



SWAMI VIVEKANAND
SUBHARTI
UNIVERSITY
UGC Approved Meerut



AN ISO 21001: 2018 ORGANIZATION

OFFICE OF THE REGISTRAR

Gp Capt M Yakoob

M-in-D (Retd.), M.Tech.

REGISTRAR

registrar@subharti.org

Ref.No.U-508(i)/SVSU/2025/ 1621

Date:27.01.2025

NOTIFICATION

It is hereby notified for information of all the concerned that the Academic Council in its 34th meeting held on 25-07-2024 vide resolution No.34(9) has approved the revised syllabus (as per NEP-2020) of the following ordinance:

Ordinance No.V-135(B9), relating to B.Sc.-Biotechnology

The copy of above is enclosed and shall be applicable from Academic Session 2022-23 onwards.

This issues with the approval of the Hon'ble Vice Chancellor.

Ref.No.U-508(i)/SVSU/2025/ 1621

Copy forwarded to information of:

1. Hon'ble Vice-Chancellor
2. Controller of Examination
3. Dean-Academics
4. Director-IQAC
5. Dean-Faculty of Science (for compliance please)
6. CTO (with a request to upload the ordinance on University website)
7. Additional Registrar-Academics
8. Guard File

M Yakoob
27.01.2025

Registrar

Date: 27.01.2025

M Yakoob
27.01.2025
Registrar



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Subhartipuram, NH-58, Delhi-Haridwar Bypass Road, Meerut-250005 (U.P.) INDIA

**KERALA VERMA SUBHARTI COLLEGE OF SCIENCE
SWAMI VIVEKANAND SUBHARTI UNIVERSITY**

MEERUT



SYLLABUS

FOR

B.Sc. BIOTECHNOLOGY

UNDER

NEW EDUCATION POLICY

(Three Year)

EFFECTIVE FROM 2022 – 2023

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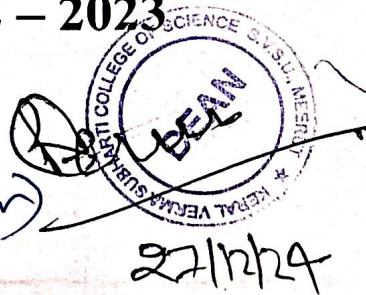
**Deptt. of Biotechnology
Faculty of Science
S.V.S.U., MEERUT**

R
(Dr. Reshu Chaudhary)

RSS
(Dr. Raj Singh)

Dr. Ashwari Kumar
(Dr. Ashwari Kumar)

M
(Dr. Manjul Muglani)



Bachelor of Science in Biotechnology (NEP)
First Year/First Sem
CERTIFICATE COURSE IN TOOLS AND TECHNIQUES OF CELL AND
MOLECULAR BIOLOGY

Semester I	Course Code	Course Name	Course Type	Teaching Load/Week				Total Credits	Evaluation Scheme					Subject Total
				L	P	T	Total		CIE				ESE	
									CT	PPT and assignment	TA	Total		
	B100101T	Cell Biology and Genetics	Major (Theory)	4	0	0	4	4	10	10	05	25	75	100
	B100102P	Cell Biology and Genetics Lab	Major (Practical)	0	2	0	2	2	10	10	05	25	75	100
	B030101T	Bioanalytical Tools and Technique	Major (Theory)	4	0	0	4	4	10	10	05	25	75	100
	B030102P	Bioanalytical Tools and Technique Lab	Major (Practical)	0	2	0	2	2	10	10	05	25	75	100
	B020101T	Fundamentals of Chemistry	Major (Theory)	4	0	0	4	4	10	10	05	25	75	100
	B020102P	Quantitative analysis	Major (Practical)	0	2	0	2	2	10	10	05	25	75	100
	Z010101T	Food, Nutrition and Hygiene	Minor (elective)	2	0	0	2	2	10	10	05	25	75	100
	VOC-1-CHI	Computer Hardware and Installation	Minor	2	0	0	2	2	10	10	05	25	75	100
Total				16	6	0	22	22	80	80	40	200	600	800

CIE- Continuous Internal Evaluation

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Bachelor of Science in Biotechnology (NEP)
First Year/Second Sem
CERTIFICATE COURSE IN TOOLS AND TECHNIQUES OF CELL AND
MOLECULAR BIOLOGY

Semester II	Course Code	Course Name	Course Type	Teaching Load/Week				Total Credits	Evaluation Scheme					Subject Total
				L	P	T	Total		*CIE				ES E	
									CT	PPT and assignment	TA	Total		
	B100201 T	Molecular Biology and Genetic Engineering	Major (Theory)	4	0	0	4	4	10	10	05	25	75	100
	B100202 P	Genetic Engineering Lab	Major (Practical)	0	2	0	2	2	10	10	05	25	75	100
	B050201 T	Biochemistry and Physiology	Major (Theory)	4	0	0	4	4	10	10	05	25	75	100
	B050202 P/R	Physiological, Biochemical & Hematology Lab	Major (Practical)	0	2	0	2	2	10	10	05	25	75	100
	B080201 T	Agriculture and Environmental Microbiology	Major (Theory)	4	0	0	4	4	10	10	05	25	75	100
	B080202 P	Experiments in Agriculture and Environmental Microbiology	Major (Practical)	0	2	0	2	2	10	10	05	25	75	100
	Minor/Elective - IV		Theory	0	2	0	2	2	10	10	05	25	75	100
	Vocation (Minor)			0	2	0	2	2	10	10	05	25	75	100
	Co-Curriculum course		Theory + Practical	0	2	0	2	2	10	10	05	25	75	100
Total				12	12		24	24	90	90	45	225	675	900

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Bachelor of Science in Biotechnology (NEP)

Second Year/ Third Sem

DIPLOMA IN TOOLS AND TECHNIQUES OF BIOTECHNOLOGY

Semester III	Course Code	Course Name	Course Type	Teaching Load/Week				Total Credits	Evaluation Scheme					Subject Total
				L	P	T	Total		CIE				ESE	
									CT	PPT and assignment	TA	Total		
	B100301T	Biochemistry and Biochemical tools	Major (Theory)	4	0	0	4	4	10	10	05	25	75	100
	B10 0302 P	Biochemistry Lab	Major (Practical)	0	2	0	2	2	10	10	05	25	75	100
	B100303T	Genomics and Proteomics	Major (Theory)	4	0	0	4	4	10	10	05	25	75	100
	B100304P	Genomics and Proteomics Lab	Major (Practical)	0	2	0	2	2	10	10	05	25	75	100
	B020301T	Chemical Dynamics & Coordination Chemistry	Major (Theory)	4	0	0	4	4	10	10	05	25	75	100
	B020302P	Physical Analysis	Major (Practical)	0	2	0	2	2	10	10	05	25	75	100
	Minor/Elective - IV		Theory	0	2	0	2	2	10	10	05	25	75	100
	Vocation (Minor)			0	2	0	2	2	10	10	05	25	75	100
	Co-Curriculum course		Theory + Practical	0	2	0	2	2	10	10	05	25	75	100
Total				12	12		24	24	90	90	45	225	675	900

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Bachelor of Science in Biotechnology (NEP)

Second Year/ Fourth Sem

DIPLOMA IN TOOLS AND TECHNIQUES OF BIOTECHNOLOGY

Semester IV	Course Code	Course Name	Course Type	Research Load/Week				Total Credits	Evaluation Scheme					Subject Total
				L	P	T	Total		C T	CIE			ES E	
										PPT and assignment	T A	Total		
	B10 0401T	Microbiology and Immunology	Major (Theory)	4	0	0	4	4	10	10	5	25	75	100
	B10 0402 P	Microbiology and Immunology Lab	Major (Practical)	0	2	0	2	2	10	10	5	25	75	100
	B10 0403T	IPR, Biosafety and Bioethics	Major (Theory)	4	0	0	4	4	10	10	5	25	75	100
	B10 0404P	IPR, Biosafety and Bioethics Lab	Major (Practical)	0	2	0	2	2	10	10	5	25	75	100
	B1040105 T	Microbial Deterioration & Its Control	Major (Theory)	4	0	0	4	4	10	10	5	25	75	100
	B1040106 P	Microbial Deterioration & Its Control Lab	Major (Practical)	0	2	0	2	2	10	10	5	25	75	100
	Minor/Elective - IV		Theory	0	2	0	2	2	10	10	05	25	75	100
	Vocation (Minor)			0	2	0	2	2	10	10	05	25	75	100
	Co-Curriculum course		Theory + Practical	0	2	0	2	2	10	10	05	25	75	100
Total				12	12	0	24	24	90	90	45	225	675	900

*CIE- Continuous Internal Evaluation

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Bachelor of Science in Biotechnology (NEP)

Third Year/ Fifth Sem

DEGREE IN BACHELOR OF SCIENCE

Semester V	Course Code	Course Name	Course Type	Research Load/Week				Total Credits	Evaluation Scheme					Subject Total
				L	P	T	Total		C T	CIE			ES E	
										PPT and assignment	T A	Total		
	B10 0501 T	Biostatistics and Bioinformatics	Major	4	0	0	4	4	10	10	05	25	75	100
	B10050 2T	Animal and Plant Biotechnology	Major	4	0	0	4	4	10	10	05	25	75	100
	B10 0503P	Bioinformatics, Biostatistics and Tissue culture Lab	Major Practical	0	2	0	2	2	10	10	05	25	75	100
			Co-Curriculum course	4	0	0	4	4	10	10	05	25	75	100
	B08050 7R	Project in Biotechnology for Pre-graduation	Qualifying	0	0	0	4	4	-	-	-	50	150	200
Total				12	2	0	14	18	70	50	30	150	400	600

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Bachelor of Science in Biotechnology (NEP)
Third Year/ Six Sem
DEGREE IN BACHELOR OF SCIENCE

Semester VI	Course Code	Course Name	Course Type	Research Load/Week				Total Credits	Evaluation Scheme					Subject Total
				L	P	T	Total		CIE				ESE	
									CT	PPT and assignment	TA	Total		
	B100601T	Industrial and Environmental Biotechnology	Major	4	0	0	4	4	10	10	5	25	75	100
	B100602T	Food Biotechnology	Major	4	0	0	4	4	10	10	5	25	75	100
	B100603P	Industrial and Environmental Biotechnology Lab	Major Practical	0	2	0	2	2	10	10	5	25	75	100
			Co-Curriculum course	4	0	0	4	4	10	10	0	25	75	100
	B080607R	Project in Biotechnology for Pre-graduation	Qualifying	0	0	0	4	4	150	30	20	200	400	600
Total				12	2	0	18	18	45	60	35	275	625	900

*CIE- Continuous Internal Evaluation

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Bachelor of Science in Biotechnology (NEP)

Fourth Year/ Seventh Sem

DEGREE IN BACHELOR (RESEARCH) OF SCIENCE

	Course Code	Course Name	Course Type	Research Load/Week				Total Credits	Evaluation Scheme					Subject Total
				L	P	T	Total		C T	CIE			ES E	
										PPT and assignment	TA	Total		
Semester VII	B100701T	Structural and Functional Genomics & Proteomics	Major	4	0	0	4	4	10	10	5	25	75	100
	B100702T	Stem Cell and Tissue Engineering	Major	4	0	0	4	4	10	10	5	25	75	100
	B100703T	Nanobiotechnology	Major	4	0	0	4	4	10	10	5	25	75	100
	B100704T	Soil Biotechnology	Major	4	0	0	4	4	10	10	5	25	75	100
	B100705P	Advanced Biotech Lab-I	Major Practical	0	4	0	4	4	10	10	5	25	75	100
			Minor Theory (Elective) (Other Faculty)	4	0	0	4	4	10	10	5	25	75	100
			Minor Practical (Elective) (Other Faculty)	0	2	0	2	2	10	10	5	25	75	100
	B100706I	Industrial Training (Winter)	Qualifying	0	0	0	6	6	-	-	-	-	150	150
Total				20	6	0	32	32	70	70	35	175	675	850

*CIE- Continuous Internal Evaluation

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Bachelor of Science in Biotechnology (NEP)
Fourth Year/ Eighth Sem
DEGREE IN BACHELOR (RESEARCH) OF SCIENCE

	Course Code	Course Name	Course Type	Research Load/Week				Total Credits	Evaluation Scheme					Subject Total
				L	P	T	Total		C T	CIE			ESE	
										PPT and Assignment	TA	Total		
Semester VIII	B100801T	Bioprocess Technology	Major	4	0	0	4	4	10	10	5	25	75	100
	B100802T	Computational Modeling in Biotechnology	Major	4	0	0	4	4	10	10	5	25	75	100
	B100803T	Advanced Agricultural Biotechnology	Major	4	0	0	4	4	10	10	5	25	75	100
	B100804T	Gene Therapy	Major	4	0	0	4	4	10	10	5	25	75	100
	B100805P	Advanced Biotech Lab-II	Major Practical	0	4	0	4	4	10	10	5	25	75	100
			Minor Theory (Elective) (Other Faculty)	4	0	0	4	4	10	10	5	25	75	100
			Minor Practical (Elective) (Other Faculty)	0	2	0	2	2	10	10	5	25	75	100
	B100806I	Industrial Training (Summer)	Qualifying	0	0	0	06	06	-	-	-	-	150	150
Total				20	6	0	32	32	70	70	35	325	725	1050

*CIE- Continuous Internal Evaluation

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Bachelor of Science in Biotechnology (NEP)
Fifth Year/ Ninth Sem
DEGREE IN MASTER OF SCIENCE

	Course Code	Course Name	Course Type	Research Load/Week				Total Credits	Evaluation Scheme					Subject Total
				L	P	T	Total		C T	CIE			ESE	
										PPT and Assignment	T A	Total		
Semester IX	B100901T	Molecular Drug Designing and Targeting	Major	4	0	0	4	4	10	10	5	25	75	100
	B100902T	Metabolomics	Major	4	0	0	4	4	10	10	5	25	75	100
	B100903T	Management in Biotechnology	Major	4	0	0	4	4	10	10	5	25	75	100
	B100904T	Computational modeling in Biotechnology	Major	4	0	0	4	4	10	10	5	25	75	100
	B100905P	Advanced Biotech Lab-III	Major Practical	0	4	0	4	4	10	10	5	25	75	100
	B100906I	Industrial Training (Summer)	Qualifying	0	0	0	06	06	-	-	-	-	150	150
T o t a l				7	4	0	26	26	60	60	30	150	600	750

*CIE- Continuous Internal Evaluation

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Bachelor of Science in Biotechnology (NEP)
Fifth Year/ Tenth Sem
DEGREE IN MASTER OF SCIENCE

	Course Code	Course Name	Course Type	Research Load/Week				Total Credits	Evaluation Scheme					Subject Total
				L	P	T	Total		C T	CIE			ES E	
										PPT and Assignment	TA	Total		
Semester X	B1001001 T	Advanced Virology and oncology	Major	4	0	0	4	4	10	10	5	25	75	100
	B1001002 T	Ethics, economics and social implications of biotechnology	Major	4	0	0	4	4	10	10	5	25	75	100
	B1001003 T	Advanced clinical biotechnology	Major	4	0	0	4	4	10	10	5	25	75	100
	B1001004 T	Pharmacological screening and assays	Major	4	0	0	4	4	10	10	5	25	75	100
	B1001005P	Advanced Biotech Lab-IV	Major Practical	0	4	0	4	4	10	10	5	25	75	100
	B100906I	Industrial Training (Summer)	Qualifying	0	0	0	06	06	-	-	-	-	150	150
T o t a l				16	4	0	26	26	50	50	25	125	525	650

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Subject Prerequisite

The candidate should have passed (10+2) examination in science stream with PCB (Physics, Chemistry, Biology and/or Biotechnology) or PCM (Physics, Chemistry and Maths) or any other science subject.

