Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon

||अंतरी पेटवू ज्ञानज्योत||

'A' Grade
NAAC Re-accredited
(4th Cycle)

SYLLABUS

for

First Year

Master of Science (M. Sc.)

Biotechnology

NEP 2020 based curriculum

For

Affiliated Colleges of
Kavayitri Bahinabai Chaudhari North Maharashtra University
Jalgaon 425 001 (MS)

2023 – 2024

Program at a Glance

Name of the program (Degree)	**:**	*M. Sc.*
Subject	**:**	*Biotechnology*
Faculty	**:**	*Science and Technology*
Duration of the Program	**:**	*Two years (four semesters)*
Medium of Instruction and Examination	**:**	*English*
Credits of the program	**:**	*Total 88 credits*
Examination Pattern	**:**	*The 60 : 40 (60 marks University assessment (exam) and 40 marks continuous internal college assessment (exam)*
Evaluation mode	**:**	*CGPA*
Passing standards	**:**	*The 40% in each exam separately (separate head of passing)*
Result	**:**	*As per the University's rules of CGPA system*

Prologue

The requirement for trained and skilled human resource is the need of time in the higher education and industry to match with rapid pace of technology development. Students need to acquire thorough knowledge of theoretical concepts and hands-on laboratory methods in the subject. Thus, it is imperative to revise and update the curriculum to accommodate the fundamental aspects as well as advanced developments in various disciplines of ***Biotechnology*** *and to complement the needs of its applied sectors. The program is designed to provide skilled manpower in this subject, facilitate to improve linkages with industries, and intended to offer practical skills needed to pursue the jobs in a chosen profession. Beside this, the students will be enlightened with knowledge in the newer areas of Bioinformatics, Bioinstrumentations, Biomolecules, Genetics, Immunology, etc. Students are taught how to plan experiments, perform them carefully, analyse the data accurately, and present the results both, qualitatively and quantitatively through their dissertations or the project work. The students are encouraged to deliver seminars on the topics of research to develop presentation skills and enable to build confidence which will lead them to read about different themes and enhances their assimilation abilities. A project component in the final year will enable students to select a research problem, plan to execute experiments related to it, collect data and analyse it, and present the results in the form of an oral presentation as well as a thesis. This not only equips the student for a career in research as well as industry, but also fosters self- confidence and self-reliance in the student as he/she learns to work and think independently. At the end of the programme the student will be well-versed in this subject as well as be familiar with the most recent advances in the field of Life Sciences, and will have gained hands-on experience in this subject of study. The student will be able to take up a suitable position in academia or industry and will be equipped to pursue a career in research or be an entrepreneur, if so desired.*

Process of Curriculum Design

The Choice-Based Credit System (CBCS) provides a framework within which there is flexibility in the design of courses and their content, simultaneously also providing the student a choice of the courses he/she wishes to study. The courses are assigned credits based on teaching hours, which in turn is linked to course content and structure. When revising the syllabi for the courses, the courses to be implemented as well as the content of each course was extensively discussed and debated on, over meetings between the faculty members and the students. Several alumni contributed to useful inputs. Furthermore, the opinions of prospective employers of the corporate sector were also sought and obtained. The opinions of experts were taken into consideration as well. The syllabi presented here are the culmination of the combined efforts of the faculty members, feedback obtained from students, alumni, external experts and members of industry.

The student will acquire knowledge about different branches of Biotechnology such as Genetic Engineering, plant biotechnology, and Microbial Diversity, Molecular Biology, Pharmaceutical Biotechnology and familiar with various applications of Biotechnology such as Applied and Environmental Biotechnology, Industrial Biotechnology, Agricultural Biotechnology and Food Biotechnology. The student can design and execute experiments related to Basic Biotechnology, Molecular Biology, Recombinant DNA Technology, and Microbial Genetics and can execute a short research project incorporating techniques of Basic and Advanced Biotechnology under supervision.

Program Objectives for M.Sc. Program:

1. *To impart the profound theoretical and practical knowledge of the specific science discipline along with the fundamental core concepts*
2. *To train the students to employ modern techniques, tools, methodologies, equipment, hardware/software etc. to perform objective oriented scientific and planned experiments.*
3. *To groom the students for all-round development and mold them in a trained workforce to provide teaching-learning, research, business, professional supports in the various science disciplines.*
4. *To make the student to develop the ability to think analytically, independently and draw logical conclusions to solve real-life problems.*
5. *To utilize the skills and knowledge gained through the subject to deal with real life situations and problems related to society, environment, research and development etc.*

Structure of M.Sc. program in Biotechnology

M.Sc. Biotechnology program is of two years duration and is conducted into four semesters. Since inception, the program was mostly student centric. Now in lieu of accreditation standards of NAAC, the university adopted outcome-based education approach. The various courses of the program are designed to include classroom teaching, laboratory work, project, seminars, assignments, etc. Three categories of courses are being offered in this program: (A) Department Specific courses (DSC) (11 theory of which 8

of 4 credits and 3 of 2 credits and 8 practical's of 2 credit each as mandatory courses), (B) Department Specific Elective (DSE) courses (04 theory courses of 4 credits each) and (C) Research Methodology (01 theory course of 4 credits) (D) On Job Training/Field Project/Internship (01 of 4 credits) (E) Research Project of 10 credits. The student is required to accumulate 22 credits each semester, a total of 88 credits, to fulfill the requirements for a M.Sc. degree. Forty percent of the total marks for each course will be awarded through internal assessment. Final examinations for four credit courses will be of three hours duration while examinations for each laboratory- based courses will be held over two days of three hours (incubation based practicals) each or one day of 5-6 hours each. However, there could be certain changes in the number of classes of theory and practicals, ways of teaching either through online or offline mode and even the examination pattern owing to the prevailing situation like pandemic and as per the need by following the rules and regulations.

Duration

The duration of M.Sc. degree program shall consist of two academic years divided in to four semesters. Each Semester consist of 90 working days. Each theory and practical course should be completed in about 60 lectures (2credit theory course should be completed in 30 lectures).

Medium of instruction

The medium of instruction and examination for each course shall be English.

Credit to contact hour

One credit is equivalent to 15 periods of 60 minutes each for theory course lecture. While credit weightage for self-learning based on e-content shall be 50% or less than that for lectures.

Attendance

The student enrolled for M.Sc. biotechnology must have 75% attendance in each course in order to appear for term end examinations, otherwise the candidate may not be allowed to appear for term end examination as per ordinance.

Program specific objectives (M.Sc. Biotechnology):

After completion, the students are expected to understand the:

1. *basic and applied aspects of molecular biology and plant biotechnology, biomolecules and enzymology and applications of basic aspects of microbial diversity.*
2. *principles, working and application of bioinstruments used in learning biotechnology,*
3. *characteristics and significance of bacteria, algae, fungi, viruses, etc*
4. *impact of various groups of microbes on earth atmosphere, human, plant and animal health and technology development,*
5. *structure, properties, pathways, significance and applications of microbial biomolecules,*
6. *basic and applied aspects of Genetic makeup of bacteria, algae, fungi and viruses,*
7. *causes, mechanisms and consequences of defect in gene/genome of microorganisms*

8. *basic concepts of microbial enzymes, enzyme kinetics, regulation of enzyme activity, industrial applications of enzymes, enzyme function in non-aqueous environment.*

M.Sc. (Biotechnology) programme structure

Year	Level	Sem	Mandatory			Elective			RM		OJT/FP/Int		RP		Cumulative credits/sem
			DSC	Credit	T/P	DSE	Credit	T/P	Credit	T/P	Credit	T/P	Credit	T/P	
1	6.0	I	DSC-25	4	T	DSE-5 (A/B)	4	T	4	T	---	---	---	---	22
			DSC-26	2	T										
			DSC-27	4	T										
			DSC-28	2	P										
			DSC-29	2	P										
		II	DSC-30	4	T	DSE-6 (A/B)	4	T	---	---	4	P	---	---	22
			DSC-31	2	T										
			DSC-32	4	T										
			DSC-33	2	P										
			DSC-34	2	P										
Cumulative credit for 1st yr PG				28			8		4		4		--		44
2	6.5	III	DSC-35	4	T	DSE-7 (A/B)	4	T	---	---	---	---	4	P	22
			DSC-36	2	T										
			DSC-37	4	T										
			DSC-38	2	P										
			DSC-39	2	P										
		IV	DSC-40	4	T	DSE-8 (A/B)	4	T	---	---	---	---	6	P	22
			DSC-41	4	T										
			DSC-42	2	P										
			DSC-43	2	P										
Cumulative credit for 2nd yr PG				26			8						10		44
Cumulative credit for PG Prog.				54			16		4		4		10		88

