SHRI GURU RAM RAI UNIVERSITY

[Estd. by Govt. of Uttarakhand, vide Shri Guru Ram Rai University Act no. 03 of 2017 & recognized by UGC u/s (2f) of UGC Act

1956]

DEPARTMENT OF MICROBIOLOGY

SCHOOL OF BASIC & APPLIED SCIENCES

SHRI GURU RAM RAI UNIVERSITY

Bachelor of Science (Hons.) in Microbiology

OR

Bachelor of Science (Hons.) with Research in Microbiology

Based on NEP 2020

[Exit Options after completion of 01 Year, 02 Years, 03 Years, and 04 Years]

Effective from the Academic Session

2025-2029

VISION AND MISSION- DEPARTMENT OF MICROBIOLOGY

Vision: Our vision is to cultivate a new generation of microbiologists who are innovative leaders in scientific research and societal advancement. We strive to empower students with the knowledge and skills to address global challenges such as infectious diseases, food security, and environmental sustainability. By promoting interdisciplinary collaboration and responsible research, we aim to contribute to a healthier and more sustainable world.

Mission: The mission of the Microbiology course is to provide students with a comprehensive understanding of microbial life and its impact on the environment, human health, and industry. We aim to foster critical thinking, analytical skills, and a commitment to ethical research practices. Through hands-on laboratory experiences, students will develop practical skills essential for careers in research, healthcare, and Microbiology.

C U R R I C U L U M

B. Sc Microbiology GRADUATE/ B. Sc Microbiology HONORS/B. Sc. Microbiology with RESEARCH DEGREE PROGRAMME
(2024-28 Onward)

1. Nomenclature:
There will be a full-time Biotechnology Degree Programme named as B. Sc. Microbiology (three full academic years), B.Sc. (Hons.) Microbiology (four full academic years) and B.Sc. Microbiology with Research (four full academic years). The duration of this programme shall be three years/four years (three/four full academic years), which shall be divided into six semesters/eight semesters. Each semester will be six. months. Actual teaching in each semester requires a minimum of 90 days. The examination for the first, third, fifth, and seventh semesters will normally be held in the month of December, and for the second, fourth, sixth, and eighth semesters in the month of May or as convenient to the University.

2. The Medium of Instruction:

The medium of Instruction will be English.

3. The Medium of Examination:

The medium of examination will be English.

4. Intake: The intake to B. Sc. (Hons.) The Microbiology course has 40 students. It may increase or decrease as per the provisions of the University.

5. Eligibility to apply for Admission:

No candidate shall be eligible for admission to three years/four years Full Time B. Sc. Microbiology (three full academic years), B.Sc. (Hons.) Microbiology (four full academic years) and B.Sc. Microbiology with Research (four full academic years) unless he/she has completed higher secondary or Intermediate (with any biological/mathematical/science subject) with the prescribed number of credits or percentage through the examinations conducted by a National/State Board. Such qualifications as are recognized by the University. Any candidate who has passed the plus two of the higher secondary board of Examinations in any state recognized as equivalent to the plus two of the Higher Secondary Board in with not less than 45 % marks in aggregate is eligible for admission, However, SC/ST, OBC and other eligible communities shall be given relaxation as per University rules.

Duration of the Programme:**3/4 Years**

6. Selection Procedure for Admission: A candidate willing to seek admission to B. Sc. Microbiology (three full academic years), B.Sc. (Hons.) Microbiology (four full academic years) and B.Sc.

Microbiology (with Research (four full academic years) will have to appear in the written entrance Test conducted by the University or on behalf of the University, and followed by the counseling as per

University norms. The selection for admission will be made on a merit basis or as per University norms.

7. Semesters:

(a) An academic year shall consist of two semesters:

Odd Semester (I, III, and VII Semesters): generally July to November/December

Even Semester (II, IV, VI, and VIII Semesters): generally, January to May/ June

The academic calendar for each semester shall be notified well before the commencement of the semester by the Dean, School of Basic and Applied Sciences.

(b) A semester shall normally extend over a period of 15 weeks. Each week shall have 30 hours of instruction, including lab/ field work as applicable.

8. Credits:

(a) Credit defines the quantum of contents/ syllabus prescribed for a course and determines the number of hours of instruction required per week. Thus, credits shall be assigned on the basis of the number of lectures/tutorials/laboratory work/ project work and other forms of learning required to complete the course contents in a 15-week schedule.

(b) 1 Credit = 1 hour of lecture for theory and 1 Credit = 2 hour of laboratory for practicals.

(c) Motivate students with an industrial visit, educational trip, seminar/conference during the semester.

9. Roll Numbers and Enrollment Numbers:

The University shall allot a Roll Number to the students after payment realization, thorough scrutiny/ verification of the required documents for the course. After the completion of the admission procedure, the enrolment number for the students shall be allotted by the University at the entry point, which shall remain the same for the entire period of study in the University.

10. The Credit-Based Course Structure: B. Sc (Hons.) Microbiology and B. Sc. (Hons.) Microbiology with Research-Three-Year/Four-Year Program- Choice-Based Credit System (CBCS)

B. Sc Microbiology (three full academic years), B.Sc. (Hons.) Microbiology (four full academic years) and B.Sc. (Hons.) The Microbiology with Research (four full academic years) program shall be based on the choice-based credit system in which credit defines the quantum of content/ syllabus prescribed for a course system and determines the number of hours of instruction per week.

Total Credits:

A. 64 (DSC/ MC)+ 16 (DSE/ME)+ 16 (GE/OE)+ 08 (VA/VAC)+ 12 (SEC)+ 08 (AEC)+ 6 (Minor Project/Educational of Tour) =130 (For three years B. Sc. Microbiology)

B. 130 (For three years B. Sc. Microbiology) + 16 (DSC/MC) + 8 (DSE/ME) + 08 (OE)+ 12 (Project)=

C. 174 (For four years B. Sc. (Hons.) Microbiology)

D. 130 (For three years B. Sc. Microbiology) + 12 (DSC/MC) + 19 (Research Project) + 13 (Dissertation)=174 (For four years B. Sc. (Hons.) Microbiology with Research)

E. Were,

a. DSC/MC=Discipline Specific Core/ Major Core

b. DSE/ME= Discipline Specific Elective/Major Elective

c. GE/OE= Generic Elective/Open Elective

d. VA/VAC= Value Added/Vocational

e. SEC= Skill Enhancement Course

f. AEC= Ability Enhancement Course

F. Undergraduate degree programs of either 3 or 4-year duration, with multiple entry and exit points and re-entry options within this period, with appropriate certifications such as:

1. **a certificate after completing 1 year (2 semesters) of study in the chosen fields of study,**
2. **a diploma after 2 years (4 semesters) of study,**
3. **a bachelor's degree after a 3-year (6 semesters) programmed of study,**
4. **a bachelor's degree with honours after a 4-year (eight semesters) programs of study or a bachelor's degree with research after a 4-year (eight semesters) programe of study if the student completes a rigorous research project in their major area(s) of study.**

G. Remote/blended learning modes: Options will be available for students to earn credit by completing quality-assured remote learning modes, including online programmed offered on the Study Webs of Active Learning for Young Aspiring Minds (SWAYAM: www.swayam.gov.in) or other online educational platform approved by the competent body from time to time. Students may opt to earn credits from such courses up to 40 per cent of the total credits required for the award of a certificate/Diploma/Degree.

11.Student Advisor:

Every student shall have a teacher of the Department as his/her student advisor. All teachers of the department shall function as student advisors and will have more or less equal number of students with

them. The student advisor will advise the students in choosing elective courses and offer all possible student support services.

12.Attendance:

a. The teacher handling a course shall be responsible for maintaining a record of attendance of students

B. who have registered for the course.

All teachers shall intimate the Head of the Department at least seven calendar days before the last instruction day in the semester, the particulars of all students who have less than 75% attendance in one or more courses.

b. A candidate who has less than 75% attendance shall not be permitted to sit for the end-of-semester examination in the course in which the shortfall exists. However, it shall be open to the Dean/ HOD to grant exemption to a candidate who has failed to obtain the prescribed 75% attendance for valid reasons on payment of the prescribed fee, and such exemptions shall not under any circumstances be granted for attendance below 65%.

c. A candidate who fails to put in at least 75% attendance in I semester shall not be allowed to pursue the studies in the next semester. Such candidates may apply to the Dean/HOD for re-registration in the II semester in the next academic session.

Note: The Rest of the provisions will be as framed by the University.

13. Fee and Resource Generation

As per decision of the University.

14. Examination and Evaluation

(a) Evaluation will be done on a continuous basis. Three times during each semester. For the purpose of uniformity, there will be a uniform procedure of examination to be adopted by all teachers. There will be two sessional tests (Three if any student are unable to attend any sessional test) and one end-semester examination.

(b) Sessional tests (of one to two hours duration) may employ one or more assessment tools such as objective tests, assignments, paper presentation, laboratory work, etc suitable to the course. This requires an element of openness. The students are to be informed in advance about the nature of assessment. It will be obligatory for the Students to attend the both Sessional tests, failing which they will not be allowed to appear in the concerned semester examination. The sessional test as part of the continuous internal assessment shall be conducted and evaluated by the teacher offering the course. A Student cannot repeat

sessional tests (without permission from HOD). However, if for any compulsive reason the student could not attend the test, the prerogative of arranging a special test lies with the teacher with the approval of the Head of the Department. In case of students who could not attend any of the sessional tests due to medical reason or under extraordinary circumstances, a separate test shall be conducted before the concerned semester examinations by the concerned faculty member after the approval of the Head of the Department and the Dean concerned.

(c) The sessional tests will carry 30% of total marks for the course. The marks of the two Sessional Tests shall be taken into account for the computation of Grades.

(d) There shall be a written end-of-semester examination, which shall be of 2/3 hours duration, carrying 70% of the total marks assigned for the course, covering the entire syllabus prescribed for the course.

(e) The end-of-semester practical examinations (field tour report, project report, and training report) shall normally be held before the theory examination/or as per the convenience by the Department. The internal faculty shall associate themselves with the examination process.

Basic Structure of UG Single Core Discipline Program –

B.Sc. (Hons.) in Microbiology or B.Sc. (Hons.) with Research in Microbiology

Type of Course
Discipline Specific Core (DSC)
Discipline Specific Elective (DSE)
General Elective (GE)
Ability Enhancement Courses (AEC)
Skill Enhancement Course (SEC)
Internship/Apprenticeship / Project/ Community Outreach (IAPC)
Value Addition course (VAC)

OUTCOME BASED EDUCATION

Programme outcomes (POs)

Students will be able to

PO 1	Knowledge of Microbiology and Applied Sciences Students possess foundational knowledge in Microbiology, Biochemistry (including Biomolecules), Plant Biotechnology, Environmental Science, Chemistry, and General Biology (Botany and Zoology). They are able to understand the applicability of these disciplines and effectively correlate them with natural phenomena.
PO2	Problem Analysis Students should be able to identify, articulate, and analyse problems related to Applied Microbiology, as well as those concerning basic and natural sciences.
PO3	Design and Development of Solutions Students will be able to design and develop solutions to common problems in Applied Sciences (particularly Microbiology), with the goal of enhancing public and environmental health outcomes.
PO4	**Modern Tool Usage** Students will be able to identify, select, and apply appropriate modern techniques, tools, and resources to effectively understand and explore concepts in Microbiology.
PO6	**Project Management, Laboratory Practices, and Communication** Students acquire essential skills in handling scientific instruments, planning and executing laboratory experiments, and adhering to good laboratory practices. They develop the ability to communicate effectively on complex Microbiology-related activities with the scientific community and society at large. This includes comprehending and composing well-structured reports and technical documentation, delivering impactful presentations, and exchanging clear and concise instructions.
PO7	**Future Prospects, Individual and Team Work** Upon completing this course, students will have the opportunity to pursue higher studies such as an M.Sc., engage in research for the betterment of society, or prepare for competitive examinations. They will also be equipped to function effectively both as individuals and as members or leaders of diverse, multidisciplinary teams, leveraging their knowledge of Microbiology.
PO8	**Life-long and Interdisciplinary Approach to Learning** Students will recognize how advancements in any area of Biotechnology contribute to the progress of other scientific disciplines, and vice versa. They will appreciate the value of interdisciplinary collaboration in generating innovative solutions and ideas that support sustainable development.

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	Students will also be prepared and motivated to engage in independent, life-long learning in the broadest context of Microbiology change.
PO9	**Effective Writing** Students develop the skills necessary to write scientific literature and produce content for social media platforms related to life sciences.
PO10	**Effective Communication** Students will be able to speak, read, write, and listen effectively—both in person and through electronic media—in English and at least one Indian language. They will learn to make sense of the world by connecting people, ideas, books, media, and
PO11	**Social Interaction and Ethics** Students will be able to elicit and respect the views of others, mediate disagreements, and contribute to reaching group consensus. They will recognize diverse value systems—including their own—understand the ethical dimensions of their decisions, and take responsibility for their actions in group settings.
PO12	**Interdisciplinary Approach and Practical Learning** Students will be able to analyze the relationships among animals, plants, microbes, and their roles within various industries. They will demonstrate proficiency in performing laboratory procedures according to established standards in the fields of Biochemistry, Bioinformatics, Genomics, Industrial

Program Specific Outcomes (PSOs)

PSO 1	**Students will understand the fundamental metabolic and molecular processes essential for normal cellular functions.**
PSO2	**Students will gain knowledge of various tools and techniques used in genetic manipulation, microbial culture, and biochemical analysis.**
PSO3	**Students will be able to perform basic experiments in biochemistry, microbiology, cell biology, recombinant DNA technology, and related areas.**
PSO4	**Students will be equipped to pursue higher studies in diverse fields of biological sciences or take up careers in sectors such as Microbiology, Biotechnology, Agriculture, Medicine, and Pharmaceuticals.**

Sem	**Core - Discipline Specific Core (DSC)**	**Elective- Discipline Specific Elective (DSE)**	**Elective- Generic Elective (GE)**	**Ability Enhancement Course (AEC)**	**Skill Enhancement Course (SEC)**	**(Internship/Apprenticeship / Project/ Community Outreach) (IAPC)**	**Value Addition Course (VAC)**	**Total Credits**
	Course/credit distribution (Credits 4) Theory or Theory + Practicum (3T+1L)	**Course/ credit distribution** (Credits 4) Theory or Theory + Practicum/ Lab (3T+1L or 2T+2L)	**Course/ credit distribution** (Credits 4) Theory or Theory + Practicum/ Lab (Credits 4T or 3T+1L or 2T+2L)	**Course/ credit distribution** (Credits 2)	**Course/credit distribution** (Credits 2)	**Course/ credit distribution** (Credits 2)	**Course/ credit distribution** (Credits 2)	
I	**DSC 1- (4)** **DSC 2- (4)** **DSC 3- (4)** (3T+1L)		Choose one from a pool of courses **GE – 1 (4)**	**AEC – 1 (2)**	Choose one from a pool of courses **SEC – 1 (2)**		Choose one from a pool of courses **VAC – 1 (2)**	22

II	**DSC 4- (4)** **DSC 5- (4)** **DSC 6- (4)** (3T+1L)		Choose one from a pool of courses **GE – 2 (4)**	**AEC – 2 (2)**	Choose one from a pool of courses **SEC – 2 (2)**		Choose one from a pool of courses **VAC – 2 (2)**	22
	Students on exit shall be awarded Undergraduate Certificate (in the field of study/Discipline) after securing requisite 44 credits in semester I & II							***Total credits= 44***
III	**DSC 7- (4)** **DSC 8- (4)** **DSC 9- (4)** (3T+1L)	Choose one from a pool of courses, **DSE 1 (4)** OR **GE - 3 (4)** (4 T/or 3T+1L/or 2T+2L) OR **MOOC**		**AEC – 3 (2)**	Choose one from **SEC 3 – (2)** OR **Internship/Apprenticeship / Project/ Community Outreach** **(IAPC) – (2)**		Choose one from a pool of courses **VAC – 3 (2)**	22
IV	**DSC 10- (4)** **DSC 11- (4)** **DSC 12- (4)** (3T+1L)	Choose one from a pool of courses, **DSE 2 (4)** credits) OR **GE - 4 (4)** (4 T/or 3T+1L/or 2T+2L) OR **MOOC**		**AEC – 4 (2)**	Choose one from **SEC 4 – (2)** OR **Internship/Apprenticeship / Project/ Community Outreach** **(IAPC) – (2)**		Choose one from a pool of courses **VAC – 4 (2)**	22
	Students on exit shall be awarded Undergraduate Diploma (in the field of study/Discipline) after securing requisite 88 credits in semester III & IV							**Total credits= 88**
V	**DSC 13- (4)** **DSC 14- (4)**	Choose one from a pool of courses,	Choose one from a pool of courses		Choose one from **SEC 5 – (2)**			22

	DSC 15- (4) (3T+1L)	**DSE 3 (4)** credits) (3T+1L/or 2T+2L) OR **MOOC**	**GE – 5 (4)** OR **MOOC**		OR **Internship/Apprenticeship / Project/ Community Outreach** **(IAPC) – (2)**		
VI	**DSC 16- (4)** **DSC 17- (4)** **DSC 18- (4)** (3T+1L)	Choose one from a pool of courses, **DSE 4 (4)** credits) (3T+1L/or 2T+2L) OR **MOOC (4)**	Choose one from a pool of courses **GE – 6 (4)** **OR** **MOOC**		Choose one from **SEC 5 – (2)** OR **Internship/Apprenticeship / Project/ Community Outreach** **(IAPC) – (2)**		22
Students on exit shall be awarded Bachelor of (in the field of study) Honours (Discipline) after securing requisite 132 credits on completion of semester VI							**Total credits= 132**
VII	**DSC 19 (4)** (3T+1L)	**Choose 3 DSE** (3x4) courses OR **Choose 2 DSE – (2x4) and one GE (4)** course OR **Choose 1 DSE (4) and 2 GE** (2x4) courses **(Total= 12)**			Dissertation on Major/Minor (4+2) OR Academic Project/ Entrepreneurship **(4+2)**		22
VIII	**DSC 20 (4)** (3T+1L)	**Choose 3 DSE** (3x4) courses OR **Choose 2 DSE – (2x4) and one GE (4)** course OR **Choose 1 DSE (4) and 2 GE** (2x4) courses **(Total= 12)**			Dissertation on Major/Minor (4+2) OR Academic Project/ Entrepreneurship **(4+2)**		22

Students on exit shall be awarded Bachelor of (field of study) (Honours with Research or Honors with Academic project/Entrepreneurship) Discipline after securing requisite 176 credits on completion of semester VIII	**Total credits= 176**

COURSE STRUCTURE

Semester-Wise Discipline-Specific Core

Semester	Course Type	Course Code	Course Title	L	T	P	C
I	DSC-A (Microbiology)	MICDC101	Introduction to Microbiology	3	0	0	3
		MICDL101	Practical/Lab Course	0	0	2	1
		MICDC102	Cell Biology	3	0	0	3
		MICDL102	Practical/Lab Course	0	0	2	1
		MICDC103	Biochemistry	3	0	0	3
		MICDL103	Practical/Lab Course	0	0	2	1
II	DSC-A (Microbiology)	MICDC201	Immunology	3	0	0	3
		MICDL201	Practical/Lab Course	0	0	2	1
		MICDC202	Microbial Physiology & Metabolism	3	0	0	3
		MICDL202	Practical/Lab Course	0	0	2	1
		MICDC203	Biological Technique	3	0	0	3
		MICDL203	Practical/Lab Course	0	0	2	1
III	DSC-A (Microbiology)	MICDC301	Molecular Biology	3	0	0	3
		MICDL301	Practical/Lab Course	0	0	2	1
		MICDC302	Food Processing &Preservation	3	0	0	3
		MICDL302	Practical/Lab Course	0	0	2	1
		MICDC303	Chemistry-I	3	0	0	3
		MICDL303	Practical/Lab Course	0	0	2	1
IV	DSC-A (Microbiology)	MICDC401	Industrial Microbiology	3	0	0	3
		MICDL401	Practical/Lab Course	0	0	2	1
		MICDC402	Food & Dairy Microbiology	L	T	P	C
		MICDL402	Practical/Lab Course	3	0	0	3
		MICDC403	Enzymology	0	0	2	1
		MICDL403	Practical/Lab Course	3	0	0	3
V	DSC-A (Microbiology)	MICDC501	Agricultural Microbiology	0	0	2	1
		MICDL501	Practical/Lab Course	3	0	0	3
		MICDC502	Recombinant DNA Technology	0	0	2	1
		MICDL502	Practical/Lab Course	0	0	2	1
		MICDC503	Beverage Biotechnology	3	0	0	3
		MICDEL503	Practical/Lab Course	0	0	2	1
VI	DSC-A (Microbiology)	MICDC601	Environmental Microbiology	3	0	0	3
		MICDL601	Practical/Lab Course	0	0	2	1
		MICDC602	Infection and Immunity	3	0	0	3
		MICDL602	Practical/Lab Course	0	0	2	1