Programme Outcomes (POs)

After completion of the B. Sc. Biotechnology programme, the candidate should be able to:

PO1	Demonstrate knowledge for in-depth analytical and critical thinking to identify, formulate and solve the issues related to Biotechnology research, Biotechnology Industry, Pharma industry, Medical or hospital related organizations, and Academia.
PO2	Demonstrate skills to use modern analytical tools/ software/ equipment and analyse and solve problems in various courses of biotechnology.
PO3	Execute their professional roles in society as biotechnology professionals, employers and employees in various industries, researchers and educators.
PO4	Design, perform experiments, analyse and interpret data for investigating complex problems in biotechnology and related fields.
PO5	Demonstrate learning skills to work as a team in a multidisciplinary environment.
PO6	Design and develop sustainable solutions to major biological problems by applying appropriate biotechnology tools.
PO7	Develop skills, attitude and values required for self-directed, lifelong learning and professional development.
PO8	Acquire knowledge and understanding of norms and ethics in the field of biotechnology.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

CERTIFICATE IN TOOLS AND TECHNIQUES OF CELL AND MOLECULAR BIOLOGY

First Year	<p>This course introduces the knowledge of cell biology, genetics, molecular biology and genetic engineering. After completion of this certificate course, students will be able to –</p> <p>PSO1: demonstrate and apply their knowledge of cell biology, genetics, molecular biology and genetic engineering to solve the problems related to the field of biotechnology</p> <p>PSO2: gain knowledge about the application of various types of microscope, karyotyping, banding techniques, chromosome painting and FACS.</p> <p>PSO3: understand the basic concepts of genetics and molecular biology such as inheritance pattern, DNA replication, transcription and translation</p> <p>PSO4: understand and perform various recent molecular and recombinant DNA technology techniques in early diagnosis and prognosis of human diseases.</p> <p>PSO5: perform experiments of DNA isolation, agarose gel electrophoresis, gene cloning, transformations, protein expression and purification. This experience would enable them to begin a career in industry that engages in genetic engineering as well as in research laboratories conducting fundamental research.</p> <p>PSO6: apply at technical positions in different research laboratories, diagnostic centres and industries.</p>
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DIPLOMA IN TOOL AND TECHNIQUES IN BIOTECHNOLOGY

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Second Year

After completion of diploma course, students will be able to-

PSO1: familiarize with basic laboratory instruments and understand the principle of measurements using those instruments with experiments in biochemistry.

PSO2: understand the significance of Biochemistry and basics of enzymes.

PSO3: learn the chemistry, structure and functions of major bio-molecules and metabolism of carbohydrate, protein etc.

PSO4: understand different biochemical tools and techniques such as chromatography, electrophoresis, X-ray diffraction, NMR and mass spectrometry

PSO5: perform different experiments based on the techniques such as chromatography, electrophoresis, centrifugation etc.

PSO6: understand the different methods of sterilization

PSO7: understand and also able to perform different immunological techniques like agglutination reaction, ABO typing and ELISA.

DEGREE IN BACHELOR OF SCIENCE

Third Year

After completing the three years degree course in Biotechnology, the students will be able to –

PSO1: demonstrate the concepts in computational Biology. Understand the interrelationship between Biology and Computer

PSO2: acquire knowledge in different domains of biotechnology enabling their application in industry, research and academia.

PSO3: perform and analyse the results of experiments using basic laboratory techniques of cell biology, molecular biology, genetic engineering, biochemistry, immunology, microbiology, bioinformatics, biostatistics, animal and plant biotechnology and Food biotechnology.

PSO4: recognize the foundations of modern biotechnology and explain the principles that form the basis for recombinant technology.

PSO5: develop an ability to properly understand the technical aspects of existing technologies that help in addressing the biological and medical challenges faced by humankind.

PSO6: exhibit ability to do research independently as well as in collaboration.

PSO7: recognize the importance of Bioethics, IPR, and entrepreneurship.

Maximum	Minimum	Upper	Lower	Mean	Deviation	St. Dev.	Skewness	Kurtosis
50.0000	10.0000	3.5000	2.5000	2.5000	1.0000	1.0000	0.0000	3.0000
50.0000	10.0000	3.5000	2.5000	2.5000	1.0000	1.0000	0.0000	3.0000
50.0000	10.0000	3.5000	2.5000	2.5000	1.0000	1.0000	0.0000	3.0000

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Bachelor of Science in Biotechnology (NEP)

First year Semester: First (I)

CERTIFICATE COURSE IN TOOLS AND TECHNIQUES OF CELL AND MOLECULAR BIOLOGY

Programme/Class: Certificate	Year: First (I)	Semester: First (I)
Subject: Biotechnology		
Course Code: B100101T	Course Title: Cell Biology and Genetics	
Course Outcomes (COs)		

This course introduces the principles of cell biology and genetics. After completion of this course, students will be able to-

- learn different areas of cell biology including the structure and functions of cell, its organelles such as mitochondria, nucleus etc.
- understand how genetic information is transmitted in organism.
- understand the role of cytoskeleton and its remodelling including the diseases associate with improper remodelling.
- learn how the synthesized proteins are transported to different organelles.
- understand the regulation of cell cycle, programmed cell death and Cancer.
- learn different cell biology techniques like karyotyping, chromosome banding, FISH, FACS, centrifugation and microscopy.

Credits: 4	Core Compulsory
Maximum Marks: 100 (75(UE)+25(CIE))	Minimum Passing Marks: As per University norms

Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0

Unit	Topics	NO. of Lectures
I	<ul style="list-style-type: none"> • Introduction and history of Biotechnological science with special reference to contribution of Indian scholars in biological sciences 	2
II	<ul style="list-style-type: none"> • Prototype structure of animal, plant and bacterial cells, Diversity of cell size and shape • Cell theory • C-value paradox • Cell Membrane: Chemical components of biological membranes, organization and Fluid Mosaic Model, and membrane transport. • Cytoskeleton and Extra cellular matrix 	8
III	<p>Structure and Function of Cell organelles:</p> <ul style="list-style-type: none"> • Lysosomes: Vacuoles and micro bodies: Structure and functions • Ribosomes: Structures and function including role in protein synthesis. • Mitochondria: Structure and function, Genomes, biogenesis. • Chloroplasts: Structure and function, genomes, biogenesis • Nucleus: Structure and function, nuclear envelope 	9

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IV	Chromosome structure: <ul style="list-style-type: none"> Chromosomes: chromatin and chromosomes organization, euchromatin and heterochromatin, nucleosome, metaphase chromosome, genes and chromosomes. DNA as genetic material, Structure of DNA Structural and numerical changes in human chromosomes and ploidy in plants. Mutations: Types of mutations, spontaneous and induced mutations, Physical and chemical mutagens 	9
V	Cell cycle, Cancer and Cell Signaling: <ul style="list-style-type: none"> Cell Cycle: Mitosis and Meiosis: Control points in cell-cycle progression in yeast and higher organisms Cell senescence and programmed cell death Cancer – chromosomal disorders, oncogenes and tumor suppressor genes Introduction to cell signalling and cell –cell interaction 	7
VI	Mendelian and nonmendelian genetics: <ul style="list-style-type: none"> Historical developments in the field of genetics. Organisms suitable for genetic experimentation and their genetic significance Mendelian genetics : Mendel's experimental design, monohybrid, di-hybrid and tri hybrid crosses, Law of segregation & Principle of independent assortment Allelic interactions: Concept of dominance, recessiveness, incomplete dominance, co-dominance, semi-dominance, pleiotropy Sex determination and sex linkage: Mechanisms of sex determination, Environmental factors and sex determination, sex differentiation, Barr bodies, dosage compensation, genetic balance theory 	8
VII	Linkage, crossing over and population genetics: <ul style="list-style-type: none"> Linkage, crossing-over and chromosome and genetic mapping Extra chromosomal inheritance: Rules of extra nuclear inheritance, maternal effects, maternal inheritance, cytoplasmic inheritance, organelle heredity, genomic imprinting. Genetic Code: deciphering genetic code; degeneracy, unusual codons in mitochondria Mutations: types, mechanisms Evolution and population genetics: Hardy Weinberg law (prediction, derivation), allelic and genotype frequencies, changes in allelic frequencies, evolutionary genetics, natural selection. 	8

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VIII	Cytological techniques: <ul style="list-style-type: none"> • Microscopy and staining techniques • Microtomy • Karyotyping • Chromosome banding, 	9
	<ul style="list-style-type: none"> • <i>in situ</i> hybridization and FISH • chromosome painting • Fluorescence Activated Cell Sorting 	

Suggested Reading

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2014). **Molecular Biology of the Cell** (6th Ed.). New York: Garland Science
2. Cooper, G. M., and Hausman, R. E. (2013). **The Cell: a Molecular Approach** (6th Ed.). Washington: ASM ; Sunderland.
3. Karp, G. **Cell and Molecular Biology. Concepts and experiments.** John Harris, D., Wiley & sons, New York
4. Iwasa J., Marshal W. **Karp's Cell Biology**(2018) (8th edition) Wiley & Sons, NY
5. Iwasa J., Marshal W. **Karp's Cell and Molecular Biology . Concepts and experiments.** (2015) (8th edition) Wiley & sons, New York
6. Watson, J. D. Baker TA, Bell, SP Gann, A. Levine, M. Losick R. (2008). **Molecular Biology of the Gene** (5th ed.). Pearson
7. Lodish, H F. Berk, A. Kaiser, CA, Krieger, M. Bretscher, A. Ploegh, H. Aman, A. Martin, K. (2016). **Molecular Cell Biology** (8th Ed.). New York: W.H. Freeman
8. Gupta P.K. **Cell and Molecular Biology 2018.** 5th edition Rastogi Publication India.
9. Hartl, D. L., & Jones, E. W. (1998). **Genetics: Principles and Analysis.** Sudbury, MA: Jones and Bartlett.
10. Pierce, B. A. (2005). **Genetics: a Conceptual Approach.** New York: W.H. Freeman.

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Above (Figure 4.73) shows the relation between education and customer perceived value.

Programme/Class: Certificate	Year: First (1)	Semester: First (I)
Subject: Biotechnology		
Course Code: B100102P	Course Title: Cell Biology and Genetics Lab	
Course Outcomes (COs)		
After completion of this course, students will be able to- <ul style="list-style-type: none"> • Learn, understand and develop skill and hands on training in basics of cell biology and genetics. • Be able to differentiate between plant and animal cells • Be analysed different stages of mitosis and meiosis 		
Credits: 2	Core Compulsory	
Maximum Marks: 100 (75(UE)+25(CIE))	Minimum Passing Marks: As per University norms	
Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 0-0-4		
	Topics	No. of Lectures
	<ol style="list-style-type: none"> 1. Introduction to safety measures in Laboratories 2. Preparation of solutions and buffers 3. Equipment handling and pipetting 4. Study of structure of any Prokaryotic and Eukaryotic cell. 5. Microtomy: Fixation, block making, section cutting, double staining of animal tissues like liver, oesophagus, stomach, pancreas, intestine, kidney etc. 6. Cell division in onion root tip/ insect (grasshopper) gonads. 7. Vital Staining of Mitochondria with Janus green B. 8. Demonstration of diversity of cell types (Muscle, Neuron) 9. Demonstration of Sex chromatin in buccal smear. 	60

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1. Above (Figure 4.70) shows the relation between education and health
2. Sharma, V. L., Techniques in microscopy and cell biology
3. Histo-techniques: Theory & Practice J. F. Robert & J. J. White
4. Arnold L. Demain & Felix H. Davis Manual of industrial microbiology
5. Dancy R.C. 2014, Advanced Biotechnology, S Chand and company

Programme/Class: Certificate	Year: First (1)	Semester: First (I)
Subject: Biotechnology		
Course Code: B030101T	Course Title: Bioanalytical Tools and Technique	
Course Outcomes (COs)		
This course introduces the principles of cell biology and genetics. After completion of this course, students will be able to-		
<ol style="list-style-type: none"> 1. Explain the principles of microscopy. 2. Define working principle and application of the Instruments: pH meter, Balance, Centrifuge, Autoclave, Different types of microscope, Incubator and oven, Shaker, Spectrophotometer/Colorimeter 		
Credits: 4	Core Compulsory	
Maximum Marks: 100 (75(UE)+25(CIE))	Minimum Passing Marks: As per University norms	
Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0		
Unit	Topics	NO. of Lectures
I	<ul style="list-style-type: none"> • Microscopy: Principle of microscopy, simple and compound microscope, phase contrast microscopy, fluorescence and electron microscopy 	12
II	<ul style="list-style-type: none"> • Chromatographic techniques: General principle, application and types, paper chromatography, thin layer chromatography, gel filtration chromatography, affinity chromatography, Ion exchange chromatography gas chromatography, liquid chromatography 	16
III	<ul style="list-style-type: none"> • Electrophoresis: Principle of electrophoresis, SDS-PAGE, iso-electric focusing. 	8
IV	<ul style="list-style-type: none"> • Centrifugation –Basis principle common centrifuges types of rotors (fixed angle swing bucket), Types of centrifugation –preparative, differential, and density gradient. Ultra centrifugation –Sedimentation rate zonal centrifugation. Biosensor – introduction and principles First second and third generation instruments cell based biosensor 	16
V	<ul style="list-style-type: none"> • Spectroscopic methods –Principle and application of UV –visible IR, NMR, X-ray spectroscopy, autoradiography. 	8
Suggested Reading		
<ol style="list-style-type: none"> 1. Instrumental methods of chemical analysis: Chatwal and Anand, Himalaya Publishing house 2. Sharma, V .K.: Techniques in microscopy and cell biology Tata Mc Graw Hill. 3. Biochemical Techniques: Theory & Practice J.F.Roby & B.J.White Waveland press Ins . 4. Arnold L .Demain & Julian E .Davies :Manual of Industrial microbio .& Biotech second edition 5. Dubey R.C. 2014, Advanced Bioechnology, S Chand and company. 		

