmids: pBR 322, pBR327, pUC8. Phage vectors: M13 and λ. Phagemids and cosmids. Animal virus derived vectors: SV 40 and baculoviral vectors. Yeast cloning vectors: 2µm plasmid, Yep, Yip and YAC. Shuttle and expression vectors.

Unit III **Credit hours: 12**

Methods for constructing rDNA and cloning: ligation; Use of linkers, adaptors and homo-polymer tailing. Insertion of DNA into living cell- physical; electroporation, ultrasonication, biolistic, laser mediated transfer and chemical methods. Methods for screening and selection of recombinant clones; genetic, immunochemical and hybridization methods.

Unit-IV **Credit hours: 12**

Polymerase chain reaction: Concept, optimization, Types (Simple, Nested, Muliplex, Real time and reverse transcriptase PCR) and applications. Nucleic Acid sequencing: Sanger's, Maxam Gillbert's method, Next generation sequencing; pyrosequencing and Illumina sequencing. Construction and screening of Genomic and c- DNA libraries.

Unit V **Credit hours: 12**

DNA fingerprinting, Foot printing, Site directed mutagenesis, DNA microarrays and Chromosome walking. Products of rDNA technology in humulin and hGH production, herbicide resistance, Bt transgenic, golden rice. Antisense, siRNA and CRISPR technology and their applications.

Recommended Books

1. Watson, J.D. Molecular Biology of Gene. Pearson Education.

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2. Friefelder, D. Molecular Biology. Narosa Publishing House, New Delhi.
3. Weaver, R. Molecular Biology. McGraw Hill.
4. Lewin, B. Gene VIII. Pearson Education.
5. Lodish and Baltimore. Molecular Cell Biology. W.H. Freeman and Co.
6. Cooper, M. The Cell – A molecular approach. Sinauer.
7. Daniel. Molecular Cell Biology. Scientific American Books.
8. Smith. Molecular Biology. Faber and Faber Publications.
9. Dabre, P.D. Introduction to (Practical) Molecular Biology. John Wiley and Sons, Ltd

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

DCC Course (BIO8008T)

Code of the course: BIO8008T

Title of the course: ANIMAL BIOTECHNOLOGY

Level of the Course: NHEQF Level 6.0

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 Undergraduate level or equivalent.

Objectives of the Course:

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

Course Outcome:

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

- Learn the aspects of animal cell culture, primary culture, media, storage and maintenance.
- Learn the molecular techniques in transgenic animal cell culture, cryopreservation.

Syllabus:

DCC Course (BIO8008T)

ANIMAL BIOTECHNOLOGY (THEORY)

(Credits: 4, Hour: 60)

Unit I **Credit hours: 12**

Animal Cell Culture: Historical events, equipments, Materials & Techniques of animal cell culture. Types of animal cell culture. Culture Media: Natural & Artificial media, balanced salt solutions,

Serum and protein free defined Media & their applications. Physiochemical properties of different constituents of culture Medium. Control, testing and storage of media. Maintenance of cell culture.

Unit II **Credit hours: 12**

Biology of cultured cells : Cell adhesion & proliferation, Differentiation , origin of cultured cells. Characterization of the cultured cell, cell transformation, cell synchronization. Culture procedure for tumor cells & specialized cell *viz:* Epithelial cells, Neuronal cells & Hematopoietic cells.

Unit III **Credit hours: 12**

Primary culture: Types, Isolation of tissue, Disaggregation of tissue. Cell lines: Nonenclature, Designation, Selection & Maintenance of cell lines. Cell cloning & cell separation. Animal cell culture, scale up: Scale up in suspension & Scale up in Monolayer culture.

Unit IV **Credit hours: 12**

Contamination: Sources of contamination, routes & monitoring for contamination, cross contamination. Cryopreservation: Need for cryopreservation, Stages of Cryopreservation,. Quantitation: Cell counting, Measurement of Growth, Measurement of cell death & Cytotoxicity Assays.

Unit V **Credit hours: 12**

Molecular techniques in cell culture: In situ molecular hybridization, Somatic cell fusion & hybridomes, DNA transfer or tranfection methods & transgenic animals. Production from cell culture.

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.
7. Jenkins, N. Animal Cell Biotechnology. Panima Books Distributors.

E-Resources

1. **https://www.khanacademy.org/**
2. **https://unacademy.com/**
3. **https://swayam.gov.in/**
4. **https://hstalks.com/**
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M. Sc. (CBCS) Biotechnology Semester-II (2023-24)
DCC COURSE- Molecular Biology and RDT Lab (BIO8009P)

Code of the course: BIO8009P

Title of the course: Molecular Biology and RDT Lab

Level of the Course: NHEQF Level 6.0

Credit of the Course: 4

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

Delivery Type of the Course: Lecture and practical 80+40=120. The 80 lectures for the hands on experiments, observations and record of the data, 20 hours for the experiment, instruments demonstration, lab practices and 20 hours on diagnostic assessment, formative assessment, subject/class activity, problem solving.

Prerequisites:

(1) Life science courses of Undergraduate level or equivalent.

Objectives of the Course:

The course aims to strengthen the practical knowledge of basic molecular biology and genetic engineering learn at college level and lay foundation for further learning of the subject which is a prerequisite for higher courses in Biotechnology.

Learning 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:

Students are required to complete at least eight experiments.

1. Demonstrate the agarose gelelectrophoresis to visualize the given DNA sample.
2. Perform agarose gel electrophoresis to study the effect of varying concentration ofDNA sample.
3. Perform agarose gel electrophoresis to study the effect of varying voltage on themobility of the DNA.
4. Perform agarose gel electrophoresis to study the effect of varying agarose concentration on the mobility of the DNA.
5. To determine the protein anti-aggregation activity of the given sample.
6. Determine the extent of polymorphism in given DNA profile using Jaccard'sCoefficient.
7. Quantify the size of unknown DNA comparing with known DNA by semi-logarithmic graph.
8. Estimate the quantity of DNA present in each band by comparing the knownquantity of DNA to an unknown quantity of DNA using percent (%) method.
9. Isolate plasmid DNA from the given bacterial sample by alkaline lysis method and test it on agarose gel by electrophoresis.
10. Isolate the genomic DNA from the given bacterial culture by Pospiech and Neumann's method.
11. Perform the polymerase chain reaction to amplify the given DNA sample using universal primers.
12. Perform restriction digestion of the given bacterial DNA sample, run on Agarose gel.
13. Purify the isolated genomic DNA by RNase treatment and test its purity on agarose gel by electrophoresis.
14. Prepare competent cells from given microbial culture using calcium chloride method
15. Identify the bacteria on basis of biochemical tests using PIB software.
16. Construct phylogeny tree from the given table (dendrogram preparation)