		MICDC603	Genomics and Proteomics	3	0	0	3
		MICDL603	Practical/Lab Course	0	0	2	1
VII	DSC-A (Microbiology)	MICDC701	Nanobiotechnology	3	0	0	3
		MICDL701	Practical/Lab Course	0	0	2	1
		MICDC702	Advances in Genetic Engineering	3	0	0	3
		MICDL702	Practical/Lab Course	0	0	2	1
		MICDC703	Microbial Analysis of air and water	3	0	0	3
		MICDL703	Practical/Lab Course	0	0	2	1
VIII	DSC-A (Microbiology)	MICDC801	Epidemiology	3	0	0	3
		MICDL801	Practical/Lab Course	0	0	2	1
		MICDC802	Management of Human Microbial	3	0	0	3
		MICDL802	Practical/Lab Course	0	0	2	1
		MICDC803	Nursing and Gardening	3	0	0	3
		MICDL803	Practical/Lab Course	0	0	2	1

Semester-Wise Discipline-Specific Elective

Semester	Course Type	Course Code	Course Title	L	T	P	C
V		MICDE503a MICDE503b	Plant Biotechnology Bioinformatics (Choose any one)	3	0	0	3
		MICDL503a MICDL503b	Practical/Lab course (Choose any one)	0	0	1	2
VI		MICDE603a MICDE603b	Mushroom Technology Bioprocess Technology Bioanalytical Tool (Choose any one)	3	0	0	3
		MICDL603a MICDL603b	Practical/Lab course (Choose any one)	0	0	1	2
VII		MICDE702	Bioprocess Technology	3	0	0	3
		MICDL703	Practical/Lab course	0	0	1	2
		MICDE704	Molecular Virology and Infection	3	0	0	3
		MICDL705	Practical/Lab course	0	0	1	2
		MICDE706	Bioentrepreneurs hip	3	0	0	3
		MICDL707	Practical/Lab course	0	0	1	2
VIII	DSE-A (Microbiology)	MICDE802	Bio math, Biostatistics, Computer Programming &application	3	0	0	3
		MICDL803	Practical/Lab course	0	0	1	2

		MICDE804	Biomedical Technology	3	0	0	3
		MICDL805	Practical/Lab course	0	0	1	2
		MICDE806	Green Chemistry	3	0	0	3
		MICDL807	Practical/Lab course	0	0	1	2

Semester-Wise Generic Elective

Semester	Course Type	Course Code	Course Title	L	T	P	C
I	GE-A (Microbiology)	MICGE104	Introduction and Scope of Microbiology	4	0	0	4
II		MICGE204	Vermitechnology	4	0	0	4
III		MICGE304	Animal Biotechnology	4	0	0	4
IV		MICGE404	Mycology	4	0	0	4
V		MICGE504	Human Immunology	4	0	0	4
VI		MICGE604	Pharmaceutical Biotechnology &Drug Designing	4	0	0	4

Semester-Wise Ability Enhancement Course

Semester	Course Type	Course Code	Course Title	L	T	P	C
I	AEC	AEC-106	Environment Science-I	2	0	0	2
II		AEC-206	Environment Science-II	2	0	0	2
III		AEC-306	English Communication-I	2	0	0	2
IV		AEC-406	English Communication-II	2	0	0	2

Semester-Wise Value Addition Course

Semester	Course Type	Course Code	Course Title	L	T	P	C
I	VAC	VAC-107	Future Trends in Microbiology	2	0	0	2
II		VAC-207	Role of Microbes in Drug Discovery	2	0	0	2
III		VAC-307	Sustainable Practices in Microbiology/Indian Knowledge system	2	0	0	2
IV		VAC-407	Genetic Engineering in Crop Improvement	2	0	0	2

Semester Wise Skill Enhancement Course/IAPC

Semester	Course Type	Course Code	Course Title	L	T	P	C
I		MICSC105	Microbial Quality Control in Food and Pharmaceutical Industries./Disaster Management .	2	0	0	2
II		MICSC205	Microbial Genetics.	2	0	0	2
III		MICSC305	Computational Biology &Bioinformatics OR	2	0	0	2

			Internship/Apprenticeship / Project/ Community Outreach/MOOC.				
IV		MICSC405	Food Fermentation Technique. OR Internship/Apprenticeship / Project/ Community Outreach/ OR MOOC.	2	0	0	2
V	SEC-A/IAPCA (Microbiology)	MICSC505	Intellectual Property Rights OR Internship/Apprenticeship / Project/ Community Outreach/ OR MOOC	2	0	0	2
VI		MICSC605	Basic of Fore science OR Internship/Apprenticeship / Project/ Community Outreach/ OR MOOC	2	0	0	2

Semester Wise Dissertation

Semester	Course Type	Course Code	Course Title	L	T	P	C
VII	IAPC	MICDT708	Dissertation on Major Core/Minor Elective (from VII Semester papers) OR Academic Project/ Entrepreneurship	4	0	0	4
		MICDL709	Lab	0	0	4	2
VIII	IAPC	MICDT808	Dissertation on Major Core/Minor Elective (from VIII Semester papers) OR Academic Project/ Entrepreneurship	4	0	0	4
			Lab	0	0	4	2

Degree Course in Microbiology with Research

Seventh Semester

S. No.	Course Category	Couse Code	Course Name	Periods				Evaluation scheme		Subject Total
				L	T	P	C	Sessional (Internal)	External (ESE)	
Theory										
	Major Core	MICDC701	Research Methodology	3	0	0	3	30	70	100
	Major Core	MICDC 702	Research Publications and Ethics	3	0	0	3	30	70	100
Research										
	Research 1	MICRM 703	Review of Literature/ Minor Project	0	0	0	9	60	140	200

L – Lecture, T – Tutorial, P – Practical, C – Credit

Eight Semester

S. No.	Course Category	Couse Code	Course Name	Periods				Evaluation scheme		Subject Total
				L	T	P	C	Sessional (Internal)	External (ESE)	
Theory										
	Major Core	MICRR- 801	Research –IPR	3	0	0	3	30	70	100
Research										
	Dissertation	MICMP-802	Major Project/ Internship	0	0	0	12	60	240	300
	Research 3	MICRS 803	Research Seminar Presentation-II	0	0	0	5	50	50	100
Total				3	0	0	20	140	360	500

L – Lecture, T – Tutorial, P – Practical, C – Credit

Certificate Course in Microbiology

B. Sc Microbiology (Discipline Specific Course)

Course code	**: MICDC- 101**
Course Name	**: Introduction to Microbiology**
Semester	**: I**

L	T	P	C
3	0	0	3

Course Objective: The objective of the course is

1. To provide foundational knowledge of microorganisms, including their classification, structure, and roles in health, environment, and industry.
2. To understand the principles of microbial growth, reproduction, and metabolism, and their relevance to biological systems.
3. To introduce basic laboratory techniques in microbiology, such as sterilization, culturing, staining, and identification of microbes.
4. To explore the significance of microbiology in medical, agricultural, and biotechnological applications, highlighting its impact on public health and innovation

COURSE CONTENT

Unit I: History of Microbiology

Discovery of microorganisms; Spontaneous generation vs. biogenesis; Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Martinus W. Beijerinck, Sergei N. Winogradsky, Alexander Fleming, Selman A. Waksman, Paul Ehrlich, Elie Metchnikoff, and Edward Jenner; Golden era of microbiology; Scope of microbiology.

Unit II: Classification

Kingdom classification of microorganisms: Haeckel's three kingdom concept, Whittaker's five kingdom concept, Six kingdom classification, Eight kingdom classification, Three domain concept of Carl Woese.

Unit III: Media and Pure Culture Techniques

Culture media: Solid and liquid media, Synthetic and complex media, Enriched and enrichment media, Selective and differential media; Culture techniques for isolation of pure culture: Pour plating, Spread plating, Streaking, Enrichment culture technique; Maintenance and preservation of pure culture; Cultivation of anaerobic bacteria.

Unit IV: Acellular Microorganisms

Characteristic features of viruses, prions and bacteriophage; Ultrastructure: Capsids, Types of envelope, Types and structure of genome; Cultivation of viruses and bacteriophage; Multiplication of viruses; Lytic and lysogeny cycle of λ phage.

Unit V: Cellular Microorganisms

Bacteria: Morphology of bacteria, Structure and functions of cell wall, cell membrane, flagella, pili, ribosome, nucleoid, cytoplasmic inclusions and endospore; Fungi: General characteristics, Ultra structure and reproduction; Protozoa: General characteristics with special reference to *Amoeba* and *Paramaecium*; Algae: General characteristics.

Suggested Readings

1.	Wiley, J.M., Sherwood, L.M. and Woolverton, C.J. Prescott, Harley and Klein's microbiology. McGraw-Hill, New York.
2.	Black, J.G. Microbiology: Principles and exploration. John Wiley and Sons, New Jersey.
3.	Pelczar, M.J., Chan, E.C.S. and Kreig, N.R. Microbiology. McGraw-Hill, New York.
4.	Dimmock, N.J., Easton, A.J. and Leppard, K.N. Introduction to modern virology. Wiley-Blackwell, New Jersey.
5.	Primrose, S.B. Introduction to modern virology. John Wiley and Sons, New Jersey.
6.	Cappuccino, J. and Sherman, N. Microbiology: A laboratory manual. Benjamin/Cummings Publishing Company, San Francisco.
7.	Prescott, L.M. and Harley, J.P. Laboratory exercises in microbiology. William C. Brown, Dubuque.
8.	Aneja, K.R. Experiments in microbiology, plant pathology and biotechnology. New Age International (P) Limited, New Delhi.
9.	Kannan, K. Laboratory manual in general microbiology. Punima, New Delhi.
10.	Atlas, R.M., Brown, A.E. and Parks, L.C. Laboratory manual of experimental microbiology. Mosby College Publishing Company, St. Louis.

Upon successful completion of the course, a student will be able to

CO 1	Describe the historical development of microbiology, including major discoveries, contributors, and the evolution of microbial science from spontaneous generation to biogenesis.
CO 2	Classify microorganisms using various classification systems, including Haeckel's, Whittaker's, six and eight kingdom models, and Carl Woese's three-domain concept.
CO 3	Demonstrate knowledge of microbial cultivation techniques, including types of culture media, isolation methods, and maintenance of pure cultures, including anaerobic bacteria.
CO 4	Explain the structural and functional characteristics of acellular microorganisms such as viruses, prions, and bacteriophages, including their replication cycles and cultivation methods.
CO 5	Analyze the morphology, structure, and functions of cellular microorganisms including bacteria, fungi, protozoa, and algae, with emphasis on their unique features and reproduction.
CO 6	Integrate foundational microbiological concepts to understand the scope, relevance, and applications of microbiology in health, environment, and biotechnology.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO1 1	PO 12	PSO1	PSO 2	PSO3	PSO4
CO1	3	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	1	1	1	2	1
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	1	1	1	1

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlate

B. Sc. MICROBIOLOGY (Discipline Specific Course)

Course code	**: MICDL 101**
Course Name	**: Lab Course Based on MICDC- 101**
Semester	**: I**

L	T	P	C
0	0	2	2

Practical's

1. Safety rules of working in a microbiology lab.
2. Study of principles and applications of important instruments (autoclave, laminar air flow, hot air oven, microscope, incubator, inoculator, colony counter, and vortex) used in the microbiology laboratory.
3. Preparation of solid and liquid media.
4. Enumeration of total viable count in water/soil sample.
5. Isolation of a pure culture of bacteria.
6. Differentiation between lactose fermenters and no fermenters on MacConkey agar.
7. Study of colony morphology of *E. coli* on EMB agar.
8. Simple staining of a bacterial cell.
9. Gram staining of a bacterial cell.
10. Negative staining of a bacterial cell.
11. Staining of a fungal cell

Upon successful completion of the course, a student will be able to

CO 1	Memorize the Safety rules of working and recognize different instruments used in the microbiology Laboratory, and enumerate the total viable count in water/soil samples.
CO 2	Identify different types of bacteria and fungi on the basis of different staining techniques.
CO 3	Prepare different types of solid and liquid media.
CO 4	Differentiate between a lactose fermenter and a non-fermentarian on MacConkey agar.
CO 5	Assess characteristic features of *Aspergillus*, *Penicillium*, *Amoeba,* and *Paramaecium* And colony morphology of *E. coli* on EMB Agar.
CO 6	Prepare an isolation of a pure culture of bacteria.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO 12	PSO1	PSO 2	PSO3	PSO4
CO1	3	2	2	2	2	1	1	2	2	1	1	2	2	2	1	1
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	1	1
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	1	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	1	3
CO5	2	2	2	2	1	1	1	2	2	1	1	2	2	2	1	1
CO6	2	2	2	2	2	1	1	2	2	1	2	2	1	1	1	1

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlate

B. Sc. MICROBIOLOGY (Discipline Specific Course)

Course code	**: MICDC-102**
Course Name	**: Cell Biology**
Semester	**: I**

L	T	P	C
3	0	0	3

Course Objective: Course Objective: Cell is the structural and functional unit of life. It is often referred to as the building block of life as well. The course on cell biology aims to impart knowledge of cell structure and functions of diverse cellular organelles.

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UNIT-I

Cell organization: Eukaryotic (plant and animal cell) and prokaryotic. Plasma Membrane: Structure and functions. Fluid Mosaic Model. Solute transport across membrane. Interactions Adhesion junctions, tight junctions, gap junctions, and plasmodesmata (only structural aspects)

UNIT II

Membrane Vacuolar system, cytoskeleton and cell motility: Structure and function of microtubules, Microfilaments, Intermediate filaments. Endoplasmic reticulum: Structure, function including role in protein segregation. Golgi complex: Structure, biogenesis and functions including role in protein secretion.

UNIT III

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, chromosomes and their structure.

UNIT IV

Signalling molecules and their receptors. Signal transduction. Pathways of intracellular receptors- cyclic AMP pathway, cyclic GMP and MAP kinase pathway

UNIT V

Cell cycle and its regulation, Mitosis and Meiosis, Programmed Cell Death- Intrinsic and Extrinsic pathway

SUGGESTED READING AND TEXT BOOKS

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition.Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASMPress & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

Upon successful completion of the course a student will be able to

CO1	Define Intracellular Compartmentalization of Cell, cell signaling, replication, protein synthesis and cell cycle with reference to cell death.
CO2	Summarize the types of cell organelles and cell signaling , mode of replication , transcription and Translation process in cell, Gene regulation , Mitosis and meiosis ,types of cell death.
CO3	Explain the various cell organelles and function, method of signaling, Evidence and mechanism of Replication, protein synthesis in Prokaryotes and Eukaryotes, Types of cell division and cell death.
CO4	Explain Structure , organization and functions of cell organelles, process of cell signaling ,Protein synthesis process in Prokaryotes and Eukaroyes, Types of Gene Regulation,
CO5	Summarize the function of cell organelles, role of signal molecule in cell, Protein synthesis in Pro-and Eukaroytes with post transcriptional and translational modification. Control of gene expression .Phases of cell cycle and mechanism of cell death.
CO6	Justify cell organelles, cell cycle , signaling ,protein synthesis and gene regulation and cell death.

CO- PSO-PO Mapping:

Course	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO4**
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlate

Course code	**: MICDL102(Discipline Specific Course)**
Course Name	**: Lab Course Based on MIDC 102**
Semester	**: I**

L	T	P	C
0	0	2	2

Practical's

1. Study the effect of temperature and organic solvents on semi permeable membrane.
2. Study the working and function in of microscope.
3. Demonstration of dialysis.
4. Study of plasmolysis and de-plasmolysis.
5. Cell fractionation and determination of enzyme activity in organelles using sprouted seed or any other suitable source.
6. Study of structure of any Prokaryotic and Eukaryotic cell.
7. Cell division in onion root tip.

Upon successful completion of the course a student will be able to

CO1	Identify different stages of cell cycle.
CO2	Identify and determine the enzyme activity in organelles.
CO3	Demonstrate the process of mutagenesis, photoreactivation, transformation and conjugation.
CO4	Analyse and study of structure of any Prokaryotic and Eukaryotic cell.
CO5	Estimate the quantity of DNA
CO6	Prepare slides of mitosis and meiosis.

CO- PSO-PO Mapping:

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11	PO 12	PSO 1	PSO 2	PSO 3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	1	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	1	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	1	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlate

B. Sc MICROBIOLOGY (Discipline Specific Course)

Course code	**: MICDC 103**
Course Name	**: BIOCHEMISTRY**
Semester	**: I**

L	T	P	C
3	0	0	3

Course objectives:

Course Objectives: The objectives of this course are

1. **To understand the principles of bioenergetics** and **enzyme catalysis**.
2. **To gain knowledge about the nature and functions of biological macromolecules, including proteins, lipids, and carbohydrates**.

Course Contents

Unit I: Bioenergetics

First and second laws of thermodynamics, Definitions and relationships among: Gibbs free energy, Enthalpy, Entropy, standard free energy change, and equilibrium constant. Energy-rich compounds: Phosphoenolpyruvate, 1,3-Bisphosphoglycerate, Thioesters, ATP.

Unit II: Carbohydrates

Families of monosaccharides and disaccharides. Concept of reducing and non-reducing sugars. Storage polysaccharides: Starch, Glycogen, Structural polysaccharides: Cellulose, Peptidoglycan, Chitin.