Sem- Semester, **DSC**- Department Specific Course, **DSE**- Department Specific Elective, **T**- Theory, **P**- Practical, **RM**- Research Methodology, **OJT**- On Job Training, **FP**- Field Project, **Int**- Internship, **RP**- Research Project

Details of M.Sc. 1st year (Biotechnology)

Semester I, Level – 6.0

Course	Course Type	Course Code	Course Title	Credits	Teaching Hours/ Week			Marks			
					T	P	Total	Internal		External	
								T	P	T	P
DSC-25	DSC	BT-411	Microbial Diversity	4	4	---	4	40	---	60	---
DSC-26	DSC	BT-412	Biophysics	2	2	---	2	20	---	30	---
DSC-27	DSC	BT-413	Biomolecules and their Metabolism	4	4	---	4	40	---	60	---
DSC-28	DSC	BT-414	Laboratory course based on Microbial diversity and Biomolecules	2	---	4	4	---	20	---	30
DSC-29	DSC	BT-415	Laboratory Course based on Immunology and Enzymology	2	---	4	4	---	20	---	30
DSE-5	DSE	BT-416 (A)	Bioinstrumentation	4	4	---	4	40	---	60	---
		BT-416 (B)	Biostatistics	4	4	---	4	40	---	60	---
RM	RM	BT-417	Research Methodology	4	4	---	4	40	---	60	---
Total Credit for Semester I: 22 (T = Theory: 18; P = Practical:4)											

Semester II, Level – 6.0

Course	Course Type	Course Code	Course Title	Credits	Teaching Hours/ Week			Marks			
					T	P	Total	Internal		External	
								T	P	T	P
DSC-30	DSC	BT-421	Molecular Biology	4	4	---	4	40	---	60	---
DSC-31	DSC	BT-422	Enzymology	2	2	---	2	20	---	30	---
DSC-32	DSC	BT-423	Bioprocess Engineering and Technology	4	4	---	4	40	---	60	---
DSC-33	DSC	BT-424	Laboratory Course based Molecular Biology and Bioinstrumentation	2	---	4	4	---	20	---	30
DSC-34	DSC	BT-425	Laboratory Course based on Bioprocess Technology	2	---	4	4	---	20	---	30
DSE-6	DSE	BT-426 (A)	Immunology	4	4	---	4	40	---	60	---
		BT-426 (B)	Food Biotechnology	4	4	---	4	40	---	60	---
OJT	OJT	BT-427	OJT/FP/Int	4	---	4	4	---	40	---	60
Total Credit for Semester I: 22 (T = Theory: 14; P = Practical:8)											

Details of M.Sc. 2nd year (Biotechnology)

Semester III, Level – 6.5

Course	Course Type	Course Code	Course Title	Credits	Teaching Hours/ Week			Marks			
					T	P	Total	Internal		External	
								T	P	T	P
DSC-35	DSC	BT-511	Genetic engineering	4	4	---	4	40	---	60	---
DSC-36	DSC	BT-512	Advanced environmental biotechnology	2	2	---	2	20	---	30	---
DSC-37	DSC	BT-513	Plant Biotechnology	4	4	---	4	40	---	60	---
DSC-38	DSC	BT-514	Laboratory course based on Plant Biotechnology	2	---	4	4	---	20	---	30
DSC-39	DSC	BT-515	Laboratory course based on Genetic Engineering and Environmental Biotechnology	2	---	4	4	---	20	---	30
DSE-7	DSE	BT-516 (A)	Agricultural Biotechnology	4	4	---	4	40	---	60	---
		BT-516 (B)	Animal Tissue Culture	4	4	---	4	40	---	60	---
RP	RP	BT-517	Research Project	4	---	8	8	---	40	---	60
Total Credit for Semester I: 22 (T = Theory: 14; P = Practical:8)											

Semester IV, Level – 6.5

Course	Course Type	Course Code	Course Title	Credits	Teaching Hours/ Week			Marks			
					T	P	Total	Internal		External	
								T	P	T	P
DSC-40	DSC	BT-521	Industrial and Business Biotechnology	4	4	---	4	40	---	60	---
DSC-41	DSC	BT-522	Bioinformatics	4	4	---	4	40	---	60	---
DSC-42	DSC	BT-523	Laboratory course based on Industrial and Pharmaceutical Biotechnology	2	---	4	4	---	20	---	30
DSC-43	DSC	BT-524	Laboratory course based on Bioinformatics	2	---	4	4	---	20	---	30
DSE-8	DSE	BT-525 (A)	Pharmaceutical Biotechnology	4	4	---	4	40	---	60	---
		BT-525 (B)	Nanobiotechnology	4	4	---	4	40	---	60	---
RP	RP	BT-526	Research Project	6	---	12	12	---	60	---	90
Total Credit for Semester I: 22 (T = Theory:12; P = Practical:10)											

DSC-25

BT-411: Microbial Diversity

Total Hours: 60 **Credits: 4**

Course Objectives	• To understand the ubiquitous nature of microbes to build basic concept • To give basic knowledge on Prokaryotic and Eukaryotic • To provide knowledge on characteristics of various microbes	
Course Outcomes	On completion of this course, the student will be able to: • differentiate various groups of microbes and microbial taxonomy • acquire knowledge on adaptability of extremophiles and microbial diversity • acquaint with the scope of microbiology in different diversified areas	
Unit	**Topic Particular**	**Hours**
Unit-I	Classification of microorganism: the five-kingdom concept of classification, Bacteria: Purple and green bacteria; Cyanobacteria; Acetic acid bacteria; Spirilla; Spirochaetes; Pseudomonads; Lactic and propionic acid bacteria; Mycobacteria; Rickettsia. Archaea: Archaea as earliest Life forms; Halophiles; Methanogens; Hyperthermophilic archaea; Thermoplasma. Eukarya: Algae, Fungi, Slime molds and Protozoa. Viruses: Discovery, classification and structure of viruses (T4 bacteriophage, TMV, Corona).	12
Unit-II	Prokaryotic and Eukaryotic cell structures; Nutritional requirements and nutritional grouping of microorganisms; Different media (simple, complex and defined)- Growth curve; Axenic culture, Synchronous culture, Continuous culture; Effects of physical and chemical factors on microbial growth.	12
Unit-III	Microbes in natural habitats - air, water & soil. Primary and secondary metabolites and their applications; microorganisms and pollution control-bioremediation. Microbial ecology: Biogeochemical cycling, Microbes in marine & freshwater environments, Microbes in terrestrial environment, Microbial interactions.	12
Unit-IV	Bacterial cell wall biosynthesis, Photoautotrophy, Chemolithotrophy, Methylotrophy, Metabolic diversity among micro-organisms: Photosynthesis in microorganisms; Methanogenesis and acetogenesis; Nitrogen fixation; Hydrocarbon transformation	12
Unit-V	Phylogenetic relationships between various genera of microbes, Evolutionary chronometers, New approaches to bacterial taxonomy classification including ribotyping: ribosomal RNA sequencing, FISH assay, Merits and demerits of culture dependent and culture independent methods of assessing microbial diversity. Molecular analysis of bacterial community: Denaturing Gradient Gel Electrophoresis (DGGE), Metagenomics.	12

Recommended Books:	• Microbiology, L.M. Prescott, J.P. Harley and D.A. Klein, 6/e, 2005. McGraw Hill, Boston. • Fundamental Principles of Bacteriology, A.J. Salle, 1999. Tata McGraw - Hill Publishing Co. Ltd, New Delhi. • Medical Microbiology, D. Greenwood, R. Slack & J. Peutherer, 1997. ELST with Chur. Liv., Hong Kong. • Microbial Ecology. Fundamentals and Applications, R. M. Atlas and R. Bartha, 2000. • Microbiology, M.J. Pelzer Jr., E.C.S. Chan and N.R. Kreig, 1993. McGraw Hill Inc., New York. • Microbial Functional Genomics, J.Zhou, D.K. Thomson. Y.Xu. J.M. Tiedje. J.Wiley, 2004.	