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

SPOTS:

1. Semi-discontinuous replication
2. OriC
3. UV-transilluminator
4. Gel electrophoresis apparatus
5. Ethidium bromide dye
6. Bromophenol blue dye
7. Gel Doc System
8. PCR machine
9. SDS-PAGE
10. Questions based on solution preparations.
11. Role of chemicals
12. SDS
13. Chloroform
14. Isopropanol
15. NaCl
16. 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 Examination:

1. Major Exercise I	15 Marks
2. Major Exercise II	15Marks
3. Minor Exercise I	10 Marks
4. Minor Exercise II	10 Marks
5. Spots	2X5=10 Marks
6. Viva-voce	10 Marks
7. Record	10 Marks

M. Sc. (CBCS) Biotechnology Semester-II (2023-24)

DCC COURSE- Animal and Plant Biotechnology Lab (BIO8010P)

Code of the course: BIO8010P

Title of the course: Animal and Plant Biotechnology Lab

Level of the Course: NHEQF Level 6.0

Credit of the Course: 4

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

Delivery Type of the Course: Lecture and practical 80+40=120. The 80 lectures for the hands on experiments, observations and record of the data, 20 hours for the experiment, instruments demonstration, lab practices and 20 hours on diagnostic assessment, formative assessment, subject/class activity, problem solving.

Prerequisites:

(1) Life science courses of Undergraduate level or equivalent.

Objectives of the Course:

The course aims to strengthen the practical knowledge of basic molecular biology and genetic engineering learn at college level and lay foundation for further learning of the subject which is a prerequisite for higher courses in Biotechnology.

Learning 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:

Students are required to complete at least eight experiments.

1. Prepare single cell suspension from spleen and quantify the number of cells using haemocytometer.
2. Prepare chick fibroblast culture from chick embryo's hears.
3. Estimate the cell viability by dye exclusion method.
4. Prepare a culture of primary explants using watch glass technique.
5. Prepare a culture of primary explants using raft technique.
6. Determine the total soluble protein content in given cell suspension.
7. Determine the total DNA content in given cell suspension.
8. Determine the glucose content in given cell suspension.
9. Perform mechanical disaggregation for preparation of single cell suspension.
10. Prepare lymphocyte culture from given blood sample.
11. To learn the technique of green synthesis of magnetic (Iron Oxide) nanoparticles using several plant extracts and their characterization.
12. Estimation of several phytochemicals present in dicot/monocot plants at the stage IV of micropropagation raised through tissue culture techniques.
13. Preparation of stock solution of MS (Murashige and Skoog, 1962) basal medium and plant growth regulator stocks.
14. Demonstrate the procedure of Bergmann's cell plating for single cell culture.
15. Prepare suitable explants from the given plant material and demonstrate the process of embryo culture for embryo rescue.
16. To learn the technique of routine maintenance of plants through subculturing of In-vitro raised cultures of seed embryos.
17. Prepare suitable explants from the given plant material and demonstrate the culture of anther for the production of androgenic haploids.
18. Prepare suitable explants from the given plant material and demonstrate the process of ovary culture for the production of gynogenic haploids.

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

SPOTS:

1. Callus

2. Soilrite

3. Molecular Farming

4. Glass bead sterilizer

5. CRISPR-Cas systems

6. Plant Growth Chamber

7. Ethical Issues related to Transgenic Plants

8. Principles of Map-based or Positional Cloning

9. CO_2 incubator

10. Filter sterilization membrane

11. Inverted microscope

12. Haemocytometer

13. Trypan blue dye

Recommended Books

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

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

3. Online Virtual Labs

Scheme of Examination:

1. Major Exercise I	15 Marks
2. Major Exercise II	15Marks
3. Minor Exercise I	10 Marks
4. Minor Exercise II	10 Marks
5. Spots	2X5=10 Marks
6. Viva-voce	10 Marks
7. Record	10 Marks

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

GEC Course (BIO8100T)

Code of the course: BIO8100T

Title of the course: BIOINFORMATICS AND BIOSTATISTICS

Level of the Course: NHEQF Level 6.0

Credit of the Course: 4

Type of the Course: Generic Elective (GEC) Course for all Discipline/ Subject

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

Prerequisites:

(1) Life science/ Mathematical/ Computer Sciences courses of Undergraduate level or equivalent.

Objectives of the Course:

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

Course Outcome:

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

- Understand the basic concepts of biostatistics.
- Learn the formula and principles used in biology.
- Explore methods and software tools for understanding biological data.

Syllabus:

GEC Course (BIO8100T)

BIOINFORMATICS AND BIOSTATISTICS (THEORY)

(Credits: 4, Hour: 60)

Unit I **Credit hours: 12**

Computer Architecture, Internal and External devices, Computer Networking – Topology and Advantages of Networking, Types of Networking (LAN, MAN, WAN). Network Protocol – Internet Protocol (TCP, IP) and File Transfer Protocol. Introduction to Programming languages, C^{++}, Perl.

Unit II **Credit hours: 12**

Introduction and brief history of Bioinformatics, Applications of Bioinformatics in different fields of Sciences. Biological Databases – Nucleotide sequence Databases (GenBank, EMBL, DDBJ), Protein sequence Databases (Swiss Prot, PIR, PROSITE), Structural Databases (PDB, SCOP).

Unit III **Credit hours: 12**

Sequence Alignment – Pairwise Sequence Alignment: Sequence Homology, Sequence Similarity, Sequence Identity, Gaps, Gap penalties, Gcoring schemes, DOT PLOT, DOT MATRIX, Database similarity searching – BLAST, FASTA. Multiple sequence alignment.

Unit IV **Credit hours: 12**

Introduction and brief history of Biostatistics, Applications of Biostatistics. Collection of Data – Types of Sampling methods. Brief description of Classification of data, Tabulation of data and their Graphical representation – Class Intervals, Tally marks, Frequency, Frequency distribution.

Unit V **Credit hours: 12**

Measures of Central Tendency and Dispersion: Mean, Median, Mode, Range, Standard deviation, Variance, Standard error, Degree of freedom. Brief idea of statistical softwares and their applications. Analysis of Variance (ANOVA), Elementary idea of Test of Hypothesis, Test of Significance, Student T test, Chi square test.

Recommended Books

1. Xinong J. Essential Bioinformatics, Cambridge University Press.
2. Mount D.W. Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor Laboratory Press.
3. Sharma V., Munjal A., Shanker A. A Text Book of Bioinformatics. Rastogi Publications.
4. Rastogi V.B. Biostatistics, Third Revised Edition, Medtech.
5. Gupta S. C. Fundamentals of Statistics. Himalaya Publishing House.
6. Sinha K P., Sinha P. Computer Fundamentals. BPB Publications.
7. Swardlaw, A.C. (Practical) statistics for experimental Biology. John Wiley and Sons.