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Programme/Class: Certificate	Year: First (1)	Semester: First (I)
Subject: Biotechnology		
Course Code: B030102P	Course Title: Bioanalytical Tools and Technique Lab	
Course Outcomes (COs)		
After completion of this course, students will be able to- <ul style="list-style-type: none"> • Learn, understand and develop skill and hands on training in basics of Instrumentation. • Be able to prepare a pellet from the sample provided by centrifugation technique. • Be analysed separation of amino acids by paper chromatography and SDS-PAGE. 		
Credits: 2	Core Compulsory	
Maximum Marks: 100 (75(UE)+25(CIE))	Minimum Passing Marks: As per University norms	
Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 0-0-4		
	Topics	No. of Lectures
	<ol style="list-style-type: none"> 1. Demonstration including working principle and application of the Instruments: pH meter, Balance, Centrifuge, Autoclave, Different types of microscope, Incubator and oven, Shaker, Spectrophotometer/Colorimeter 2. Preparation of solution of different molarities. 3. To determine the pH. 4. To prepare a pellet from the sample provided by centrifugation technique. 5. Separation of amino acids by paper chromatography. 6. Sterilization of glassware and surgical instruments. 7. Demonstration of SDS-PAGE for separation of proteins. 	60

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Programme/Class: Biotechnology	Year: First	Semester: First
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Paper-1 Theory Subject: Chemistry		
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Course Code: B020101T	Course Title: Fundamentals of Chemistry
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Course outcomes:

There is nothing more fundamental to chemistry than the chemical bond. Chemical bonding is the language of logic for chemists. Chemical bonding enables scientists to take the 100-plus elements of the periodic table and combine them in myriad ways to form chemical compounds and materials. Periodic trends, arising from the arrangement of the periodic table, provide chemists with an invaluable tool to quickly predict an element's properties. These trends exist because of the similar atomic structure of the elements within their respective group families or periods, and because of the periodic nature of the elements. Reaction mechanism gives the fundamental knowledge of carrying out an organic reaction in a step-by-step manner. This course will provide a broad foundation in chemistry that stresses scientific reasoning and analytical problem solving with a molecular perspective. Students will gain an understanding of Molecular geometries, physical and chemical properties of the molecules. Current bonding models for simple inorganic and organic molecules in order to predict structures and important bonding parameters. The chapter Recapitulation of basics of organic chemistry gives the most primary and utmost important knowledge and concepts of organic Chemistry. This course gives a broader theoretical picture in multiple stages in an overall chemical reaction. It describes reactive intermediates, transition states and states of all the bonds broken and formed. It enables to understand the reactants, catalyst, stereochemistry and major and minor products of any organic reaction. It describes the types of reactions and the Kinetic and thermodynamic aspects one should know for carrying out any reaction and the ways how the reaction mechanism can be determined. The chapters Stereochemistry gives the clear picture of two-dimensional and three-dimensional structure of the molecules, and their role in reaction mechanism.

Credits: 4	Compulsory
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Max. Marks: 25+75	Min. Passing Marks:
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Total No. of Lectures = 60	
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Unit	Topics	No. of Lectures
I	Introduction to Indian ancient Chemistry and contribution of Indian Chemists, in context to the holistic development of modern science and technology, should be included under Continues Evaluation (CIE)	10
	Molecular polarity and Weak Chemical Forces : Resonance and resonance energy, formal charge, Van der Waals forces, ion-dipole forces, dipole dipole interactions, induced dipole interaction, dipole moment and molecular Structure (Diatomic and polyatomic molecules), Percentage ionic character from dipole moment, polarizing power and polarizability. Fajan's rules and consequences of polarization. Hydrogen bonding, van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interaction.	

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II	<p>Simple Bonding theories of Molecules</p> <p>Atomic orbitals, Aufbau principle, multiple bonding (σ and π bond approach) and bond lengths, the valence bond theory (VBT), Concept of hybridization, hybrid orbitals and molecular geometry, Bent's rule, Valence shell electron pair repulsion theory (VSEPR), shapes of the following simple molecules and ions containing lone pairs and bond pairs of electrons: H₂O, NH₃, PCl₅, SF₆, SF₄, ClF₃, I₃, and H₃O. Molecular orbital theory (MOT). Molecular orbital diagrams bond orders of homonuclear and heteronuclear diatomic molecules and ions (N₂, O₂, C₂, B₂, F₂, CO, NO, and their ions).</p>	10
III	<p>Periodic properties of Atoms (with reference to s & p-block):</p> <p>Brief discussion, factors affecting and variation trends of following properties in groups and periods. Effective nuclear charge, shielding or screening effect, Slater rules, Atomic and ionic radii, Electronegativity, Pauling's/ Allred Rochow's scales, Ionization enthalpy, Electron gain enthalpy.</p>	05
IV	<p>Recapitulation of basics of Organic Chemistry: Hybridization, bond lengths and bond angles, bond energy, localized and delocalized chemical bonding, Van der Waals interactions, inclusion compounds, Clathrates, Charge transfer complexes, hyperconjugation, Dipole moment; Electronic Displacements: Inductive, electromeric, resonance mesomeric effects and their applications</p>	05
V	<p>Mechanism of Organic Reactions: Curved arrow notation, drawing electron movements with allows, half-headed and double-headed arrows, homolytic and heterolytic bond fission, Types of reagents – electrophiles and nucleophiles, Types of organic reactions, Energy considerations. Reactive intermediates– Carbocations, carbanions, free radicals, carbenes, arynes and nitrenes (with examples).</p>	10
VI	<p>Stereochemistry (To be taught with demonstration of Molecular models in the classroom teaching)- Concept of isomerism, Types of isomerism; Optical isomerism – elements of symmetry, molecular chirality, enantiomers, stereogenic center, optical activity, properties of enantiomers, chiral and achiral molecules with two stereogenic centers, diastereomers, threo and erythro diastereomers, meso compounds, resolution of enantiomer, inversion, retention and racemization. Relative and absolute configuration, sequence rules, D & L and R & S systems of nomenclature. Geometric isomerism – determination of configuration of geometric isomers, E & Z system of nomenclature, geometric isomerism in oximes and alicyclic compounds. Conformational isomerism – conformational analysis of ethane and n-butane; conformations of cyclohexane, axial and equatorial bonds, conformation of mono substituted cyclohexane derivatives, Newman projection and Sawhorse formulae, Fischer and flying wedge formulae, Difference between configuration and conformation.</p>	10
VII	<p>Basic Computer system (in brief)-Hardware and Software; Input devices, Storage devices, Output devices, Central Processing Unit (Control Unit and Arithmetic Logic Unit); Number system (Binary, Octal and Hexadecimal Operating System); Computer Codes (BCD and ASCII); Numeric/String constants and variables. Operating Systems (DOS, WINDOWS, and Linux); Introduction of Software languages: Low level and High Level languages (Machine language, Assembly language; QBASIC, FORTRAN) Software Products (Office, chemsketch, scilab, matlab, hyperchem, etc.), internet application.</p>	05
VIII	<p>Mathematical Concepts for Chemistry</p> <p>Logarithmic relations, curve sketching, linear graphs and calculation of slopes, differentiation of functions like Kx, ex, Xn, $\sin x$, $\log x$; maxima and minima, partial differentiation and reciprocity relations, Integration of some useful/relevant functions; permutations and combinations, Factorials, Probability</p>	05

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Suggested Readings:

1. Lee, J.D. Concise Inorganic Chemistry, Pearson Education 2010
2. Huheey, J.E., Keiter, E.A., Keiter, R. L., Medhi, O.K. Inorganic Chemistry, Principles of Structure and Reactivity, Pearson Education 2006.
3. Douglas, B.E. and Mc Daniel, D.H., Concepts & Models of Inorganic Chemistry, Oxford, 1970
4. Shriver, D.D. & P. Atkins, *Inorganic Chemistry 2nd Ed.*, Oxford University Press, 1994.
5. Day, M.C. and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications 1962.
6. Singh J., Yadav L.D.S., Advanced Organic Chemistry, Pragati Edition
7. Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
8. Carey, F. A., Giuliano, R. M. *Organic Chemistry*, Eighth edition, McGraw Hill Education, 2012.
9. Loudon, G. M. *Organic Chemistry*, Fourth edition, Oxford University Press, 2008.
10. Clayden, J., Greeves, N. & Warren, S. *Organic Chemistry*, 2nd edition, Oxford University Press, 2012.

Programme: Biotechnology	Year: First	Semester: I
Practical paper-2		Subject: Chemistry
Course Code: B020102P	Course Title: Quantitative Analysis	
Course outcomes: Upon completion of this course the students will have the knowledge and skills to: understand the laboratory methods and tests related to estimation of metals ions and estimation of acids and alkali contents in commercial products. · Potability tests of water samples. <ul style="list-style-type: none"> · Estimation of metal ions in samples · Estimation of alkali and acid contents in samples · Estimation of inorganic salts and hydrated water in samples 		
Credits: 2		Elective
Max. Marks: 25+75 = 100		Min. Passing Marks:
Practical 60 h		
Unit	Topics	No of Lectures
I	Water Quality analysis 1. Estimation of hardness of water by EDTA. 2. Determination of chemical oxygen demand (COD). 3. Determination of Biological oxygen demand (BOD).	16
II	Estimation of Metals ions 1. Estimation of ferrous and ferric by dichromate method. 2. Estimation of copper using thiosulphate.	14

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II	Estimation of acids and alkali contents 1. Determination of acetic acid in commercial vinegar using NaOH. 2. Determination of alkali content – antacid tablet using HCl. 3. Estimation of oxalic acid by titrating it with KMnO ₄ .	14
IV	Estimation of inorganic salts and hydrated water 1. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture. 2. Estimation of calcium content in chalk as calcium oxalate by permanganometry. 3. Estimation of water of crystallization in Mohr's salt by titrating with KMnO ₄ .	16
Programme/ Class: Certificate	Year: First (1)	Semester: First (I)

Co-Curricular Course

Course Code: Z010101T **Course Title: Food, Nutrition and Hygiene**

Course Outcomes (COs)

This course introduces the principles of cell biology and genetics. After completion of this course, students will be able to-

1. To learn the basic concept of the Food and Nutrition
2. To study the nutritive requirement during special conditions like pregnancy and lactation
3. To learn meal planning
4. To learn 100 days Nutrition Concept
5. To study common health issues in the society
6. To learn the special requirement of food during common illness

Credits: 4

Core Compulsory

**Maximum Marks: 100
(75(UE)+25(CIE))**

Minimum Passing Marks: As per University norms

Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 2-0-0

Unit	Topics	NO. of Lectures
I	<ul style="list-style-type: none"> • Concept of Food and Nutrition • (a) Definition of Food, Nutrients, Nutrition, Health, balanced Diet • (b) Types of Nutrition- Optimum Nutrition, under Nutrition, Over Nutrition • (c) Meal planning- Concept and factors affecting Meal Planning • (d) Food groups and functions of food 	8
II	<ul style="list-style-type: none"> • Nutrients: Macro and Micro • RDA, Sources, Functions, Deficiency and excess of • (a) Carbohydrate • (b) Fats • (c) Protein • (d) Minerals • Major: Calcium, Phosphorus, Sodium, Potassium • Trace: Iron, Iodine, Fluorine, Zinc • (e) Vitamins • Water soluble vitamins: Vitamin B, C 	7

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	<ul style="list-style-type: none"> • Fat soluble vitamins: Vitamin A, D, E, K • (f) Water • (g) Dietary Fibre 	
III	<ul style="list-style-type: none"> • 1000 days Nutrition • (a) Concept, Requirement, Factors affecting growth of child • (b) Prenatal Nutrition (0 - 280 days): Additional Nutrients' Requirement and risk factors during pregnancy • (c) Breast / Formula Feeding (Birth – 6 months of age) • Complementary and Early Diet (6 months – 2 years of age) 	8
IV	<ul style="list-style-type: none"> • Community Health Concept • (a) Causes of common diseases prevalent in the society and Nutrition requirement in the following: <ul style="list-style-type: none"> • Diabetes • Hypertension (High Blood Pressure) • Obesity • Constipation • Diarrhea • Typhoid • (b) National and International Program and Policies for improving Dietary Nutrition • (c) Immunity Boosting Food 	7

Suggested Reading

1. Anju Singh, Gauri Goel "Food, Nutrition and Hygiene" Sahitya publication Agara.
2. Singh, Anita, "Food and Nutrition", Star Publication, Agra, India, 2018.
3. 1000Days-Nutrition_Brief_Brain-Think_Babies_FINAL.pdf
3. <https://pediatrics.aappublications.org/content/141/2/e20173716>
4. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5750909/>

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Bachelor of Science in Biotechnology (NEP)
First year Semester: Second (II)
CERTIFICATE COURSE IN TOOLS AND TECHNIQUES OF CELL AND MOLECULAR BIOLOGY

Programme/Class: Certificate	Year: First (I)	Semester: Second (II)
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Subject: Biotechnology

Course Code: B100201T	Course Title: Molecular Biology and Genetic Engineering
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Course Outcomes (COs)

Student will be able to-

- learn and understand the important discoveries that are made in the field of molecular biology.
- learn key molecular events that occur during the DNA replication, transcription, translation and regulation of gene concept.
- gain knowledge on the foundation of genetic engineering and their applications in biological research as well as in biotechnology industries.
- understand gene concept, plasmids, and wide range of techniques, especially modern molecular tools in diagnosis.
- acquainted with various techniques of genetic engineering and their applications in biological research, diagnostics as well as in biotechnology industries.