DSC-26

BT-412: Biophysics

Total Hours: 30 **Credits: 2**

Course Objectives	• To study various biophysical processes. • To understand the significance of biophysical processes. • To study laws of thermodynamics and bioenergetics.	
Course Outcomes	On completion of this course, the student will be able to: • Understand the concept of acid-base and buffers. • Study various biophysical processes like diffusion, osmosis, viscosity, etc. • Learn energy rich compounds, bioenergetics and laws of thermodynamics.	
Unit	**Topic Particular**	**Hours**
Unit-I	Properties of water in relation to life process: Expansion on freezing, Uniquely high surface tension, Uniquely high heat capacity, High solvent power Concept of Acid and Base: Arrhenius theory, Lewis acid and base, Lowry-Bronsted Theory Acid-Base equilibria in water: Law of Mass Action, Ionisation of water, Equilibrium constant and Ionisation constant of water, Concept of pH Buffers: Concept and definition, Henderson-Hasselbalch equation, Biological buffer systems- Phosphate buffer system, Bicarbonate buffer system	10
Unit-II	Adsorption: Introduction, adsorbent, adsorbate, desorption, comparison between adsorption and absorption, Types of adsorption: physisorption and chemisorption and their comparison, Factors affecting adsorption, Characteristics of adsorption, Applications of adsorption Diffusion: definition, Fick's first law of diffusion, diffusion co-efficient and its significance, types- simple, facilitated, active- primary and secondary diffusion, Rate of diffusion and factors affecting it, Biological importance of diffusion Osmosis: definition, osmotic pressure, mechanism and salient features of osmotic pressure, Definition of osmole, osmolality and Osmolarity, Osmosis and plant cell, Importance of osmosis in medicine and biology	10
Unit-III	Colloids: Introduction and examples, Classification based on physical state, affinity of phases and molecular size, Properties of colloids- general properties, optical property (Tyndall effect), colour, kinetic property (Brownian motion) and electrical properties, Applications of colloids Viscosity: concept, Factors affecting viscosity, Measurement of viscosity, Applications of viscometry, Significance of viscosity in biological systems Surface tension: concept, Factors affecting surface tension,	10

	Measurement of surface tension Thermodynamics: definition, First and second law of thermodynamics, Enthalpy, Entropy, Standard free energy change, Exergonic and endergonic reactions, Redox potential and its measurement	
Recommended Books:	• Frifielder D. (1983), Physical Biochemistry, W. H. Freeman and Co. New York. • Holmes D. J., Peck H. (1983), Analytical biochemistry, academic press, N. Y. • Upadhyay A., Upadhyay K., Nath N. (2016), Biophysical chemistry: Principle and technique, Himalaya Pub. Nagpur. • Wilson K., Walker J. (2010), Principles and techniques of Biochemistry and Molecular Biology, 7th edition, Cambridge University press, UK • Satyanarayana U. (2008), Biotechnology, Books and Allied (P) Ltd, Kolkata. • Powar C.B., Chatwal G.R. (2011), Biochemistry, Himalaya Publishing House, Mumbai • Boyer R. (2002), Modern Experimental Biochemistry, 3rd ed., Pearson Ed., Inc. • Roy R.N. (2001), A Textbook of Biophysics, New Central Book agency (P) Ltd.	

DSC-27

BT-413: Biomolecules and their metabolism

Total Hours: 60 **Credits: 4**

Course Objectives	• To know the structural organization, characteristics and metabolism of biomolecules • To learn microbial metabolic pathways and its enzymatic regulation • To acquire knowledge on transport of solute and energy metabolism and to understand basic aspects of microbial enzyme	
Course Outcomes	On completion of this course, the student will be able to: • acquire knowledge on metabolism of biomolecules and to apply the knowledge to explore applications of various enzymes • familiar with amino acids, proteins, lipids, nucleic acids and enzymes and kinetics of enzyme	
Unit	**Topic Particular**	**Hours**
Unit-I	Definition of metabolism, terminologies of metabolism, functions of metabolism, classical subdivision of metabolism, metabolic pathways, central pathways, catabolism vs anabolism, anaplerotic pathways, secondary pathways, unifying themes of metabolic pathways, regulation of metabolic pathways	12
Unit-II	**Carbohydrates:** Classification, structure, function and properties of sugars, storage polysaccharides and cell walls, Glycolysis, Kreb cycle, gluconeogenesis, HMP shunt and glycogen metabolism. Synthesis of cellulose and starch, Oxidative phosphorylation, Regulation of carbohydrate metabolism.	12
Unit-III	**Lipids:** Classification, nomenclature and structure of fatty acids, triacylglycerols, sphingolipids and phospholipids, waxes, glycolopids and sterols. Activation of fatty acids, Beta-oxidation of fatty acids (even C-atom chain, odd, unsaturated), biosynthesis of fatty acids and triacylglycerols, desaturation of fatty acids, Lipid proteins system, Regulation of lipid metabolism.	12
Unit-IV	**Proteins:** Classification, Primary, secondary, tertiary and quaternary structure of proteins, Sequencing, stabilizing bonds, Ramchandran Plot. Optical and chemical properties of peptides and small proteins. Hydrolysis of proteins. Digestion of protein with the help of various digestive enzymes, catabolism of amino acids (with examples)- transamination (with mechanism), oxidative deamination, transmethylation, decarboxylation, urea cycle, creatine synthesis	12
Unit-V	**DNA:** General structure and functions of purines, pyrimidines, nucleosides, nucleotides; hydrolysis of nucleic acids. Strategies of coiling and supercoiling, concept of linking number, twisting number and writhing number, Forms of DNA, The law of DNA constancy and C-value paradox. Biosynthesis of ribonucleotides (AMP, GMP, UTP, CTP) and deoxyribomucleotides (dADP, dGDP, dCDP, dTMP) and their regulation, purine and pyrimidine degradation	12

Recommended Books:	• Lehninger's Principles of Biochemistry by Nelson DL and Cox MM, CBS Publications, 2000 • Biochemistry by Stryer L. (4th Edition). W.H. Freeman & Co., New York, USA, 1992. • Fundamentals of Enzymology (3rd edition) by Price NC and Stevens L. Oxford University Press, NY, USA, 2000. • Harper's Biochemistry. Ed. Murray RK, Granner DK, Mayes PA and Rodwell VW. Appleton and Lange, Stamford, Connecticut. • Fundamentals of Biochemistry. Ed Voet & Voet JG. John Wiley & Sons, Inc., 1999 • Molecular Biomethods Handbook, R.Rapley & J.M. Walker, 1998. Humana press. • Biochemistry 4th edition, G. Zubay, 1998. Mc Millan Publishing Co. New York. • Fundamentals of Enzymology : Nicholes C. Price and Lewis Stevens, Oxford Univ. Press.	

DSC-28

BT-414: Laboratory course based on Microbial diversity and Biomolecules

Total Hours: 60 **Credits: 2**

Course Objectives	• To familiarize the student in biochemical techniques and learn basic microbial biochemistry • To familiarize in General Microbiology techniques	
Course Outcomes	On completion of this course, the student will be able to: • acquire expertise in basic biochemical techniques. • get knowledge in the analysis and estimation of biomolecules • develop expertise in basic analytical techniques of microbiology.	
Sr. No.	**Topic Particular**	**Hours**
1	Isolation of microorganism by pour plate and streak plate method.	4
2	Determination of viable count from soil sample.	4
3	Gram staining	4
4	Bacterial spore staining	4
5	Measurement of growth by turbidometry.	4
6	Effect of pH, Temperature and Salinity on bacterial growth.	4
7	Biochemical tests for identification of bacteria (Sugar fermentation and IMViC).	4
8	Isolation of mutant by UV-mutagenesis	4
9	Antimicrobial assay by agar diffusion method	4
10	Analysis of water for potability and determination of MPN	4
11	Determination of pka of amino acid.	4
12	Quantitative assay of protein by Lowry/ Biuret method.	4
13	Quantitative assay of sugar by DNSA reagent.	4
14	Determination of Acid and saponification Value of fats	4
15	Quantitative estimation of amino acids.	4
Recommended Books:	• Practical Biochemistry: Principles and techniques (5th Edition) by K. Wilson and J. Walker.Cambridge University Press, Cambridge, 2000. • An Introduction to Practical Biochemistry by Plummer D. (3rd Edition) Tata MacGraw Hill Publisher, 2005. • Laboratory Manual in Biochemistry by Jayaraman J. New Age International (P) Ltd., Publishers, New Delhi, 1999. • Methods in Agricultural Biochemistry (2nd edition) by Sadashivam S and Manikam A. New Age International	

	(P) Ltd, Publishers, New Delhi and Tamil Nadu Agricultural University, • Coimbatore, 1996. • Microbiology – a Laboratory Manual (4th Edition) by Cappuccino JG and Sherman N. Addison Wesley, 1999. • Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation (2nd edition) by Aneja KR. Wishwa Prakashan, New Age International Pvt Ltd., 1996. • Lab Exercise in Microbiology (3rd edition) by Harley JP and Prescott Lm. WCB/Mac Graw Hill, USA, 1996. • Laboratory techniques in Biochemistry and Molecular Biology, Work and Work. • A Biologists guide to Principles and Techniques of Practical Biochemistry by Wilson and Goulding • A Laboratory Manual in General Microbiology by Benson HJ. WCB Wm C, Brown Publishers. • Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation (2nd edition) by Aneja KR. Wishwa Prakashan, New Age International Pvt Ltd., 1996.	