E-Resources

1. **https://www.khanacademy.org/**
2. **https://unacademy.com/**
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M. Sc. BIOTECHNOLOGY SEMESTER –II (2023-24)

GEC Course (BIO8101T)

Code of the course: BIO8101T

Title of the course: BIOSAFETY, BIOETHICS AND IPR

Level of the Course: NHEQF Level 6.0

Credit of the Course: 4

Type of the Course: Generic Elective (GEC) Course for all Discipline/ Subject

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

Prerequisites:

(1) Life science/ Mathematical/ Computer Sciences courses of Undergraduate level or equivalent.

Objectives of the Course:

The course aims to strengthen the conceptual knowledge of copyright, good laboratory practices learn at School level and lay foundation for further learning of the subject through this course on Biosafety, Bioethics and IPR which is a prerequisite for higher courses in Biotechnology and life sciences.

Course Outcome

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

- Understand the basic concepts of intellectual property and intellectual property rights.
- Learn about the ethical implications of cloning and biosafety.

Syllabus:

GEC Course (BIO8101T)

BIOSAFETY, BIOETHICS AND IPR (THEORY)

(Credits: 4, Hour: 60)

UNIT I **Credit hours: 12**

Introduction to ethics and bioethics : Personal ethics: profession and professionalism – Moral Reasoning – Ethical theories – person as an experimenter – Moral leadership (integrity and ingenuinity) - framework for ethical decision making.

UNIT II **Credit hours: 12**

Biotechnology and ethics: Biotechnology in agriculture and environment: benefits and risks – benefits and risks of genetic engineering – ethical aspects of genetic testing – ethical aspects relating to use of genetic information – genetic engineering and biowarfare.

UNIT III **Credit hours: 12**

Ethical implications of cloning: Reproductive cloning , therapeutic cloning ; Ethical, legal and socio-economic aspects of gene therapy, germ line, somatic, embryonic and adult stem cell research- GM crops and GMO's – biotechnology and biopiracy – ELSI of human genome project.

UNIT IV **Credit hours: 12**

Introduction to biosafety: Biosafety issues in biotechnology – risk assessment and risk management – safety protocols: risk groups – biosafety levels – biosafety guidelines and regulations (National and International), types of biosafety containment. Ethical issues for animal cell culture.

UNIT V **Credit hours: 12**

Introduction to intellectual property and intellectual property rights: Types, patents, copy rights, trade secrets and trade marks, design rights, geographical indications – importance of IPR – patentable and non patentables – patenting life – legal protection of biotechnological inventions – world intellectual property rights organization (WIPO)

Recommended Books

1. Principles of cloning, Jose Cibelli, Robert P. lanza, Keith H. S. Campbell, Michael D. West, Academic Press,2002Glimpses of Biodiversity – B. Bltosetti
2. Ethics in engineering, Martin. M.W. and Schinzinger.R. III Edition, Tata McGraw-Hill, New Delhi. 2003.

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

FERMENTATION TECHNOLOGY (BIO9011T)

Code of the course: BIO9011T

Title of the course: FERMENTATION TECHNOLOGY

Level of the Course: NHEQF Level 6.5

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 Undergraduate level or equivalent.

Objectives of the Course:

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

Course Outcome:

Upon completion of this course, students will able to:

- Apply biological and engineering principles for cultivating microorganisms inFermenters.
- Comprehend the principles of fermentor design, sterile engineering, processdevelopment, and production economics.
- Assess parameters critical to fermentation such as aeration, agitation, and KL estimation.

Syllabus:

DCC Course (BIO9011T)

FERMENTATION TECHNOLOGY (THEORY)

(Credits: 4, Hour: 60)

Unit I **Credit hours: 12**

Introduction and principle of fermentation, Fermentation processes: types; Solid-state and Submerged fermentations, batch, continuous, fed-batch fermentations. Growth kinetics, TDP, TDT, D-value and Death kinetics. Effect of temperature, pH, substrate concentration on growth and product formation.

Unit II **Credit hours: 12**

Bioreactors and Fermentors: Design, components, Types of bioreactors; continuous stirred tank, airlift, bubble column, fluidized-bed and packed bed bioreactors. Measurement and control of fermentation parameters. Media; components, formulation, antifoams and optimization (Plackett-Burman design).

Unit III **Credit hours: 12**

Scale up, Downstream processing: Cell disruption, filtration, centrifugation, solvent extraction, precipitation, lyophilization and spray drying. Sources of industrially important microorganisms and methods of isolation, strain improvement, storage and maintenance. Inoculum development for large scale bioprocess.

Unit IV **Credit hours: 12**

Production of commercially important products: Enzymes (amylase, protease, lipase), organic acids (Citric acid), amino acids (Glutamic acid), Vitamins B12, Antibiotics (Penicillin), Alcohol (Ethanol), micro-organisms involved, media, fermentation conditions, downstream processing and uses. Productions of bread. Alcoholic beverages: types and production.

Unit V **Credit hours: 12**

Starter cultures and their biochemical activities. Application of microbial enzymes infood industry. Microbes as foods; Probiotics; organisms and significance, prebiotics and synbiotics, single cell protein. Microbial polysaccharides; xanthan, dextran. Microbial production of bioplastics (PHB and PHA).

Recommended Books

1. Stanbury, P. F., Whitaker and Hall, A. S. J., Principles of Fermentation Technology. Butterworth-Heinemann
2. Hui, Y. Handbook of Food and Beverage Fermentation Technology (Food Science andTechnology).
3. Rastogi, S.C. Biotechnology: Principles and Applications.
4. Panday, A. Advances in Fermentation Technology.

5. Shuler, M.L. and Karg, I F., Bioprocess Engineering Basic Concepts, Prentice Hall.
6. Vogel, H.C. Todaro, C.L. and Todaro C.C., Fermentation and Biochemical Engineering Handbook: Principles, Process Design, and Equipment, Noyes Data Corporation/ Noyes Publications.
7. Crueger W. and Crueger, A., Biotechnology. A Textbook of Industrial Microbiology, Sinauer Associates. Reed, G., Prescott and Dunn's Industrial Microbiology, AVI publication.

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

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

PLANT BIOTECHNOLOGY (BIO9012T)

Code of the course: BIO9012T

Title of the course: PLANT BIOTECHNOLOGY

Level of the Course: NHEQF Level 6.5

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 Undergraduate level or equivalent.