Unit III: Lipids

Definition and major classes of lipids: Storage lipids, Structural lipids. Fatty acids: Structure and functions. Essential fatty acids. Triacylglycerols: Structure, functions, and properties Saponification Structural lipids: Phosphoglycerides and their building blocks

Unit IV: Proteins

Structure and classification of proteins: Amino acids: General formula, zwitterion concept, Titration curve and its significance, Ninhydrin reaction, Protein structure: Secondary, Tertiary, Quaternary, Functions of proteins

Unit V: Enzymes

Structure and classification of enzymes, Apoenzymes, and cofactors, Mechanism of enzyme action: Active site. Lock and key hypothesis, Induced fit hypothesis, Enzyme kinetics: Hyperbolic and double reciprocal plots, Km value and allosteric mechanisms, Key definitions: Enzyme unit, Specific activity, Turnover number

Text Books:

1. JainJ.L () Biochemistry
2. Campbell, M. K. (2012) Biochemistry. Cengage LearningPublishers,7thed

Reference Books:

1. Campbell,P.N.andSmith,A.D.(2011).BiochemistryIllustrated.ChurchillLivingstone, London, 4th ed
2. Berg, M.,Tymoczko, J.L and Stryer L.(2011) Biochemistry. W.H. Freeman and Company, New York.
3. Nelson,D.L.andCox,M.M.(2008).Lehningerprinciplesofbiochemistry.W.H.FreemanandCompany,NewYork,5thed
4. Wiley, J.M., Sherwood, L.M. and Woolverton, C.J. Prescott, Harley, and Klein's Microbiology,

Upon successful completion of the course a student will be able to

CO 1	Define basics of bioenergetics, carbohydrates, proteins, lipids and enzymes
CO 2	Explain and describe different terminology used in bioenergetics and classify and compare types of biomolecules.
CO 3	Illustrate and develop an understanding about families of carbohydrates, storage and structural lipids, proteins, enzymes and its mechanisms.
CO 4	Explain bioenergetics, biomolecules and enzymes.
CO 5	Compare and summarize between biomolecules and enzymes
CO6	Create structure of biomolecules and express an understanding of bioenergetics, biomolecules and enzymes

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	2
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	1	2	1	1	2	2	1	2	2	2	0	2	0

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. MICROBIOLOGY (Discipline Specific Course)

Course code	**: MICDL 103**
Course Name	**: Lab based on MICDC-103**
Semester	**: I**

L	T	P	C
0	0	2	2

Course Objectives: The objectives of this lab course are

1. Standard free energy change in coupled reactions
2. Qualitative tests for carbohydrates, including the identification of reducing and non-reducing sugars
3. Qualitative tests for lipids and proteins
4. Analysis of protein secondary and tertiary structures using models
5. Study of enzyme kinetics, including calculation of Vmax, Km, and Kcat values

Upon successful completion of the course a student will be able to

CO 1	Define the safety rules of working in the lab
CO 2	Estimate quantitatively and qualitatively the sugar
CO 3	Preparation of media
CO 4	Calculation of moles
CO 5	Estimate the qualitative test of protein.
CO6	Write and design the study of protein structure using by SPVD model.

CO- PSO-PO Mapping:

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11	PO 12	PSO 1	PSO 2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	1	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	1	2	1	2	1	1	1	1	1

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. Microbiology (Generic Elective Course)

Course code	**: MICGE 104**
Course Name	**: Introduction and Scope of Microbiology-**
Semester	**: I**

L	T	P	C
4	0	0	4

Course Objective

1. To introduce the fundamental concepts of microbiology, including the discovery, nature, and classification of microorganisms.
2. To explore the historical milestones and contributions of key scientists that shaped the development of microbiology as a scientific discipline.
3. To understand the diverse roles of microorganisms in health, industry, agriculture, and the environment.
4. To highlight the scope and applications of microbiology in modern science and technology, including its relevance to medicine, biotechnology, and public health.

Unit I

An Introduction to Microbiology, biogenesis *vs*. abiogenesis. Contributions of Antony van Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming, Edward Jenner. General characteristics of different groups: Acellular microorganisms (Viruses, Viroids, Prions) and Cellular microorganisms (Prokaryote: Archaea and Bacteria, Eukarya: Algae, Fungi and Protozoa), giving definitions and Morphology.

Unit II

Moist Heat, Autoclave, Dry Heat, Hot Air Oven, Tyndallization, Filtration. Bright Field Microscope, Dark Field Microscope, Phase Contrast Microscope, Fluorescence Microscope, Transmission Electron Microscope, Scanning Electron Microscope.

UNIT –III Definition of fermentation, primary and secondary metabolites, types of fermentations, and fermenters and microbes producing important industrial products through fermentation.

UNIT-IV Microorganisms as food (SCP), microorganisms in food fermentations (dairy and non-dairy based fermented foods), and probiotics. Microorganisms in food spoilage and food-borne infections.

SUGGESTED READING AND TEXT BOOKS

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition.
2. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASMPress & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

Upon successful completion of the course a student will be able to

CO 1	Describe the history and scope of microbiology, and explain the classification of microorganisms, including both cellular and acellular forms.
CO 2	Compare and differentiate the contributions of various scientists in microbiology, and distinguish between cellular and acellular microorganisms while explaining classification systems.
CO 3	Illustrate and explain the contributions of key scientists in microbiology, various classification systems, culture techniques, and the characteristics of cellular and acellular microorganisms.
CO 4	Distinguish between cellular and acellular microorganisms, describe different culture techniques, and explain the classification systems, history, and scope of microbiology..
CO 5	Summarize the history, scope, and classification of microorganisms, describe culture techniques, and differentiate between cellular and acellular microorganisms.
CO 6	Develop a generalized understanding of microbiology and its foundational concepts.

CO- PSO-PO Mapping:

Course	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc Microbiology (Skill Enhancement Course)

Course code	**: MICSC 105**
Course Name	**: MICROBIAL QUALITY CONTROL IN FOOD AND PHARMACEUTICAL INDUSTRIES**
Semester	**: I**

L	T	P	C
2	0	0	2

Course Objectives: The objectives of this course are

1. **To instill good and safe laboratory practices in students**
2. **To identify and examine microbes in food and pharmaceutical samples using various cultural and microscopic techniques**
3. **To promote awareness of food safety, quality assurance, and validation procedures**

Course Contents

Unit I: Microbiological Laboratory and Safe Practice

Laboratory Practices: Good Laboratory Practices (GLP), Good Microbiological Practices (GMP), Biosafety Cabinets: Working principles of biosafety cabinets, Specifications for Biosafety Levels: BSL-1, BSL-2, BSL-3, Discarding Biohazardous Waste: Methodologies for disinfection, Autoclaving and incineration techniques, Sterilization and preservation methods for microorganisms, Food Safety and Quality: HACCP (Hazard Analysis and Critical Control Points) for food safety, Quality Assurance (QA), and Quality Control (QC).

Unit II: Determining Microbes in Food/Pharmaceutical Samples

Culture and Microscopic Methods: Standard Plate Count (SPC), Most Probable Number (MPN), Direct Microscopic Count, Biochemical, Immunological, and Molecular Detection Methods, Microbial Quality of Milk, Enrichment Culture Techniques, Detection of Specific Microorganisms Using Selective Media.

Suggested Readings

1. Wiley, J.M., Sherwood, L.M. and Woolverton, C.J. Prescott, Harley and Klein's microbiology. McGraw-Hill, New York.
2. Black, J.G. Microbiology: Principles and exploration. John Wiley and Sons, New Jersey.
3. Pelczar, M.J., Chan, E.C.S. and Kreig, N.R. Microbiology. McGraw-Hill, New York.
4. Dimmoc, N.J., Easton, A.J. and Leppard, K.N. Introduction to modern virology. Wiley-Blackwell, New Jersey.

5. Primrose, S.B. Introduction to modern virology. John Wiley and Sons, New Jersey.
6. Cappucino, J. and Sherman, N. Microbiology: A laboratory manual. Benjamin/Cummings Publishing Company, San Francisco.
7. Prescott, L.M. and Harley, J.P. Laboratory exercises in microbiology. William C. Brown, Dubuque.
8. Aneja, K.R. Experiments in microbiology, plant pathology, and biotechnology. New Age International (P) Limited, New Delhi.

Upon successful completion of the course are students will be able to

CO 1	Define good and safe microbiological practices applicable to food and pharmaceutical industries.
CO 2	Describe and apply various methods for detecting microbes and pathogenic microorganisms in food, pharmaceutical, and water samples.
CO 3	Identify and isolate pathogenic microorganisms from food and water samples using appropriate techniques.
CO 4	Explain microbial standards for different types of food and water samples.
CO 5	Demonstrate good laboratory practices in microbiological analysis. .
CO6	Describe the principles of quality control, quality assurance, and validation in microbiological testing.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. Microbiology (Ability Enhancement Course)

Course code	**: AEC-106**
Course Name	**: Environmental Science-I**
Semester	**: I**

L	T	P	C
2	0	0	2

Course Objective: The basic objective of the environmental studies is to enable the students for interdisciplinary approach to complex environmental problems using basic tools of the natural and social sciences including ecosystem, geosystems, biology, chemistry and global process. They will acquire an attitude of concern for the environment and will be able to critically evaluate the science and policy ramifications of water quality natural resources etc.

Unit1: Introduction to Environmental Sciences and Ecosystems

Multidisciplinary nature of Environmental Sciences; Scope and importance; Concept of sustainability and sustainable development. What tis an ecosystem? Structure and function of ecosystem; Energy flow in an ecosystem: food chains food web sand ecological succession.

Unit2: Renewable and Non-renewable Resources/Biodiversity and Conservation

Land resources and land use change; Land degradation soil erosion and desertification.

Deforestation, Water. Energy resources: Renewable and non-renewable energy sources, use of alternate energy sources growing energy needs, case studies. Levels of biological diversity : genetic, species and ecosystem diversity; Biogeographic zone sof India; Biodiversity pattern sand global biodiversity hotspots, India as omega- biodiversity nation.

Unit3: Environmental Pollution/Human Communities and the Environment

Environmental pollution. Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture. Disaster management: floods, earth quake, cyclone sand land slides. Environmental movements: Chipko, Silent valley, Bishnois of Rajasthan. Environmental ethics: Role of Indian and other religion sand cultures in environmental conservation. Environmental communication and public awareness, case studies (e.g.,CN Gvehiclesin Delhi).

SUGGESTED READING AND TEXT BOOKS

1. Agarwal, K.C. 2001 Environmental Biology, Nidi Publ. Ltd. Bikaner.
2. Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad – 380 013, India, Email:mapin@icenet.net (R).
3. Brunner R.C., 1989, Hazardous Waste Incineration, McGraw Hill Inc. 480p.

Clark R.S., Marine Pollution, Clanderson Press Oxford (TB).

4. Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T. 2001, Environmental

Upon successful completion of the course are students will be able to

CO	Description
CO1	Understand the multidisciplinary nature, scope, and importance of Environmental Sciences and the concept of sustainability and sustainable development.
CO2	Explain the structure and functioning of ecosystems, including energy flow, food chains, food webs, and ecological succession.
CO3	Identify and analyze various renewable and non-renewable natural resources, their challenges, and sustainable alternatives.
CO4	Demonstrate awareness of biodiversity, its different levels, patterns, hotspots, and conservation practices, with emphasis on India.
CO5	Assess the causes and consequences of major environmental issues such as pollution, climate change, and natural disasters, and explore management strategies.
CO6	Appreciate environmental ethics, analyze the role of cultural and religious practices in conservation, and communicate the importance of public awareness through case studies

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	1	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	1	2	2	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	1	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	1	2	2	1	1	2	2	1	2	2	2	2	2	1

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. Microbiology (Value Addition Course)

Course code	**: VAC-107**
Course Name	**: Future Trends in Microbiology**
Semester	**: I**

L	T	P	C
2	0	0	2

Course Description:

This course explores the cutting-edge developments and future trends in microbiology. It covers advancements in microbial genomics, synthetic biology, microbiome research, biotechnology applications, and emerging infectious diseases. The course aims to provide students with a comprehensive understanding of how these trends are shaping the future of microbiology and their potential impact on various sectors such as healthcare, agriculture, and the environment.

Unit 1: Advances in Microbial Genomics and Biotechnology

Introduction to Microbial Genomics, Comparative genomics of microorganisms, Principles of synthetic biology, Applications of genetic engineering in microorganisms.

Unit 2: Microbiome Research and Emerging Trends in Microbiology.

Composition and diversity of the human microbiome, Microbial interactions in ecosystems, Advances in microbial diagnostics and therapeutics

Upon successful completion of the course are students will be able to

CO	Description
CO1	Understand the principles and advancements in microbial genomics and sequencing technologies.
CO2	Explain the concepts of synthetic biology and their applications in genetic engineering.
CO3	Analyze genomic data using bioinformatics tools and interpret results for research applications.
CO4	Evaluate the biotechnological applications of microorganisms in various industries.
CO5	Analyze the composition and function of the human microbiome and its impact on health and disease.
CO6	Evaluate the role of environmental and agricultural microbiomes in ecosystem functioning and sustainability.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	1	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	1	2	2	2	1	1	2	2	1	2	2	2	1	1	1

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc Microbiology (Value Addition Course)

Course code	**: VAC-108**
Course Name	**:** Disaster Management
Semester	**: I**

L	T	P	C
2	0	0	2

Unit-1 Introduction to Disaster Management, types of disasters, Natural vs. man-made disasters, Risk, vulnerability, and hazard analysis, Earthquakes, floods, droughts, landslides, Socio-economic and environmental impacts.

UNIT-II Disaster management cycle, National & state disaster bodies, Early warning systems, retrofitting buildings, Training & Awareness, Preparedness drills, GIS and remote sensing applications. Applications of Disaster Management, Disadvantages of Disaster Management, Technology used in Disaster Management, and Examples of Disaster Recovery Processes.

Upon successful completion of the course are students will be able to

CO	Description
CO1	Understand the fundamental concepts of disaster management, including types of disasters and key terminology such as risk, vulnerability, and hazard.
CO2	Analyze the causes and impacts of major natural disasters like earthquakes, floods, droughts, and landslides, and assess their socio-economic and environmental consequences.
CO3	Explain the disaster management cycle and evaluate the roles of national and state disaster management authorities in coordinating response efforts.
CO4	Apply early warning systems, retrofitting techniques, and preparedness drills to enhance community resilience and minimize disaster risks.
CO5	Utilize GIS and remote sensing technologies to support disaster preparedness, response, and recovery operations.
CO6	Critically assess the advantages and disadvantages of disaster management strategies, and examine real-world examples of disaster recovery processes and technological interventions.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	1	1	1	2	2	1	2	2	2	2	3	1
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	1	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	1	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. Microbiology ((Discipline Specific Course)

Course code	: **MICDC 201**
Course Name	**: IMMUNOLOGY**
Semester	**: II**

L	T	P	C
3	0	0	3

Course Objectives: The objectives of this course are

1. To understand the fundamental concepts of the immune system,
2. To explore the types of immunity and immune responses,
3. To study the roles of antigens, antibodies, and major histocompatibility complexes.
4. To examine immunological techniques and their applications

Course Content

Unit I: Introduction to the immune system

History of immunology, composition and functions of cells and organs involved in the immune system; Immune response and its type- innate (non-specific), acquired (cell-mediated and humoral) immunity. Cytokines.

Unit II: Antigens and Antibodies

Antigens- structure and properties, Antigenicity and Immunogenicity, Immunoglobulin- structures, properties & functions, and types. Monoclonal antibodies.

Unit III: Immunological Techniques

ELISA, RIA, Precipitation, Agglutination, Immunodiffusion, Immuno electrophoresis, Western blotting, Immunofluorescence, complement fixation, and Flow cytometry.

UNIT-IV: Complement System and Major Histocompatibility Complex

Complements- Structure, functions, and Complement pathways (Classical and Alternative)

Major Histocompatibility Complex (MHC): Structure and functions. Transplantation and its types.

Unit V: Immunopathology

Autoimmunity and autoimmune disorders (Rheumatoid arthritis, Hashimoto's thyroiditis) Vaccines, Hypersensitivity reactions and its types.

Text Books:

1. **Delves, P.J., Martin, S.J., Burton, D.R. and Roitt , I.M. Roitt's esessential immunology. Wiley-Blackwell, New Jersey.**

2. Abbas, A.K., Lichtman, A.H.H. and Pillai, S. Cellular and molecular Immunology. Saunders, Philadelphia.

Reference Books

1. **Kindt, T.J., Goldsby, R.A., Osborne, B.A. and Kuby, J. Kuby immunology. W.H. Freeman and Company, New York.**
2. **Male, D.K. Immunology: An illustrated outline. Elsevier Health Sciences, Philadelphia.**
3. **Abbas, A.K. and Lichtman, A.H.H. Basic immunology: Functions and disorders of the immune system. Saunders, Philadelphia. Chakrabarty. Immunology & Immunotechnology. Oxford**
4. **Pathak, S. and Palan, U. Immunology: Essential and fundamental. Science, New Hampshire. Rao, C.V. Immunology. Alpha Science International, New Delhi.**

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	**Define** essential immunological terms: antigens, antibodies, complement system, MHC, immune responses, and medical applications.
CO2	Differentiate immune cells, types of immunity and responses, antigens vs. antibodies, complement system, MHC, and clinical relevance.
CO3	**Describe** basic immunity concepts and explain, with diagrams, antigens, antibodies, complement pathways, MHC, transplantation, immune regulation, and immunopathology.
CO4	**Illustrate** immune cells and diagrammatically explain immunity types, antigen-antibody interactions, MHC, complement activation, transplantation, and medical applications.
CO5	**Summarize** the immune system, antigens, antibodies, complement system, MHC, transplantation, and immune regulation using diagrams.
CO6	**Generalize** core immunology concepts and their importance in maintaining health and managing disease.

CO- PSO-PO Mapping:
Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

B. Sc. Microbiology (Discipline Specific Course)

Course code	: **MICDL 201**
Course Name	**: IMMUNOLOGY**
Semester	**: II**

L	T	P	C
0	0	2	2

1. Separation and preservation of serum and plasma.
2. Determination of blood group and Rh factor.
3. Demonstration of agglutination reaction of bacterial cultures by the slide agglutination test.
4. Quantitative estimation of antigen by radial diffusion.
5. Detection and quantification of either antibody or antigen by the doublediffusion method.
6. Determination of concentration of antigen by rocket immune electrophoresis.
7. Determination of the presence of a specific antibody for its antigen by the Dot-ELISA method.

Separate the components of the antigen mixture and study the pattern by immuno-electrophoresis.

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO	Description
CO1	Define preservation of serum and plasma.
CO2	Explain and determination of blood group and Rh factor
CO3	Explain demonstration of agglutination reaction of bacterial cultures by slide agglutination test
CO4	Explain Separation of components of antigenmixture and study the patternby immuno -electrophoresis
CO5	Summarize the preservation and determination of blood group and Rh factor
CO6	Create preservation of serum and plasma

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc Microbiology (Discipline Specific Course)

Course code	**: MICDC-202**
Course Name	**: Microbial Physiology &Metabolism**
Semester /Year	**: II**

L	T	P	C
3	0	0	3

Course Objectives: The objectives of this course are

1. **To gain knowledge of various transport systems and protein secretion pathways in bacteria**
2. **To make student aware the concept osmoregulation.**
3. **To Gain knowledge of Quorum sensing.**

Unit I: Microbial Growth and Effect of Environment on Microbial Growth

Definitions of growth; Batch culture; Continuous culture; Generation time and specific growth rate; Temperature and pH ranges of growth; Effect of solute and water activity of growth; Effect of oxygen concentration on growth; Nutritional categories of microorganisms.

Unit II: Nutrient Uptake and Transport

Passive and facilitated diffusion Primary and secondary active transport; Concept of uniport, symport and antiport; Group translocation; Iron uptake.

Unit III: Chemoheterotrophic Metabolism

Concept of aerobic and anaerobic respiration; Sugar degradation pathways: EMP, ED, Pentose phosphate pathway, TCA cycle; Fermentation: Alcohol fermentation and Pasteur effect, Lactate fermentation (Homofermentative and heterofermentative pathways), Concept of linear and branched fermentation pathways; Electron transport chain: Components of respiratory chain, Comparison of mitochondrial and bacterial ETC, Electron transport phosphorylation, Uncouplers and inhibitors.

Unit IV: Chemo lithotrophic and Phototrophic Metabolism

Chemo lithotrophic metabolism: Introduction to aerobic and anaerobic chemolithotrophy with an example each, Hydrogen oxidation (Definition and reaction), Methanogenesis (Definition and reaction); Phototrophic metabolism: Introduction, Groups of phototrophic microorganisms, Anoxygenic *vs.* oxygenic photosynthesis concerning photosynthesis in green bacteria and cyanobacteria.

Unit V: Nitrogen Metabolism

An overview, Introduction to biological nitrogen fixation, Ammonia assimilation, Assimilatory nitrate reduction, Dissimilatory nitrate reduction (Denitrification, nitrate/nitrite and nitrate/ammonia respiration, fermentative nitrate reduction).

Text Books:

1. Foster, J.W. and Spector, M.P. Microbial physiology. John Wiley and Sons, New York
2. Pelczar, M.J., Chan, E.C.S., and Kreig, N.R. Microbiology. McGraw-Hill, New York
3. Wiley, J.M., Sherwood, L.M., and Woolverton, C.J. Prescott, Harley and Klein's Microbiology. McGraw-Hill, New York.