Credits:	Core Compulsory
Maximum Marks: 100 (75(UE)+25(CIE))	Minimum Passing Marks: As per University norms

Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0

Unit	Topic	No. of Lectures
I	Gene organization and regulation of gene expression: <ul style="list-style-type: none"> • Structure of DNA, Types of DNA • Gene organization in prokaryotes and eukaryotes, polycistronic genes, split genes promoters, enhancers. • Regulation of gene expression: Prokaryotes: lac and trp operons in <i>E. coli</i>. 	7
II	DNA Replication and DNA polymerases: <ul style="list-style-type: none"> • Replication of genetic material in prokaryotes and eukaryotes • A brief description of initiation at replication origins and its cell cycle regulation. • Structure and function of prokaryotic and eukaryotic DNA polymerases 	7
III	Transcription and mRNA processing: <ul style="list-style-type: none"> • RNA structure and types of RNA • Mechanism of transcription in prokaryotes and eukaryotes: transcription factors, structure of prokaryotic and eukaryotic RNA polymerases, initiation, elongation and termination. • RNA processing: processing of mRNA (Splicing, capping and polyadenylation) 	8

IV	Prokaryotic and eukaryotic translation: <ul style="list-style-type: none"> • Ribosome structure and assembly, tRNA, aminoacyl-tRNA synthetases, Mechanism of initiation, elongation and termination of polypeptides, Fidelity of translation, Inhibitors of translation. <ul style="list-style-type: none"> • Posttranslational modifications of proteins. 	7
V	Vectors: <ul style="list-style-type: none"> • Cloning vectors (plasmids, cosmids, bacterial artificial chromosomes and yeast artificial chromosomes), • shuttle vectors, • expression vectors 	7
VI	Enzymes used in DNA manipulating: <ul style="list-style-type: none"> • Restriction endonuclease • Ligases • Polymerases • Kinases • Alkaline phosphatases • Reverse Transcriptase 	8
VII	Genomic Library, PCR, Sequencing etc: <ul style="list-style-type: none"> • Preparation and comparison of Genomic and cDNA library. • PCR and its applications. • DNA Sequencing. • Site directed mutagenesis • Protein engineering concepts and examples (any two). 	8
VIII	Molecular Biology techniques: <ul style="list-style-type: none"> • DNA isolation (Plasmid/ Genomic DNA isolation) • Blotting (Southern, Northern, Western) • Electrophoresis of nucleic acids and proteins • Gene cloning, Screening and characterization of cloned DNA • DNA Fingerprinting • RFLP, RAPD 	8

Suggested Reading

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2014). **Molecular Biology of the Cell** (6th Ed.). New York: Garland Science
2. Cooper, G. M., and Hausman, R. E. (2013). **The Cell: a Molecular Approach** (6th Ed.). Washington: ASM ; Sunderland.
3. Karp, G. **Cell and Molecular Biology. Concepts and experiments.** John Harris, D., Wiley & sons, New York
4. Iwasa J., Marshal W. **Karp's Cell Biology**(2018) (8th edition) Wiley & Sons, NY
5. Iwasa J., Marshal W. **Karp's Cell and Molecular Biology . Concepts and experiments.** (2015) (8th edition) Wiley & sons, New York
6. Watson, J. D. Baker TA, Bell, SP Gann, A. Levine, M. Losick R. (2008). **Molecular Biology of the Gene** (5th ed.). Pearson

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Programme/Class: Certificate	Year: First (1)	Semester: Second (II)
Subject: Biotechnology		
Course Code: B100202P	Course Title: Genetic Engineering Lab	
Course Outcomes (COs)		
After completion of the course, the student shall be able to -		
<ul style="list-style-type: none"> • prepare different bacterial growth media, • understand principals and methods of competent cell preparation, restriction digestion, gene ligation, gene cloning, and transformation i. e gene manipulation. • understand the method of agarose electrophoresis for plasmid and genomic DNA separation • understand the method of blotting and PCR 		
Credits: 2	Core Compulsory	
Maximum Marks: 100 (75(UE)+25(CIE))	Minimum Passing Marks: As per University norms	
Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 0-0-4		
	Topic	No. of Lectures
	<ol style="list-style-type: none"> 1. Preparation of solutions for Molecular Biology experiments. 2. Preparation of bacterial growth medium (L.B., 2XYT) 3. Competent cell preparation. 4. Transformation of <i>E.coli.</i> cells (color selection of transformants – with or without inserts) X – gal and IPTG. 5. Isolation of Plasmid DNA by alkaline lysis method 6. Isolation of genomic DNA from bacterial cells. 7. Agarose gel electrophoresis of genomic DNA & plasmid DNA 8. Concentration estimation by agarose gel electrophoresis 9. Preparation of restriction enzyme digests of DNA samples 10. Ligation 11. Southern blotting 12. PCR 	60

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Programme/Class: Certificate		Year: First	Semester: Second
Subject: Biotechnology			
Course Code: B050201T		Course Title: Biochemistry and Physiology	
Course outcomes:			
The student at the completion of the course will learn:			
<ul style="list-style-type: none"> To develop a deep understanding of structure of biomolecules like proteins, lipids and carbohydrates How simple molecules together form complex macromolecules. To understand the thermodynamics of enzyme catalyzed reactions. Mechanisms of energy production at cellular and molecular levels. To understand systems biology and various functional components of an organism. To explore the complex network of these functional components. To comprehend the regulatory mechanisms for maintenance of function in the body. 			
Credits: 4		Core: Compulsory	
Max. Marks: 25+75		Min. Passing Marks: as per rules	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P:4-0-0			
Unit	Topics	Total No. of Lectures (60)	
I	Structure and Function of Biomolecules <ul style="list-style-type: none"> □ Structure and Biological importance of carbohydrates (Monosaccharides, Disaccharides, Polysaccharides and Glycoconjugates) □ Lipids (saturated and unsaturated fatty acids, Triacylglycerols, Phospholipids, Glycolipids, Steroids) □ Structure, Classification and General properties of α-amino acids; Essential and non-essential α-amino acids, Levels of organization in proteins; Simple and conjugate proteins. 	8	
II	Enzyme Action and Regulation <ul style="list-style-type: none"> • Nomenclature and classification of enzymes; Cofactors; Specificity of enzyme action • Isozymes; Mechanism of enzyme action • Enzyme kinetics; Factors affecting rate of enzyme-catalyzed reactions; Derivation of Michaelis-Menten equation, Concept of K_m and V_{max}, Lineweaver-Burk plot; Enzyme inhibition; • Allosteric enzymes and their kinetics; Regulation of enzyme action 	8	
III	Metabolism of Carbohydrates and Lipids <ul style="list-style-type: none"> • Metabolism of Carbohydrates: glycolysis, citric acid cycle, gluconeogenesis, phosphate pentose pathway 	8	

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	<ul style="list-style-type: none"> • Glycogenolysis and Glycogenesis • Lipids --- Biosynthesis of palmitic acid; Ketogenesis, β-oxidation and omega -oxidation of saturated fatty acids with even and odd number of carbon atoms 	
IV	Metabolism of Proteins and Nucleotides <ul style="list-style-type: none"> • Catabolism of amino acids: Transamination, Deamination, Urea cycle • Nucleotides and vitamins • Review of mitochondrial respiratory chain, Oxidative phosphorylation, and its regulation 	6
V	Digestion and Respiration <ul style="list-style-type: none"> • Structural organization and functions of gastrointestinal tract and associated glands • Mechanical and chemical digestion of food; Absorptions of carbohydrates, lipids, proteins, water, minerals and vitamins; Histology of trachea and lung • Mechanism of respiration, Pulmonary ventilation; Respiratory volumes and capacities; Transport of oxygen and carbon dioxide in blood Respiratory pigments, Dissociation curves and the factors influencing it; Control of respiration 	7
VI	Circulation and Excretion <ul style="list-style-type: none"> • Components of blood and their functions • Haemostasis: Blood clotting system, Blood groups: Rh factor, ABO and MN • Structure of mammalian heart • Cardiac cycle; Cardiac output and its regulation, Electrocardiogram, Blood pressure and its regulation • Structure of kidney and its functional unit; Mechanism of urine formation 	8
VII	Nervous System and Endocrinology <ul style="list-style-type: none"> • Structure of neuron, resting membrane potential • Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers • Types of synapse • Endocrine glands - pineal, pituitary, thyroid, parathyroid, pancreas, adrenal; hormones secreted by them • Classification of hormones; Mechanism of Hormone action 	8
VIII	Muscular System Histology of different types of muscle; Ultra structure of skeletal muscle; Molecular and chemical basis of muscle contraction; Characteristics of muscle twitch; Motor unit, summation and tetanus	7

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Suggested Readings:

1. Nelson & Cox: Lehninger's Principles of Biochemistry: McMillan (2000)
2. Zubayet *al.*: Principles of Biochemistry: WCB (1995)
3. Voet & Voet: Biochemistry Vols 1 & 2: Wiley (2004)
4. Murray *et al.*: Harper's Illustrated Biochemistry: McGraw Hill (2003) Elliott and Elliott:
Biochemistry and Molecular Biology: Oxford University Press

Programme/Class: Certificate	Year: First	Semester: Second
Subject: Biotechnology		
Course Code: B050202P/R	Course Title: Physiological, Biochemical & Hematology Lab	
Course outcomes: The student at the completion of the course will be able to: <ul style="list-style-type: none"> • Understand the structure of biomolecules like proteins, lipids and carbohydrates • Perform basic hematological laboratory testing, • Distinguish normal and abnormal hematological laboratory findings to predict the diagnosis of hematological disorders and diseases. 		
Credits: 2	Core: Compulsory	
Max. Marks: 25+75	Min. Passing Marks: as per rules	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P:0-0-4		
Unit	Topics	Total No. of Lectures (60)
I	<ol style="list-style-type: none"> 1. Estimation of haemoglobin using Sahli's haemoglobinometer 2. Preparation of haemin and haemochromogen crystals 3. Counting of RBCs and WBCs using Haemocytometer 4. To study different mammalian blood cell types using Leishman stain. 5. Recording of blood pressure using a sphygmomanometer 6. Recording of blood glucose level by using glucometer 	20
II	<ol style="list-style-type: none"> 1. Study of permanent slides of Mammalian skin, Cartilage, Bone, Spinal cord, Nerve cell, Pituitary, Pancreas, Testis, Ovary, Adrenal, Thyroid and Parathyroid 2. Recording of simple muscle twitch with electrical stimulation (or Virtual) 3. Demonstration of the unconditioned reflex action (Deep tendon reflex such as knee jerk reflex) 	15
III	<ol style="list-style-type: none"> 1. Ninhydrin test for α-amino acids. 2. Benedict's test for reducing sugar and iodine test for starch. 3. Test for sugar and acetone in urine. 4. Qualitative tests of functional groups in carbohydrates, proteins and lipids. 5. Action of salivary amylase under optimum conditions. 	10

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IV	Virtual Labs (Suggestive sites) <ol style="list-style-type: none"> 1. https://www.vlab.co.in 2. https://zoologysan.blogspot.com 3. www.vlab.iitb.ac.in/vlab 4. www.onlinelabs.in 5. www.powershow.com 6. https://vlab.amrita.edu 7. https://sites.dartmouth.edu 	15
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Programme/Class: Certificate	Year: First	Semester: Second
Subject: MICROBIOLOGY		
Course Code: B080201T	Course Title: Agriculture and Environmental Microbiology	

Course Outcomes:

The student at the completion of the course will be able to:

- Get acquainted with natural habitats of diverse protection.
- Understand how microbes interact among themselves and with higher plants and animals with the help of various examples.
- Become aware of the important role microbes play in bio-geochemical cycling of essential elements occurring within an ecosystem and its significance.
- Gain in depth knowledge of different types of solid waste, liquid waste and their management.
- Get familiar with problems of pollution and applications of clear up technologies for the pollutants.
- Know about the diverse microbial populations in various natural habitats like soil, air, water.
- Gain knowledge of the bio-fertilizer and their types.

Credits: 4	Core: Compulsory
Max. Marks: 25+75	Min. Passing marks: as per rules

Total No. of Lectures-Tutorials-Practical(in hours per week): L-T-P: 4-0-0

Unit	Topics	Total No. of Lectures/ Hours (60)
I	Microorganisms and their habitats Structure and function of ecosystem; Terrestrial environment: soil profile and soil microflora; Aquatic Environment: microflora of fresh water and marine habitats; Atmosphere: Aeromicroflora and dispersion of microbes; Animal Environment: Microbes in/on human body (microbiomes) & animal (Ruminants) body; Extreme habitats: Extremophiles: Microbes thriving at high & low temperature, pH. High hydrostatic & osmotic pressures, salinity and low nutrient level; Microbial succession in decomposition of plant organic matter.	8
II	Microbial Interactions Microbe interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism, predation; Microbe-Plant interaction: positive-negative interaction; Microbe-Animal interaction: positive-negative interaction; Microorganism of rhizosphere, rhizoplane and phylloplane, mycorrhiza (types and its applications).	8

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III	Biogeochemical cycling Carbon cycle: Microbial degradation of cellulose, hemicellulase, lignin and chitin; Nitrogen cycle: Nitrogen fixation, ammonification, nitrification, denitrification and nitrate reduction; Phosphorous cycle: Phosphate Immobilisation and solubilisation; Sulphur cycle: Microbes involved in sulphur cycle.	8
IV	Waste management Solid waste management: Source and type of solid waste, method of solid waste disposal (composting and sanitary landfill), Liquid waste management: composition and strength of sewage (BOD & COD), primary, secondary, (oxidation pond, trickling filter, activated sludge process and septic tank) and tertiary sewage treatment.	8
V	Microbial Bioremediation Principle and degradation of common pesticides, organic (hydrocarbon, oilspills) and inorganic matter, biosurfactants.	6
VI	Water potability Treatment and safety of drinking water; Methods to detect potability of water sample: Standard qualitative procedure- MPN test/Presumptive test, confirmed and completed test for faecal-coliforms Membrane filter technique, Presence/Absence test fecal coliform.	6
VII	Biofertilizer Definition, Types- Bacterial, Fungal, Phosphate solubilizer, BGA & associative; Mode of application; Advantages and Disadvantages.	8
VIII	Biopesticides Introduction and definition; Types of biopesticides; Integrated pest management (IPM); Mode of action; Factor influencing; Applications, advantages & disadvantages.	8

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Suggested Readings:

1. Alexander M., Introduction to soil microbiology, Wiley Eastern limited, New Delhi.
2. Alexopoulos C.J. and MIMS C.W., Introductory Mycology, New age international, New Delhi.
3. Aneja K.R., Experiments in Microbiology, plant pathology, Tissue culture and Mushroom cultivation, New Age International, New Delhi
4. Hurst, C.J., Environmental Microbiology, ASM press, Washington D.C.
5. Mehrotra A.S., Plant Pathology, Tata Mcgraw Hill Publications limited, New Delhi.
6. Pelczar M.J., Chan E.C.S and Kreig N.R., Microbiology, Mcgraw-Hill Book Company, New York.
7. Prescott Lansing M., Harley John P. and Klein Donald A., Microbiology, WCB Mcgraw-Hill, New York.
8. Salle A.J., Fundamental Principles of Bacteriology, Tata Mcgraw-Hill Publishing Company Limited, New Delhi.
9. Stacey R.H. and Evans H.J., Biological Nitrogen Fixation, Chapman and Hall limited, London.
10. Stanier R. Y., Ingraham J.L., General Microbiology, Prentice Hall of India Private Limited, New Delhi.