Objectives of the Course:

The course aims to strengthen the conceptual knowledge of botany 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 be able to:

- Learn the principals 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 (BIO9012T)

PLANT BIOTECHNOLOGY (THEORY)

(Credits: 4, Hour: 60)

Unit I **Credit hours: 10**

Development of Plant Biotechnology. Principles of Plant Tissue Culture: totipotency, differentiation. Design of laboratory and commercial tissue culture facility. Procedures in tissue culture: fumigation, wet and dry sterilization, ultraviolet sterilization, ultrafilteration and surface sterilization. Culture media: types, composition and preparation. Role of Plant growth regulators/retardants in plant tissue culture media. Explants for tissue culture: shoot tip, axillary buds, leaf discs, cotyledons, inflorescence and floral organs.

Unit II **Credit hours: 15**

Initiation and maintenance of callus and suspension culture, single cell clones, somaclonal variations and their detection. Micropropagation: direct and indirect morphogenesis, organogenesis, somatic embryogenesis, and clonal propagation, caulogenesis, rhizogenesis, acclimatization, transfer and establishment of whole plants in soil.

Unit III **Credit hours: 10**

Protoplast isolation, culture and fusion. Selection of hybrid cells and regeneration of hybrid plants; symmetric and asymmetric hybrids; cybrids. Anther and pollen culture; production of haploid plants and homozygous lines. *In vitro* pollination, embryo culture and embryo rescue. Synthetic seed production.

Unit IV **Credit hours: 10**

Agrobacterium mediated gene transfer: Molecular biology of *Agrobacterium* infection, Ti plasmid, organization of T DNA, integration of T DNA into plant genome, vectors derived from pTi: cointegrate pTi vectors and binary vectors. Cryopreservation and germplasm conservation.

Unit V **Credit hours: 15**

Growth of plant cells in bioreactors, Production of active molecules, chemicals and secondary metabolites from plant cell cultures, metabolic engineering for secondary metabolites. Extraction of alkaloids and steroids, selection for cells for higher yields, cloning, mechanism of production. Application of plant biotechnology for production of quality oil and industrial enzymes. Elicitors and hairy root cultures for production of useful metabolites.

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

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

FOOD AND DAIRY BIOTECHNOLOGY (BIO9104T)

Code of the course: BIO9104T

Title of the course: FOOD AND DAIRY BIOTECHNOLOGY

Level of the Course: NHEQF Level 6.5

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 Undergraduate level or equivalent.

Objectives of the Course:

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

Course Outcome:

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

- Learn the aspects of microbial starter cultures and their biochemical activities, novel microflora, and fermented food product.
- Learn about food borne infections and intoxications, preservation, and quality assurance.

Syllabus:

DSE Course (BIO9104T)

FOOD AND DAIRY BIOTECHNOLOGY (THEORY)

(Credits: 4, Hour: 60)

Unit – I **Credit hours: 12**

Starter cultures and their biochemical activities; production of alcoholic beverages; production of Single cell protein and Baker's yeast; Mushroom cultivation, Food and dairy products: Cheese, bread

and yogurt. Fermented vegetables – Saurkraut; Fermented Meat – Sausages

Unit - II **Credit hours: 12**

Novel microorganisms eg. LAB (Probiotics), Cyanobacteria, methylotrophs, enzyme biotransformations, Role of Plant tissue culture for improvement of food additives; color and flavor, Genetic modifications of microorganisms; detection and rapid diagnosis. Genetically modified foods and crop.

Unit - III **Credit hours: 12**

Food borne infections and intoxications; with examples of infective and toxic types-Clostridium, Salmonella, Staphylococcus Mycotoxins in food with reference to *Aspergillus* species.

Unit - IV **Credit hours: 12**

Food preservation: canning, dehydration, ultrafiltration, sterilization, irradiation. Chemical and naturally occurring antimicrobials. Fermented foods and beverages. Use of biosensors in food industry.

Unit - V **Credit hours: 12**

Quality assurance: Microbiological quality standards of food Intellectual property rights and animal welfare, Government regulatory practices and policies. FDA, EPA, HACCP, ISI Risk analysis; consumer and industry perceptions.

Recommended Books:

1. Adams MR and Moss MO. (1995). Food Microbiology. 4th edition, New Age International (P) Limited Publishers, New Delhi, India.
2. Banwart JM. (1987). Basic Food Microbiology. 1st edition. CBS Publishers and Distributors, Delhi, India.
3. Davidson PM and Brannen AL. (1993). Antimicrobials in Foods. Marcel Dekker, New York.
4. Dillion VM and Board RG. (1996). Natural Antimicrobial Systems and Food Preservation. CAB International, Wallingford, Oxon.
5. Frazier WC and Westhoff DC. (1992). Food Microbiology. 3rd edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.
6. Gould GW. (1995). New Methods of Food Preservation. Blackie Academic and

Professional, London.

7. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7th edition, CBS Publishers and Distributors, Delhi, India.
8. Lund BM, Baird Parker AC, and Gould GW. (2000).The Microbiological Safety and Quality of Foods. Vol. 1-2, ASPEN Publication, Gaithersberg, MD.
9. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education

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

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

ENVIRONMENTAL BIOTECHNOLOGY (BIO9105T)

Code of the course: BIO9105T

Title of the course: ENVIRONMENTAL BIOTECHNOLOGY

Level of the Course: NHEQF Level 6.5

Credit of the Course: 4

Type of the Course: Discipline Specific Elective (DSE) Course for all life sciences Discipline/ Subject

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

Prerequisites:

(1) Life science courses of Undergraduate level or equivalent.

Objectives of the Course:

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

Course Outcome:

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

- Learn about the basics of toxicology, waste water treatment.
- Apply the use of microorganisms in environment protection

Syllabus:

DSE Course (BIO9105T)

ENVIRONMENTAL BIOTECHNOLOGY (THEORY)

(Credits: 4, Hour: 60)

Unit I **Credit hours: 12**

Applications of microbes in biodegradation and bioremediation: Microbial degradation of cellulose, lignin, pesticides, xenobiotics and other recalcitrant chemicals, petroleum and hydrocarbons and its ecological significance. Bioprospecting and bioleaching, Bioaccumulation of heavy metals ions from industrial effluents.

Unit II **Credit hours: 12**

Biomagnification and degradative plasmids, biotransformation. Biodeterioration and its control. Biological control and biopesticides. definition, significance, types , sources, manufacture, use and mode of action. Entemopathogenic fungi, viral insecticides. significance of *Bacillus thuringiensis* in biocontrol.