Reference Books:

1. Foster, J.W. and Spector, M.P. Microbial physiology. John Wiley and Sons, New York.
2. Madigan, M.T., Martinko, J.M., and Parker, J. Brock biology of microorganisms. Prentice Hall, New Jersey.
3. Brun, Y.V. and Shimkets, L.J. Prokaryotic development. ASM Press, Washington, D.C.
4. Rose, A.H. Advances in microbial physiology. Academic Press, New York.
5. David, W., Drummond, J.T.and Fuqua, C. Physiology and biochemistry of prokaryotes. Oxford University Press, New York.

Upon successful completion of the course, a student will be able to

CO 1	**Define** the terminology related to microbial growth, environmental effects on microbial growth, nutrient uptake and transport, chemoheterotrophic metabolism, chemolithotrophic and phototrophic metabolism, and nitrogen metabolism..
CO 2	**Discuss** the principles of microbial growth, the impact of environmental factors on growth, mechanisms of nutrient uptake and transport, and the metabolic pathways involved in chemoheterotrophy, chemolithotrophy, phototrophy, and nitrogen metabolism.
CO 3	**Illustrate**, using diagrams where appropriate, the concepts of microbial growth, growth kinetics, and the influence of various parameters on growth; mechanisms such as diffusion, group translocation, and iron uptake; and the pathways of chemoheterotrophic, chemolithotrophic, phototrophic, and nitrogen metabolism
CO 4	**Emphasize** the concepts of growth kinetics, active and passive transport, aerobic and anaerobic respiration, and the metabolic processes involved in chemolithotrophy, phototrophy, and nitrogen metabolism.
CO 5	**Summarize** the key concepts of microbial growth, nutrient uptake and transport, and the various metabolic pathways including chemoheterotrophic, chemolithotrophic, phototrophic, and nitrogen metabolism.
CO6	**Generalize** the fundamental concepts of microbial physiology and metabolism, highlighting their significance in microbial life processes and environmental interactions.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. Microbiology (Discipline Specific Course)

Course code	**: MICDL-202**
Course Name	**: Microbial Physiology &Metabolism**
Semester /Year	**: II**

L	T	P	C
0	0	2	2

Course Objectives:The objectives of this lab course are

1. To get awareness about how to check the effect to temperature and pH on the growth of bacteria and how to plot the growth curve.

2. To understand and how to calculate generation time and specific growth rate of Bacteria.

Practical's

1. Study and plot the growth curve of *E. coli* by tubidio metric and standard plate count methods.
2. Calculations of the generation time and specific growth rate of bacteria from the graph plotted with the given data.
3. Effect of temperature on the growth of *E.coli*.
4. Effect of pH on the growth of *E.coli*.

Upon successful completion of the lab course, a student will be able to

CO 1	Study and plot the growth curve of *E. coli* by tubidiometric method.
CO 2	Observe the effect of temperature on growth of *E. coli*.
CO 3	Effect of pH on growth of *E. coli*.
CO 4	Illustrate the growth curve of *E. coli* by standard plate count methods.
CO 5	Calculations of generation time and specific growth rate of bacteria from the graph plotted with the given data.
CO6	Evaluate the effect of solute and water activity on growth.

CO- PSO-PO Mapping:

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11	PO 12	PSO 1	PSO 2	PSO3	PSO4
CO1	2	1	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	1	3	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	1	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. Microbiology (Discipline Specific Course)

Course code	**: MICDC-203**
Course Name	**: Biological Technique**
Semester	**: II**

L	T	P	C
3	0	0	3

Course Objectives: The objectives of this course are

1. To **make students aware of the principle and operation of a pH meter**.
2. To **understand the principles and applications of various electrophoretic techniques**.
3. To **learn the principles and uses of spectroscopy and radioisotopic techniques**

Course Content

Unit I: Chromatography

Principles and applications of paper chromatography, Thin layer Chromatography, Column packing and fraction collection. Gel filtration chromatography, ion exchange chromatography and affinity chromatography, GLC, HPLC.

Unit II: **Spectrophotometry**

Principle and use of study of absorption spectra of biomolecules. Analysis of biomolecules using UV and visible range. Colorimetry and turbidometry.

Unit III: Electrophoresis

Principle and applications of native polyacrylamide gel electrophoresis, SDS- SDS-polyacrylamide gel electrophoresis, 2D gel electrophoresis, Isoelectric focusing, Agarose gel electrophoresis

Unit IV: Centrifugation

Preparative and analytical centrifugation, fixed-angle and swinging bucket rotors. RCF and sedimentation coefficient, differential centrifugation, density gradient centrifugation, and ultracentrifugation

Unit V: Microscopy

Brightfield and darkfield microscopy, Fluorescence Microscopy, Phase contrast Microscopy, Confocal Microscopy, Electron Microscopy (Scanning and Transmission Electron Microscopy), and Micrometry.

Text Books:

1. Wilson K and Walker J. Principles and Techniques of Biochemistry and MolecularBiology. 7th Ed., Cambridge University Press.
2. Nelson DL and Cox MM. Lehninger Principles of Biochemistry, 5th Ed., W.H.Freeman and Company.
3. De Robertis EDP and De Robertis EMF. Cell and Molecular Biology. 8th edition. Lipincott Williams and Wilkins, Philadelphia.
4. Stanley R. Maloy, John E. Cronan, David Frielfeder. Mivrobial Genetics. Naraso Publishing House.
5. R.C. Dubey and D.K. Maheshwari. Textbook of Microbiology. S. Chand & Co. Ltd.

Reference Books:

1. Sawhney, S.K. and Singh, R. Introductory practical biochemistry. Narosa Publishing House, New Delhi.
2. Segel, I.H. Biochemical calculations. John Wiley and Sons, New York.
3. Plummer, D.T. Introduction to practical biochemistry. Mc-Graw Hill, New York.
4. Boyer, R.F. Modern experimental biochemistry. Prentice Hall, New Jersey.

Course outcomes (COs):
Upon successful completion of the course a student will be able to

CO1	**Define** the basic principles of laboratory instruments, microscopy, biosensors, chromatography, electrophoresis, spectroscopy, and radioisotopes.
CO2	**Summarize** the principles and functions of laboratory instruments, microscopy, and biosensors; explain the theory, principles, and applications of chromatography, electrophoresis, and spectroscopy; and describe the applications of radioisotopes in biology.
CO3	**Explain** the principles and applications of laboratory instruments; introduce the concepts and principles of microscopy and biosensors; describe the theory and applications of chromatography and electrophoresis; and provide an elementary understanding of spectroscopy and radiotracer techniques.
CO4	**Describe** the principles of laboratory instruments, types of biosensors and microscopy, and the principles and applications of electrophoresis and radioisotopes.
CO5	**Summarize** the principles and types of pH meters, laminar airflow systems, and centrifugation techniques, and explain the applications of radioisotopes in biological research.
CO6	**Justify** the functions of basic laboratory instruments, microscopy, and biosensors; explain the principles and applications of chromatography; and discuss the biological applications of radioisotopes..

CO- PSO-PO Mapping:

Course	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. Microbiology (Discipline Specific Course)

Course code	**: MICDL-203**
Course Name	**: Biological Technique Lab course based on 203a**
Semester	**: II**

L	T	P	C
0	0	2	2

PRACTICALS

1. Separation and identification of amino acids by ascending and descending paper chromatography.
2. Separation and identification of sugars by paper chromatography.
3. Separation and identification of sugars by thin layer chromatography.
4. Verification of Lambert Beer's law.
5. Determination of molecular weight of DNA by agarose gel electrophoresis.
6. Separation and determination of molecular weight of proteins by SDS-PAGE.

Upon successful completion of the course a student will be able to

CO1	Know separation and identification of amino acids and sugars by different chromatographic techniques.
CO2	Understand the techniques for introduction of DNA into host cells and study its expression.
CO3	Gain knowledge of amplification of DNA by PCR
CO4	Learn to perform restriction digestion of DNA; RFLP
CO5	Learn to isolate genomic and plasmid DNA

CO- PSO-PO Mapping:

Course	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. MICROBIOLOGY (Generic Elective)

Course code	**: MICGE-204**
Course Name	**: VERMITECHNOLOGY**
Semester	**: III**

L	T	P	C
4	0	0	4

Course objectives:

1. To understand the biology and ecology of earthworms and their role in organic waste decomposition.
2. To learn the principles and methods of vermicomposting for sustainable waste management and soil enrichment.
3. To explore the applications of Vermitechnology in agriculture, environmental conservation, and organic farming.

UNIT-I Introduction to Vermiculture. definition, meaning, history, economic importance, their value in maintenance of soil structure, role as the four r's of recycling: reduce, reuse, recycle, restore.

UNIT-II Key to identify the species of earthworms. His role in bio transformation of the residues generated by human activity and the production of organic fertilizers. How does nature works

UNIT-III

Biology of Eisenia fetida. a) Taxonomy, Anatomy, physiology, and reproduction of Lumbricidae. b) Vital cycle of Eisenia fetida: alimentation, fecundity, annual reproductive potential, and limiting factors (gases, diet, humidity, temperature, PH, light, and climatic factors).

UNIT-IV

Biology of Eudrilus eugeniae. c) Taxonomy, Anatomy, physiology, and reproduction of Eudrilidae. d) Vital cycle of Eudrilus eugeniae: alimentation, fecundity, annual reproductive potential, and limiting factors (gases, diet, humidity, temperature, PH, light, and climatic factors).

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description
CO1	Define the basic concepts of vermitechnology, identify the species of earthworms, and describe their role in the biotransformation of residues generated by human activity and the production of organic fertilizers. Explain how nature facilitates these processes.
CO2	Explain and understand the species of earthworms and their role in the biotransformation of human-generated residues into organic fertilizers. Explore how nature supports and sustains these ecological functions.
CO3	Illustrate the identification of earthworm species and their role in transforming organic residues produced by human activities into fertilizers. Show how nature works to maintain ecological balance through these processes.
CO4	Explain the basic concepts of vermicomposting, identify the species of earthworms involved, and describe their role in the biotransformation of organic waste into fertilizers. Discuss how natural systems contribute to this transformation.
CO5	Summarize the fundamental concepts of vermitechnology, the identification of earthworm species, and their contribution to converting human-generated residues into organic fertilizers. Highlight the natural mechanisms that drive this process.
CO6	Create a conceptual model of vermitechnology that includes the identification of earthworm species and explains their role in the biotransformation of organic residues. Demonstrate how nature works to produce sustainable organic fertilizers.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. Microbiology (Skill Enhancement Course)

Course code	**: MICSC-205**
Course Name	**: MICROBIAL GENETICS**
Semester	**: II**

L	T	P	C
3	0	0	3

Course Objectives:The objectives of this course are

1. To understand the concept of genes.
2. To make student aware of mechanism of gene exchange in bacteria.
3. To gain knowledge about Mutation and Transposable Elements.

Course Content

Unit I: Essentials of Genetics
Genetic notations, Units of gene, Mutation and types of mutation, Spontaneous and induced mutations, molecular nature of mutation

Unit II: Plasmids
Bacterial plasmids: Types of plasmids, Fertility or F plasmid, resistance or R plasmid, col plasmid, degradative plasmid and virulence plasmids, plasmid replication, plasmid incompatibility, plasmid copy number, plasmid curing, plasmid amplification

Unit III: Mechanism of Gene Transfer
Transformation: Competence, Competence factors, Natural and Artificial transformation
Conjugation: F+ X F- mating, Hfr, Hfr X F-, and F', mechanism of conjugation.

Unit IV: Phage genetics
Bacteriophage: Life cycle of lytic phage (T4) and lysogenic phage (phage λ), Transduction (Mechanism of generalized and specialized transduction, LFT and HFT lysate)

Unit V: Transposable Elements
Transposition and its mechanism, Insertion Sequences, Replicative and Non-Replicative Transposons, Composite and Non composite transposons, Mu transposons, Uses of transposons

Text Books:

1. Weaver, R. F. (2012). *Molecular biology*. New York: McGraw-Hill. ISBN 0072345179.
2. P.S.VermaandV.K.Agarwal(2008).*Cell Biology, Genetics, Molecular Biology, Evolution, and Ecology*. S. Chand & Company Ltd, ISBN: 81-219-2442-1.
3. H Lodish *et* al (2016). *Molecular Cell Biology*. 8/e, Freeman, ISBN 9781464183393.
4. Stanley R. Maloy, John E. Cronan, David Frielfeder. Mivrobial Genetics. Naraso Publishing House.
5. R.C. Dubey and D.K. Maheshwari. Textbook of Microbiology. S.Chand & Co. Ltd.

Reference Books:

5. GM Cooper &REHausman.(2016).*The Cell Molecular Approach.* 7/e.ISBN978-1-60535-290-9.
6. JDWatson.(2013).*MolecularBiologyoftheGene*,7/e.Pearson.ISBN978-0321762436.
7. Benjamin Lewin, *Genes IX*. (2008). Publisher: J&B ISBN:0763752223

Course outcomes (COs):

Upon successful completion of the course, a student will be able to

CO1	Memorize the terms, discoveries and methods used in genetics.
CO2	Discuss genes, mutation, transposition and gene exchange in bacteria.
CO3	Identify different types of plasmids and bacteriophages and their role in transformation, conjugation and transduction
CO4	Correlate the knowledge of genes with mechanism of mutation and transposition, and plasmids with mechanism of transformation, transduction and conjugation.
CO5	Summarize the events that takes place in life cycles of bacteriophages and appreciate concept of genes and plasmids and gene transfer mechanism
CO6	Write about mechanism of genetic exchange, mutation and transposable elements.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. Microbiology (Ability Enhancement Course)

Course code	**: AEC-206**
Course Name	**EVS-2**
Semester	**: II**

L	T	P	C
2	0	0	2

Course Objectives:

1.To define and explain various techniques of word formation and develop skill so writing and vocabulary building .

2. To illustrate and elaborate fundamental techniques and features of writing skills.

3.To demonstrate and discuss various types of common error ecommitted by users of English and solve exercises to develop their understanding of grammatically correct sentence.

4. To organize language and work develop oral communication skills

Unit 1: Pollution

Introduction, Definitions and Causes and effects ,control measures of: Air pollution , Water pollution , Soil pollution ,Marine pollution ,Noise pollution ,Thermal pollution g. Nuclear pollution

Unit 2: Social Issues and the Environment

From unsustainable to sustainable development · Urban problems and related to energy · Water conservation, rain water harvesting, watershed management · Resettlement and rehabilitation of people; its problems and concerns. Case studies. · Environmental ethics: Issues and possible solutions · Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case studies. · Wasteland reclamation · Consumerism and waste products

Unit 3: Environment Pollution Act

Environmental Protection Act · Air (Prevention and Control of Pollution) Act · Water (Prevention and control of Pollution) Act · Wildlife Protection Act · Forest Conservation Act · Issues involved in enforcement of environmental legislation · Public awarenes

COURSE OUTCOMES (CO): On completion of this course the students will be able to:

CO	Description
CO1	Remember about pollution and its types,control,social issues of the environment and pollution acts.
CO2	Understand the various types of protection acts,pollution and social issues.
CO3	Explain the concept of control measures of pollution and social issues.
CO4	Explain types pollution and act of pollution.
CO5	Summariz the social issues,types of pollution and pollution act functions.
CO6	Develop generalized concept of pollution acts and social issues and pollutions.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. Microbiology (Value Addition Course)

Course code	**: VAC-207**
Course Name	**: Role of Microbes in Drug Discovery**
Semester	**: I**

L	T	P	C
2	0	0	2

Course Description:

This course explores the pivotal role of microbes in drug discovery, focusing on their natural biosynthetic capabilities and applications in developing novel therapeutics. Students will examine the historical context, methodologies, and modern advancements in microbial drug discovery, including antibiotic production, anticancer compounds, and the use of microbial metabolites in pharmaceuticals.

UNIT-I

Overview of microbial taxonomy and phylogeny, Importance of microbes in natural ecosystems, Discovery and development of antibiotics from microbes.

UNIT-II

Identification and development of microbial-derived anticancer agents, Role of microbial genomics in personalized medicine.

Recommended Reading:

1. "Microbial Natural Products: Drug Discovery" by Christine Beemelmanns and Pierre Stallforth
2. "Antibiotics: Challenges, Mechanisms, Opportunities" by Christopher Walsh and Timothy Wencewicz
3. "The Handbook of Microbial Metabolism of Xenobiotics" by Pankaj K. B. Mohan, J. Malcolm Murray, and Perumal Narayanasamy
4. "The Chemistry of Microbiomes: Proceedings of a Seminar Series" by Engineering National Academies of Sciences and Medicine
5. Research Articles and Journals: Current literature on microbial metabolites and drug discovery innovations.

COURSE OUTCOMES (CO): On completion of this course the students will be able to:

CO	Description
CO1	Understand the diversity of microbial life and its significance in ecosystems and drug discovery.
CO2	Describe microbial metabolism and its role in the biosynthesis of natural products.
CO3	Apply traditional and modern techniques for isolating and characterizing bioactive microbial compounds.
CO4	Analyze the discovery and development processes of antibiotics and antimicrobial agents from microbes.
CO5	Evaluate the role of microbial metabolites in developing anticancer and immunosuppressive drugs.

CO6	Discuss the therapeutic applications of microbial compounds in neurology and cardiovascular health.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Diploma Course in Microbiology
B. Sc. Microbiology (Discipline Specific Course)

Course code	**: MICDC-301**
Course Name	**: MOLECULAR BIOLOGY**
Semester	**: III**

L	T	P	C
3	0	0	3

Unit I: Nucleic acid and Chromosome Structure

Experimental evidences for nucleic acid as carrier of genetic information; Chemical properties of genetic material; Structure and types of DNA; Packaging of DNA into chromosome; Structure and functions of mRNA, tRNA and rRNA.

Unit II: Replication and Transcription

DNA replication: Meselson and Stahl's experiment, Enzymes involved in DNA replication, Mechanism of replication in prokaryotes and eukaryotes, Rolling circle model of replication; Transcription: Promoter, RNA polymerases, Mechanism of transcription in prokaryotes and eukaryotes, Post transcriptional modifications.

Unit III: Translation

Basic features of genetic code; Translation: Structure of ribosomes, Mechanism of translation in prokaryotes and eukaryotes.

Unit IV: Mutation and Repair Mechanism

Mutations: Types of mutations, Mutagens; DNA repair: Photoreactivation, Methyl directed mismatch repair, Nucleotide excision repair, Base excision repair, SOS system.

Unit V: Microbial Genetics

Transposition: Insertion sequences and transposable elements in prokaryotes and eukaryotes, Mechanism of transposition; Plasmids: Types; Gene transfer mechanisms: Basic idea of transformation, conjugation, and transduction.

Upon successful completion of the course, a student will be able to

CO 1	Define Nucleic acid, Chromosome Structure, Replication and Transcription, Mutation and Repair Mechanism, Translation, and Microbial Genetics.
CO 2	Generalize the concept of genetic material, enzymes in DNA replication, transcription, translation, and the concept of mutation and repair mechanisms
CO 3	Illustrate diagrammatically the Transcription and Translation mechanisms in prokaryotes and eukaryotes, the mutation and repair mechanisms
CO 4	Explain and differentiate between the types of nucleic acids, the role of enzymes involved in replication, transcription, and translation in prokaryotes and eukaryotes, types of mutation, and DNA repair methods.
CO 5	Summarize the process of replication, transcription, translation, mutation, and the repair mechanism.
CO6	Develop the structure of Nucleic acid and generalize the concept of molecular biology and microbial genetics.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. Microbiology (Discipline Specific Course)

Course code	**: MICDL-301**
Course Name	**: MOLECULAR BIOLOGY**
Semester	**: III**

L	T	P	C
0	0	2	2

Course Objectives: The objectives of this lab course are

1. To make students able to isolate DNA from bacterial culture and to visualize it by Agarose gel Electrophoresis.

2. To determine the quality of DNA and study the effect of pH and temperature on DNA.

3. To gain an understanding of the semi-conservative replication of DNA.

Practical's

1. Isolation of DNA from bacterial culture.
2. Visualization of DNA by Agarose Gel Electrophoresis.
3. Study of the effect of temperature on the denaturation of DNA.
4. Study of the effect of pH on the Study of different types of DNA and RNA using micrographs and model /schematic representations.
5. Study of semiconservative replication of DNA through micrographs/schematic representations.
6. Determination of the quality of DNA.
7. Quantitative estimation of DNA.
8. Quantitative estimation of RNA.
9. Isolation of genomic denaturation of DNA.