Programme/Class: Certificate	Year: First	Semester: Second
Subject: MICROBIOLOGY		
Course Code: B080202P	Course Title: Experiments in Agriculture and Environmental Microbiology	

Course Outcomes:

The student at the completion of the course will be able to:

- To understand the instruments, microbial techniques and good lab practices for working in amicrobiology laboratory.
- Practical skill in the laboratory experiments in microbiology.
- Develop skills for identifying microbes and using them for industrial, agricultural and environmental purpose.
- To prepare slides and stain to see the microbial cell.

Credits: 2**Core:** Compulsory**Max. Marks:** 25+75**Min. Passing marks:** as per rules**Total No. of Lectures-Tutorials-Practical(in hours per week):** L-T-P: 0-0-2

S. No.	Objectives	Total No. of Lectures/ Hours (60)
1	<ul style="list-style-type: none"> • To analyse soil- pH, moisture, water holding capacity. 	8
2	<ul style="list-style-type: none"> • Isolation of microorganisms (Bacteria & Fungi) from soil sample at different temperature (28° C & 45° C) • Isolation of bacteria and fungi from rhizosphere and rhizoplane. • Isolation of bacteria & fungi from air environment by exposure plate method. • Isolation of Rhizobium sp. from leguminous root nodule. 	16

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3	<ul style="list-style-type: none"> To determine BOD of waste water sample. Bacteriological examination of water by MPN test, presumptive coliform, confirmed coliform and completed coliform test. 	12
4	<ul style="list-style-type: none"> Specimen study of plant pathogens. <ol style="list-style-type: none"> Black rust of wheat White rust of crucifer Leaf curl of tomato Downy mildew Red rot of sugarcane 	10
5	Study of permanent slide and life materials <ul style="list-style-type: none"> Cladosporium Helmithosporium Mucor Curvularia Alternaria Geotrichum Trichoderma Rhizopus 	14

Bachelor of Science in Biotechnology (NEP)

Second Year/ Third Sem

DIPLOMA IN TOOLS AND TECHNIQUES OF BIOTECHNOLOGY

Programme/Class: Diploma	Year: Second (2)	Semester: Third (III)
Subject: Biotechnology		
Course Code: B100301T	Course Title: Biochemistry and Biochemical tools	
Course Outcomes		
After successful completion of the course, student will be able to: <ul style="list-style-type: none"> understand the significance of Biochemistry. learn the chemistry of carbohydrates, lipids, proteins and amino acids. understand the basics of enzymes. understand the metabolism of carbohydrate and proteins know the chemical structure of nucleotides including their components, describe primary, secondary structure of DNA and RNA. 		
Credits: 4	Core Compulsory	
Maximum Marks: 100 (75(UE)+25(CIE))	Minimum Passing Marks: As per University norms	
Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0		
Unit	Topic	No. of Lectures
I	Amino acids and Protein: <ul style="list-style-type: none"> Structure and properties of Amino acids Types of proteins and their classification Forces stabilizing protein structure. Different Level of structural organization of proteins. Denaturation and renaturation of proteins. 	7

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II	Carbohydrates: <ul style="list-style-type: none"> • Structure, Function and properties of Monosaccharides, Disaccharides and Polysaccharides. • Homo and Hetero Polysaccharides, Mucopolysaccharides, • Bacterial cell wall polysaccharides, Glycoprotein's and their biological functions. 	7
III	Nucleic acids: <ul style="list-style-type: none"> • Structure and functions: • Physical & chemical properties of Nucleic acids, nucleosides & nucleotides, purines & pyrimidines,. Biologically important nucleotides, • Double helical model of DNA structure and forces stabilizing DNA double helical structure, A, B and Z – DNA, denaturation and renaturation of DNA. 	7
IV	Lipids: <ul style="list-style-type: none"> • Structure and functions of Lipids • Classification, nomenclature and properties of fatty acids, essential fatty acids. • Phospholipids, sphingolipids, glycolipids, cerebrosides, gangliosides, Prostaglandins, Cholesterol. 	6
V	Enzymes and Enzyme classification: <ul style="list-style-type: none"> • Nomenclature and classification of Enzymes, brief introduction to active site. • Kinetics of enzyme actions • Cofactors, coenzyme, prosthetic groups, holoenzyme and apoenzyme • Enzyme inhibition – competitive, Non-competitive & uncompetitive type. 	8
VI	Metabolism: <ul style="list-style-type: none"> • Metabolism of carbohydrates- Gluconeogenesis, Glycolysis, TCA, and Glyoxylate cycle • Metabolism of fatty acids-oxidation of saturated, unsaturated fatty acids • Oxidation of amino acids and urea cycle. 	9
VII	Vitamins and Hormone: <ul style="list-style-type: none"> • Introduction to Vitamins, hormones, Phytohormones and their role • Deficiency of vitamins and hormones and related human diseases. 	8
VIII	Techniques: <ul style="list-style-type: none"> • Chromatography (Column chromatography, Ion- exchange chromatography, Gel- permeation (molecular sieve, chromatography, Affinity chromatography, Paper chromatography, Thin-layer chromatography, Gas chromatography and HPLC) • Spectroscopy (UV-Vis) 	8

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- NMR
- X-ray diffraction
- Centrifugation
- Mass spectrometry

Suggested Reading

1. Berg, JM Tymoczko, JL. Gatto, GJ., Stryer, L. (2015). **Biochemistry**. (8th ed.) W H Freeman and Company New York.
2. Nelson DL. Cox MM. (2017) **Lehninger Principles of Biochemistry** (7th ed.). W H Freeman New York.
3. Voet, D., & Voet, J. G. (2016). **Biochemistry** (5th ed.). Hoboken, NJ: J. Wiley & Sons.
4. Rodwell VW. Bender D. Botham KM. Kennelly PJ Weil PA.(2018). **Harper's Illustrated Biochemistry**.(31st edition) McGraw-Hill Education
5. Hofmann A. Clokie S. **Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology**. (2018) (8th edition)Cambridge University Press

Programme/Class: Diploma	Year: Second (2)	Semester: Third(III)
Subject: Biotechnology		
Couse Code: B100302P	Course Title: Biochemistry Lab	
Course Outcomes		
<p>Students will get practical exposure to commonly used biochemical techniques and also they become familiar to use instruments like calorimeter, pHmeter etc.</p> <p>Introduce the primary steps in biomolecules (focus on proteins) purification which includes various methods in isolation and quantitation of proteins.</p> <ol style="list-style-type: none"> 2. Learn how to separate proteins from a heterogenous mixture. 3. Learn to apply important chromatographic techniques to purify biomolecules 4. Familiarize the working principles of electrophoresis and UV/Vis and fluorescence spectroscopic techniques and application of the knowledge to get basic structural information of proteins 		
Credits: 2	Core Compulsory	
Maximum Marks: 100 (75(UE)+25(CIE))	Minimum Passing Marks: As per University norms	
Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 0-0-4		
	Topic	No. of Lectures
	<ol style="list-style-type: none"> 1. Preparation of normal and molar solutions 2. Preparation of buffers. 3. To study activity of any enzyme under optimum conditions. 4. To study the effect of pH, temperature on the activity of salivary amylase enzyme. 	60
	<ol style="list-style-type: none"> 5. Estimation of blood glucose by glucose oxidase method. 6. Spectrophotometer/colorimeter(Beer-Lambert's law) Estimation of Protein by UV-vis Spectrometer <ol style="list-style-type: none"> i. (i)Lowry et al. method for estimation of protein (ii)Biuret method for estimation of protein 	

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<ul style="list-style-type: none"> 7. Spectroscopic estimation of DNA (UV) 8. Electrophoresis (a) Electrophoresis of red blood cell proteins (b) Electrophoresis of DNA 9. Separation of Amino acids by paper chromatography. 10. Qualitative tests for Carbohydrates, lipids and proteins 11. Estimation of DNA by Diphenylamine and RNA by Orcinol methods. 12. Estimation of reducing and total sugar by DNS and H₂SO₄-phenol methods. 13. Effect of pH and temperature on enzyme activity. 14. Determination of pK_a value of a weak acid by titrating with strong base. 	
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Programme/Class: Diploma **Year:** Second (2) **Semester:** Third (III)

Subject: Biotechnology

Course Code: B100303T

Course Title: Genomics and Proteomics

Course Outcomes

After successful completion of the course, student will be able to:

- **Describe** methods of whole genome sequencing.
- **Explain** the use of genomics in biomedicine and agriculture
- **Define** the protein expression profiling and protein chips
- **Analyze** the nucleic acid and protein sequence data

Credits: 4

Core Compulsory

Maximum Marks: 100
(75(UE)+25(CIE))

Minimum Passing Marks: As per University norms

Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0

Unit	Topic	No. of Lectures
I	<ul style="list-style-type: none"> • Methods for whole genome sequencing, Microbial genome, Plant genome, Animal genomes (fruitfly, housefly, mouse). Human genome project –history and salient features, Arabidopsis as a model plant for genetic engineering, Stem cells –current status, Recombinant Vaccines -Malaria AIDS 	12
II	<ul style="list-style-type: none"> • Use of genome analysis for designing vaccines and drugs, genomics of agriculture microbes genomes of mitochondria and chloroplast 	12
III	<ul style="list-style-type: none"> • Pharmacogenomics, use of genomics in biomedicine involving diagnosis and treatment of disease, genome in medical practice, use of SNP in Pharmacogenomics, and industry 	12
IV	<ul style="list-style-type: none"> • Methods of proteomics research -SDS –PAGE, 2D-PAGE, X-ray crystallography, NMR spectroscopy, isoelectro-focussing, mass spectroscopy differential display protein chips and antibody micro arrays 	12

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V	<ul style="list-style-type: none"> Analysis of nucleic acid/ protein sequence and structure data, genome proteome data using web based tools: integration of different data sets. Proteomics research –Significance, methods of proteome analysis, resolution identification of proteins. Post transitional modification of proteins. 	12
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Suggested Reading

1. Biotechnology and Genomics, P. K. Gupta, Rastogi Publication, Meerut Biotechnology.
2. U.Satyanarayan. Books and Allied Pvt. Ltd.
3. Horizons of Biotechnology: B.D. Singh : Kalyani publications

Programme/Class: Diploma	Year: Second (2)	Semester: Third(III)
Subject: Biotechnology		
Course Code: B100304P	Course Title: Genomics and Proteomics Lab	
Course Outcomes		
<p>Students will get practical exposure to commonly used biochemical techniques and also they become familiar to use instruments like calorimeter, pHmeter etc.</p> <p>Introduce the primary steps in biomolecules (focus on proteins) purification which includes various methods in isolation and quantitation of proteins.</p> <ol style="list-style-type: none"> 5. Learn how to separate proteins from a heterogenous mixture. 6. Learn to apply important chromatographic techniques to purify biomolecules 7. Familiarize the working principles of electrophoresis and UV/Vis and fluorescence spectroscopic techniques and application of the knowledge to get basic structural information of proteins 		
Credits: 2	Core Compulsory	
Maximum Marks: 100 (75(UE)+25(CIE))	Minimum Passing Marks: As per University norms	
Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 0-0-4		
	Topic	No. of Lectures
	1. Analysis of Nucleic acids /protein sequence and structure data	60
	2. Analysis of Genome and Proteome data using web based tools	
	3 Spectroscopic estimation of DNA (UV)	
	4 Electrophoresis (a)Electrophoresis of red blood cell proteins	
	5. Electrophoresis of DNA	
	6. Estimation of DNA by Diphenylamine and RNA by Orcinol methods.	

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Programme: Biotechnology	Year: Two	Semester: III
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Paper-1 Theory Subject: Chemistry

Course Code: B020301T	Course Title: Chemical Dynamics & Coordination Chemistry
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Course outcomes: Upon successful completion of this course students should be able to describe the characteristic of the three states of matter and describe the different physical properties of each state of matter, kinetic theory of gases, laws of crystallography, liquid state and liquid crystals, conductometric, potentiometric, optical methods, polarimetry and spectrophotometer technique to study Chemical kinetics and chemical equilibrium. After the completion of the course, Students will be able to understand metal- ligand bonding in transition metal complexes, thermodynamic and kinetic aspects of metal complexes.