Note: At least 12 experiments should be performed.

DSC-29

BT-415: Laboratory Course based on Immunology and Enzymology

Total Hours: 60 **Credits: 2**

Course Objectives	• To impart hands on training in enzyme kinetics and immunochemical techniques • To familiarize the student with basic immunology and immunodiagnostic tools	
Course Outcomes	On completion of this course, the student will be able to: • undertake enzyme kinetics in industrial application • apply molecular diagnostic and immunodiagnostic techniques.	
Sr. No.	**Topic Particular**	**Hours**
1	Blood Film Preparation and identification of cells.	4
2	Direct agglutination reaction: determination of human blood group antigens	4
3	Determination of RBC count	4
4	Determination of hemoglobin concentration	4
5	Ouchterlony Double diffusion	4
6	Radial immunodiffusion	4
7	Purification of IgG from serum.	4
8	Diagnosis assay for typhoid using Widal test	4
9	Demonstration of ELISA	4
10	Rocket immunoelectrophoresis	4
11	Determination of specific activity, enzyme activity and Turn over number of the given enzyme.	4
12	Effect of substrate concentration on enzyme activity (Determination of Km and Vmax).	4
13	Effector of activator and inhibitor on enzyme activity	4
14	Effect of pH and temperature on enzyme activity	4
15	Enzyme immobilization	4
Recommended Books:	• Immunological techniques, D.M. Weir, 1992. • Current Protocols in Immunology 3 Volumes, Wiley Publications 1994. • Monoclonal Antibodies: Principles and Practice, J. W. Goding, 1983. Academic Press • Vaccines, New Approaches to immunization, F.Brown, R.M.Chanock, KA Lerner, 1986. Cold spring Harborolab. • Topley and Wilson principles of bacteriology, Virology and immunology, G. Wilson, A.Miles, M.T.Paker, 1984.	

	Arnold, Heineman. • Basic and Clinical Immunology, D.P. Stities and J.D. Stobo. • Practical Biochemistry: Principles and techniques (5th Edition) by K. Wilson and J. Walker.Cambridge University Press, Cambridge, 2000. • An Introduction to Practical Biochemistry by Plummer D. (3rd Edition) Tata MacGraw Hill Publisher, 2005. • Experimental Biochemistry: A Student Campanion by Rao BS and Deshpande V. I.K. International Pvt Ltd., New Delhi, 2005. • Laboratory Manual in Biochemistry by Jayaraman J. New Age International (P) Ltd., Publishers, New Delhi, 1999. • Experimental Biochemistry: A Student Campanion by Rao BS and Deshpande V. I.K. International Pvt Ltd., New Delhi, 2005. • Laboratory Manual in Biochemistry by Jayaraman J. New Age International (P) Ltd., Publishers, New Delhi, 1999.	

Note: At least 12 experiments should be performed.

DSE-5(A)

BT-416 (A): Bioinstrumentation

Total Hours: 60 **Credits: 4**

Course Objectives	• To introduce the student to the variety of biophysical and biochemical techniques • To make them familiar with various approaches of analytical techniques	
Course Outcomes	On completion of this course, the student will be able to: • acquire knowledge on basic biophysical and biochemical aspects • learn purification of molecules, analytical tools, electrophoretic separation • learn how to interpret protein mobility on PAGE under native and SDS	
Unit	**Topic Particular**	**Hours**
Unit-I	Principles and Applications of Light, Phase Contrast, Fluorescence Microscopy, Scanning and Transmission, Electron Microscopy, Confocal Microscopy, Cytophotometry and Flow Cytometry. Principle and techniques: Preparative, Analytical Centrifuges, ultracentrifuges, Sedimentation analysis RCF and Density Gradient Centrifugation.	12
Unit-II	Chromatography: introduction, history, concept of distribution coefficient, Modes of chromatography, Classification of chromatography Principle, theory and applications of- Paper chromatography, Thin layer chromatography, Gel filtration chromatography, Ion exchange chromatography, Affinity chromatography, Gas liquid chromatography, Liquid-liquid chromatography (HPLC)	12
Unit-III	Principle of electrophoresis, Migration of an ion in an electric field, Factors affecting electrophoretic mobility Principle, theory and applications of- Paper electrophoresis, Agarose gel electrophoresis, Polyacrylamide gel electrophoresis, SDS-Polyacrylamide gel electrophoresis, 2D electrophoresis, Isoelectric focusing, Capillary electrophoresis, Immunoelectrophoresis	12
Unit-IV	Basic Principles and Instrumentation, working and applications of- Purification of Proteins/ Enzymes, Protein Sequencing Techniques, DNA Sequencing Techniques, RNA Sequencing Techniques, Blotting Techniques Radioactivity: Radioisotopes, Radioactive Decay, GM Counter, Liquid Scintillation counter, Solid Scintillation counters, Auto radiography: Principle and applications.	12
Unit-V	Concept of electromagnetic radiations, electromagnetic spectrum, Laws of absorption- Lambert and Beer Law, Chromophore concept- auxochrome, various chromic shifts Instrumentation, theory and Applications of UV and Visible Spectroscopy, Fluorescence Spectroscopy, Flame spectrophotometry, NMR, ESR, Atomic Absorption Spectroscopy,	12

	X-ray Diffraction, MS, MALDI-TOF, ORD and CD	
Recommended Books:	• Physical Biochemistry: Application to Biochemistry and Molecular Biology – Freilder. • Biochemical Technique : Theory and Practice , Robyt & White • Principle of Instrumental Analysis – Skoog & West • Principle & Technique – Practical Biochemistry 5th Ed. (2000) - Walker J. & Wilson K. • Biophysical Chemistry – Upadhyay & Nath.	

DSE-5(B)

BT-416 (B): Biostatistics

Total Hours: 60 **Credits: 4**

Course Objectives	• To learn basic statistical concepts/methods. • To apply biostatisitcs in biological processes and experiments.	
Course Outcomes	On completion of this course, the student will be able to: • Describe and identify data generated from biological processes and experiments. • Use summary statistics: measures of central tendency, measures of dispersion with their interpretations to explain the data more effectively through graphical tools. • Apply knowledge of correlation, regression analysis and testing of hypothesis to real life data and understand their interpretation.	
Unit	**Topic Particular**	**Hours**
Unit-I	• Introduction to Biostatistics, definition of Biostatisitics, development of Biostatistics, Applications of Biostatisitics, role of Biostatistics. • Definition of statistics, descriptive and inferential statistics, some definitions concerning statistics inference • Types of Data: qualitative and quantitative data; nominal and ordinal data; discrete and continuous data; frequency and non-frequency data, Different types of scale - nominal, ordinal, ratio and interval.	12
Unit-II	• Analysis of univariate Quantitative Data: Concepts of central tendency or location, dispersion, skewness and kurtosis, measures of dispersion: range, quartile deviation, variance, standard deviation. • Analysis of bivariate Data: measures of association, correlation. • Presentation of Data: construction of tables with one or more factors of classification, diagrammatic and graphical representation of non-frequency data, frequency distributions, histogram. • Graphical presentation of data through bar graph, line graph, pie chart, histogram, dot plot, box-plot, multiple line/bar graphs etc.	12
Unit-III	• Bivariate data: scatter diagram, coefficient of determination, rank correlation:Spearman's rank correlation coefficient. • Meaning and concept of regression, fitting of simple linear regression and quadratic regression in single predictor variable. • Multivariate data: multiple regression, coefficient of determination, R-square and its interpretation, testing significance of predictor variables.	12

Unit-IV	• Introduction of methods of sampling. • Statistical hypothesis, problem of testing of hypothesis, simple and composite hypothesis, types of errors, p-value, conclusions in hypothesis testing. • Statistical tests: one sample t-test, paired t-test, test for proportions, chi-square test for testing independence/association of attributes. • Design of experiments: introduction to basic terms of design of experiments, standard designs: Completely Randomized Design (CRD), Randomized Block Design(RBD), concept of ANOVA, F-test in ANOVA, interpretation of results from ANOVA.	12
Unit-V	Exercise based learning of statistical methods (Emphasis on examples from Biological Sciences) • Graphical Representation of data • Measurements of Central Tendency & Dispersion • Distributions Binomial Poisson Normal • Statistical tests: student t, F, and Chi-square • Basic statistical designs	12
Recommended Books:	• Le C. T., Eberly L. E., (2016), Introductory Biostatistics, 2nd edition, Wiley, USA. • Motulsky H., (2010), Intuitive Biostatistics, 2nd edition, Oxford University Press, UK. • Rosner B., (2016), Fundamentals of Biostatistics, 8th edition, Cengage Learning, USA. • Arora P.N., Malhan P.K. (2008), Biostatics, latest edition, Himalaya publishing house, Nagpur. • Khan I.A. and Khanum A. (2008), Fundamentals of Biostastistics, 3rd edition, Ukaaz-Publication, Hyderabad. • Jin Xiong, (2007), Essentials of Bioinformatics, first edition, Cambridge university press, USA. • Daniel W.W., (2006), Biostatistics, 7th edition, Wiley Dreamtech India (P) Ltd, New Delhi	