Upon successful completion of the course, a student will be able to

CO 1	State semi-conservative replication of DNA through micrographs/ schematic presentations. Visualize DNA by Agarose Gel Electrophoresis.
CO 2	Quantitatively estimate DNA and RNA, and illustrate the methods of isolation of genomic DNA.
CO 3	Determine the quality of DNA
CO 4	Determine the effect of temperature on denaturation of DNA and effect of pH on Study of different types of DNA and RNA .
CO 5	Test of quality of DNA
CO6	Create a competent cell

CO- PSO-PO Mapping:

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11	PO 12	PSO 1	PSO 2	PSO3	PSO4
CO1	1	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	1	2	1	2	2	1	1	2	2	1	2	2	2	2	1	3
CO5	2	2	1	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B.Sc. Microbiology (Discipline Specific Course)

Course code	**: MICDC-302**
Course Name	**: Food Processing and Preservation**
Semester /Year	**: I**

L	T	P	C
3	0	0	3

Course Objectives: The objectives of this course are

1. To provide scientific knowledge related to various techniques associated with Food and Beverages Biotechnology.
2. To impart laboratory skills for handling analytical tools in Food and Beverages industry and research institution.
3. To give the scientific knowledge regarding safety regulations for handling of instruments in the laboratory and industry.
4. To demonstrate the operating procedures associated with upstream and downstream process related to Food and Beverages.

Couse Contents

Unit 1

Food and Microorganism: Microorganism in food & beverage industry, contamination of food. General principles underlying spoilage and chemical changes

Unit 2

Contamination and spoilage of different kinds of food & beverages: Cereals & cereal products, sugar and sugar products, vegetables and fruits, meat, fish, poultry & eggs,sea food, milk & milk products, canned foods, Alcohol & alcoholic beverages fruit juices & soft drinks etc.

Unit 3

Biotechnology of food and feed; cultures & fermentation,Beverage production: Alcohol & alcoholic beverages, fruit furies, soft drinks, feed production, SCP, fats, amino acid, food additives.

Unit 4

Food, Beverages &Disease : Food borne illness due to bacterial food poisoning, infection and intoxication. Food-borne disease outbreaks, Disease-investigation, Materials & Equipments, laboratory testing, field analysis, interpretation of data and preventive measures.

Unit 5

Food hygiene: Food sanitation, Bacteriology of water and food products, and food manufacturing practice. Hazard Analysis Critical Points. Processing Industry and Microbial criteria of food. Principles of food preservation: Preservation by high temperature, low temperatures, Drying, Food additives, and Radiation.

Suggested Reading and Text Books

1. Food Sciences and Food Biotechnology- G.F.G. Lopez, G. Canaas, E.V.Nathan
2. Genetically Modified Foods- M.Ruse, D. Castle (Eds.)
3. Biotechnology of Food Crops in Developing Countries- T.Hohn and K.M. Leisinger (Eds.)
4. Biotechnology and Food Process Engineering- H.G. Schwartzberg, M.A. Rao (Eds.)
5. Food Biotechnology- (Eds.) R.Angold, G.A.Beech, J.Taggart.
6. Food Biotechnology—Microorganisms- (Ed.) Y.H. Hui et al.

Upon successful completion of the course, a student will be able to

CO 1	Define food microorganisms, food hygiene, and sanitization.
CO 2	Generalize the concept of food-borne illness, food, beverage, and disease.
CO 3	Illustrate diagrammatically different types of food spoilage.
CO 4	Explain and differentiate between the types of contamination of food products and their prevention.
CO 5	Summarize the process of food preservation and storage.
CO6	Develop the structure of food and Beverages and generalize the concept of Food Microbiology.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	3	2	2	1	1	2	2	1	2	2	2	2	2	1
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	1	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	1
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	1	1	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B.Sc. Microbiology (Discipline Specific Course)

L	T	P	C
0	0	2	2

1. Microbiological examination of food.
2. Assay of quality of milk sample using MBRT test.

Course code	**: MICDL-302**
Course Name	**: Food Processing and Preservation**
Semester /Year	**: I**

3. Adulteration tests for milk.
4. Microbial production of curd.
5. Isolation and identification of *Lactobacillus* from fermented dairy products.
6. Isolation and biochemical identification of microorganisms from contaminated food and dairy samples.
7. Production of sauerkraut.
8. Estimation of lactic acid production in sauerkraut.
9. Effect of salt concentration on lactic acid production in sauerkraut.

Upon successful completion of the course, a student will be able to

CO1	Identification of food-borne, environmental, and soil-borne diseases and detection of viral antigens in blood samples.
CO2	Interpretation of aerial photographs and data in GIS
CO3	Assess the quality of food, drugs, and environmental samples.
CO4	Characterize bacteria isolated from soil, food, and the environment.
CO5	Evaluate the production of lactic acid in sauerkraut.
CO6	Production of mushrooms.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	1	2
CO3	1	3	1	2	2	1	1	2	2	1	2	2	1	3	1	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	1	3
CO5	2	2	1	2	1	1	1	2	2	1	2	2	1	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	1	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc Microbiology (Discipline Specific Course)

Course code	**: MICDC 303**
COURSE NAME :	**CHEMISTRY-I**
Semester	**: III**

L	T	P	C
3	0	0	3

Course objectives: The course aims to teach the principles of chemistry. The specific objectives of the course are:

1. To teach students the basic concepts of chemistry.
2. To make students understand the importance of chemistry in sustainable development.
3. To teach students the fundamental principles of biocatalysis, photochemistry and electrochemistry.
4. To teach students about chemistry in daily practice.

UNIT I

Stereochemistry: Writing of Fischer projection, Newmann and Sawhorse projection and Wedge formulae. Interconversion of one type of structural representation into another type. Conformation: Restricted rotation about single bonds, Various conformations of ethane, butane and cyclohexane. Relative stability of different conformations in terms of energy difference is to be discussed for all these compounds. Geometrical Isomerism: Requirements for a molecule to show geometrical isomerism.

UNIT II

Alkenes and Alkynes: Hydrogenation, addition of halogens, Hydrohalogenation (Markovnikov's and anti-Markovnikov's addition), hydration, hydroxylation (cis and trans),oxy mercuration demercuration, hydroboration-oxidation, ozonolysis. Reactivity of alkenes vs alkynes.

UNIT III

Free radical substitution reactions: Halogenation of alkanes, allylic compounds and alkylbenzenes.

Nucleophilic substitution reactions: Alkyl, allyl and benzyl halides – substitution of halogen by some common nucleophiles. Mechanism of SN1 and SN2 reactions (stereochemistry, nature of substrate, nucleophile and leaving group).

UNIT IV

Elimination Reactions: Alkyl halides (dehydrohalogenation, Saytzeff's rule), vicinal dihalides(dehalogenation), alcohols (dehydration), Quaternary ammonium salts (Hofmann's elimination).Mechanism of E1 and E2 reactions (nature of substrate and base), elimination vs substitution. Oxidation Aromatic side chain: Oxidation with potassium permanganate, potassium dichromate Introduction and reactions of Alcohols, Aldehydes, Ketones and Nitro compounds

SUGGESTED READING AND TEXT BOOKS

1. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical OrganicChemistry, 5th Ed., Pearson (2012).
2. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Longman, London & New York.
3. Ahluwalia, V.K.; Dhingra, S. & Gulati, A. College Practical Chemistry, Universities Press.
4. I. L. Finar: Organic Chemistry (Vol. I & II), E. L. B. S.
5. R. T. Morrison & R. N. Boyd: Organic Chemistry, Pearson Education.
6. Arun Bahl and B. S. Bahl : Advanced Organic Chemistry, S. Chand
7. Peter Sykes: A Guide Book to Mechanism in Organic Chemistry, Orient Longman.
8. Eliel, E. L. & Wilen, S. H. Stereochemistry of Organic Compounds; Wiley: London, 1994.
9. **T. W. Graham Solomon's Organic Chemistry, John Wiley and Sons.**
10. P.S. Kalsi, Stereochemistry, Conformation and Mechanism, John Wiley and Sons.
11. Nasipuri, Stereochemistry of Organic Compounds, New Age International Publishers.

Course Outcomes (COs): On completion of this course ,the students will be:

CO	Description
CO1	**Describe** the different basic concepts of chemistry: stereochemistry, alkenes and alkynes, Aldehydes and ketones, Free radical substitution reactions, Nucleophilic substitution reactions, Electrophilic Substitution Reactions, Elimination Reactions and the different functional groups.
CO2	**Explain** the specific concepts of chemistry: stereochemistry, alkenes and alkynes, Aldehydes and ketones, Free radical substitution reactions, Nucleophilic substitution reactions, Electrophilic Substitution Reactions, Elimination Reactions and the different functional groups.
CO3	**Explain** the essential techniques and feature concepts of chemistry: stereochemistry, alkenes and alkynes, Aldehydes and ketones, Free radical substitution reactions, Nucleophilic substitution reactions, Electrophilic Substitution Reactions, Elimination Reactions and the different functional groups.
CO4	**Focus** on the concept of concepts of chemistry: stereochemistry, alkenes and alkynes, Aldehydes and ketones, Free radical substitution reactions, Nucleophilic substitution reactions, Electrophilic Substitution Reactions, Elimination Reactions and the different functional groups.
CO5	Summarize about analyzing, applying, remembering, and understanding the principle, methods, properties and functions of chemistry: stereochemistry, alkenes and alkynes, Aldehydes and ketones, Free radical substitution reactions, Nucleophilic substitution reactions, Electrophilic Substitution Reactions, Elimination Reactions and the different functional groups.
CO6	**Generalize** about the Evaluating, Analyzing, demonstrating, remembering, and understanding the Take part in essential techniques and features of chemistry: stereochemistry, alkenes and alkynes, Aldehydes and ketones, Free radical substitution reactions, Nucleophilic substitution reactions, Electrophilic Substitution Reactions, Elimination Reactions and the different functional groups.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	1	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	1	2	2	2	2	1	1	2	2	1	2	2	2	1	1	1

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. Microbiology (Discipline Specific Course)

Course code	**: MICDL-303**
Course Name	**: Lab Course Based on MICDC 303**
Semester	**: III**

L	T	P	C
0	0	2	2

Practicals

1. Purification of organic compounds by crystallization using the following solvents: (a) Water (b) Alcohol

2. Determination of the melting points of organic compounds (by the Kjeldahl method and electrically heated melting point apparatus).

3. Determination of optical- 1g of starting compound. Recrystallize the product and determine the melting point of activity by using a polarimeter. Organic preparations: Carry out the following preparations using 0.5 of the recrystallized sample.

4. To prepare acetanilide by the acetylation of aniline.

5. To prepare p-bromoacetanilide.

6. Benzolyation of aniline or β-naphthol by the Schotten-Baumann reaction

7. Hydrolysis of benzamide or ethyl bezoate.

8. Semicarbazone derivative of one the following compounds: acetone, ethyl methylketone, diethylketone, cyclohexanone, benzaldehyde.

9. Nitration of nitrobenzene.

10. Oxidation of benzaldehyde by using alkaline potassium permanganate.

CO	Description
CO1	Identify and describe the concept of Chemistry and the analysis of chemical compounds..
CO2	Explain the specific and basic concepts of chemistry, sustainable development, Biocatalysis, Photochemistry, electrochemistry, and fuel cells**.**
CO3	.Determine and write about the concepts of Chemistry, sustainable development, biocatalyst, Photochemistry, electrochemistry, and fuel cells.
CO4	Focus on the concept of chemistry and its principles, sustainability parameters, biocatalyst, and the Impact of green process technology on the chemical industry.
CO5	.Summarize about Chemistry, sustainable development, biocatalyst, Photochemistry, electrochemistry, and fuel cells.
CO6	Generalize the basics of chemistry and its principles, sustainability parameters , biocatalyst and Impact of green process technology on the chemical industry.

CO- PSO-PO Mapping:

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11	PO 12	PSO 1	PSO 2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	1	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	1	2	1	2	2	1	1	2	2	1	2	1	1	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	1	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	1	2	2	1	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. MICROBIOLOGY (Generic Elective)

Course code	**: MICGE-304**
Course Name	**: Animal Biotechnology**
Semester	**: III**

L	T	P	C
3	0	0	3

Course objectives: The course aims to make students gain knowledge in the current trends and techniques in animal biotechnology. The specific objectives of the course are as follows:

1. To develop an understanding about animal cell culture and gene delivery methods in animals.
2. To provide an overview in-vitro fertilization, embryo transfer methods and other related techniques.
3. To gain knowledge about the stem cell sand their various applications
4. To learn about the production of transgenic animals and gene therapy and their applications.

UNIT I

Gene transfer methods in Animals – Microinjection, Embryonic Stem cell, gene transfer, Retrovirus & Gene transfer.

UNIT II

Introduction to transgenesis. Transgenic Animals – Mice, Cow, Pig, Sheep, Goat, Bird, Insect. Animal diseases need the help of Biotechnology – Foot-and-mouth disease, Coccidiosis, Trypanosomiasis, Theileriosis.

UNIT III

Animal propagation – Artificial insemination, Animal Clones. Conservation Biology – Embryo transfer techniques. Introduction to Stem Cell Technology and its applications.

UNIT IV

Genetic modification in Medicine - gene therapy, types of gene therapy, vectors in gene therapy, molecular engineering, human genetic engineering, problems & ethics.

SUGGESTED READING AND TEXT BOOKS

1. Brown, T.A. (1998). Molecular biology Labfax II: Gene analysis. II Edition. Academic Press, California,USA.

2. Butler, M. (2004). Animal cell culture and technology: The basics. II Edition. Bios scientific publishers.

3. Glick, B.R. and Pasternak, J.J. (2009). Molecular biotechnology- Principles and applications of recombinant DNA. IV Edition. ASM press, Washington, USA.

4. Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M. (2009). An introduction to genetic analysis. IX Edition. Freeman & Co., N.Y., USA.

5. Watson, J.D., Myers, R.M., Caudy, A. and Witkowski, J.K. (2007). Recombinant DNAgenes and genomes- A short course. III Edition. Freeman and Co., N.Y., USA.

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description
CO1	Define a gene transfer methods in animals, transgenesis, animal diseases need help of biotechnology, animal propagation and genetic modification in medicine.
CO2	**Explain** basic concepts of animal biotechnology, gene transfer methods in animals, transgenesis, animal diseases need help of biotechnology, animal propagation and genetic modification in medicine..
CO3	**Illustrate** the detailed processes, essential techniques for identification and features of animal biotechnology, gene transfer methods in animals, transgenesis, animal diseases need help of biotechnology, animal propagation and genetic modification in medicine.
CO4	**Explain** the detailed study related to animal biotechnology, gene transfer methods in animals, transgenesis, animal diseases need help of biotechnology, animal propagation and genetic modification in medicine.
CO5	**Summarize** the animal biotechnology, gene transfer methods in animals, transgenesis, animal diseases need help of biotechnology, animal propagation and genetic modification in medicine.
CO6	**Create**, gene transfer methods in animals, transgenesis, animal diseases need help of biotechnology, animal propagation and genetic modification in medicine.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	1	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	1	2	1	2	2	1	1	2	2	1	2	1	1	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	1	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	1	2	2	1	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. MICROBIOLOGY (Skill Ability course)

Course code	:	**MICSC-305**
Course Name	:	**Computational Biology & Bio-informatics**
Semester	:	**III**

L	T	P	C
2	0	0	2

UNIT-1 Introduction to Genomics **-** information flow in biology, DNA sequence data, Experimental approach to genome sequence data, genome information resources.

UNIT-II. Functional Proteomics **-** protein sequence and structural data, protein information resources, and secondary databases.

UNIT-III Computational Genomics **-** Internet basics, biological data analysis and application, sequence databases, NCBI model, file format.

UNIT IV Sequence alignment & database search **-** Protein primary sequence analysis, DNA sequence analysis, pairwise sequence alignment, FASTA algorithm, BLAST, multiple sequence alignment, Database searching using BLAST and FASTA.

UNIT-V Structural databases **-** Small molecules databases, protein information resources, protein data ban

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description
CO1	**Understand and explain the fundamental concepts of genomics**, including the flow of biological information, DNA sequence data, experimental approaches to genome sequencing, and genome information resources.
CO2	Analyse and interpret functional proteomics data, focusing on protein sequences, structural data, and the use of primary and secondary protein information resources.
CO3	**Apply computational genomics techniques** to biological data analysis, utilizing sequence databases, the NCBI model, and various file formats for effective data management and application.
CO4	**Perform sequence alignment and database searches**, including protein and DNA sequence analysis, pairwise sequence alignment, and the use of algorithms such as FASTA and BLAST for multiple sequence alignment and database searching.
CO5	**Utilize structural databases** to analyze small molecules, protein information resources, and protein data banks for understanding molecular structures and interactions.
CO6	**Integrate knowledge of genomics, proteomics, and computational tools** to design and execute advanced biological data analyses, leveraging sequence alignment techniques and structural databases for research and application in bioinformatics.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. Microbiology (Ability Enhancement Course)

Course code	**: AEC-306**
Course Name	**: English Communication -II**
Semester	**: III**

L	T	P	C
2	0	0	2

Course objectives: The course is designed to give an overview and applications of different molecular biology technique used in disease diagnosis. The specific objectives of the course are:

1. To teach students different molecular techniques used for disease diagnosis.
2. To make students understand the utilization of these techniques in disease diagnosis.
3. To teach the use of different enzyme immunoassay based diagnostic methods.
4. To impart the knowledge about the molecular diagnostic of different human diseases.

Unit I: Introductory English Grammar:
Parts of Speech, Tenses, Punctuation, Common Errors in English.
Unit II: Writing Skills; Social and Official Correspondence:
Enquiries, Complaints and Replies, Letters to the Editor, Social Appeals in the Form of Letter/ Pamphlets, Standard Business Letter, Email Drafting and Etiquettes, Preparing Agenda and Writing Minutes for Meetings.

Unit III: Career Skills:
Job Application, Cover Letter, Bio-data, CV and Resume and Effective Profiling, Mock Interviews, Group Discussions.

SUGGESTED READINGS AND TEXT BOOKS
1. Fluency in English- Part II, Oxford University Press, 2006.

2. Business English, Pearson, 2008.
3. Language, Literature and Creativity, Orient Blackswan, 2013.
4. Language through Literature (Forthcoming) ed. Dr. Gauri Mishra, Dr. Ranjhana Kaul, Dr. Brati Biswas.

COURSE OUTCOMES (CO): On completion of this course, the students will be able to:

CO	Description
CO1	Remember about the mode of communication, listening, and writing skills.
CO2	Understand the concept of communication and the features of writing skills
CO3	Explain the concept of writing and social skills.
CO4	Explain types of communication, including official correspondence.
CO5	Summarize the skill of communication.
CO6	Develop a generalized concept of fundamental techniques and features of writing skills.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. Microbiology (Value Addition Course)

Course code	**: VAC-307**
Course Name	**: Sustainable Practices in Microbiology**
Semester	**: I**

L	T	P	C
2	0	0	2

Description:

This course explores sustainable practices in microbiology, emphasizing microbial processes that contribute to environmental sustainability and resource management. Topics include bioremediation, waste management, renewable energy production, and sustainable agricultural practices. The course aims to equip students with the knowledge and skills to apply microbiological principles to address global sustainability challenges**.**

UNIT-I

Principles of bioremediation and microbial degradation, Microbial treatment of pollutants and hazardous waste, Microbial biotechnology in environmental sustainability.