Credits: 4	Elective
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Max. Marks: 25+75	Min. Passing Marks:.....
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Total No. of Lectures = 60

Unit	Topics	No. of Lectures
I	<p>Chemical Kinetics: Rate of a reaction, molecularity and order of reaction, concentration dependence of rates, mathematical characteristic of simple chemical reactions – zero order, first order, second order, pseudo order, half-life and mean life. Determination of the order of reaction – differential method, method of integration, half-life method and isolation method.</p> <p>Theories of chemical kinetics: Effect of temperature on rate of reaction, Arrhenius equation, concept of activation energy. Simple collision theory based on hard sphere model, transition state theory (equilibrium hypothesis). Expression for the rate constant based on equilibrium constant and thermodynamic aspects (no derivation).</p>	10
II	<p>Chemical Equilibrium : Equilibrium constant and free energy, thermodynamic derivation of law of mass action. Le-Chatelier's principle. reaction isotherm and reaction isochore – Clapeyron Clausius equation and its applications.</p>	5

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III	Phase Equilibrium : Statement and meaning of the terms-phase, component and degree of freedom, derivation of Gibbs phase rule, phase equilibria of one component system– water, CO ₂ and systems. Phase equilibria of two component systems – Solid - liquid equilibria , simple eutectic – Bi-Cd, Pb Ag systems.	05
IV	Kinetic theories of gases Gaseous State: Postulates of kinetic theory of gases, deviation from ideal behavior, van der Waals equation of state. Critical phenomena: PV isotherms of real gases, continuity of states, the isotherms of Van der Waals equation, relationship between critical constants and Van der Waals constants, the law of corresponding states, reduced equation of state. Molecular Velocities: Qualitative discussion of the Maxwell's distribution of molecular velocities, collision number, mean free path and collision diameter.	10
V	Liquid State Liquid State: Intermolecular forces, structure of liquids (a qualitative description). Structural differences between solids, liquids and gases. Liquid crystals: Difference between liquid crystal, solid and liquid. Classification, structure of nematic and cholesterol phases. Liquids in solids (gels): Classification, preparation and properties, inhibition, general application	5
VI	Coordination Chemistry Werner's theory of coordination complexes, classification of ligands, ambidentate ligands, chelates, coordination numbers, IUPAC nomenclature of coordination complexes (up to two metal centers), Isomerism in coordination compounds, constitutional and stereo isomerism, geometrical and optical isomerism in square planar and octahedral complexes.	5
VII	Theories of Coordination Chemistry I Metal- ligand bonding in transition metal complexes, limitations of valance bond theory, an elementary idea of crystal field theory, crystal field splitting in octahedral, tetrahedral and square planner complexes, John teller effect, factors affecting the crystal-field parameters. II. Thermodynamic and kinetic aspects of metal complexes: A brief outline of thermodynamic stability of metal complexes, concept of hard and soft acids and	10

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	bases and factors affecting the stability, stability constants of complexes and their determination, substitution reactions of square planar complexes	
VIII	<p>Inorganic Spectroscopy and Magnetism</p> <p>I) Electronic spectra of Transition Metal Complexes Types of electronic transitions, selection rules for d-d transitions, spectroscopic ground states, spectrochemical series, Orgel-energy level diagram for d1 and d9 states, discussion of the electronic spectrum of $[Ti(H_2O)_6]^{3+}$ complex ion.</p> <p>II) Magnetic properties of transition metal complexes, types of magnetic behaviour, methods of determining magnetic susceptibility, spin-only formula, L-S coupling, correlation of μ_s and μ_{eff} values, orbital contribution to magnetic moments, application of magnetic moment data for 3d- metal complexes.</p>	10

Suggested Readings:

- Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry Ed., Oxford University Press 13 (2006).
- Ball, D. W. Physical Chemistry Thomson Press, India (2007).
- Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).
- Cotton, F.A, Wilkinson, G and Gaus, P. L, Basic Inorganic Chemistry, 3rd Edition, Wiley 1995
- Lee, J.D, Concise Inorganic Chemistry 4th Edition ELBS, 1977
- Douglas, B, McDaniel, D and Alexander, J, Concepts of Models of Inorganic Chemistry, John Wiley & Sons; 3rd edition, 1994
- Shriver, D.E Atkins, P.W and Langford, C.H, Inorganic Chemistry, Oxford University Press, 1994.
- Porterfield, W.W, Inorganic Chemistry, Addison Wesley 1984.
- Sharpe, A.G, Inorganic Chemistry, ELBS, 3RD edition, 1993
- Miessler, G.L, Tarr, D.A, Inorganic Chemistry, 2nd edition, Prentice Hall, 2001

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Programme: Biotechnology		Year: Two	Semester: III
Practical paper-2		Subject: Chemistry	
Course Code: B020302P		Course Title: Physical Analysis	
Course Outcomes: Upon successful completion of this course students should be able to calibrate apparatus and prepare solutions of various concentrations, estimation of components through volumetric analysis; to perform dilatometric experiments: one and two component phase equilibrium experiments.			
Credits: 4		Elective	
Max. Marks: 25 +75		Min. Passing Marks:	
Practical 60 h			
Unit	Topics	No of Lectures	
I	Strengths of Solution Calibration of fractional weights, pipettes and burettes. Preparation of standards solutions. Dilution –0.1 M to 0.001 M solutions. Mole Concept and Concentration Units :Mole Concept, molecular weight, formula weight, and equivalent weight. Concentration units: Molarity, Formality, Normality, Molality, Mole fraction, Percent by weight, Percent by volume, Parts per thousand, Parts per million, Parts per billion, pH, pOH, milli equivalents, Milli moles	20	
II	Surface Tension and Viscosity 1. Determination of surface tension of pure liquid or solution 2. Determination of viscosity of liquid pure liquid or solution	06	
III	Boiling point and Transition Temperature 1. Boiling point of common organic liquid compounds ANY FIVE n-butylalcohol, cyclohexanol, ethyl methyl ketone, cyclohexanone, acetylacetone, isobutyl methyl ketone, isobutyl alcohol, acetonitrile, benzaldehyde and acetophenone. [Boiling points of the chosen organic compounds should preferably be within 180°C]. 2. Transition Temperature, Determination of the transition temperature of the given substance by thermometric /dilatometric method (e.g. $MnCl_2 \cdot 4H_2O/SrBr_2 \cdot 2H_2O$)	14	

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IV	<p>Phase Equilibrium</p> <p>1. To study the effect of a solute (e.g. NaCl, succinic acid) on the critical solution temperature of two partially miscible liquids (e.g. phenol-water system) and to determine the concentration of that solute in the given phenol-water system</p> <p>2. To construct the phase diagram of two component (e.g. diphenylamine – benzophenone) system by cooling curve method.</p>	20
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**Bachelor of Science in Biotechnology (NEP)
Second Year/ Fourth Sem**

DIPLOMA IN TOOLS AND TECHNIQUES OF BIOTECHNOLOGY

Programme/Class: Diploma	Year: Second (2)	Semester: Fourth (IV)
Subject: Biotechnology		
Couse Code: B100401T	Course Title: Microbiology and Immunology	
Course Outcomes		
<p>On the successful completion of the course, student will be able to:</p> <ul style="list-style-type: none"> • the pioneers in microbiology and their contributions • understand the physical and chemical method of sterilization • analyze the media composition and grow the desired microbe. • understand the methods of cultivation of microorganisms • understand different staining methods • understand and differentiate the different types of microbes. • understand the principles of immunology • learn about structural features of components of immune system as well as their function and development of immune system and mechanisms by which our body elicits immune response. • predict about nature of immune response that develops against bacterial, viral or parasitic infection, and prove it by designing new experiments. • understand different tools and techniques of immunology • understand the biology of different vaccines against infectious agents 		
Credits: 4	Core Compulsory	
Maximum Marks: 100 (75(UE)+25(CIE))	Minimum Passing Marks: As per University norms	
Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0		
Unit	Topic	No. of Lectures
I	<p>Diversity and classification of microbes:</p> <ul style="list-style-type: none"> • Fundamentals, History and Evolution of Microbiology. • Classification of microorganisms: Microbial taxonomy, criteria used including molecular approaches, Microbial phylogeny and current classification of bacteria. • Microbial Diversity: Distribution and characterization Prokaryotic and Eukaryotic cells, • Morphology and cell structure of major groups of microorganisms - Viruses, Bacteria, Algae, Fungi, and Protozoa. 	7

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II	Microbial growth: <ul style="list-style-type: none"> • Growth curve, Generation time, synchronous batch and continuous culture, measurement of growth and factors affecting growth of bacteria. • Microbial Metabolism: Metabolic pathways, amphicatabolic and biosynthetic pathways • Bacterial Reproduction: Transformation, Transduction and Conjugation. Endospores and sporulation in bacteria. 	8
III	Pathogen contamination and infectious diseases: <ul style="list-style-type: none"> • Water Microbiology: Bacterial pollutants of water, coliforms and non coliforms. Sewage composition and its disposal. • Food Microbiology: Important microorganism in food Microbiology: Moulds, Yeasts, bacteria. • Major food born infections and intoxications, Preservation of various types of foods. Fermented Foods. • Bacterial diseases of human- Tuberculosis, Tetanus, Typhoid, Cholera • Viral diseases of human-Hepatitis B andC, AIDS 	8
IV	Sterilization, cultivation and staining: <ul style="list-style-type: none"> • Principals and applications of different methods of sterilization • Cultivation and Maintenance of microorganisms: Nutritional categories of micro-organisms • Methods of isolation, Purification and preservation. • Principals of staining and types of staining 	7
V	Introduction to immune system: <ul style="list-style-type: none"> • Introduction to Immunology, Components of mammalian immune system (cell and organs), Innate and Adaptive immunity • Humoral and cell mediated immune response, Clonal selection theory • An overview of primary and secondary immune responses 	8
VI	Antigen and Antibody structure and diversity: <ul style="list-style-type: none"> • Antigen, epitopes and Adjuvents • Structure and isotypes of Immunoglobulins allotypes and idiotypes • B- and T-cell receptors • B and T cell maturation • Antibody diversity generation, somatic gene rearrangements during B-lymphocyte differentiation, allelic exclusion, affinity maturation, class switching, somatic hypermutation 	8

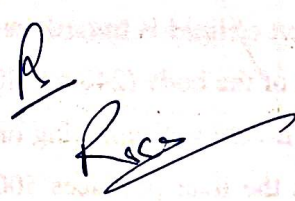
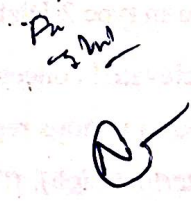
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VII	MHC, antigen processing and presentation: <ul style="list-style-type: none"> • Major Histocompatibility complexes – class I & class II MHC antigens, antigen processing. • Antigen processing and presentation • Autoimmune diseases, Immunodeficiency-AIDS and SCID. 	7
VIII	Immunological Techniques and Vaccines: <ul style="list-style-type: none"> • Introduction to immunodiagnostics – Precipitation, Agglutination, RIA, ELISA and Immunofluorescence. • Passive & active immunization. • Types of vaccines-DNA vaccines, recombinant vaccines, inactivated vaccine • Common indigenous vaccines 	7

Suggested Reading

1. Pelczar M J, Reid R D, and Chan EC. (2001). **Microbiology** (5th ed.). New York: McGraw-Hill.
2. Willey J M, Sherwood L, Woolverton C J, Prescott L M, and Willey J M. (2011). **Prescott's Microbiology**. New York: McGraw-Hill.
3. Mattha, W, Berg C Y, and Black JG. (2005). **Microbiology, Principles and Explorations**. Boston, MA: John Wiley & Sons.
4. Cappuccino J G, and Welsh, C. (2016). **Microbiology: a Laboratory Manual**. Benjamin-Cummings Publishing Company.
5. Collins C H, Lyne PM, Grange J M, and Falkinham III J. (2004). **Collins and Lyne's Microbiological Methods** (8th ed.). Arnolds.
6. Levinson WE. (2020). **Review of Medical Microbiology and Immunology** (16th edition). McGraw Hill Education.
7. Ananthanarayana R, Panicker CKJ(2020). **Ananthanarayana and Panicker's Textbook of Microbiology**(11th edition) Universities Press (India) Pvt. Ltd
8. Punt J, Stranford S, Jones P., Owen JA, (2018). **Kuby Immunology**.(8th edition) New York: W.H. Freeman.
9. Delves P J, Martin SJ, Burton DR, and Roitt IM. (2017). **Roitt's Essential Immunology**.(13th edition). Wiley- Blackwell.
10. Murphy K, and Weaver C, (2016). **Janeway's Immunobiology**. (9th edition) New York: Garland Science.

Programme/Class: Diploma	Year: Second (2)	Semester: Fourth (IV)
Subject: Biotechnology		
Course Code: B100402 P	Course Title: Microbiology and Immunology Lab	

Course Outcomes

After completion of this course , students will be able to:

- Understand methods of cleaning and sterilization of plasticwares and glasswares.
- understand and perform pure culture techniques which includes, pour plate and spread plate .
- understand the preparation and use of differential, selective and special media.
- understand and identify the morphology of cells of the immune system.
- understand the basic concepts of blood grouping.
- understand antigen antibody interactions and thus quantitate the presence of antigen and or antibodies in biological samples.

Credits: 2	Core Compulsory
Maximum Marks: 100 (75(UE)+25(CIE))	Minimum Passing Marks: As per University norms

Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 0-0-4

	Topic	No. of Lectures
	<ol style="list-style-type: none"> 1. Safety measures in microbiology laboratory 2. Study of instruments: Compound microscope, Autoclave, Hot air oven, PH meter, and Laminar airflow 3. Introduction to different sterilization techniques 4. Isolation of bacteria & their biochemical characterization. 5. Staining methods: simple staining, Gram staining, spore staining, negative staining, hanging drop. 6. Preparation of media and sterilization, 7. Methods of isolation of bacteria from different sources. 8. Determination of bacterial cell size by micrometry. 9. Enumeration of microorganism - total & viable count. 10. Differential leucocytes count 11. Total leucocytes count 12. Total RBC count 13. Haemagglutination assay 14. Separation of serum from blood 15. Double immunodiffusion test using specific antibody and antigen. 16. ELISA demonstration 	60

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Programme/Class: Diploma	Year: Second (2)	Semester: Fourth (IV)
Subject: Biotechnology		
Couse Code: B10 0403T	Course Title: IPR, Biosafety and Bioethics	
Course Outcomes		
On the successful completion of the course, student will be able to:		
<ul style="list-style-type: none"> • Describe different types of IPRs. • Explain Scope and salient features of patent, Trade Marks, Geographical Indications. • Define biosafety and bioethics. 		
Credits: 4	Core Compulsory	
Maximum Marks: 100 (75(UE)+25(CIE))	Minimum Passing Marks: As per University norms	
Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0		
Unit	Topic	No. of Lectures
I	<ul style="list-style-type: none"> • General patent information: IPR, patent claims and patent life, utilization of intellectual Patents, patent search ownership of patents IPR rights 	12
II	<ul style="list-style-type: none"> • Genetic resources and IPR, basis of IPR categories of IPR (copyright and trademark), GATT and TRIPS patents for higher plants and higher animals, patenting of transgenic, Organism patenting of isolated genes DNA sequences 	12
III	<ul style="list-style-type: none"> • Patent infringement: Literal infringement contributory infringement, defense to infringement, patent misuse, applying for foreign patent protection future development of IPR; Indian tradition, medicine and protection 	12
IV	<ul style="list-style-type: none"> • Bio-safeties: Lab-safety measures Bio-safety related institutional setup in India International biosafety protocol and CBD, difficulties in implementation Biosafety-in national and international organization. Bio-safety of genetically engineered product human growth hormone bovine growth hormone recombinant Bovine Somato-tropins and debate over its use insulin synthetic and trptopha precautionary measures 	12
V	<ul style="list-style-type: none"> • Bioethics- Cloning, ethical issue legal issue, environmental issue, Health and safety issue of gene therapy, Possible benefits of cloning social and ethical impact of cloning, ; problems of allergenicity due to transgenic food. 	12
Suggested Reading		
<ol style="list-style-type: none"> 1. Biotechnology, U.Satyanarayan. Books and Allied Pvt. Ltd 2. Applied plant biotechnology-Ignacimuthu, Tata McGraw Hill New Delhi. 3 Horizons of Biotechnology: B.D. Singh : Kalyani publications 4. An introduction to plant tissue culture: M .K. Razdan Elsevier publication 5. Biotechnology and genomics: P.K. Gupta 		