RM

BT-417: Research Methodology

Total Hours: 60 **Credits: 4**

Course Objectives	• To learn the basics of science, scientific research its importance. • To learn the Ethics and plagiarism precautions to be taken while doing research. • To understand the detailed referencing and literature review procedure before beginning the research. • To understand the process of writing research papers, research project report and research proposal. • To learn various advanced tools useful for the science and aware about the laboratory safety.	
Course Outcomes	On completion of this course, the student will be able to: • Understand the basic concept of science and scientific research. • Learn and follow the ethical guidelines while doing research avoid plagiarism in research publications. • Write a comprehensive literature review on a given research topic. • Write a crisp research proposal or research project independently. • Learn most advanced chemistry tools for the efficient research work. • Acquire knowledge about various hazardous chemical handling procedures and implement it while working in the laboratory.	
Unit	**Topic Particular**	**Hours**
Unit-I	**Science and Scientific Research** What is Science? Characteristics of Science, Technology and techno-science, Meaning of Research, Characteristics and types of research, Importance of research activities, Principles of quality research work, Problems in research, Scientific attitude and temper, Qualities of good researcher, Scientific community, Non-science and Pseudoscience,Scientific realism.	12
Unit-II	**Design and Criteria of Scientific Research** Introduction, Research planning and design, Selection of research topic, Criteria for good research problem, Source of research Idea, Principles of good research, Criteria of good research, Guidelines for research skill and awareness, Research validity and reliability, Artefact and bias in research. **Scientific methodology:** Rules and principles of scientific methods, Research methods versus methodology, Hypothesis and testing of hypothesis. Research ethics: Principles and values. Plagiarism: its types and how to avoid it.	14
Unit-III	**Literature Survey** Literature review, Approaching the literature, Scholarly literature, Data provenance and evaluation, Intellectual property. **Sources of information:**Primary, Secondary, Tertiary sources, Patents, Journals (Print and e-journal),Type of Journals, Conference Proceedings. Journal Impact Factor, Citation index, *h*-index.	14

	Understanding of literature: Reading A Scientific Paper, Abstracts, Current titles, Reviews, Monographs, Books, Current contents, Cross referencing, Indian patent database. **Tools for Digital Literature Survey:** Scientificdatabases, e-journals, INFLIBNET, Shodsindhu, Shodhganga, Google/Google Scholar, ResearchGate, PubMed, finding and citing Information.	
Unit-IV	**Scientific Writing** Introduction to scientific writing, writingscience laboratory Notebook.**Writing Research Paper:** Title, Abstracts, Keywords, Introduction, Material and Methods, Results and discussion, Conclusion, Acknowledgement, References and Supplementary data. Difference between research communication and Review article, Reply to Referee comments for science research paper. Preparation of Poster and Oral Presentation **Writing Proposals:**Research grant and its variouscomponents	12
Unit-V	**AdvancedScientificTools and Laboratory Safety** A) **Advanced Tools:** Tools for citing and referencing: Mendeley,Zotero, Endnote etc. **Styles of referencing:**Referencing from reputed publishing houses National and International. **Online searching Databases**: *SciFinder*, *Scopus, Web of Science, ACM Digital Library, ProQuest Biological Sciences (All the databases only introduction).* **B) Laboratory Safety** Laboratory safety, Laboratory manual, Lab as a safe place: habits, Cause of accidents and What to do in case of an accident, Personal protective equipment, Emergency equipment for general purpose.Laboratory ventilation.	08
Recommended Books:	• Research Methodology for Scientific Research, K. Prathapan, I.K. International Pvt. Ltd., New Delhi – 110002, (2019). • Research Methodology: The Aims, Practices and Ethics of Science, Peter Pruzan,Springer International Publishing (2016). • Research Methodology: Methods and Techniques, 3rdedition, Kothari, C.R. Published by New Age International (P) Ltd., Publishers (2004). • Teaching to Avoid PlagiarismHow To Promote Good Source, Diane Pecorari, Use-Open University Press (2013). • APPENDIX A: The Literature of Organic Chemistry March'sAdvanced Organic Chemistry: Reactions, Mechanisms, and Structure, Seventh Edition, by Michael B. Smith and Jerry March Copyright John Wiley & Sons, Inc. (2013). • Joaquín Isac-García, José A. Dobado, Francisco G. Calvo-Flores, Henar Martínez-García - Experimental Organic Chemistry laboratory manual, Academic Press (2016)	

	• A Practical Guide to Scientific Writing in Chemistry Scientific Papers, Research Grants and Book Proposals Tyowua, A. T., CRC Press is an imprint of Taylor & Francis Group, LLC (2023). • Chemical Information for Chemists: A Primer, edited by Currano, J. N., Roth, D. L. Publisher The Royal Society of Chemistry (2014). • Handbook of Safety in Science Laboratories Education Bureau Kowloon Tong Education Services Centre, Hong Kong (2013). • A Manual for Referencing Styles in Research, M. H. Alvi(2016) • https://academic.oup.com/pages/authoring/books/preparing-your-manuscript/referencing-styles • https://revvitysignals.com/products/research/chemdraw • LaTeX Beginner's Guide, Stefan Kottwitz, Packt Publishing, http://static.latexstudio.net/wp-content/uploads/2015/03/LaTeX_Beginners_Guide.pdf • Falagas, M.E., Pitsouni, E.I., Malietzis, G.A. and Pappas, G. (2008), Comparison of PubMed, Scopus, Web of Science, and Google Scholar: strengths and weaknesses. The FASEB Journal, 22: 338-342. https://doi.org/10.1096/fj.07-9492LSF • Plagiarism, Citation and Referencing: Issues and Styles, A Manual for Referencing Styles in Research, Mohsin Hassan Alvi, DOI: 10.13140/RG.2.1.5149.6408 http://bit.ly/46nFwYi • Citation tools: Easing up the researchers' efforts, Dhiraj Kumar, Gyankosh: The Journal of Lib. & Info. Management Vol 4 No. 2 Jul-Dec, 2013 • Citation Management:How to use citation managers such as EndNoteand Zotero. • URL:https://guides.lib.uchicago.edu/citationmanagement • https://pubs.acs.org/doi/full/10.1021/acsguide.40303 • https://edu.rsc.org/resources/how-to-reference-using-the-rsc-style/1664.article • https://www.springer.com/gp/authors-editors/journal-author/journal-author-helpdesk/preparation/1276 • https://service.elsevier.com/app/answers/detail/a_id/28224/supporthub/publishing/ • EndNote: A comprehensive guide to the reference management software EndNote. URL: https://aut.ac.nz.libguides.com/endnote • Zotero: Learn how to use the reference management software Zotero. URL: https://aut.ac.nz.libguides.com/zotero	

	• Mendeley: Learn how to use the reference management programme Mendeley. URL: https://aut.ac.nz.libguides.com/mendeley • Grammarly User Guide, • https://bpb-ap se2.wpmucdn.com/blogs.auckland.ac.nz/dist/3/316/files/2020/02/Grammarly-Manual-Feb-2020-1.pdf • Online Resources: Publishers, Chemical Societies, Electronic Journals etc.: https://www-jmg.ch.cam.ac.uk/data/c2k/cj/ • https://scholar.google.com/ • https://shodhganga.inflibnet.ac.in/ • https://patents.google.com/ • https://ipindia.gov.in/history-of-indian-patent-system.htm • https://www.cas.org/about-us • https://clarivate.com/products/scientific-and-academic-research/research-discovery-and-workflow-solutions/webofscience-platform/ • https://www.mendeley.com/guides	