UNIT-II

Microorganisms in composting and recycling processes, Microbial production of biofuels (e.g., bioethanol, biodiesel, biogas), Future trends in sustainable microbiological practices

COURSE OUTCOMES (CO): On completion of this course the students will be able to:

CO	Description
CO1	Understand the principles of bioremediation and evaluate microbial processes for environmental cleanup.
CO2	Discuss innovations in microbial technology and their implications for promoting environmental sustainability.
CO3	Analyze the role of microorganisms in waste management and develop sustainable waste reduction strategies.
CO4	Evaluate the role of microorganisms in sustainable agriculture and apply microbial technologies for enhanced crop production
CO5	Explore the potential of microbes in renewable energy production and assess their contributions to sustainable energy solutions.
CO6	Summarize the future trends in sustainable microbiological practices.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	1	1	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	1	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	1	2	1	1	2	2	1	2	2	2	2	3	3
CO5	1	1	2	1	1	1	1	2	2	1	2	2	2	2	2	1
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc Microbiology

Course code	**: BBTVC 308**
Course Name	**: Indian Knowledge System**
Semester /Year	**: III**

L	T	P	C
2	0	0	2

Course Objectives: The objectives of this course are

1. To document, preserve, and promote India's rich heritage of traditional knowledge across disciplines such as philosophy, medicine, literature, agriculture, and architecture.
2. To foster interdisciplinary and transdisciplinary research by integrating ancient Indian wisdom with contemporary academic and scientific frameworks.
3. To encourage the application of traditional ecological, health, and lifestyle practices—like Ayurveda, Yoga, and conservation methods—for addressing modern challenges such as climate change, mental health, and sustainability.
4. To cultivate a deeper understanding of Indian civilization's contributions and worldview, empowering learners to approach global issues through an indigenous lens rooted in timeless values and experiential knowledge.

Unit 1

Introduction to Indian Knowledge System (IKS), Definition, Concept and Scope of IKS: Definition, Concept and Scope of IKS, IKS based approaches on Knowledge Paradigms, IKS in ancient India and in modern India. IKS and Indian Scholars, Indian Literature**:** Philosophy and Literature (Maharishi Vyas, Manu, Kanad, Pingala, Parasar, Banabhatta, Nagarjuna and Panini), Mathematics and Astronomy (Aryabhatta, Mahaviracharya, Bodhayan, Bhashkaracharya, Varahamihira and Brahmgupta), Medicine and Yoga (Charak, Susruta, Maharishi Patanjali and Dhanwantri), Sahitya (Vedas, Upvedas, Upavedas (Ayurveda, Dhanurveda, Gandharvaveda) Puran and Upnishad) and shad darshan (Vedanta, Nyaya.Vaisheshik, Sankhya, Mimamsa, Yoga, Adhyatma and Meditation), Shastra (Nyaya, vyakarana, Krishi, Shilp, Vastu, Natya and Sangeet)

Unit 2

Indian Traditional/tribal/ethnic communities, their livelihood and local wisdom: Geophysical aspects, Resources and Vulnerability, Resource availability, utilization pattern and limitations, Socio-Cultural linkages with Traditional Knowledge System, Tangible and intangible cultural heritage. Unique Traditional Practices and Applied Traditional Knowledge: Myths, Rituals, Spirituals, Taboos and Belief System, Folk Stories, Songs, Proverbs, Dance, Play, Acts and Traditional Narratives; Agriculture, animal husbandry, Forest, Sacred Groves, Water Mills, Sacred Water Bodies, Land, water and Soil Conservation and management Practices; Indigenous Bio-resource Conservation, Utilization Practices and Food Preservation Methods, Handicrafts, Wood Processing and Carving,-Fiber Extraction and Costumes; Vaidya (traditional health care system),Tantra-Mantra, Amchi Medicine System; Knowledge of dyeing, chemistry of dyes, pigments and chemicals

Unit 3

Protection, preservation, conservation and Management of Indian Knowledge System: Documentation and Preservation of IKS; Approaches for conservation and Management of nature and bio-resources; Approaches and strategies to protection and conservation of IKS.

Suggested Reading and Text Books

1. Introduction to Indian Knowledge System: Concepts and Applications**:** B. Mahadevan, Vinayak Rajat Bhat, R.N. Nagendra

Pavana.

2. Rediscovering Indian Knowledge System**:** Satish Kulkarni (Editor), Pranay Abhang, Pramod Moghe, Prashant Holay (Research and Compilation).
3. Indian Knowledge Systems **(Vol. 1 & 2):** Kapil Kapoor.
4. Ancient Indian Knowledge System : Archaeological Perspective**:** Dr. Vasant Shinde.
5. An Introduction to Indian Philosophy**:** Satishchandra Chatterjee.
6. Ancient Indian Knowledge: Implications To Education System**:** Boski Singh.

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description
CO1	Understand the definition, concept, and scope of the Indian Knowledge System and its relevance in ancient and modern India.
CO2	Identify key Indian scholars and their contributions across literature, philosophy, mathematics, astronomy, and medicine.
CO3	Analyze the role of Indian scriptures and classical texts (Vedas, Upvedas, Puranas, Upanishads) in shaping knowledge paradigms.
CO4	Examine traditional practices and indigenous knowledge systems among tribal and ethnic communities in India.
CO5	Evaluate the socio-cultural linkages and ecological wisdom embedded in traditional livelihoods and conservation methods.
CO6	Apply strategies for documentation, preservation, and sustainable management of Indian Knowledge Systems.

Mapping of COs with POs & PSOs

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**: MICDC-401(Discipline Specific Course)**
Course Name	**: Industrial Microbiology**
Semester	**: IV**

L	T	P	C
3	0	0	3

UNIT-I Introduction to Industrial microbiology
Brief history and developments in industrial microbiology, Design of fermenters, Types of fermentation processes - solid state, liquid state, batch, fed-batch and continuous Types of fermenters – laboratory, pilot-scale and production fermenters, Components of a typical continuously stirred tank bioreactor.

UNIT-II Isolation of Industrial Strains and Fermentation Medium
Primary and secondary screening, Preservation and maintenance of industrial strains, Ingredients used in fermentation medium - molasses, corn steep liquor, whey and Yeast extract **.**
UNIT-III Microbial fermentation processes
Downstream processing - filtration, centrifugation, cell disruption, solvent extraction. Microbial production of industrial products - citric acid, ethanol and penicillin. Industrial production and uses of the enzymes - amylases, proteases, lipases and cellulases

UNIT-IV Modern trends in microbial production
Modern trends in microbial production of bioplastics, bioinsectices (thuricide), biopolymer, Biofertilizers.

Food Fermentation
UNIT -V An introduction to food fermentation, factors affecting, fermentation in food, production of cheese, curd, yogurt, wine and beer, Kefir koumiss.

SUGGESTED READINGS

1. Hershnergev, C.L., Queener, S.W. and Hedemen, Q. Genetics and biotechnology of industrial microorganisms. ASM Press, Washington, D.C.
2. Crueger, W. and Crueger, A. Biotechnology: A textbook of industrial microbiology. Sinauer Associates, Sunderland.
3. Reed, G. Prescott and Dunn's industrial microbiology. Globe Bookservices, London.
4. Demain, A.L and Davies, J.E. Manual of industrial microbiology and biotechnology. ASM Press, Washington, D.C.
5. Casida, J.E. Industrial microbiology. Wiley Eastern, New Delhi.
6. Patel, A.H. Industrial microbiology. MacMillan India Limited, New Delhi.
7. Stanbury, A.H., Whittaker, A. and Hall, S.J. Principles of fermentation technology. Pergamon Press, Oxford.
8. Richard, H., George, B., Hagemann, D. and Paul, L. Industrial microorganisms: Basic and applied molecular genetics. ASM Press, Washington, D.C.

Upon successful completion of the course, a student will be able to

CO1	Define Basic Aspects of Fermentation, Introduction to Industrial Microbiology, Antibiotic production and Quality Assurance and Vvalidation
CO2	Summarize basic structure and function of fermenter, strain improvement and QA and QC

CO3	Write about fermentation, concept of strain improvement, antibiotic production and Guidelines for QA and QC (GMP)and (GLP)in pharmaceutical industry.
CO4	Explain the basic concept of fermenter, Strategies for strain improvement: Production of antibiotic and Quality Assurance and Validation.
CO5	Summarize the concept of Industrial and Pharmaceutical Microbiology.
CO6	Compile and write about the study of Industrial and Pharmaceutical Microbiology.

Mapping of COs with POs & PSOs

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. Microbiology

Course code	**: MICDL-401(Discipline Specific Course)**
Course Name	**: Industrial Microbiology (Lab Course Based on MICDC-401)**
Semester	**: IV**

L	T	P	C
0	0	2	2

1. Isolation and screening of bacterial and fungal cultures for enzyme production.
2. Estimation of enzyme production by microbial culture *via* liquid state fermentation.
3. Estimation of enzyme production by microbial culture *via* solid state fermentation.
4. Mediaformulationforenhancedenzymeproductionbymicrobialculture*via* liquid and solid state fermentation.
5. Optimizationofcultureconditionsforenhancedenzymeproductionbymicrobialculture *via* liquid and solid state fermentation.
6. Production of wine from fruit juice.
7. Monitoring of sugar reduction during wine production.

CO1	Identify and memorize Biosafety guidelines and biosafety levels.
CO2	Production, monitoring, and Estimation of wine.
CO3	Determination of the Isolation, biochemical characterization, and antimicrobial susceptibility of pathogenic bacteria/fungi /clinical specimens.
CO4	Experiment to determine MIC and MBC concentration of antibiotics by the broth dilution test.
CO5	Estimate enzyme production by bacterial and fungal cultures.
CO6	Formulation of media for enzyme production by microbial cultures.

CO- PSO-PO Mapping:

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11	PO 12	PSO 1	PSO 2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	1	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	1	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc Microbiology

Course code	**: MICDC-402 (Discipline Specific Course)**
Course Name	**: FOOD &DAIRY MICROBIOLOGY**
Semester	**: IV**

L	T	P	C
3	0	0	3

Course Objectives: The objectives of this course are

1. **To aware the student principles of food preservation.**
2. **To make student to aware spoilage of fermented foods**
3. **To aware the student Food Safety and Quality Assurance**

Course Content

Unit I: Food as a substrate for microbial growth

Microbial growth in food- Intrinsic and extrinsic factors, Microorganisms important in food industry: Molds yeast, Bacteria-General characteristics, classification and importance.

Unit II: Food Preservation

Principles of food Preservation, Methods of food preservation-Physical methods-asepsis, high temperature, low temperature, drying, Smoking. Chemical methods (chemical preservatives and food additives), canning.

Unit III: Food borne diseases

Infection and Intoxication of *Clostridium*, *Escherichia, Staphylococcus and salmonella*

UNIT IV: Contamination and spoilage of foods

Contamination of food from green plants and fruits/animal/sewage/soil/water/air/during handling and processing. Causes of spoilage in food.
Characterization of contamination and spoilage of cereals, vegetables, fruits, milk and meat. Spoilage of canned foods.

Unit V: Dairy Microbiology

Normal flora of milk and milk products, Fermented milk products: Acidophilus milk, yoghurt, cheese and determination of quality of milk by MBRT and Resazurin test. Probiotics-definition, examples and benefits.

References

1.Adams, M.R., and Moss, M.O. Food microbiology. Royal Society of Chemistry Publication, Cambridge.
2. Frazier, W.C. and Westhoff, D.C. Food microbiology. Tata McGraw-Hill, New Delhi.
3. Stanbuty, P.F. and Hall, S.J. Principles of fermentation technology. Pergamon Press, Oxford.
4. Banwart, G.J. Basic food microbiology.CBS Publishers and Distributors, New Delhi.
5. Robinson, R.K. Dairy microbiology. Elsevier Applied Sciences, London.
6. James M.J. Modern food microbiology. CBS Publishers and Distributors, New Delhi.

Text Books:

1. Adams, M.R.,andMoss, M.O.Foodmicrobiology.Royal Society of Chemistry Publication, Cambridge
2. Frazier, W.C. and Westhoff, D.C. Food microbiology. Tata McGraw-Hill, New Delhi.
3. Stanbury, P.F., and Hall, S.J. Principles of fermentation technology. Pergamon Press, Oxford.

Reference Books

1. Banwart, G.J. Basic food microbiology. CBS Publishers and Distributors, New Delhi.
2. Robinson, R.K. Dairy microbiology. Elsevier Applied Sciences, London.
3. James M.J. Modern food microbiology. CBS Publishers and Distributors, New Delhi.
4. Wood, B.J. Microbiology of fermented foods. Elsevier Applied Sciences, London
5. . Ayres, J.C., Mundt, O., and Sandinee, W.E. Microbiology of foods. W.H. Freeman and Company, New

Course outcomes:
Upon successful completion of the course, a student will be able to:

CO1	Define microorganisms in food, factors affecting growth of microbes in food, Principles of Food Preservation**,** canning, Contamination and Spoilage, Food-borne Infections and Intoxications, Dairy microbiology and probiotics.
CO2	Describe microorganisms in food, factors affecting the growth of microbes in food, principles and methods of Food Preservation, and canning. Factors influencing microbial growth, Characterization of contamination and spoilage of different food products, explain and differentiate between infection and intoxication, and dairy microbiology and probiotics.
CO3	Write about microorganisms in food, factors affecting the growth of microbes in food, Principles of Food Preservation**,** canning, Contamination and Spoilage, Food-borne Infections and Intoxications, dairy microbiology, and probiotics.
CO4	Explain the detailed understanding about microorganisms in food, factors affecting growth of microbes in food, Principles of Food Preservation**,** canning, Contamination and Spoilage, Foodborne Infections and Intoxications, dairy microbiology and probiotics.
CO5	Summarize the concept of food and dairy microbiology
CO6	Compile and write about the study of food and dairy microbiology.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B Sc. Microbiology.

Course code	**: MICDL-402(Discipline Specific Course)**
Course Name	**: FOOD & DAIRY MICROBIOLOGY**
Semester	**: IV**

L	T	P	C
0	0	2	2

1. Assay of quality of milk sample using MBRT test.
2. Adulteration tests for milk.
3. Microbial production of curd.
4. Isolation and identification of *Lactobacillus* from fermented dairy products.
5. Isolation and biochemical identification of microorganisms from contaminated food and dairy samples.

6. Production of sauerkraut.

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11	PO 12	PSO 1	PSO 2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	1	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	1	1	1	2	1	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	1	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	1	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	1	2

7. Estimation of lactic acid production in sauerkraut.

8. Effect of salt concentration on lactic acid production in sauerkraut.

Course outcomes:
Upon successful completion of the course, a student will be able to:

CO1	Define Principles of Food Preservation,
CO2	Describe principles and methods of Food Preservation and production in sauerkraut.
CO3	Write about Principles of Food Preservation technique.
CO4	Explain and demonstrate of Microbiological examination of food .
CO5	Summarize the concept of food and dairy microbiology
CO6	Compile and write about the study of food and dairy microbiology.

CO- PSO-PO Mapping:

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B Sc. Microbiology.

Course code	**: MICDE-403**
Course Name	**: Enzymology**
Semester	**: IV**

Course objectives: The course aims to impart the knowledge about fundamental principles ofenzyme reactions, and applications of enzyme engineering. The specific objectives of the course are:

1. To help students understand the mechanism of enzyme action**.**
2. To teach students the Michaelis–Menten equation and its application in enzyme kinetics**.**
3. To explain the regulation of enzyme activity and kinetics**.**
4. To impart knowledge about enzyme engineering and its industrial and biotechnological applications**.**

UNIT - I
Isolation, crystallization and purification of enzymes, test of homogeneity of enzyme preparation, methods of enzyme analysis. Enzyme classification (rationale, overview and specific examples) Zymogens and their activation (Proteases and Prothrombin). Enzyme substrate complex: concept of E-S complex.

UNIT – II
Two substrate reactions (Random, ordered and ping-pong mechanism) Enzyme inhibition types of inhibition, determination of Ki, suicide inhibitor. Mechanism of enzyme action.

UNIT – III
Allosteric enzymes., Isoenzymes– multiple forms of enzymes with special reference to lactate dehydrogenase. Multienzyme complexes. Ribozymes. Multifunctional enzyme-eg Fatty Acid synthase.

UNIT – IV
Enzyme technology: Methods for large scale production of enzymes. Immobilized enzyme and their comparison with soluble enzymes, Methods for immobilization of enzymes. Immobilized enzyme reactors. Application of Immobilized and soluble enzyme in health and industry. Application to fundamental studies of biochemistry. Enzyme electrodes.

SUGGESTED READING AND TEXT BOOKS
1. Biochemistry, Lubert Stryer, 6th Edition, WH Freeman, 2006.
2. Harper's illustrated Biochemistry by Robert K. Murray, David A Bender, Kathleen M.Botham, Peter J. Kennelly, Victor W. Rodwell, P. Anthony Weil. 28th Edition,McGrawHill, 2009.
3. Biochemistry, Donald Voet and Judith Voet, 2nd Edition, Publisher: John Wiley andSons,1995.
4. Biochemistry by Mary K.Campbell & Shawn O.Farrell, 5th Edition, Cenage Learning,2005.
5. Fundamentals of Enzymology Nicholas Price and Lewis Stevens Oxford University Press 1999
6. Fundamentals of Enzyme Kinetics Athel Cornish-Bowden Portland Press 2004.
7. Practical Enzymology Hans Bisswanger Wiley–VCH 2004
8. The Organic Chemistry of Enzyme-catalyzed Reactions Richard B. Silverman Academic Press 2002

Course outcomes:

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

CO	Description
CO1	Recall the basic concepts of enzyme isolation, crystallization, purification, classification, and kinetics.
CO2	Describe the mechanisms of enzyme kinetics, including two-substrate reactions and allosteric regulation.

CO3	Utilize enzyme technology concepts in solving real-world biochemical problems.
CO4	Compare and contrast different methods of enzyme purification and classification.
CO5	Evaluate enzyme performance based on kinetic parameters and regulatory mechanisms.

Course Outcomes (COs): On completion of this course, the students will be:

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	1
CO3	1	1	2	1	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	1	2	1	1	1	2	2	1	2	2	2	2	3	1
CO5	2	1	2	1	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. Microbiology (Discipline Specific Elective)

Course code	**: MICDL-403**
Course Name	**: Lab Course Based on MICDE-403**
Semester	**: IV**

L	T	P	C
0	0	2	2

Practical's

1. Method of isolation of plant and animal enzymes.
2. Separation of amino acids by paper chromatography
3. To determine the concentration of glycine solution by formylation method.
4. Study of titration curve of amylase
5. Action of salivary amylase on starch
6. Effect of temperature on the action of salivary amylase on starch.

CO	Description
CO1	Demonstrate the method of isolating enzymes from plant and animal sources using standard laboratory techniques.
CO2	perform paper chromatography to separate and identify amino acids based on their chemical properties.
CO3	Determine the concentration of glycine solution using the formylation method and interpret the results.
CO4	Analyse the titration curve of amylase to understand its buffering capacity and enzyme behaviour.
CO5	Examine the enzymatic action of salivary amylase on starch and assess its efficiency under controlled conditions.
CO6	Investigate the effect of temperature on salivary amylase activity and interpret the impact on enzyme kinetics.

CO- PSO-PO Mapping:

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11	PO 12	PSO 1	PSO 2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. Microbiology (Generic Elective)

Course code	**: MICGE-404**
Course Name	**: Mycology**
Semester	**: IV**

L	T	P	C
4	0	0	4

Course Objectives: The objectives of this course are
Learning about the detailed structure (morphology and microscopy) and characteristics of fungi.