Unit III **Credit hours: 12**

Microbes and pollution :waste water; Types, Sources, Microbiology. Methods of waste water treatment. Eutrophication: Definition, causes and effects. Algal blooms, Red tides. Solid waste: Source, types and characterization. Methods of treatment: Physical, chemical, biological, aerobic, anaerobic, primary, secondary and tertiary treatments. Use of genetically engineered organisms for control of pollution.

Unit IV **Credit hours: 12**

Bioconversion of Solid Waste: Composting, vermi composting and vermi culture. Microbial biofertilizers: types, sources, manufacture and significance. Green manuring, Mycorrhizae as fertilizers: Rhizhobia and other symbiotic and non symbiotic nitrogen fixing microbes as biofertilizer. Application of microbes as biofertilizers. Significance and application of PSB (Phosphate Solubilizing Bacteria) and PGPR (Plant Growth Promoting Rhizobacteria).

Unit V **Credit hours: 12**

Microbes as biological weapons, Role of microbes in production of Biofuels. Biogas production and factors affecting methane formation. Biosensors: Principle, working, Types of biosensors Applications of biosensors in environmental monitoring. Application of microbes as biosensors.

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

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

MEDICAL BIOTECHNOLOGY AND CANCER CELL BIOLOGY (BIO9118T)

Code of the course: BIO9118T

Title of the course: MEDICAL BIOTECHNOLOGY AND CANCER CELL BIOLOGY

Level of the Course: NHEQF Level 6.5

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 Undergraduate level or equivalent.

Objectives of the Course:

The course aims to strengthen the conceptual knowledge of cell biology, and human physiology molecular biology and biochemistry learn at School level and lay foundation for further learning of the subject through the course on medical biotechnology and cancer cell biology which is a prerequisite for higher courses in Biotechnology.

Course Outcome:

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

- Learn the aspects of production of biopharmaceuticals, drug manufacturing, and clinical biochemistry
- Learn the basics of cancer cell biology, and genetic basis of disease.

Syllabus:

DSE Course (BIO9118T)

MEDICAL BIOTECHNOLOGY AND CANCER CELL BIOLOGY (THEORY)
(Credits: 4, Hour: 60)

Unit I **Credit hours: 10**

Production of Biopharmaceuticals- Insulin, Interferon. Vaccines-Live vaccines, killed vaccines-Subunit vaccines-Recombinant vaccines-DNA vaccines, Applications of biotechnology in forensics. Microencapsulation in medicine, Biosensors and their application in medicine. Detection of genetic diseases: amniocentesis, carrier detection.

Unit II **Credit hours: 15**

Drug manufacturing process: Computer aided drug design. Drug delivery-theory of controlled release drug delivery systems: zero order kinetics, theory of diffusion: release and diffusion of drug polymers. Metabolism of Xenobiotics: Role of Isoforms of Cytochrome P450, Phase I and II reactions.

Unit III **Credit hours: 10**

Clinical Biochemistry: Importance of Lab tests, Abnormal level of analytes, Reference range, Validity of Test results and its assessment, Different types of analytical samples, Techniques in clinical biochemistry: enzymes, ligand binding assays, dipsticks, organ function tests; LFT, KFT, T3, T4, adrenal function test, cardiovascular markers

Unit IV **Credit hours: 15**

Cancer: Overview, Neoplasm: benign and malignant tumors. Major features of Cancer cells, Origin and development of cancer, Causes of genetic damage: radiation, chemicals and viruses, Survival strategies: altered Apoptosis, High telomerase activity, modified metabolic programming, angiogenesis. Study of cancer development: cultured cells and animal models.

Unit V **Credit hours: 10**

Genetic basis of cancer, Concept of Oncogenes, Protooncogenes, Tumor suppressor genes, Causes of Tumorigenesis: Mutation; Gain of function, loss of function, epigenetic changes, MicroRNA. Tumor microenvironment, Diagnosis, Treatment and Prevention.

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 Primrose, S.B. Molecular Biotechnology. Panima.
8 Watson and Zoller. Recombinant DNA. Panima.
9 Boylan, M. Genetic engineering – science and ethics on new frontier. Pearson Edu.
10 10 Old and Primrose. Principles of Gene Manipulation.
11 Glick and Pasternak. Molecular Biotechnology. ASM Press Washington, USA.
12. Harper. 31st Edition. Biochemistry. 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**

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

AGRICULTURE BIOTECHNOLOGY (BIO9119T)

Code of the course: BIO9119T

Title of the course: AGRICULTURE BIOTECHNOLOGY

Level of the Course: NHEQF Level 6.5

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 Undergraduate level or equivalent.

Objectives of the Course:

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

Course Outcome:

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

- Understand Crop development, Callus culture, Biotechnological applications of plants, the principles, practices.
- Learn the applications of agriculture biotechnology, plant tissue culture, and genetic engineering.

Syllabus:

DSE Course (BIO9119T)

AGRICULTURE BIOTECHNOLOGY
(Credits: 4, Hour: 60)

Unit I **Credit hours: 15**

Micropropagation and its application in forestry, floriculture, agriculture and conservation of biodiversity and threatened plants. Hardening and acclimatization – success and bottlenecks. Greenhouse: design, management and operation. Quality control, packaging and shipment, cost-benefit analysis. Global market, commercial opportunities in plant tissue culture with special reference to plant tissue culture industries in India.

Unit II **Credit hours: 10**

Scaling-up production and automation in plant propagation. Use of robotics in plant production. Mass scale plant production facilities: design and planning, media preparation, storage, dispensation and examination and control. Air conditioning, air handling and purification, evaporative cooling, water treatment: softening, demineralization, distillation, reverse osmosis.

Unit III **Credit hours: 10**

In vitro approaches to genetic manipulations of plants. Development of transgenic plants for crop improvement, molecular farming, and study of regulated gene expression. Commercial status and biosafety concern of transgenic plant and ethical issues. Plantibodies, plant-derived vaccines.

Unit IV **Credit hours: 10**

Application of plant genetic engineering: current status and commercial opportunities for genetically engineered plants for stress tolerance: drought, salt, flooding and temperature, biotic and abiotic stress tolerance-insects, fungi, bacteria, viruses, weeds, herbicide and pesticide. Development of male sterile plants. Applications of plant tissue culture in plant pathology: development of virus free plant and development of disease resistant plants, growth of obligate parasites in culture.

Unit V **Credit hours: 15**

Genetic engineering for increasing crop productivity by manipulation of photosynthesis, nitrogen fixation, nutrient uptake efficiency. Quality improvement of protein, lipids, carbohydrates, vitamins and mineral nutrients. Molecular breeding and molecular tagging of genes. Brief idea of gene synteny, map based cloning and their use in transgenesis.

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.