DSC-30

BT-421: Molecular Biology

Total Hours: 60 **Credits: 4**

Course Objectives	• To extend the knowledge on structure and functions of genetic material • To introduce genome organization, transcription and translation process in Prokaryotes and Eukaryotes and study various tools to understand molecular mechanisms.	
Course Outcomes	On completion of this course, the student will be able to: • receive elaborate knowledge on nucleic acids and molecular mechanisms in Prokaryotes and Eukaryotes • understand gene expressions and signal sequences in Prokaryotes and Eukaryotes	
Unit	**Topic Particular**	**Hours**
Unit-I	Concept of Gene, Nature of Gene, Gene cistron relationship in Prokaryotes and Eukaryotes, DNA Replication machinery in Prokaryotes and its comparison with Eukaryotes, Replication fork, fidelity of replication, Enzymes involved in replication: DNA Polymerase; Primases; Ligases; Helicases; Topoisomerases; Gyrases and Single Stranded Binding Proteins. Molecular methods of DNA replication, Models of replication, theta mode of replication, rolling circle model of replication, unidirectional replication, Bi directional replication, replication of linear DNA. Regulation of DNA replication.	12
Unit-II	Types of DNA damage: deamination, oxidative damage, alkylation, pyrimidine dimmers DNA mutations: spontaneous and inducible and mutagenic agents DNA repair pathways: methyl directed mismatch repair, very short patch repair, nucleotide excision repair, base excision repair, recombination, SOS system	12
Unit-III	Transcription in prokaryotes: Initiation, elongation and termination, Transcription in Eukaryotes, Control of transcriptional termination: Attenuation and antitermination**,** Splicing of RNA, Response Elements, Post-transcriptional Modification	12
Unit-IV	Protein synthesis and processing: Ribosome structure, genetic code, aminoacylation of tRNA, tRNA- identity, aminoacyl tRNA synthetases, formation of initiation complex, intiation factors and their regulation, elongation and elongation factors, termination, translational inhibitors. Post- translational modification of proteins: Types and Significance, Protein targeting, Protein folding.	12
Unit-V	Regulation of gene expression in prokaryotes: Operon concept, induction and repression, Structure and regulation of lactose, arabinose and tryptophan operons. Regulation of gene expression in eukaryotes, Control of gene	12

	expression at transcription and translation level.	
Recommended Books:	• Genes IX Benjamin Lewin • Molecular Biology , turner et al • Cell and Molecular Biology: Concepts and Experiments, Gerald Karp • An Introduction to Genetic Analysis, Griffiths et al • Genome (1999), Brown • Concepts of Genetics, klug and Cummings • Molecular Cell Biology, Lodish et al • Biochemistry and Molecular Biology of Plants (2000), Buchanan • Molecular Biology of the Gene, by James D. Watson, Tania A. Baker, Stephen P. Bell • Alexander Gann (2007), Publisher: Benjamin Cummings; 6th edition • Fundamental Molecular Biology by Lizabeth A. Allison (2007), Publisher: Wiley- Blackwell; 1st edition • Molecular Biology by Robert F. Weaver (2007) Publisher: Mcgraw-Hill College; 4th edition • Cell and Molecular Biology: Concepts and Experiments by Gerald Karp (2007) Publisher: Wiley; 5th edition • Molecular Biology of the Cell by Bruce Alberts, Alexander Johnson, Julian Lewis, and Martin Raff Publisher: Garland Science; 5th edition	

DSC-31

BT-422: Enzymology

Total Hours: 30 **Credits: 2**

Course Objectives	• To accustom students with basics of enzymology. • To attune students with mechanism of enzyme action. • To understand applications enzyme in various fields.	
Course Outcomes	On completion of this course, the student will be able to: • Understand classification and specificity of enzymes. • Learn mechanism of enzyme action and enzyme kinetics. • Study activation and deactivation of regulatory enzymes. • Explore various industrial applications of enzymes	
Unit	**Topic Particular**	**Hours**
Unit-I	Classification and nomenclature of enzymes, Mechanism of enzyme action: concept of active site and energetic of enzyme substrate complex formation. Coenzymes and Cofactors: Structure and function of coenzyme - reactions involving TPP, pyrodoxal phosphate, nicotinamide, flavin nucleotide, coenzyme A and biotin.	10
Unit-II	Enzyme kinetics: Units of enzyme activity, Specific activity of enzyme and Enzyme specificity. Unisubstrate enzyme kinetics; Kinetics of multisubstrate reactions, Derivation of Michaelis Menton equation, L B plot, Significance of Vmax and Km.	10
Unit-III	Allosteric enzymes; Sigmoidal kinetics and their physiological significance; Symmetric and sequential modes for action of allosteric enzymes and their significance Enzyme inhibition: type of inhibition; Competitive, non-competitive and uncompetitive kinetics, Feedback inhibition The preparation of immobilised enzymes –rationale, choice of matrix, methods of immobilization kinetics and their uses, Whole cell immobilization, Immobilized enzymes and their industrial application.	10
Recommended Books:	• Lehninger's Principles of Biochemistry by Nelson DL and Cox MM, CBS Publications, 2000 • Biochemistry by Stryer L. (4th Edition). W.H. Freeman & Co., New York, USA, 1992. • Fundamentals of Enzymology (3rd edition) by Price NC and Stevens L. Oxford University Press, NY, USA, 2000. • Harper's Biochemistry. Ed. Murray RK, Granner DK, Mayes PA and Rodwell VW. Appleton and Lange, Stamford, Connecticut. • Fundamentals of Biochemistry. Ed Voet & Voet JG. John Wiley & Sons, Inc., 1999 • Molecular Biomethods Handbook, R.Rapley & J.M. Walker, 1998. Humana press.	

	• Biochemistry 4th edition, G. Zubay, 1998. Mc Millan Publishing Co. New York. • Fundamentals of Enzymology : Nicholes C. Price and Lewis Stevens, Oxford Univ. Press. • Enzyme Structure and mechanism : Alan Fersht, Reading, USA. • Understanding Enzymes : Trevor Palmer	

DSC-32

BT-423: Bioprocess Engineering and Technology

Total Hours: 60 **Credits: 4**

Course Objectives	• To develop skills to modify, design and operate different types of fermenters and attachments. • To understand and implement various fermentation procedures. • To train students in scale up fermentation operations.	
Course Outcomes	On completion of this course, the student will be able to: • Describe the design and operation of various types of fermenters. • Elaborate the theoretical aspects and practical requirements for the growth of microorganisms in industries and R and D organizations. • Describe the theoretical basis of fermentation technology for industrial applications. • Understand and conduct fermentation process kinetics.	
Unit	**Topic Particular**	**Hours**
Unit-I	Introduction to bioprocesses engineering. Sources of microorganisms: Culture collection centres. Enrichment, isolation, preservation and maintenance of industrial strains. Screening for the desired product: primary, secondary and High-throughput screening. Improvement of strain producing primary and secondary metabolites. Methods used in strain improvement: mutagenesis, protoplast fusion and genetic engineering. Production of recombinant molecules in heterologus system.	12
Unit-II	Designing of stirred tank reactor: Ideal Properties of Bioreactor, Body Construction, Agitator, Types of impellors, Baffles foam separators, sparger, culture vessel, cooling and heating devices. Probes for on- line monitoring. Computer control of fermentation process, Neural network. Measurement and control of process parameters (pH, temperature, cell density, gas and liquid flow). Reactors for specialized applications: Packed bed reactors, Airlift bioreactors, Fluidized bed reactors and Trickle flow reactors.	12
Unit-III	Growth kinetics: Batch, Fed-batch and Continuous culture. Media: Importance of media in fermentation, C and N substrates for industrial media, media formulation and modification. Sterilization of media, reactor and air: Factors affecting sterilization, Batch and Continuous sterilization, Del factor, D and Z value. Development of inoculum for bacterial, yeast and mycelial processes.	12
Unit-IV	Fluid dynamics: Classification of fluids, Fluid flow and mixing, concept of Reynold's number, Rheological properties of fermentation process. Mass transfer of oxygen and heat in the bioreactor: Concept, significance and determination of mass transfer coefficient, factors affecting oxygen availability. Scale-up of the process.	12

Unit-V	Downstream processing: Strategy for recovery, Harvesting of Biomass, Removal of microbial cells and solid matter, foam separation, filtration, centrifugation, cell disruption. Liquid liquid extraction: Solvents used, two-phase aqueous extraction, supercritical fluid extraction. Drying and crystallization. Bioprocess economics. Comparison between SSC and SLC, Factors affecting solid-state fermentations. Safety consideration in downstream processing.	12
Recommended Books:	• Introduction to Industrial microbiology, Cruger-ACS Publication • Industrial microbiology- Casida- ACS Publication • Comprensive Biotechnology Vol III Mooyoung Elsevier Publication • Biochemical Engineering, Aiba *et al* • Biochemical Engineering Fundamentals, Baily and Ollis • Fermentation Biotechnology-Principles, Process and Products(1998), Ward,O.P • Process Engineering in Biotechnology, Jackson A.T. • Bioreaction Engineering Principles, Nielson & Villadson • Industrial Microbiology (1992)4th edition,Prescott & Dunn • Microbial Biotechnology (1998) Glazer & Nikaido • A Text Book of Industrial Microbiology,2nds edition (2002),Cruger and Cruger • Manual of Industrial Microbiology & Biotechnology 2nd edition (1999)	