UNIT-I -History of Mycology, Classification of fungi, Morphology, microscopy and structure of fungi,

UNIT-II General Overview Phylum: - Chytridiomycota (The chytrids),Zygomycota(The conjugated fungi),Ascomycota (The sac fungi),Basidiomycota (The club fungi) Deuteromycete (The imperfect fungi, Zygomycota (The conjugated fungi, Ascomycota (The sac fungi),Basidiomycota (The club fungi),

UNIT-III Deuteromycete, Symbiotic association of fungi, Nutrition requirements. Symbiotic association of fungi, Nutrition requirements

UNIT-IV Rusts and Smuts, Fungal diseases of plants and humans

UNIT- V Application of fungi (Mushroom, *Penicillium, Aspergillus, Monasus, Trichoderma*) in various industrial sectors.

Text Books:

1. Atlas,R.M.andBartha,R.Microbialecology:Fundamentalsandapplications.Benjamin/CummingsSciencePublishing,USA.
2. Evans,G.M.andJohn,J.C.F.Environmentalbiotechnology:Theoryandapplications.JohnWileyandSons,NewYork.

Reference Books:

1. Da Silva, N., Taniwaki, M. H., Junqueira, V .C., Silveira, N., Nascimento, M.S., Gomes,

R.A.R. Microbiological examination methods of food and water: A laboratory manual. CR C Press, Boca Raton.

2. **Madigan, M.T., Martinko, J.M., and Parker, J. Brock biology of microorganisms. Prentice Hall, New Jersey.**
3. **Mitchell, R., and Gu, J.D.Environmental Microbiology.Wiley-Blackwell, New Jersey.**
4. **Maier,R., Pepper, I., and Gerba,C.Environmental Microbiology.AcademicPresSanDiego.**
5. **Hurst,C.J., Crawford, R.L., Garland,J.L., Lipson, D.A.,Mills, A.L., and Stetzenbach, L.D.Manual of environmental microbiology. ASM Press, Washington, D.C.**

Upon successful completion of the course, a student will be able to

CO 1	Identify and examine airborne microorganisms, Air Sample, Water sample, Control Measures.
CO 2	Summarize the impact of airborne, waterborne pathogens and their impact on human and the environment
CO 3	Determine sampling, collection methods and control measures for air borne and water borne pathogens
CO 4	Isolation of airborne and water borne pathogens from PDA Plate.
CO 5	Consider different sampling, collection and control measures for air borne and water borne microorganisms.
CO6	Generalize the concept of air and water microbiology.

CO- PSO-PO Mapping:

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11	PO 12	PSO 1	PSO 2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc Microbiology (Skill Enhancement Course)

Course code	**: MICSC-405**
Course Name	**:** Food Fermentation Technique
Semester	**: IV**

L	T	P	C
2	0	0	2

Unit I: Fermented Foods No. of Hours: 05 Definition, types, advantages and health benefits of fermented foods; Probiotics.

Unit II: Milk Based Fermented Foods

Preparation of inoculums, microorganisms and production process: Dahi, Yogurt, Buttermilk, Cheese.

Unit III: Grain Based Fermented Foods

Microorganisms and production process: Soy sauce, Bread, Idli, Dosa.

Unit IV: Vegetable Based Fermented Foods

Microorganisms and production process: Pickle, Sauerkraut.

Unit V: Fermented Meat and Fish Products

Microorganisms and production process: Sausages and sauces.

TextBooks:

1. .Frazier, W.C.and Westh off, D. C. Food Microbiology .Tata McGraw Hill, New Delhi

ReferenceBooks:

2. Adams, M.R. and Moss, M.O. Food microbiology. Royal Society of Chemistry Publication, Cambridge.
3. Stanbuty, P.F. and Hall, S.J. Principles of fermentation technology. Pergamon Press, Oxford.
4. Robinson, R.K. Dairy Microbiology. Elsevier Applied Sciences, London
5. James M.J. Modern food microbiology. CBS Publishers and Distributors, New Delhi.
6. Wood, B.J. Microbiology of fermented foods. Elsevier Applied Sciences , London
7. Ayres, J.C., Mundt, O. and Sandinee, W.E. Microbiology of foods. W.H. Freeman and Company, New York.
8. Hui,Y. H.,Meunier Goddik,L., Josephsen,J.,Nip,W.K.and Stanfield,P.S. Handbook of food and fermentation technology. CRCPress, Boca Raton.

Upon successful completion of the course a student will be able to

CO 1	Define fermented foods and state its importance, recognize milk based, grain based, meat and vegetable based fermented foods
CO 2	Describe types and health benefits of fermented foods, microorganisms involved in fermented foods.
CO 3	Illustrate the methods involved in the production of fermented foods.

CO 4	Differentiate between the milk, grain, and meat-based fermented foods.
CO 5	Summarize the role of microbes involved in the fermentation process and the role of probiotics
CO6	Generalize the concept of different food-based fermented products

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. Microbiology (Ability Enhancement Course)

Course code	**: AEC -406**
Course Name	**: English Communication -II**
Semester	**: IV**

L	T	P	C
2	0	0	2

Course Objectives:

1. To define and explain various techniques of word formation and develop skill so writing and vocabulary building.
2. To illustrate and elaborate fundamental techniques and features of writing skills.
3.To demonstrate and discuss various types of common error ecommitted by users of English and solve exercises to develop their understanding of grammatically correct sentence.
4. To organize language and work develop oral communication skills

Course Content

Unit I: Introductory English Grammar:

Parts of Speech, Tenses, Punctuation, Common Errors in English.

Unit II: Writing Skills; Social and Official Correspondence:

Enquiries, Complaints and Replies, Letters to the Editor, Social Appeals in the Form of Letter/ Pamphlets, Standard Business Letter, Email Drafting and Etiquettes, Preparing Agendaand Writing Minutes for Meetings.

Unit III: Career Skills:

Job Application, Cover Letter, Bio-data, CV and Resume and Effective Profiling,
Mock Interviews, Group Discussions.

COURSE OUTCOMES (CO): On completion of this course the students will be able to:

CO	Description
CO1	Remember about mode of communication, listening and writing skills.
CO2	Understand the concept of communication and features of writing skills
CO3	Explain the concept of writing and social skill.
CO4	Explain types of communication including official corresponding.
CO5	Summarize the skill of communication.
CO6	Develop generalized concept of fundamental techniques and features of writing skills.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. Microbiology (Value Addition Course)

Course code	**: VAC-407**
Course Name	**: Genetic Engineering in Crop Improvement**
Semester	**: IV**

L	T	P	C
2	0	0	2

Course Description:

This course provides an in-depth understanding of genetic engineering techniques and their application in crop improvement. It covers the fundamentals of genetic modification, the development of genetically engineered crops, and their role in enhancing agricultural productivity and sustainability. Students will explore the principles of genetic engineering, its tools and techniques, and its implications for food security and environmental sustainability.

UNIT-I

Overview of genetic engineering in agriculture, Restriction enzymes and cloning vectors, Polymerase Chain Reaction (PCR) and gel electrophoresis Agrobacterium-mediated transformation.

UNIT-II

Development of pest-resistant crops (e.g., Bt crops), Genetic engineering for increased crop yield, Future trends and innovations in crop biotechnology.

COURSE OUTCOMES (CO): On completion of this course the students will be able to:

CO	Description
CO1	Understand the fundamental principles of genetic engineering and its applications in agriculture.
CO2	Describe the molecular tools and techniques used in plant genetic modification.
CO3	Analyse different plant transformation methods and their efficiencies.
CO4	Evaluate gene expression and regulation strategies in genetically engineered crops.
CO5	Discuss genetic modifications that improve crop tolerance to abiotic stresses.
CO6	Summarize Genetic Engineering in Crop Improvement

DEGREE COURSE IN MICROBIOLOGY

B. Sc Microbiology (Discipline Specific Course)

Course code	**: MICDC 501**
Course Name	**: Agricultural Microbiology**
Semester	**: V**

L	T	P	C
3	0	0	3

Course Objectives: The objectives of this course are

1.To learn and understand the physico-chemical characteristics of soil.

2. To gain knowledge about biocontrol agents for agriculturally important crop plants.

3. To acquire expertise in the isolation, purification, and mass multiplication of biofertilizers.

Course Content

Unit I: Soil Microorganisms: Development and significant contributions in the field of soil microbiology (Beijerinck and Winogradsky), physical and chemical properties of soil, classification of soils, soil profile, soil microflora and soil as a natural habitat for microbes.

UNIT II Organic Matter Decomposition: Soil organic matters and humus. Microbial decomposition of plant and animal residues by microorganisms. Organic matter dynamics in soil: Degradation of cellulose, hemicelluloses and lignin. Factors affecting organic matter decomposition. Soil microbial biomass as an index of soil fertility.

UNIT III Rhizosphere and Rhizoplane microorganism: Microorganisms in the rhizosphere, root surfaces and phylloplane; Composition of root exudates; Factors affecting exudation; Rhizosphere effect; Factors affecting microbial community in soil. Mechanism of plant growth promotion. Biofertilizers

UNIT IV Plant Diseases: Plant diseases Mode of entry of pathogens, disease symptoms, Bacterial diseases: Crown gall, Citrus cancer; Viral diseases, viroids TMV; Fungal diseases: Late blight of potato , Loose smut of wheat. Control of plant diseases Principles and practices, cultural practices, chemical methods, biological methods and genetic engineering for disease resistant plants. Biopesticides.

Unit V: Genetic Engineering in Agriculture: Significance of Agrobacterium tumefaciens and viral vectors in development of transgenic plants- brief technique used. Brief discussion of Bt- cotton, release of GMOs

Text Books:

1. Gupta, S.K, Biofertilizers, Kedar Nath Ram Nath, Meerut.
2. Subba Rao,N.S(1995).SoilmicroorganismsandplantgrowthOxfordandIBHpublishing co. Pvt. Ltd., New Delhi.

Reference Books

1. Kannaiyan, S. (2003). Bioetchnology of biofertilizers, CHIPS, Texas.
2. Rai, M.K. (2005).Hand book of microbial biofertilizers, The Haworth Press, Inc. New York.
3. Reddy, S.M. etal. (2002). Bioinoculants for sustainable agriculture and forestry. Scientific Publishers.
4. Saleem, F. and Shakoori, A.R. (2012). Development of bioinsecticide. Lap Lambert Academic Publishing GmbH and Company.
5. Aggarwal, S.K. (2005). Advanced environmental biotechnology. APH publication

Course outcomes (COs): Upon successful completion of the course a student will be able to

CO1	Describe the role and effect of microorganism in agriculture.
CO2	Identify phytopathogens and apply the knowledge of their life cycle in prevention of plant diseases.
CO3	Apply the knowledge of Rhizosphere located bacteria in development of biofertilizers.
CO4	Summarize the mechanism of biocontrol utilized by biopesticides
CO5	Appreciate the diversity of microorganism and microbial communities inhabiting soil and affecting soil composition and causing plant diseases.
CO6	Compile information on plant microbes' interactions like rhizosphere and mycorrhizae and their applications especially the biopesticides, biofertilizers and their production techniques.

Course	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	1	2	2	1	1	2	2	1	2	2	3	1	3	2
CO4	2	1	3	1	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	1	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	1	2	1	2	1	1	2	2	1	2	2	2	2	2	2

B. Sc. Microbiology (Discipline Specific Course)

Course code	**: MICDL 501**
Course Name	**: Agricultural Microbiology(Lab course based on MICDC 501)**
Semester	**: V**

L	T	P
0	0	2

1.Isolation of Microorganism in soil.
2. Isolation and Identification of PGPR from soil.
3. Isolation and Identification of *Azotobacter sp* from soil.
3. Perform Biochemical test.
4. IMVIC TEST

5. Production of Biofertilizer from Rhizospheric soil.

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description
CO1	Define the different basic concepts of the introduction to soil microorganisms.
CO2	Explain the identification of soil microorganisms.
CO3	Illustrate the processes of nitrogen fixation in plants by experimental method.
CO4	Focus on the identification of microorganisms present in soil.
CO5	Summarize the production of bioinoculants and their effects on plants.
C06	Create the importance of nitrogen-fixing microorganisms in the Agriculture sector.

CO- PSO-PO Mapping:

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11	PO 12	PSO 1	PSO 2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. Microbiology (Discipline Specific Course)

Course code	**: MICDC- 502**
Course Name	**: Recombinant DNA Technology**
Semester	**: V**

L	T	P	C
3	0	0	3

UNIT I Introduction and Scope of RDT

History and advent of Recombinant DNA technology; Milestones in Genetic Engineering. Scope and applications of RDT

UNIT II Tools and enzymes used in RDT

Cloning vector: Plasmids, Phages, cosmids, Yeast cloning vectors, Animal and plant viruses as vectors. BAC, PAC & YAC. Expression Vectors. Nucleic acid modifying enzymes. Restriction endonuclease

UNIT III Gene Cloning and its strategies

Isolation of nucleic acid from plant, animal & bacteria. Basic steps of gene cloning: Cloning strategies Cutting and joining vectors; use of linkers and adaptors Introduction of recombinant DNA in host cell, methods of screening transformants and recombinants. Synthesis of cDNA. Construction of cDNA and genomic libraries.

UNIT IV Techniques in RDT

Blotting techniques: Southern, Northern and Western blotting (Methodologies and applications) Probe labeling and hybridization. DNA sequencing: chemical and enzymatic methods. PCR

UNIT V Applications of RDT

Transgenic Technology: Types approaches & application (Plant & Animals) Gene Therapy: Principle, strategies and ethics of gene therapy DNA finger printing Human Genome Project: Strategy and Implications

Text Books:

1. Brown, T.A. Gene cloning and DNA analysis: An introduction. Wiley-Blackwell, NewJersey.
2. Primrose, S.B.and Twyman,R.Principlesofgenemanipulationandgenomics.Wiley-Blackwell, New Jersey.

3. Brown, T.A. Genomes. Wiley-Liss, Oxford
4. Sambrook, J.and Russell,D.W. Molecular Cloning: A laboratory manual .Cold Spring Harbor Lab Press, New York.

Reference Books

1. Nicholl, D.S.T. An introduction to genetic engineering. Cambridge University Press, Cambridge.
2. Glick, B.R., Pasternak, J.J. and Patten, C.L. Molecular biotechnology: Principles and applications of recombinant DNA. ASM Press, Washington, D.C. Hartwell, L. Genetics: From genes to genome. McGraw-Hill, New York.
3. Old, R.W and Primrose,S.B.Principlesofgenemanipulations.BlackwellScience,Oxford.
4. Winnacker, E.L. From genes to clones: Introduction to gene technology. Wiley-VCH, Germany.
5. Reece R.J. Analysis of genes and genomes. John Wiley and Sons, New York.
6. Recombinant DNA safety guidelines. Department of Biotechnology, Ministry of Science and Technology, Government of India, New Delhi.

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Describe principles, tools, techniques and strategies used in gene cloning and genome analysis.
CO2	Elucidate the molecular techniques involved in gene manipulation and rDNA technology .
CO3	Explain the concept of vectors and gene transfer methods for the production of transgenic plants and animals.
CO4	Appreciate the techniques used in genome analysis and their applications.
CO5	Summarize the role of vectors in gene cloning and expression.
CO6	Develop understanding of sequence detection, gene amplification, modification and genome analysis techniques and also applications of RDT.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. Microbiology (Discipline Specific Course)

Course code	**: MICDL- 502**
Course Name	**: RDT**
Semester	**: V**

L	T	P	C
0	0	2	2

1. Determination of molecular weight of DNA by Agarose Gel Electrophoresis.
2. Separation and determination of molecular weight of proteins by SDS-PAGE.
3. Visualization of enzyme activity by NATIVE-PAGE.
4. Isolation of genomic DNA from plant sample.
5. Isolation of genomic DNA from animal cell
6. Isolation of plasmid DNA from bacterial cell.
7. Isolation of genomic DNA from bacterial cell
8. PCR amplification of DNA.
9. Restriction digestion of vector and DNA.
10. Preparation of competent cells.
11. Determination of similarity between different bacterial isolates using RFLP.

Course outcomes (Cos):

Upon successful completion of the course a student will be able to

CO1	Identify and separate amino acid and sugars by chromatographic techniques**.**
CO2	Interpret molecular weight of DNA by gel electrophoresis techniques.
CO3	Demonstrate isolation of genomic and plasmid DNA and visualize by electrophoresis
CO4	Verify Lambert Beer's law.
CO5	Perform restriction digestion and amplification of DNA.
CO6	Prepare competent cells.

CO- PSO-PO Mapping:

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11	PO 12	PSO 1	PSO 2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	1	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	1	2	1	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. MICROBIOLOGY (Discipline Specific Course)

Course code	**: MICDC 503**
Course Name	**: Beverage Biotechnology**
Semester	**: V**

L	T	P	C
3	0	0	3

Course Objectives: The objectives of this course are

1. **To aware the student Microorganism in the food & beverage industry.**
2. **To make students aware of the principles of food preservation**
3. **To learn about food additives.**

Course Content

UNIT I Type of beverages: fruit & vegetable juices, fermented and non-fermented beverages, synthetic beverages, carbonated and non-carbonated beverages. Tea, Coffee and Cocoa: Production, composition, processing and preparation.

UNIT II Historical background of Food technology, traditional fermented foods (meat, fish, bread, sauerkraut, soy bean, coffee, cocoa, tea), importance, global trends, nutritional labelling in India, FSSAI guidelines, improvements through Biotechnology (e.g. Golden Rice, Potato, Flavor Savr Tomato, etc.)

UNIT-III Water for beverages: Types of water required for beverages, treatment of water. Additives for beverages: Natural and synthetic sweeteners and colours, acids, emulsifiers, preservatives, flavours, and flavour enhancers.

UNIT-IV non-carbonated and carbonated synthetic beverages: Ingredients, source of carbon dioxide, chemical and physical properties of carbon dioxide, carbonating process, packaging of carbonating beverages. Alcoholic Beverages: non-distilled beverages and distilled beverages.

UNIT-V Enzymes in Food Industry: carbohydrates, Proteases, Lipases; Modification of food using enzymes: Role of endogenous enzymes in food quality, Enzymes used as processing aid and ingredients

Food Fermentations: Common fermented foods - Cheese, Butter, Yoghurt, fermented/condensed milk, and kefir.

Text Books:

1. Frazier, W.C. and Westhoff, D.C. Food microbiology.Tata McGraw Hill, New Delhi.
2. Casida, J.E. Industrial microbiology.Wiley Eastern, New Delhi.

Reference Books:

1. Crueger, W.and Crueger,A.Biotechnology: A Textbook of Industrial Microbiology.Sinauer Associates, Sunderland.
2. McLandsborough, L. Food microbiology laboratory. CRC Press, Boca Raton.
3. Harrigan, W.F.Laboratorymethodsinfoodmicrobiology.GulfProfessionalPublishing,Houston.
4. Cappucino, J.andSherman,N.Microbiology:Alaboratorymanual.BenjaminCummings Publishing Company, San Francisco.
5. Frazier, W.C. and Westhoff, D.C. Food microbiology.Tata McGraw Hill, New Delhi.