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

M. Sc. (CBCS) Biotechnology Semester-III (2023-24)

DSE COURSE-FOOD FERMENTATION AND MEDICAL BIOTECNOLOGY LAB (BIO91212P)

Code of the course: BIO91212P

Title of the course: Food Fermentation and Medical Biotechnology Lab

Level of the Course: NHEQF Level 6.5

Credit of the Course: 4

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

Delivery Type of the Course: Lecture and practical 80+40=120. The 80 lectures for the hands on experiments, observations and record of the data, 20 hours for the experiment, instruments demonstration, lab practices and 20 hours on diagnostic assessment, formative assessment, subject/class activity, problem solving.

Prerequisites:

(1) Life science courses of Undergraduate level or equivalent.

Objectives of the Course:

The course aims to strengthen the practical knowledge of basic food fermentation and medical biotechnology lab learn at college level and lay foundation for further learning of the subject which is a prerequisite for higher courses in Biotechnology.

Learning 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:

Students are required to complete at least eight experiments.

1. Identify the acid producing lactobacilli using BCP supplemented MRS medium.
2. Determine the quality of milk sample by methylene blue reductase test (MBRT).
3. Determine the antibacterial activity of lactic acid bacteria using agar well assay method.
4. Detection of antibiotic resistance of Probiotic lactobacilli.
5. Determine the carbohydrate fermentation pattern of the given bacterial sample.
6. Determine the esculin hydrolysis activity for the given bacterial sample.
7. Detection of coliforms in the given milk samples using EMB agar.
8. Production of sauerkraut by microorganisms and acidity calculation of fermented juice.
9. Isolation of fungi on Sabouraud agar from fermented sugarcane juice and its visualization using lactophenol cotton blue.
10. To study adulteration of starch in milk.
11. To study adulteration of detergents in milk.
12. To perform Methyl Red Voges-Proskauer (MRVP) test for differentiation between Enterobacteriaceae group.
13. To perform indole test for checking the ability of microorganism to convert tryptophan
14. To evaluate the anti-inflammatory activity of a given sample using albumin denaturation inhibition assay.
15. To prepare media for culturing cancer cells and sterilize it using the filter sterilization technique.
16. To perform passaging of cancer cells via trypsinization method.
17. To store cancer cells using cryopreservation technique.
18. To determine cell viability using MTT assay.
19. To perform differentiation of neuroblastoma cells using retinoic acid.
20. To isolate serum from the given blood sample.
21. To detect serum lipid level using a colorimetric assay.

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

SPOTS:

1. Types of Bioreactors: Fluidized bed, Trickle bed, Bubble column, Stirred tank,
2. Prepared slide of various fungi
3. Results of MBRT, BCP-MRS plates
4. Composition and functions of media components MRS, EMB, Sabouraud agar, Sauerkraut
5. T25 Flask
6. Hemocytometer
7. Inverted Microscope
8. Hayflick limit
9. Metastasis
10. Vacuum filtration assembly
11. MTT reagent

Recommended Books

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

2. Patil, R. (2023). Community Medicine: Practical Manual 2E-E-Book. Elsevier Health Sciences.

3. P. Papademas (2015) Dairy Microbiology A Practical Approach, 1st Edition

4. Online virtual labs

Scheme of Examination:

1. Major Exercise I	15 Marks
2. Major Exercise II	15Marks
3. Minor Exercise I	10 Marks
4. Minor Exercise II	10 Marks
5. Spots	2X5=10 Marks
6. Viva-voce	10 Marks
7. Record	10 Marks

M. Sc. (CBCS) Biotechnology Semester-III (2023-24)

DSE COURSE- ENVIRONMENTAL AND AGRICULTURE BIOTECHNOLOGY LAB (BIO91213P)

Code of the course: BIO91213P

Title of the course: Environmental and Agriculture Biotechnology Lab

Level of the Course: NHEQF Level 6.5

Credit of the Course: 4

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

Delivery Type of the Course: Lecture and practical 80+40=120. The 80 lectures for the hands on experiments, observations and record of the data, 20 hours for the experiment, instruments demonstration, lab practices and 20 hours on diagnostic assessment, formative assessment, subject/class activity, problem solving.

Prerequisites:

(1) Life science courses of Undergraduate level or equivalent.

Objectives of the Course:

The course aims to strengthen the practical knowledge of basic Environmental and Agriculture Biotechnology learn at college level and lay foundation for further learning of the subject which is a prerequisite for higher courses in Biotechnology.

Learning 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:

Students are required to complete at least eight experiments.

1. Determine phosphate solubilization activity of given bacteria.
2. Determine biological oxygen demand (BOD) of given sewage samples.
3. Determine chemical oxygen demand (COD) of given sewage samples
4. Determine dissolved oxygen (DO) of given water sample.
5. Determine the chlorine content of given water sample.
6. Determine the hardness of given water samples.
7. Determine the Alkalinity of given water samples.
8. Determine the Total dissolved solids (TDS) of given water samples.
9. Isolate the Heavy metal tolerant bacteria from given soil sample.
10. Determine the effect of heavy metal (ZnSO4.7H2O) on bacteria by agar well assay method.
11. To the learn the technique of CTAB method of total Plant Genomic DNA isolation from plant tissues.
12. To perform gel casting and sample loading in the agarose gel electrophoresis of the genomic DNA isolated from plant tissues.
13. Prepare suitable explants form the given plant material and demonstrate the process of meristem tip culture for the production of disease free plants.
14. Prepare suitable media for rooting of micro shoot and inoculate it for rooting.
15. Demonstrate the technique of micropropagation by culturing of leaf disc on suitable media.
16. Estimation of antioxidants and antioxidant enzymes from plants - Ascorbate, Superoxide dismutase, Catalase, and Peroxidase
17. Isolation and culture of cyanobacteria from water sample.
18. To calculate the R:S ratio by isolating bacteria from rhizospheric and non-rhizospheric soil.
19. Effect of biofertilizer on growth of plant.

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

SPOTS:

1. TDS meter
2. Reverse Osmosis System
3. Diagram showing Biogas Plant
4. Slide showing Nostoc

5. Phenyl orange indicator
6. Greenhouse
7. Plant tissue culture industries in India
8. Transgenic plants
9. Root nodules
10. Calculation of the solutions (Molar, Molal, Normal & PPM).
11. Nostoc – slide
12. Anabena – slide
13. Horticulture

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 Examination:

1. Major Exercise I	15 Marks
2. Major Exercise II	15Marks
3. Minor Exercise I	10 Marks
4. Minor Exercise II	10 Marks
5. Spots	2X5=10 Marks
6. Viva-voce	10 Marks
7. Record	10 Marks

M. Sc. (CBCS) Biotechnology Semester-III (2023-24)

GEC COURSE-INSTRUMENTATION AND ANALYTICAL TECHNIQUES LAB (BIO91316P)

Code of the course: BIO91316P

Title of the course: Instrumentation and Analytical Techniques Lab

Level of the Course: NHEQF Level 6.5

Credit of the Course: 4

Type of the Course: Generic Elective (GEC) Course for all Discipline/ Subject

Delivery Type of the Course: Lecture and practical 80+40=120. The 80 lectures for the hands on experiments, observations and record of the data, 20 hours for the experiment, instruments demonstration, lab practices and 20 hours on diagnostic assessment, formative assessment, subject/class activity, problem solving.