DSC-33

BT-424: Laboratory Course based Molecular Biology and Bioinstrumentation

Total Hours: 60 **Credits: 2**

Course Objectives	• To accustom students with Techniques in Molecular Biology. • To attune students with separation techniques. • To demonstrate students advanced analytical instruments.	
Course Outcomes	On completion of this course, the student will be able to: • Isolate, amplify and separate DNA and RNA • Separate biomolecules by chromatography and electrophoresis • Handle advanced analytical instruments	
Sr. No.	**Topic Particular**	**Hours**
1	Isolation of genomic DNA from bacteria, animal and plant cells.	4
2	Estimation of DNA by DPA method	4
3	Estimation of RNA by Orcinol method	4
4	Spectrophotometric estimation of protein/DNA	4
5	DNA digestion using restriction endonucleases.	4
6	Amplification of DNA fragment using PCR.	4
7	Isolation of plasmid DNA by using alkaline lysis method.	4
8	Determination of Tm of nucleic acid/Quantitation of DNA	4
9	Transformation of *E. coli*	4
10	Electrophoresis of proteins	4
11	Amino acid separations by paper chromatography	4
12	Separation of lipids by thin layer chromatography	4
13	Ion Exchange and gel filtration column chromatography	4
14	Demonstration of FTIR and AAS	4
15	Demonstration of GC and HPLC	4
Recommended Books:	• Practical Biochemistry: Principles and techniques (5th Edition) by K. Wilson and J. Walker. Cambridge University Press, Cambridge, 2000. • An Introduction to Practical Biochemistry by Plummer D. (3rd edition) Tata MacGraw Hill Publisher, 2005. • Laboratory Manual in Biochemistry by Jayaraman J. New Age International (P) Ltd., Publishers, New Delhi, 1999. • Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation (2nd edition) by Aneja KR. Wishwa Prakashan, New Age International Pvt	

	Ltd., 1996. • Biotechnology: Hand Book by Board N. Asia Pacific Business Press Inc., New Delhi, 2005. • Solid Substrate Cultivation edited by Doelle HW, Mitchell DA and Rolz CE. Elsevier Applied Science, London, 1992.	

Note: At least 12 experiments should be performed.

DSC-34

BT-425: Laboratory Course based on Bioprocess Technology

Total Hours: 60 **Credits: 2**

Course Objectives	• To make students familiar with fermentation process. • To accustom students with Techniques in fermentation technology. • To attune students with microbial screening and isolation techniques.	
Course Outcomes	On completion of this course, the student will be able to: • Screen, isolate and maintain micro-organisms • Carry out fermentation process independently • Analyse various parameters of fermentation process	
Sr. No.	**Topic Particular**	**Hours**
1	Isolation of actinomycetes by enrichment technique	4
2	Isolation of molds and yeasts by suitable technique	4
3	Study of Growth Kinetics of Yeast by turbidometry	4
4	Screening of industrially important microorganisms	4
5	Maintenance of industrially important microorganisms	4
6	Preparation of fungal spore inoculum and spore count.	4
7	Selection of mutants by gradient plate technique	4
8	Preparation of inoculum for mycelia cultures	4
9	Production of the enzyme/s in shake flask/ Batch fermentation in conical flask	4
10	Production of citric acid by fermentation of different carbon sources by *Aspergillus niger*	4
11	Alcohol fermentation using different substrates and its downstream process	4
12	Determination of TDP	4
13	Determination of TDT	4
14	Assay of antibiotic using sensitive bacterial strain	4
15	Demonstration of working of fermenter.	4
Recommended Books:	• Principles of Fermentation Technology by Stanbury PF, Whitaker A and Hall SJ. Aditya Books (P) Ltd., New Delhi, 1997. • Process Biotechnology: Fundamentals (2nd Edition) by Mukhopadhyay SN, Viva Books Pvt Ltd., New Delhi, 2004. • Biotechnology: Hand Book by Board N. Asia Pacific Business Press Inc., New Delhi, 2005. • Solid Substrate Cultivation edited by Doelle HW,	

	Mitchell DA and Rolz CE. Elsevier Applied Science, London, 1992. • Aneja K. R. (2003), Experiments in Microbiology, Plant Pathology and Biotechnology, New Age International Pvt. Ltd.	

Note: Mandatory to perform any 12 practical.

DSE-6(A)

BT-426 (A): Immunology

Total Hours: 60 **Credits: 4**

Course Objectives	• To understand various components of host immune system, its structure and function • To acquaint with operational mechanisms of the host defence system, allergy, GVR	
Course Outcomes	On completion of this course, the student will be able to: • understand fundamental basis of immune system and immune response • apply host defence, allergy, organ transplant and immunological diseases • use various immunochemical techniques for diagnosis of diseases.	
Unit	**Topic Particular**	**Hours**
Unit-I	Innate immune mechanisms and adaptive immune responses, Organs of immune system: Primary Lymphoid Organs, Secondary Lymphoid Organs, Cell of immune system: Hematopoiesis, Mononuclear cells and granulocyte, Antigen presenting cells lymphocytes and their subsets. Antigens, Super antigen, Heptanes, Factor affecting immunogenicity, Immunoglobulins: molecular structures, types and function, Antigenic determinants on immunoglobulins, Antigen-Antibody interactions	12
Unit-II	Major Histocompatibility systems: Structure of MHC I and II molecules, Gene Organization of MHC complex in mouse and humans. Recognition of antigens by T and B cells: Antigen processing, Role of MHC molecules in Antigen presentation and co stimulatory signals. T-Cell receptor complex, T- Cell accessory membrane molecules, activation of T –cells, B-cell receptor complex, activation of B-cells.	12
Unit-III	Complement System, components, Activation pathway and regulation of activation pathway, complement deficiency, Inflammation: its mediators and the process, cell-adhesion molecules and their role in inflammation, lymphocyte homing. Cytokines: Structure and functions, cytokine receptors, therapeutic applications of cytokines.	12
Unit-IV	Hypersensitivity: definition, IgE mediated hypersensitivity, mechanism of mast cell degranulation, mediators of type I reactions and consequences. Type II reactions, immune complex mediated hypersensitivity and delayed type hypersensitivity. Immunodeficiency Syndrome: Primary Immunodeficiencies and Secondary Immunodeficiencies and their diagnosis and therapeutic approaches. Autoimmunity: Organ-specific diseases, systemic disease, mechanism of autoimmunity.	12

Unit-V	Immunodiagnostics: Precipitation techniques, Agglutination, Fluorescence Techniques, ELISA, RIA, Western Blotting, immunoelectrophoresis, Fluorescent activated cell sorter, immunoelectrofocusing, Monoclonal antibodies: production, characterization and application in diagnosis and therapy.	12
Recommended Books:	• Immunology, Richard A. Goldsby, Thomas J. Kindt. Barbara, A. Osborne, Janis Kuby 5th Edition, 2003. W. H. Freeman & Company. • Immunology- A short Course, Eli Benamini, Richard Coico, Geoffrey Sunshine. • Immunology by Tizzard • Fundamentals of Immunology, William Paul. • Immunology, L.M. Roitt, J. Brestoff and D.K. Male • Immunology by Abbas. • Clinical parasitology a practical approach by Zubey • Immunological techniques, D.M. Weir, 1992. • Current Protocols in Immunology 3 Volumes, Wiley Publications 1994. • Monoclonal Antibodies: Principles and Practice, J. W. Goding, 1983. Academic Press • Hybridoma Technology in the Biosciences and medicine, T.A. Springer, 1985. Plenum Press NY. • Vaccines, New Approaches to immunization, F.Brown, R.M.Chanock, KA Lerner, 1986. Cold spring Harborolab. • Topley and Wilson principles of bacteriology, Virology and immunology, G. Wilson, A.Miles, M.T.Paker, 1984. Arnold, Heineman. • Basic Immunology by Arun Ingale, NCBA Publication	

DSE-6 (B)