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Programme/Class: Diploma	Year: Second (2)	Semester: Fourth (IV)
Subject: Biotechnology		
Couse Code: B10 0404 P	Course Title: IPR, Biosafety and Bioethics Lab	
Course Outcomes		
After completion of this course , students will be able to:		
<ul style="list-style-type: none"> • Understand methods of filing Indian patent • Understand the planning of establishing a hypothetical biotechnology industry in India . • Understand the women health ethics 		
Credits: 2	Core Compulsory	
Maximum Marks: 100 (75(UE)+25(CIE))	Minimum Passing Marks: As per University norms	
Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 0-0-4		
	Topic	No. of Lectures
	1. Proxy filing of Indian Product patent 2. Planning of establishing a hypothetical biotechnology industry in India 3. A case study on clinical trials of drugs in India with emphasis on ethical issues. 4. Case study on women health ethics. 5. Case study on medical errors and negligence. 6. Case study on handling and disposal of radioactive waste	60

Programme/Class: Diploma	Year: Second (2)	Semester: Fourth (IV)
Subject: Biotechnology		
Couse Code: B1040105T	Course Title: Microbial Deterioration & Its Control	
Course Outcomes		
On the successful completion of the course, student will be able to:		
<ul style="list-style-type: none"> • Concept of microbial food spoilage and microbial deterioration of leather, jute, cotton, paper, paint, wood, metals etc. • Concept of Control of microbial deterioration by various methods. • Concept of bioremediation of environmentally polluted sites by microbes and GEMs. 		
Credits: 4	Core Compulsory	
Maximum Marks: 100 (75(UE)+25(CIE))	Minimum Passing Marks: As per University norms	
Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0		
Unit	Topic	No. of Lectures
I	Microbial deterioration of food – factors (intrinsic and extrinsic), sources of contamination, spoilage of cereals, vegetables and fruits, egg, milk, meat, seafood and their products.	15
II	Microbial degradation of leather, jute, cotton, paper, paint, wood, metals, buildings – process of degradation, bio-chemical reactions involved	15
III	Control of deterioration, preservation techniques, testing methods for presence of contamination in food, water and other products related to human consumption	15

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IV	Bioremediation of contaminated sites due to industrial pollution, oil spills, pesticides, explosives. In situ and ex situ bioremediation techniques, role of genetically engineered microbes in bioremediation	15
Suggested Reading		
<ol style="list-style-type: none"> 1. Biotechnology, U.Satyanarayan. Books and Allied Pvt. Ltd 2. Applied Microbiology, Tata McGraw Hill New Delhi. 3 Horizons of Biotechnology: B.D. Singh : Kalyani publications 4. An introduction to Microbial culture: M .K. Razdan Elsevier publication 5. Biotechnology and genomics: P.K. Gupta 		
Programme/Class: Diploma	Year: Second (2)	Semester: Fourth (IV)
Subject: Biotechnology		
Course Code: B1040106P	Course Title: Microbial Deterioration & Its Control Lab	
Course Outcomes		
After completion of this course , students will be able to:		
<ul style="list-style-type: none"> • Understand methods of filing Indian patent • Understand the planning of establishing a hypothetical biotechnology industry in India . • Understand the women health ethics 		
Credits: 2	Core Compulsory	
Maximum Marks: 100 (75(UE)+25(CIE))	Minimum Passing Marks: As per University norms	
Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 0-0-4		
	Topic	No. of Lectures
	<ol style="list-style-type: none"> 1. Isolation of bacteria & their biochemical characterization. 2. Staining methods: simple staining, Gram staining, spore staining, negative staining, hanging drop. 3. Preparation of media & sterilization methods, Methods of Isolation of bacteria from different sources. 4. Determination of bacterial cell size by micrometry. 5. Enumeration of microorganism - total & viable count. 	60

Bachelor of Science in Biotechnology (NEP)

Third Year/ Fifth Sem

DEGREE IN BACHELOR OF SCIENCE

Programme/Class: Degree	Year: Third (3)	Semester: Fifth (V)
Subject: Biotechnology		
Course Code: B100501T	Course Title: Biostatistics and Bioinformatics	
Course Outcomes		
After completion of the course, students will be able to -		
<ul style="list-style-type: none"> • learn the need of statistical approach, identify the different axiomatic approach. • learn to study the variability of observation. • know effective use of Office package –word, excel, ppt and publisher etc • understand simple calculation usinf excel • understand the basic theories and practicals of common computational tools and databases which facilitate investigation of molecular biology and evolution-related concepts. • critically analyse and interpret results of their studies with the help of bioinfomatical and 		

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biostatistical tools.

Credits: 4

Core Compulsory

Maximum Marks: 100
(75(UE)+25(CIE))

Minimum Passing Marks: As per University norms

Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0

Unit	Topic	No. of Lectures
I	History and introduction to Bioinformatics: <ul style="list-style-type: none">• Introduction and applications of bioinformatics• Data generation; Generation of large scale molecular biology data. (Through Genome sequencing, Protein sequencing, Gel electrophoresis, NMR Spectroscopy, X-Ray Diffraction, and microarray). Applications of Bioinformatics.	7
II	Databases, Data generation, Data storage and retrieval: <ul style="list-style-type: none">• General Introduction of Biological Databases; Nucleic acid databases (NCBI, DDBJ, and EMBL), Protein databases (Primary, Composite, and Secondary).• Specialized Genome databases: (SGD, TIGR, and ACeDB).• Structure databases (CATH, SCOP, and PDBsum)• File Format (Genbank, DDBJ, FASTA, PDB, SwissProt).• Introduction to Metadata and search; Indices, Boolean, Fuzzy, Neighboring search.	8
III	Sequence and Phylogeny analysis: <ul style="list-style-type: none">• Introduction to Sequences, alignments and Dynamic Programming; Local alignment and Global alignment (algorithm and example), Pairwise alignment (BLAST and FASTA Algorithm) and multiple sequence alignment (Clustal W algorithm).• Introduction to BLAST, using it on the web, Interpreting results, Phylogenetic Analysis.• PCR primer designing etc.	8
IV	Searching Databases: <ul style="list-style-type: none">• SRS, Entrez, Sequence Similarity Searches-BLAST, FASTA, Data Submission.• Genome Annotation: Pattern and repeat finding, Gene identification tools.	7
V	Types and Collection of data: <ul style="list-style-type: none">• Primary and Secondary data, Classification and Graphical representation of Statistical data.• Measures of central tendency and Dispersion.• Measures of Skewness and Kurtosis.	7
VI	Probability: <ul style="list-style-type: none">• Definition of probability, Theorems on total and compound probability• Elementary ideas of Binomial, Poisson and Normal distributions.	8

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VII	Sampling: <ul style="list-style-type: none"> • Methods of sampling, confidence level, critical region, testing of hypothesis and standard error, large sample test and small sample test. • Problems on test of significance, t-test, chi-square test • for goodness of fit and analysis of variance (ANOVA) 	8
VIII	Correlation and Regression: <ul style="list-style-type: none"> • Types, Karl-Pearson's correlation, Spearman's Rank correlation, Regression equation and fitting • Main features of regression analysis-simple and multiple regression analysis • Differences between correlation and regression analysis 	7

Suggested Reading

1. Lesk, A. M. (2002). **Introduction to Bioinformatics**. Oxford: Oxford University Press.
2. Mount, D. W. (2001). **Bioinformatics: Sequence and Genome Analysis**. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
3. Baxevanis, A. D., & Ouellette, B. F. (2001). **Bioinformatics: a Practical Guide to the Analysis of Genes and Proteins**. New York: Wiley-Interscience.
4. Pevsner, J. (2015). **Bioinformatics and Functional Genomics**. Hoboken, NJ.: Wiley-Blackwell.
5. Bourne, P. E., & Gu, J. (2009). **Structural Bioinformatics**. Hoboken, NJ: Wiley-Liss.
6. Sharma V. Munjal A. Shanker A. (2018). **A Textbook of Bioinformatics**. (2nd Edition). Rastogi Publication.
7. Choudhuri S. (2014) **Bioinformatics for beginners**. (1st edition) Elsevier.
8. Harisha S. (2019) **Fundamentals of Bioinformatics**. Dreamtech Press
9. Rastogi SC. Mendiratta N. Rastogi P. (2013). **Bioinformatics Methods and Applications Genomics Proteomics and Drug Discovery**. (4th edition). Prentice Hall India Learning Private Limited
10. Ghosh Z. Mallick B. (2008). **Bioinformatics: Principles and Applications**. OUP India

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Programme/Class: Degree	Year: Third (3)	Semester: Fifth (V)
Subject: Biotechnology		
Course Code: B100503P	Course Title: Bioinformatics, Biostatistics Tissue culture Lab	
Course Outcomes (COs)		
Students should be able to -		
<ul style="list-style-type: none"> • apply basic bioinformatics tools for the studies and research in other areas of their biotechnology and microbiology programs, such as finding • gene/protein homologs, designing primers, identifying mutations, etc. • do cleaning, sterilization of laboratory, plastic and glasswares. • prepare different types of culture media for animal and plant cell culture • understand and solve the problems in the area of animal and plant Biotechnology. 		
Credits: 2	Core Compulsory	
Maximum Marks: 100 (75(UE)+25(CIE))	Minimum Passing Marks: As per University norms	
Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 0-0-4		
	Topic	No. of Lectures
	<ol style="list-style-type: none"> 1. An introduction to Computers, MS-Word, MS Excel, MS Power Point. 2. Sequence information resource: Using NCBI, EMBL, Genbank, Entrez, Swissprot/ TrEMBL, UniProt. 3. Similarity searches using tools like BLAST and interpretation of results. 4. Multiple sequence alignment using ClustalW and interpretation of results. 5. Use of gene prediction methods (GRAIL, Genscan, Glimmer). 6. Use of various primer designing and restriction site prediction tools. 7. Use of different protein structure prediction databases (PDB, SCOP, CATH etc.). 8. Exercise to data entry, edit, copy , move etc. using MS EXCEL spreadsheet 9. Computations analysis of biological data by Mean, Median, Mode, S.D., Correlation, regression Analysis, Chi square test, Student test, ANOVA 10. Designing of bar diagram, pi chart, histogram, scatter plots, in EXCEL for presentation of data. 11. Measure of skewness and kurtosis 12. Sterilization techniques: Theory and Practical: Glass ware sterilization, Media sterilization, Laboratory sterilization 13. Sources of contamination and decontamination measures. 14. Preparation of Hanks Balanced salt solution 15. Preparation of Minimal Essential Growth medium 16. Preparation of simple growth nutrient (knop's medium), full strength, half strength, solid and liquid. 17. Preparation of complex nutrient medium (Murashige & Skoog's medium) 18. To selection, Prune, sterilize and prepare an explant for culture. 19. Significance of growth hormones in culture medium. 20. To demonstrate various steps of Micropropagation. 	60

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Programme/Class: Degree	Year: Third (3)	Semester: Fifth (V)
Subject: Biotechnology		
Course Code: B100502T	Course Title: Animal and Plant Biotechnology	

Course Outcomes (COs)

After completion of this course, students will be able to-

- understand the principles, practices and application of animal biotechnology in Transgenesis, Tissue Engineering, and biopharmaceuticals.
- understand the principles, practices and applications of plant biotechnology, transgenic plant generation, plant tissue culture, plant genomics, and genetic transformation.
- understand applications of stem cells and tissues engineering.
- learn different gene delivery methods to deliver foreign gene in plants and animals
- know about different products of transgenic animals, plants and microbes.