Prerequisites:

(1) Life science courses of Undergraduate level or equivalent.

Objectives of the Course:

The course aims to strengthen the practical knowledge of basic Instrumentation and Analytical Techniques learn at college level and lay foundation for further learning of the subject which is a prerequisite for higher courses in Biotechnology.

Learning 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:

Students are required to complete at least eight experiments.

1. Extract and separate pigments from *Curcuma longa* using thin layer chromatography and calculate their Rf values.
2. Evaluate the effectiveness of moist heat sterilization using linear streak method.
3. Evaluate the effectiveness of dry heat sterilization using linear streak method.
4. To evaluate the effectiveness of ultra violet radiations using linear streak method.
5. Evaluate the effectiveness of alcohol as a skin antiseptic using thumb impression method.
6. Evaluate the antiseptics (30% hydrogen peroxide and 70% Isopropyl alcohol) by filter paper disk method.
7. Extract and separate photosynthetic pigments by paper chromatography and calculate their Rf values.
8. Demonstration of lyophilizer

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

SPOTS:

1. Instruments
   a) Autoclave
   b) Incubator
   c) Laminar air flow
   d) Spectrophotometer
   e) Centrifuge
   g) pH meter

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

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 Examination:

1. Major Exercise I	20 Marks
2. Minor Exercise I	15 Marks
3. Minor Exercise II	15 Marks
4. Spots	2X5=10 Marks
5. Viva-voce	10 Marks
6. Record	10 Marks

M. Sc. (CBCS) Biotechnology Semester-III (2023-24)

GEC COURSE-APPLICATION OF BIOINFORMATICS IN BIOLOGICAL SCIENCES LAB (BIO91317P)

Code of the course: BIO91317P

Title of the course: Application of Bioinformatics in Biological Sciences Lab

Level of the Course: NHEQF Level 6.5

Credit of the Course: 4

Type of the Course: Generic Elective (GEC) Course for all Discipline/ Subject

Delivery Type of the Course: Lecture and practical 80+40=120. The 80 lectures for the hands on experiments, observations and record of the data, 20 hours for the experiment, instruments demonstration, lab practices and 20 hours on diagnostic assessment, formative assessment, subject/class activity, problem solving.

Prerequisites:

(1) Life science courses of Undergraduate level or equivalent.

Objectives of the Course:

The course aims to strengthen the practical knowledge of basic Bioinformatics learn at college level and lay foundation for further learning of the subject which is a prerequisite for higher courses in Biotechnology.

Learning 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:
Students are required to complete at least eight experiments.

1. To give an introduction to the National Center for Biotechnology Information (NCBI)

and its popular resources.

2. Retrieve a nucleotide sequence from the NCBI database, perform its BLAST search

analysis, study the obtained results and generate the phylogenetic tree.

3. Find the Open Reading Frames and the Conserved Domains of the given genome

sequence through NCBI available ORF Finder and CD Search Tool.

4. To quickly identify segments / contamination of a nucleic acid sequence that may be of vector origin with the help of NCBI available VecScreen software.

5. To perform the reverse translation of a give protein sequence with the help of Sequence Manipulation Suite online server.

6. To construct the restriction map of the given sequence using NEBcutter from New

England BioLabs online server.

7. Retrieving structural data of a SARS Coronavirus Main Protease 2VJ1 using PDB

database

8. To calculate the Impact Factor of a Journal for the current year.

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

SPOTS:

1. C ++ Language

2. Perl Language

3. Chemical Database

4. Functional Genomics

5. Microarray Technology

6. Human Genome Project

7. Software for Phylogenetic Analysis

8. European Molecular Biology Laboratory (EMBL)

Recommended Books:

1. Uesaka, K., Oka, H., Kato, R., Kanie, K., Kojima, T., Tsugawa, H., ... & Horinouchi, T. (2022). Bioinformatics in bioscience and bioengineering: recent advances, applications, and perspectives. Journal of bioscience and bioengineering.

2. Online virtual labs

Scheme of Examination:

1. Major Exercise I	20 Marks
2. Minor Exercise I	15 Marks
3. Minor Exercise II	15 Marks
4. Spots	2X5=10 Marks
5. Viva-voce	10 Marks
6. Record	10 Marks

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

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

Industrial Training: Major Research Project at research laboratory or institute of repute (600 Hours)

Code of the course: BIO914XS

Level of the Course: NHEQF Level 6.5

Credit of the Course: 24

Course Outcome

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

- Undertake dissertation for 600 Hours to learn the basics of research in biotechnology and life sciences.

NOTE:

1. In the IV semester student shall undertake a Project work. After completion the student shall submit a dissertation. The work shall be typically carried out in an industrial/Research organization/Institute individually by the students admitted in the IV semester. Each student shall complete the dissertation under a mentor/ supervisor. Just after joining a mentor, the student will inform to the Head of the Department/Course Director. It will be mandatory to submit the progress report in the middle of the semester to the Department. It has to be duly signed by the mentor/Supervisor giving number of hour the students has worked for the project. During the project period, a student is expected to work at least 30 hrs/week. Thus a candidate who successfully completes the project work can earn 24 credit points. At the end of the semester, the student has to submit work carried out in the project as Dissertation in a prescribed format. He is required to attach a certificate of successful completion of the project from his mentor/supervisor giving total number of hours worked to carry out the project work and staining his conduct in the entire period of project work. Evaluation of the project will be carried out by a committee consisting of external examiner, internal examiner and a professor by examining the Dissertation,

presentation of the project and demonstration of the work carried out with sufficient supporting data to check the work carried out in the project.

2. The students will have to take prior permission from the HOD at least 3 months in advance to join for MRP and submit their acceptance letter from the institute where he/she is going to do the training one month in advance. Failing this the student will not be permitted to go for training.
3. The student will have submit a duly signed and sealed certificate from the mentor and competent authority in the prescribed format (Annexure 1)
4. Student will be required to submit a hard copy of the grades prepared by the mentor as per the prescribed format filled in a sealed envelope. The mentor will also have to send a soft copy of the same to the HOD (Annexure 2).
5. Such students will also have to submit a dissertation report as per the prescribed format for the training (Annexure 3).