BT-426 (B): Food Biotechnology

Total Hours: 60 **Credits: 4**

Course Objectives	• To accustom students with basic concepts of Food Biochemistry • To study different types of food adulteration • To study various types of food spoilage and food preservation methods	
Course Outcomes	On completion of this course, the student will be able to: • Calculate energy value of food and its measurement • Explain food adulteration and its types • Understand food spoilage, food allergy and food additives • Discuss various methods of food preservation	
Unit	**Topic Particular**	**Hours**
Unit-I	Nutritive value of different foods: cereals and millets, pulses, nuts and oils, vegetables, fruits, milk and milk products, eggs, meat, fish and other animal foods, fats and oils, sugar and other carbohydrate food, condiments and spices Classification of food based on function: energy yielding, body building and protective food, Five food group plan as per ICMR Energy value of food: carbohydrate, protein, lipid, Energy unit: calorie, kilo calorie, Joule, mega Joule, Physiological energy value of food: loss in digestion and metabolism, Determination of energy value using Bomb calorimeter Respiratory quotient: definition, RQ for carbohydrate, fat and protein, Relation between RQ and energy output, Specific dynamic action of food (SDA), Basal Metabolic Rate: definition, determination, factors affecting BMR, Recommended dietary allowance: definition, factors affecting RDA, RDA for adult man	12
Unit-II	Adulteration: Definition, types- Intentional and incidental, Common adulterants in different foods: Milk and Milk product, vegetable oils, and fats, wheat products, pulses, honey, beverages, spices and condiments, miscellaneous. Food spoilage, factors determining food spoilage- intrinsic, extrinsic modes of processing and preservation, implicit parameters, Micro-organisms involved in food spoilage and food intoxication: bacteria, yeast, molds, and fungi, Food spoilage by enzymes, and insect, Chemical spoilage: lipid oxidation, enzymatic oxidation, lipolysis, discoloration Contamination of food with metals, Parasitic infection, toxicants naturally occurring in some food, insect and rodent contamination of stored food.	12
Unit-III	Food preservation: Concept and principle Methods of food preservation: Preservation by low temperature: freezing, chilling/cold storage/refrigeration, Preservation by high temperature: heating below 100°C (pasteurization), heating at 100°C, heating above 100°C, Preservation by drying:	12

	conventional air drying, microwave drying, osmotic dehydration, freeze drying, mechanical drying, spray drying, foam-mat drying, drying by smoking, Irradiation: Types- radiation sterilization, radurization, radicidation, thermoradiation; ionizing radiation used for food irradiation- electron beam, x-rays, gamma rays and UV; uses of food irradiation, effect of ionizing radiation on nutrients of food, Chemicals: acids and their salts, nitrites, NaCl, sulphites, dimethyl dicarbonate, phenolic antioxidants, phosphate Food laws and standards: Prevention of food adulteration act 1954; Bureau of Indian Standards, Agmark, Consumer protection act 1986, Hazard analysis critical control point (HACCP)	
Unit-IV	Food additives: Concept, importance of food additives, Examples of food additives: antimicrobial agents, antioxidants, colour and adjuncts, emulsifiers, flavor enhancers, enzymes, sweeteners, non-nutritive and nutritive additives, propellants, aerating agents and gases. Food allergy: Concept, classification immediate and delayed allergy. Clinical signs and symptoms, Food as allergen: Animal origin - cow milk, goat milk, egg, fish, meat. Plant origin: cereals, soybean, peanut, other legumes, edible fungi, fats, oils, vegetables, fruits and beverages, Detection of food allergy: history taking, diet diaries, elimination diet, provocative diet, pulse acceleration test, leukopenic index, x-ray, skin testing. Therapeutic diet / diet modification in diseases: Definition and types of therapeutic diet, Concept and significance of balanced diet.	12
Unit-V	Introduction to food packaging, Packaging as a method for preservation of foods; functions of food packaging, levels of packaging, different materials used in food packaging such as paper, board, glass, metal containers, aluminum foil, plastics, composites, traditional materials and their physicochemical characteristics, additives used in packaging materials, packaging applications for various food commodities Packaging materials for newer techniques like radiation processing, microwave and radiowave processing, high pressure processing, CAP/ MAP and thermal processing as retortable pouches, aseptic packaging; biodegradable packaging; active packaging; intelligent packaging; migration; flavor scalping, application of nanotechnology in food packaging, environmental concerns and life cycle assessment	12
Recommended Books:	• Simpson B. K. (2012). Food Biochemistry and Processing, 2nd edition, John Wiley & Sons, Inc. • Michael Eskin N.A., Shahidi F. (2012). Biochemistry of Food, 3rd edition, Academic Press • Yildiz F. (2017). Advances in Food Biochemistry, 1st edition, CRC press. • Brody T. (1998). Nutritional Biochemistry, 2nd edition, Academic Press.	

	• Alais C. (2012). Food Biochemistry, Springer Science & Business Media • Swaminathan M. (1998). Essentials of food and Nutrition. Vol I, II, 2nd edition, The Bangalore Printing and Publishing Co. Ltd. • Srilakshmi B. (2006). Food Science 3rd edition, New Age International Pvt. Ltd Publishers. • Vijaya Ramesh K. (2009). Food Microbiology MJP Publishers. • Mirajkar M. and Menon S. (2010). Food Science and Processing Technology, Vol.2 Commercial Processing and Packaging, Kanishka Publishers. • Swaminathan M. (2018). Handbook of food & Nutrition, The Bangalore Printing and Publishing Co. Ltd. • Satyanarayana U. (2006). Biochemistry, 3rd edition, Chakrapani. U. (ed.) Books and Allied (P) Ltd.	

OJT

BT-427: OJT/FP/INT

Total Hours: 60 **Credits: 4**

Course Objectives	• Introduction of students to the industrial work culture • Introduction of students to the various departments of the industry • To develop professionalism and practical skills among students
Course Outcomes	On completion of this course, the student will be able to: • Understand and work according to industrial work culture • Understand working of various departments of the industry • Perform practical work skillfully and professionally

Students need to complete one month on job training or internship in any industry related to major subject.

Epilogue

Skill imparted:

This is the first-year syllabus of the two-year post-graduate course in Biotechnology. Overall, the curriculum is designed in such way that the student will get basic and applied knowledge of the subject. One of the major objectives considered during designing is to create human resource which is technically sound with knowledge having practical utility. The included basic subjects in theory and practical would be helpful to find out unseen facts in various problems in day to day life. The subjects like genetic engineering, and bioinstrumentation are designed in such a way that students will get theoretical and practical knowledge of modern scientific advances in the field. To make skillful human resource with precision, the important allied courses are also included. This course after completion of 2 years would give not only the practical knowledge of industry and industrial processes but also make aware the students with the global environmental problems like pollutions, contamination, infections and food quality.

Practical courses are based on theory courses and are designed to improve research orientedskills of students.

Job opportunity: *The designed curriculum offers job opportunities in various sectors like,*

- *Pharmaceutical industry: Clinical, medicine, vaccine, QC division*
- *Biotech industry: Recombinant product, QC, QA*
- *Agrochemical & pesticide industry*
- *Chemical industry: synthesis, testing*
- *Environmental protection industry & Agencies*
- *Research leading up to Ph. D. degree*
- *Marketing of biological & pharmaceutical products*
- *Food and nutraceutical industry, Govt. agencies*

Entrepreneurship: *This is another avenue available for the candidates making them sound in technical knowledge of Biotechnology upon completion of this two year post graduate course that could be useful in Entrepreneurship in Biotechnology.*

Equivalence
M.Sc. 1st yr. Biotechnology

Old syllabus AY 2021-22	NEP based syllabus 2023-24
SEM-I	
BT-101: Microbial Physiology and Diversity (T)	**BT-411**: Microbial Diversity (T)
BT-102: Biomolecules and Molecular Enzymology (T)	**BT-413**: Biomolecules and their metabolism (T)
BT-103: Immunology (T)	**BT-426(A):** Immunology (T)
BT-104: Laboratory Course-I (P)	**BT-414:** Laboratory course based on Microbial diversity and Biomolecules (P)
BT-105: Laboratory Course-II (P)	**BT-415:** Laboratory Course based on Immunology and Enzymology (P)
SEM-II	
BT-201: Molecular Biology (T)	**BT-421**: Molecular Biology (T)
BT-202: Bioinstrumentation and Biostatistics (T)	**BT-416 (A)**: Bioinstrumentation
BT-203: Bioprocess Engineering and Technology (T)	**BT-423**: Bioprocess Engineering and Technology (T)
BT-204: Laboratory Course-III (P)	**BT-424**: Laboratory Course based Molecular Biology and Bioinstrumentation
BT-205: Laboratory Course-IV (P)	**BT-425**: Laboratory Course based on Bioprocess Technology

AY: Academic Year, (T) : Theory, (P): Practical