Credits: 4	Core Compulsory
Maximum Marks: 100 (75(UE)+25(CIE))	Minimum Passing Marks: As per University norms

Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0

Unit	Topic	No. of Lectures
I	Transgenesis: <ul style="list-style-type: none"> • Introduction to transgenesis. Transgenic Animals – Mice, Cow, Pig, Sheep, Goat, Bird, Insect. • Animal diseases need help of Biotechnology – Foot-and mouth disease, Coccidiosis, Trypanosomiasis, Theileriosis. 	7
II	Gene delivery methods for animals : <ul style="list-style-type: none"> • Viral vectors • Vector less or direct DNA transfer, particle bombardment, electroporation, microinjection & chemical methods, creation of animal models of human diseases. 	8
III	Animal propagation: <ul style="list-style-type: none"> • Artificial insemination, animal Clones. • Conservation Biology – embryo transfer techniques. 	6
IV	Genetic modification in Medicine: <ul style="list-style-type: none"> • Gene therapy, types of gene therapy, vectors in gene therapy, molecular engineering, • Human genetic engineering, problems & ethics • Introduction to Stem Cell Technology and its applications 	8
V	Introduction, Cryo and organogenic differentiation: <ul style="list-style-type: none"> • Types of culture: Seed , Embryo, Callus, Organs, Cell and Protoplast culture. • Micropopagation Axillary bud proliferation, Meristem and shoot tip culture, cud culture, organogenesis, embryogenesis, advantages and disadvantages of micropopagation. 	7

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	<ul style="list-style-type: none"> • Protoplast isolation and fusion, methods of protoplast isolation, Protoplast development, Somatic hybridization, identification and selection of hybrid cells, Cybrids, Potential of somatic hybridization limitations. • Somaclonal variation nomenclature, methods, applications basis and disadvantages 	
VI	In vitro haploid production Androgenic methods: <ul style="list-style-type: none"> • Anther culture, Microspore culture androgenesis • Significance and use of haploids, Ploidy level and chromosome doubling, diploidization, Gynogenic haploids, factors effecting gynogenesis • Chromosome elimination techniques for production of haploids in cereals. 	8
VII	Plant Growth Promoting bacteria: <ul style="list-style-type: none"> • Nitrogen fixation, • Nitrogenase, Hydrogenase, Nodulation • Biocontrol of pathogens • Growth promotion by free-living bacteria. 	8
VIII	Transgenesis: <ul style="list-style-type: none"> • Plant transformation technologies • Agrobacterium tumifaciens infection, basis of tumor formation, features of Ti & Ri plasmids, • mechanisms of DNA transfer, role of virulence genes, use of Ti plasmid as vector, binary vectors • Application of plant transformation for productivity and performance: Herbicides resistance, insect resistance, Bt genes, non-Bt like protease inhibitors, • virus resistance, long shelf life of fruits and flowers 	8

Suggested Reading

1. Razdan, M. K. (2003). Introduction to Plant Tissue Culture. Enfield, NH: Science
2. Chawla, H. S. (2000). Introduction to Plant Biotechnology. Enfield, NH: Science.
3. Smith R(2012). Plant Tissue Culture (3rd Edition) Academic Press.
4. Slater, A., Scott, N. W., & Fowler, M. R. (2008). Plant Biotechnology: an Introduction to Genetic Engineering. Oxford: Oxford University Press.
5. Buchanan, B. B., Gruissem, W., & Jones, R. L. (2015). Biochemistry & Molecular Biology of Plants. Chichester, West Sussex: John Wiley & Sons.
7. Umesha, S. (2013). Plant Biotechnology. The Energy and Resources.
8. Glick, B. R., & Pasternak, J. J. (2010). Molecular Biotechnology: Principles and Applications of Recombinant DNA. Washington, D.C.: ASM Press.
9. Brown, T. A. (2006). Gene Cloning and DNA Analysis: an Introduction. Oxford: Blackwell Pub.
10. Primrose, S. B., & Twyman, R. M. (2006). Principles of Gene Manipulation and Genomics. Malden, MA: Blackwell Pub.
11. Slater, A., Scott, N. W., & Fowler, M. R. (2003). Plant Biotechnology: The Genetic Manipulation of Plants. Oxford: Oxford University Press.

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Programme / Class: Bachelors of Science	Year: Third	Semester: Fifth
Subject: Microbiology		
Course Code: B080503P	Course Title: Experiments in Medical Microbiology & Immunology	

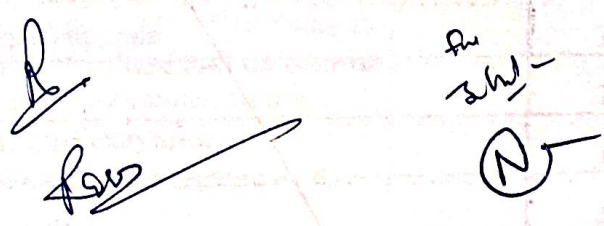
Course outcomes:
 Upon completion of the practical course in medical microbiology and immunology the students will learn about

- The preparation of culture media, microorganisms associated with human body, characterization of microorganisms associated with disease.
- Antigen- antibody interaction
- Learning of the application of antibodies for diagnostic purposes, antibiotic sensitivity test and resistance transfer.

Credits: 2	Core: Compulsory
Max. Marks: 25+75	Min. Passing Marks: as per rules

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:0-0-2**

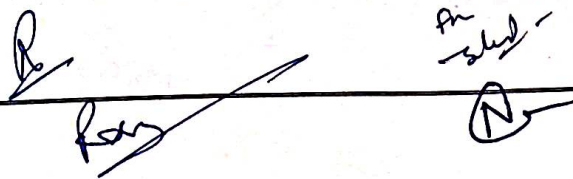
S. No.	Objectives	Total No. of Lectures/ Hours (60)
1	Preparation of chocolate agar, and other media required for medically important microorganisms	6
2	Isolation and characterization of skin normal microflora	6
3	Isolation of bacteria from teeth crevices	6
4	Demonstration of α and β haemolysis on blood agar medium.	8
5	Demonstration of serological tests: blood groups, Rh factor determination, pregnancy test, Widal, VDRL, ELISA	12
6	Demonstration of pathogenic fungi in mycoses lesion	8
7	Antibiotic sensitivity test and MIC determination	6
8	Demonstration of antibiotic resistance transfer from resistant to sensitive microorganism	8



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Bachelor of Science in Biotechnology (NEP)
Third Year/ Six Sem
DEGREE IN BACHELOR OF SCIENCE

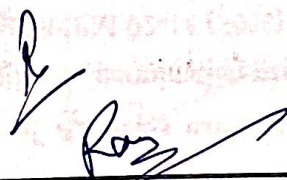
Programme/Class: Degree	Year: Third (3)	Semester: Sixth (VI)
Subject: Biotechnology		
Course Code: B100601T	Course Title: Industrial and Environmental Biotechnology	
Course Outcomes		
<p>After successful completion of the course, student will be able to:</p> <ul style="list-style-type: none"> • understand the problems in isolation, strain improvement and growth of microorganisms in industrial processes. • isolate and improve the industrially important microorganisms. • understand design and types of fermenters and operation of fermenters. • learn fundamentals of Environmental Biotechnology • understand the importance of clean (pollution free) environment • understand biotechnological solutions to address environmental issues including pollution, mineral resource winning, renewable energy and water recycling. • understand the regulation of bioethics and policies of IPR and entrepreneurship. 		
Credits: 4	Elective	
Maximum Marks: 100 (75(UE)+25(CIE))	Minimum Passing Marks: As per University norms	
Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0		
Unit	Topic	No. of Lectures
I	Introduction of Industrial microbiology and Bioprocess technology: <ul style="list-style-type: none"> • History-Introduction, scope and relation with other sciences. • Screening for new metabolites: primary and secondary products. • Strain development through selection, mutations and recombination, and other recent methods 	7
II	Bioprocess technology: <ul style="list-style-type: none"> • Introduction to bioprocess technology. • Design and working of a typical bioreactor • Range of bioprocess technology and its chronological development. • Basic principle components of fermentation technology. Types of microbial culture and its growth kinetics– Batch, Fedbatch and Continuous culture. 	9
III	Production of alcohols, antibiotic and enzymes: <ul style="list-style-type: none"> • Production of alcohols (Ethanol) and organic acids (citric and acetic). Production of biologically active compounds: antibiotics (penicillin) and enzymes (amylase, protease). <ul style="list-style-type: none"> • Production of microbial food and single cell proteins • Bioreactor for immobilized cells/enzyme system • Biosensors and their applications 	9

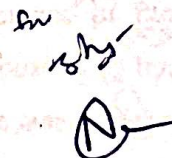


IV	Environment and pollution: <ul style="list-style-type: none"> • Physico-chemical and biological characteristics of environment. • Water, soil and air as a component of environment. • Pollutants: Nature, origin, source, monitoring and their impacts. • Air, Water and Noise pollution • Conventional fuels and their environmental impact 	8
V	Bioremediation: <ul style="list-style-type: none"> • Bioremediation of soil & water contaminated with oil spills, heavy metals and detergents. • Degradation of lignin and cellulose using microbes. Phyto-remediation. • Degradation of pesticides and other toxic chemicals by micro-organisms- degradation aromatic and chlorinated hydrocarbons and petroleum products. 	8
VI	Sewage treatment and biofertilizers: <ul style="list-style-type: none"> • Treatment of municipal waste and Industrial effluents. • Bio-fertilizers: Role of symbiotic and asymbiotic nitrogen fixing bacteria in the enrichment of soil. • Algal and fungal biofertilizers (VAM) 	7
VIII	Bioleaching and genetically modified organisms: <ul style="list-style-type: none"> • Enrichment of ores by microorganisms (Gold, Copper and Uranium). • Environmental significance of genetically modified microbes, plants and animals. 	6
VIII	Bioethics, IPR, Entrepreneurship: <ul style="list-style-type: none"> • Importance of Bioethics, IPR and entrepreneurship • Introduction to Intellectual Property Rights (IPR)- World Intellectual properties, Indian Intellectual properties • Entrepreneurship in India 	6

Suggested Reading

1. Glazier AN and Nikaido H (2007). Microbial Biotechnology – Fundamental & Applied Microbiology – Second Edition. Cambridge University Press.
2. Casida LE (2019) **Industrial Microbiology**. Second Edition, New Age International Publisher.
3. Stanbury P F and Whitaker, A. (2010). **Principles of Fermentation Technology**. Oxford: Pergamon Press
4. Shuler M L and Kargi F. (2002). **Bioprocess Engineering: Basic Concepts**. Upper Saddle River, NJ: Prentice Hall.
5. Crueger W and Crueger A (2002) **Cruegers Biotechnology: A Textbook of Industrial Microbiology**. Third Edition, Panima Publishing Corp., New Delhi.
6. Blanch H W and Clark D S. (1997). **Biochemical Engineering**. New York: M.





Programme/Class: Degree		Year: Third (3)	Semester: Sixth (VI)
Subject: Biotechnology			
Course Code: B100602T		Course Title: Food Biotechnology	
Course Outcomes			
After successful completion of the course, student will be able to:			
<ul style="list-style-type: none"> • Understand the history and evolution of food technology and processing. • Understand the importance microorganisms in food preservation • Learn various food processing and preservation technologies. 			
Credits: 4		Core Compulsory	
Maximum Marks: 100 (75(UE)+25(CIE))		Minimum Passing Marks: As per University norms	
Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0			
Unit	Topic	No. of Lectures	
I	Introduction to Food Biotechnology <ul style="list-style-type: none"> • Historical Background of Food technology • Traditional fermented foods (meat, fish, bread, sauerkraut, soy bean, coffee, cocoa, tea) • Importance, global trends, codex guidelines, nutritional labelling in India, FSSAI guidelines • Improvements through Biotechnology (e.g. Golden Rice, Potato, Flavr Savr Tomato etc.) 	7	
II	Enzymes in Food Industry: <ul style="list-style-type: none"> • Carbohydrases • Proteasase • Lipases • Modification of food using enzymes: • Role of endogenous enzymes in food quality, • Enzymes use as processing aid and ingredients 	8	
III	Food Fermentations: <ul style="list-style-type: none"> • Common fermented foods - Cheese, Butter, Yoghurt, fermented/condensed milk and kefir. • Alcoholic beverages (Beer, Wine, Whisky), • Sauerkraut, Pickles, Soy products, Tea, coffee etc. 	7	
IV	Food preservation: <ul style="list-style-type: none"> • Food adulteration and prevailing food standards in India. • Source of microorganisms in milk and their types. • Microbiological examination of milk (standard plate count, direct microscopic count, reductase and phosphatase test). • Dehydration and pasteurization of milk. 	7	

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V	Value addition products: <ul style="list-style-type: none"> • Value addition products like High Fructose Syrup, Invert Sugars etc. SCPs (e.g. Spirulina, Yeast etc.) as food supplements, • Edible fungus: Mushrooms. Potential of Probiotics. • Flavour enhancers: Nucleosides, nucleotides and related compounds. Organic acids (Citric acid, Acetic acid) and their uses in foods/food products. 	7
VI	Vitamins and Minerals: <ul style="list-style-type: none"> • Importance of Vitamins and their supplementation in foods and feedstock. • Food preservation and storage. Food Processing • Important minerals and their function in body and deficiency conditions • Requirements, allowances, enrichment, restorations, fortifications, losses of minerals, optimization and retention of minerals; 	7
VII	Growth of microorganisms in food: <ul style="list-style-type: none"> • Intrinsic and extrinsic factors. • Food Spoilage (microbial and non-microbial) Control mechanisms of food spoilage: Physical and Chemical. • Microbial spoilage of food and factors affecting them: Spoilage of various kinds of foods: fish. meat, poultry, sea foods, bread and dairy products). • Food adulteration and prevailing food standards in India. • Indicator Microorganisms: As an indicator of good quality 	8
VIII	Food and water borne diseases: <ul style="list-style-type: none"> • Gastroenteritis, Diarrhoea, Shigellosis, Salmonellosis, Typhoid, Cholera, Polio, Hepatitis, Dental Infections, etc. • Food borne intoxications: Staphylococcal, Bacillus, Clostridium etc. • Detection of food-borne pathogens. 	9

Suggested Reading

1. Ray B and Bhunia A. 2008. **Fundamental Food Microbiology**, 4th Ed., CRC press, Taylor and Francis Group, USA.
2. Martin RA and Maurice OM. 2008. **Food Microbiology**, 3rd Ed., The Royal Society of Chemistry, Cambridge, UK.
3. James M J.. 2000. **Modern Food Microbiology**, 6th Ed. Aspen Publishers, Inc., Gaithersburg, Maryland, USA.
4. Frazier WC, and Westhoff DC. **Food Microbiology**. Fourth edition, MacGraw Hills publication
5. Lopez GFG, Canaas G, Nathan EV. **Food Sciences and Food biotechnology**.
6. Adams AR, and Moss MO. *Food Microbiology*. Third edition, Royal Society of Chemistry publishing .
7. Hohn T and Leisinger KM. **Biotechnology of Food Crops in Developing Countries**.

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Programme/Class: Degree	Year: Third (3)	Semester: Sixth (VI)
Subject: Biotechnology		
Couse Code: B100603P	Course Title: Industrial and Environmental Biotechnology Lab	
Course Outcomes		
After completion of this course , students will be able to- <ul style="list-style-type: none"> • understand various methods of screening of industrially important microorganisms from different sources. • understand the working of small scale fermenter and also determine the aeration efficiency of the fermenter • understand the technique of immobilization of cells like yeast and E.coli. 		
Credits: 2	Core Compulsory	
Maximum Marks: 100 (75(UE)+25(CIE))	Minimum Passing Marks: As per University norms	
Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 0-0-4		
	Topic	No. of Lectures
	<ol style="list-style-type: none"> 1. Calculation of bacterial growth curve. 2. Calculation thermal death point (TDP) of a microbial sample. 3. Production and analysis of ethanol. 4. Production and analysis of amylase.. 5. Production and analysis of lactic acid. 6. Isolation of industrially important microorganism from natural resource. 7. Calculation of Total Dissolved Solids (TDS) of water sample. 8. Calculation of BOD of water sample. 9. Calculation of COD of water sample. 10. Bacterial Examination of Water by MPN Method. 	60



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Dept. of Biotechnology
Faculty of Science
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