Internal Examination

In the paper entitled "Dissertation", student will submit a report on the progress of the work done in the middle of the semester to the head/Course Director. The report will be routed through the Mentor with his grading. A three member committee constituted by the Course Director shall finally award the internal marks of the "Dissertation".

Dissertation Evaluation

On completion of the dissertation the student has to submit the project report in the Department. The dissertation is to be written in a specified format (Annexure 1). It should be duly signed and certified by the mentor. On the day of examination student will give presentation of 25 minutes before the panel of examiners. The panel of examiner will consists of (i) One Professor (ii) External Expert (iii) Internal Examiner. One professor and the internal examiner will be picked up by the head of the Department/course Director.

The Dissertation shall be examined and marks will be awarded following the marks distribution scheme given in table (Annexure 4).

ANNEXURE 1

DEPARTMENT OF BIOTECHNOLOGY

Vigyan Bhawan- Block 'B': New Campus

MOHANLAL SUKHADIA UNIVERSITY

UDAIPUR

2023-24

INSTITUTE NAME AND LOGO

Ref no.-…….. Date……

CERTIFICATE

This is to certify that the dissertation/project report entitled "**……**" submitted towards the partial fulfillment for the award of the degree of Master of Science in Biotechnology, from Mohanlal Sukhadia University, Udaipur (Rajasthan) India is the result of bonafide work compiled by **Mr./Ms. ……** carried out under the guidance of **Dr. ……** at **……** in the academic year of …….. During the dissertation period, the candidate has worked for at least 30 hrs/week with a total of 600 hours. It has no part the dissertation has been submitted for the award of any degree, diploma, fellowship or other similar titles or prizes and that the work has not been published in part or full in any scientific or popular journals or magazines.

Date

Name & Signature of the supervisor

Seal of the supervisor

ANNEXURE 2

M. Sc. Biotechnology Semester IV

ASSESSMENT SHEET

(To by submitted by Mentor)

Major Research Project

Name of Student:

S.No.	Assessment	Grade
	Technical Competence and instrument handling	
	Experimental Skills	
	Data Interpretation/ Result Analysis	
	Regularity	
	Communication Skills (Written and oral)	

Grade: Indicative Marks

A: (91-100)

B: (81-90)

C: (71-80)

D: (61-70)

E: (51-60)

F: (50 and Below)

Remark on professional competence (or deficiency) of the trainee and overall performance.

Name of the Mentor:

Designation : E-mail……

Ph. No.

Organization:

Date: Signature with seal

ANNEXURE 3

General Guidelines for Preparation of Project Report

(For specific details the students are advised to consult their respective supervisors)

1. Strictly follow the format given to write the manuscript of the project.
2. On the front page include title of the project (font size 21, centered). The title should not contain abbreviation and scientific names of organisms should be in *italics.* This page should not be numbered.
3. Starting from second page, the pages must be numbered consecutively, including figures and table.
4. Text should be 1.5 point spaced type written using Times New Roman Font, Font Size 12, on one side of A 4 Size paper, with 1.5 inch margins throughout. Scientific names of the organisms should be in *italics.* Main headings (Summary, Introduction, Chapter details, Conclusions and References) should be bold type, justified and separated from the text.
5. The full text of project should not exceed 20-25 one side typed pages.
6. Literature citation in the text should be cited in alphabetic order. The form and style of references should be as indicated below.

(a) Journal article

Carvalho, L.C., Goulao, L., Oliveira, C., Goncalves, C.J. and Amancio, S. 2004. Rapid assessment for identification of clonal identity and genetic stability of *in vitro* propagated chestnut hybrids. Plant Cell Tiss. Org. Cult. 77:23-27.

Chae, W.B., Choi, G.W. and Chung, I.S. 2004. Plant regeneration depending on explant type in *Chrysanthemum coronarium* L. J. Plant Biotech. 6:253-258.

(b) Book reference

Salisbury, F. B., Ross, C. W. 1992. Plant Physiology. 4th edn. Wadsworth Publishing Company. Belmount.

(c) Edited books

Constantine, D.R. 1986. Micropropagation in the commercial environment. In : "Plant Tissue Culture and its Agricultural Applications". L.A. Withers and P.G. Alderson (Eds.) pp. 175-186. Butterworths, London, UK.

(d) Paper presented at a conference

Chaturvedi, H.C. 1992. Hardening of *in vitro* raised plants for transplant success. A state of art report. Paper presented in DBT Project Monitoring Committee Meeting held on 6th-7th July, 1992 in DBT, New Delhi, India.

(e) Proceeding of a symposium

Rajsekharan, P. E., Ganeshan, S. 2005. Designing *exsitu* conservation strategies for threatened medicinal plant species of South India. In: " Proc. Natl. Symp. and 27th Annual Meeting of PTCA(I)." A.K. Kukreja *et al* (Eds). Pp.159-164. CIMAP, Lucknow, India.

(f) Thesis/ Dissertation

Dave, N. 2004. Factors influencing micropropagation of two varieties of *Achras sapota* and their rootstock *Mimusops hexandra*. Ph.D. Thesis, Mohanlal Sukhadia University, Udaipur, India.

(g) Patent

Trepaginer, J.H. 2000. New surface finishings and coatings. US Pat 1276323 (to DuPont Inc, USA). 27 June, 2000. Chem Abstr, 49 (2000) 27689.

(h) Reports

Anonymous, 1976. The Wealth of India. Raw Meterials. Vo. X. pp. 44-48. CSIR, New Delhi, India.

TITLE MUST BE IN CAPITAL LETTERS, SIZE 21 AND CENTERED, WITH *Scientific names* IN ITALICS

A Project Report submitted

for the partial fulfillment of the Degree of Master of Science

By

(**Name of student**)

[M.Sc. (Biotechnology/Microbiology), IV Semester]

Declaration

I, **……..** Roll No. **_____**student of M. Sc. IV Semester Biotechnology (Session 2010-11) hereby declare that the project entitled "……." is my own compilation. I have strictly adhered to the guidelines provided by the department for the preparation of the project report.

Dated: Signature of the Student

TABLE OF CONTENTS

ANNEXURE 4

Marks Distribution and Examination Scheme for Major Research Project

M. Sc. Biotechnology Semester IV

Duration: 35 min		**Maximum Marks 600**	**Min Marks 216**
S. No.	**Sections**	**Marks**	
1	Continuous assessment (30 each) Technical Competence Professional Qualities Ability to understand Research Communication Skills	120	
2	Dissertation write-up	300	
3	Presentation	100	
4	Viva-voce	80	
	TOTAL MARKS	**600**	