6. Casida, J.E. Industrial microbiology.Wiley Eastern, New Delhi

Upon successful completion of the course a student will be able to

CO1	Identify beverage types, production methods, traditional fermented foods, water and additives, and enzyme roles.
CO2	Discuss beverage and fermented food production, historical significance, nutrition labelling in India, and biotech advancements.
CO3	Describe beverage processing, traditional fermented foods, and the use of water, additives, and enzymes in industry.
CO4	Explain all aspects of beverage biotechnology, including types, production, additives, fermentation, and enzyme applications.
CO5	Summarize key concepts of beverage biotechnology.
CO6	Generalize the scope and importance of beverage biotechnology.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. MICROBIOLOGY (Discipline Specific Course)

Course code	**:** MICDL 503
Course Name	**:** Beverage Biotechnology (Lab course based on MICDL 503)
Semester	**: V**

L	T	P	C
0	0	2	2

1. Microbiological examination of food.

2. Assay of quality of milk sample using MBRT test.

3. Adulteration tests for milk.

4. Microbial production of curd.

5. Isolation and identification of *Lactobacillus* from fermented dairy products.

6. Isolation and biochemical identification of microorganisms from contaminated food and dairy samples.

7. Production of sauerkraut.

8. Estimation of lactic acid production in sauerkraut.

9. Effect of salt concentration on lactic acid production in sauerkraut.

Upon successful completion of the course a student will be able to

CO1	Define the principles of food preservation.
CO2	Describe the principles and methods of food preservation, including the production process of sauerkraut.
CO3	Explain various techniques used in food preservation.
CO4	Demonstrate and explain microbiological examination methods for food
CO5	Summarize the core concepts of food and dairy microbiology.
CO6	Compile and present key studies and findings in food and dairy microbiology.

CO- PSO-PO Mapping:

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11	PO 12	PSO 1	PSO 2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. Microbiology (Discipline Specific Elective)

Course code	**: MICDE-503a(Discipline Specific Course)**
Course Name	**: Plant Biotechnology**
Semester	**: V**

L	T	P	C
3	0	0	3

Course objectives: This course provides a comprehensive overview of the techniques and theoretical foundations of plant tissue culture and plant genetic engineering, along with their practical applications. To enable students, acquire knowledge of the fundamental principles of plant tissue culture.

1. To enable students to understand the fundamental principles of plant tissue culture. To make students understand the principles of Agrobacterium tumefaciens biology and Ti-plasmid.
2. To introduce various plant culture techniques and methodologies.
3. To explain the biology of *Agrobacterium tumefaciens* and the role of the Ti-plasmid in genetic transformation.
4. To impart knowledge on the diverse applications of plant biotechnology, including the development of genetically modified crops.

UNIT I

Introduction, Cryo and organogenic differentiation, 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 micropropagation.

UNIT- II

In vitro haploid production: Androgenic methods: Anther culture, Microspore culture and oogenesis 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.

UNIT – III

Protoplast Isolation and fusion: Methods of protoplast isolation, Protoplast development, Somatic hybridization, identification and selection of hybrid cells, Cybrids, Potential of somatic hybridization limitations. Somatic clonal variation Nomenclature, methods, applications basis and disadvantages.

UNIT – IV

Plant Growth Promoting bacteria. Nitrogen fixation, Nitrogenase, Hydrogenase, Nodulation, Biocontrol of pathogens, Growth promotion by free-living bacteria.

SUGGESTED READING AND TEXT BOOKS

1. Bhojwani, S.S. and Razdan 2004 Plant Tissue Culture and Practice.
2. Brown, T. A. Gene cloning and DNA analysis: An Introduction. Blackwell Publication.
3. Gardner, E.J. Simmonns, M.J. Snustad, D.P. 2008 8th edition Principles of Genetics. Wiley India.
4. Raven, P.H., Johnson, GB., Losos, J.B. and Singer, S.R. 2005 Biology. Tata MC Graw Hill.
5. Reinert, J. and Bajaj, Y.P.S. 1997 Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture. Narosa Publishing House.
6. Russell, P.J. 2009 Genetics – A Molecular Approach. 3rdedition. Benjamin Co.
7. Sambrook & Russel. Molecular Cloning: A laboratory manual. (3rd edition)
8. Slater, A., Scott, N.W. & Fowler, M.R. 2008 Plant Biotechnology: The Genetic Manipulation of Plants, Oxford University Press.

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description
CO1	Define basic concepts of plant biotechnology, cryopreservation, organogenic differentiation, culture types, haploid production, protoplast fusion, and PGPR (Plant
CO2	Explain principles of plant biotechnology and somaclonal variation, including culture methods, applications, and limitations.
CO3	Illustrate key techniques in tissue culture and somatic clonal variation, such as haploid production, protoplast fusion, and microbial interactions.
CO4	Analyze advanced concepts of plant biotechnology and somaclonal variation, including their applications and challenges.
CO5	Summarize the scope of plant biotechnology and somaclonal variation techniques in crop

CO6	Generalize plant biotechnology tools and processes related to genetic diversity and microbial enhancement strategies.

CO- PSO-PO Mapping:

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11	PO 12	PSO 1	PSO 2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlate

B. Sc. Microbiology

Course code	**: : MICDL-503(Discipline Specific Course)**
Course Name	**: Lab Course Based on MICDE-503**
Semester	**: V**

L	T	P	C
0	0	2	2

Practical's

1. Sterilization of glassware and plasticware; preparation of stock solutions.
2. Preparation of Murashige and Skoog (MS) medium.
3. Sterilization and inoculation of explants on MS medium.
4. Induction of callus from explants.
5. Isolation of DNA from plant tissue using the CTAB method.
6. Isolation of RNA from plant tissue.
7. Isolation of protein from plant tissue.
8. Isolation of protoplasts using mechanical methods.
9. Seed viability testing using tetrazolium chloride.
10. Isolation of plant embryos and their in vitro culture.

CO1	Define and identify the protein from the sample
CO2	Explain and learn the preparation of MS Media.
CO3	Illustrate the Sterilization and inoculation of the explant on MS medium.
CO4	Explain the plant tissue culture technique.
CO5	Summarize the concept of the seed viability test by tetrazolium chloride.
CO6	Create a theory of plant tissue culture, plant genetic engineering, and their applications

CO- PSO-PO Mapping:

Course	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlate

Course code	**: MICDE- 504b (Discipline Specific Elective)**
Course Name	**: Bioinformatics**
Semester	**: VI**

L	T	P	C
3	0	0	3

UNIT-I Introduction to Bioinformatics. Fundamentals of computer and internet. Various protocols followed on internet. Applications of bioinformatics in microbiology.

UNIT-II Major biological databases. Protein, nucleic acid sequence and structure databases. Gene expression and metabolic pathway databases. Various file formats.

UNIT-III Sequence alignment algorithms, types and applications. Phylogenetic tree construction using various algorithms. Statistical significance of sequence alignment.

UNIT-IV. Validation of protein structure with emphasis on Ramachandran plot. Drug designing on prevalent diseases.

UNIT-V Microbial Bioinformatics Specialized Microbial Databases Metagenomics, Meta transcriptomics, Metabolomics and Systems Biology Host pathogen interaction Comparative genomics and proteomics of microbes Microbial Bar Coding and Bioinformatics

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description
CO1	Define computer and internet fundamentals, major biological databases, sequence alignment, structure prediction, microbial barcoding, and bioinformatics.
CO2	Explain core bioinformatics concepts, gene expression data, metabolic pathways, statistical alignment, drug design, and microbial genomics.
CO3	Illustrate bioinformatics applications in microbiology, including gene expression, pathway databases, and comparative genomics.
CO4	Discuss microbial genomics, proteomics, barcoding, and bioinformatics in drug design and data analysis.
CO5	Compare gene expression and metabolic databases, structure-function relationships, and drug development tools.
CO6	Create insights using sequence alignment statistics, gene and pathway databases, and microbial genomics.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlate

B. Sc. Microbiology

Course code	**: MICDE- 504b(Discipline Specific Elective)**
Course Name	**: Lab Course Based on MICDE- 504b**
Semester	**: VI**

L	T	P	C
0	0	2	2

1. Identification of unknown sequences using BLAST and functional annotation.
2. SNP analysis using the NCBI SNP database.
3. Genome comparison of organisms using the Syn Map tool from CoGe.
4. Demonstration of microarray applications and analysis of microarray data.
5. Calculation of pI and molecular weight of a protein using Ex ExPASy ProtParam tool.
6. Demonstration of 2D-PAGE and analysis of protein gel data.
7. Construction of protein interaction networks using STRING software.
8. Subcellular protein localization using the CELLO prediction tool.
9. Analysis of protein motifs and modifications using MEME software.
10. Conserved domain analysis using the NCBI Batch CD-Search tool

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description
CO1	Apply BLAST and functional annotation tools to identify unknown sequences and interpret their biological significance.
CO2	Perform SNP analysis using NCBI databases and evaluate genetic variations across populations.
CO3	Compare genomes of different organisms using SynMap and analyze synteny relationships.
CO4	Demonstrate microarray techniques and analyze gene expression data for biological insights.
CO5	Calculate the isoelectric point and molecular weight of proteins using ExPASy ProtParam and interpret protein properties.
CO6	Construct and analyze protein interaction networks, motifs, domains, and localization using tools like STRING, MEME, CELLO, and CD-Search

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlate

B. Sc. Microbiology (Generic Elective)

Course code	**: MICGE- 505**
Course Name	**: Human Immunology**
Semester	**: V**

L	T	P	C
4	0	0	4

1. Educate students on the diagnostic relevance and underlying principles of ELISA, RIA, immunodiffusion, and related techniques.
2. Highlight clinical applications and limitations of immunological diagnostic methods.
3. Introduce students to key challenges in health diagnostics and clinical testing.
4. Equip students with hands-on skills in operating laboratory devices used in immunological assays and diagnostic kits.

Unit 1

Overview of the Immune System. Cells and Organs of the Immune System. Antigens. Haptens & Epitopes.

Unit 2

Immunoglobulins: Structure and Function. Major Histocompatibility Complex. Antigen processing and presentation. Structure and functions of BCR & TCR.

Unit 3

Cytokines. Complement System. Cell-mediated cytotoxicity: Mechanism of T cell & NK cell-mediated lysis. Ab-dependent cell-mediated cytotoxicity (ADCC).

Unit 4

Overview of Hypersensitivity and Introduction to Transplantation. Vaccines: Active and Passive Immunization.

Unit 5

Introduction to Monoclonal Antibodies and Polyclonal Antibodies. Antigen-Antibody Interactions: RIA, ELISA, Western Blotting, Immuno precipitation, Immuno-fluorescence.

Suggested Reading and Text Books

1. Kuby: Immunology (4^{th} ed.)
2. Roitt, Male & Brostoff: Immunology (3^{rd} ed).
3. Elgert & Elgert: Immunology
4. Wilson & Walker: Practical Biochemistry (4^{th} ed.)

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description
CO1	Recall key immunological concepts. the basics of immune response, antibodies, gene regulation, MHC, infection immunity, vaccines, and immunodiagnostics.
CO2	Comprehend specific immunological mechanisms. Grasp foundational processes like antibody functions, MHC roles, and diagnostic tools such as ELISA and RIA.

CO3	Apply immunological techniques and concepts and use detailed knowledge to interpret immune responses and lab techniques in real-world contexts.
CO4	Analyze immune processes across organisms *and* immunology applies to different species and diagnostic tools.
CO5	Evaluate principles and functions in immunology *and* diagnostic methods, antibody behavior, and immune gene regulation.
CO6	Create and demonstrate immunological models and experiments and demonstrate expertise in immunological tests, vaccine responses, and molecular functions.

CO- PSO-PO Mapping:

Course	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	1	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	1	1	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	1	2	1	1	1	2	2	1	2	2	2	2	3	3
CO5	2	1	2	1	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	1	2	1	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlat

B. Sc Microbiology

Course code	**: MICSC-506 (Skill Enhancement Course)**
Course Name	**: Intellectual Property Rights**
Semester	**: V**

L	T	P	C
2	0	0	2

Course objectives:

1. Introduce students to various types of Intellectual Property Rights (IPRs) and their practical significance.
2. Explain the procedures and requirements for filing a patent.
3. Teach students bioethical standards and biosafety practices relevant to biotechnology.
4. Familiarize students with copyright, trademarks, industrial designs, and the Information Technology Act.

UNITI: Introduction to IPR

Basic understanding of intellectual property rights; utility of IPRs; different types of IPRs; introduction to Indian patent law; world trade organization and its related intellectual property provisions world organizations: WIPO and TRIPS agreement, international treaties and conventionson intellectual property. Intellectual /industrial property and its legal protection in research, design and development. Forms of protection of IPR : Introduction to copyrights and its applicability; fundamental concepts and importance of trademarks and trade secrets; geographical indications; design layout design of integrated circuits.

UNITII: Patents

Methods of patenting and general concept of patent; patenting agencies; use of technical information in patent documents; revocation of patent; patenting of biological material like microorganisms, plants, and animals; patenting in biotechnology, economic, ethical, and depository considerations. Nature of Copyright. Trademarks; registration of trademarks; rights of the holder and assignment and licensing of marks.

SUGGESTED READINGS AND TEXTBOOKS

1. Pandey, Nand Dharni, K 2014.Intellectual Property Rights, 1st.PHILearningPvt.Ltd.
2. To mkowicz, R2011. Intellectual Property Overlaps: Theory, Strategies and Solutions, 1st.Routledge.
3. Bouchoux, DE2013. Intellectual Property: The Law of Trademarks, Copyrights, Patents and Trade Secrets, 4th ed. Cenage Learning.

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description
CO1	Define basic concepts of IPR and legal protections, patents, copyrights, trademarks, licensing, and assignment rights.
CO2	Explain IPR procedures and ethical considerations., patent filing processes, biotechnology patents, and related ethical aspects.
CO3	Illustrate key features of IPR and biotechnology patenting. Present the structure, utility, and implications of various IPRs.
CO4	Analyze applications of IPR in biotechnology, the legal, ethical, and economic factors in patenting biotech inventions.
CO5	Summarize principles and roles of IPR systems. Review core components of intellectual property frameworks and biotechnology rights.
CO6	Create strategies involving IPR protection in biotech., plans for securing rights, filing patents, and ensuring ethical compliance.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. Microbiology

Course code	**: MICDC-601(Discipline Specific Course)**
Course Name	**: ENVIRONMENTAL MICROBIOLOGY**
Semester	**: VI**

L	T	P	C
3	0	0	3

UNIT-I Microorganisms and their Habitats

Structure and function of ecosystems, Terrestrial Environment: Soil profile and soil microflora, Aquatic Environment: Microflora of freshwater and marine habitats. Extreme Habitats: Extremophiles: Microbes thriving at high and low temperatures, pH, high hydrostatic and osmotic pressures, salinity and low nutrient levels. Microbial succession on the decomposition of plant organic matter.

UNIT-II Microbial Interactions

Microbe interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism, predation. Microbe-Plant interaction: Symbiotic and non-symbiotic interactions. Microbe-animal interaction: Microbes in ruminants, nematophagus fungi, and symbiotic luminescent bacteria.

UNIT-III Biogeochemical Cycling

Carbon cycle: Microbial degradation of cellulose, hemicelluloses, lignin, and chitin. Nitrogen cycle: Nitrogen fixation, ammonification, nitrification, denitrification, and nitrate reduction. Phosphorus cycle: Phosphate immobilization and solubilization; Sulphur cycle: Microbes involved in the sulphur cycle

UNIT-IV Waste Management

Solid Waste management: Sources and types of solid waste, Methods of solid waste disposal (composting and sanitary landfill), Liquid waste management: Composition and strength of sewage (BOD and COD), Primary, secondary (oxidation ponds, trickling filter, activated sludge process and septic tank) and tertiary sewage treatment. Treatment and safety of drinking (potable) water, methods to detect portability of water samples.

UNIT-V Microbial Bioremediation

Ex situ and *in situ* bioremediation, Principles and degradation of common pesticides, organic (hydrocarbons, oil spills) and inorganic (metals) matter, microbial biosurfactants

Text Books:

1. Atlas, R.M. and Bartha, R. Microbiology :Fundamentals and applications. Benjamin /Cummings Science Publishing, USA.
2. Evans, G.M. and John, J.C.F. Environmental biotechnology: Theory and applications .John Wiley and Sons, New York.

Reference Books

1. Alexander, M. Microbial ecology. John Wiley and Sons, New York
2. Eldowney, S., and Waites, S. Pollution: Ecology and biotreatment. Longman, Harlow.
3. Baker, K.H. and Herson, D.S. Bioremediation. McGraw- Hill, New York.
4. Marshal, K.C. Advances of microbial ecology. Plenum Press, New York.

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Define key terms in microbial ecology, air and aquatic microbiology, microbial interactions, pollution control, and environmental impact
CO2	Explain ecological concepts, microbial communities, transmission pathways, interactions, and pollution impacts with examples.
CO3	Describe ecosystem structures, microbial roles, plant and animal interactions, and environmental consequences of microbes.
CO4	Analyze microbial ecology and its relationship to environmental systems and pollution control.
CO5	Summarize principles of microbial ecology, aquatic and air microbiology, and their environmental significance.
CO6	Generalize the scope and importance of environmental microbiology in ecosystem sustainability.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc Microbiology

Course code	**: MICDL-601(Discipline Specific Course)**
Course Name	**: Lab Course Based on MICDC-601**
Semester	**: VI**

L	T	P	C
0	0	2	2

Practicals

1. Isolation of Airborne Microorganisms by Using settle plate technique or air samplers to capture microbes from the environment.
2. Testing water samples for microbial load using MPN (Most Probable Number) or membrane filtration.
3. Isolating and identifying bacteria and fungi from different soil types.
4. Investigating microbial breakdown of kitchen waste or agricultural residues.
5. Studying microbes that reflect the level of pollution in water or soil environments.
6. Observing inhibition zones in dual-culture plates to demonstrate microbial competition.
7. Detecting nitrogen-fixing bacteria (e.g., Rhizobium) using selective media.
8. Monitoring microbial succession during compost formation.
9. Identifying microbes involved in leaf litter breakdown or decaying wood.
10. Testing how heavy metals or pesticides influence microbial growth and metabolism.

11. Calculation of BOD and COD of water sample.

Upon successful completion of the course, a student will be able to

CO1	Demonstrate techniques to isolate and identify airborne, waterborne, and soil microorganisms.
CO2	Analyze microbial load and diversity in environmental samples using standard microbiological methods.
CO3	Assess microbial roles in biodegradation, composting, and organic waste management.
CO4	Investigate microbial interactions and competition through dual-culture assays and bioindicator studies.
CO5	Summarize the study of Microbial Ecology, Air and Aquatic Microbiology, Microbial Interactions, Pollution and its Control, Impact of Microbes on the Environment
CO6	Generalize the concept of Environmental Microbiology

CO- PSO-PO Mapping:

Course	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc Microbiology

Course code	**: MICDC-602(Discipline Specific Course)**
Course Name	**: INFECTION AND IMMUNITY**
Semester	**: VI**

L	T	P	C
3	0	0	3

Course Objectives: The objectives of this course are

1.To learn about infection and infectious agents.

2. To learn about role of cells and molecules of immune system in infections.

Course Content

Unit I: Infectious Agents

Infection and its types; Infectious agents: Viruses, Bacteria, Fungi, Protozoa, Helminthes(worms), Parasites, Prions; Pathogens and immunity; Immunogenicity of pathogens; Virulence and susceptibility; Pathogen-associated molecular patterns.

Unit II: Immune Regulation of Infection

Barriers preventing establishment of infection; Mechanism of establishment of infection: Invasion, Survival in intracellular and cytoplasmic space, Role of molecular factors in establishment of infection, Role of cells and molecules of the immune system in infection, Adoptive immunity to infection, Immune elimination of infection, Mechanisms of escape from immune-mediated destruction, Infection in immunocompromised host.

Unit III: Immune Responses to Infection

Immunealteration during early and late phases of infection; Immunological basis of infection; Infection and antigen presentation; Recognition of molecular pattern of pathogen; Phagocytosis and killing of infectious agents; Humoral and cell-mediated immunity against infection; Infection-associated immunosuppression; Immunodeficiency and infection; Acquired immunodeficiencies; Nosocomial and community-acquired infections; Coinfections; Immunity in local and systemic infection (Bacterimia and viremia); Septic infection and immunity; Immunological memory against infection and secondary responses; Immunization: Active and passive; Vaccination.

Unit IV: Immunity against Bacterial, Viral, and Prions Infections

Immune responses and immunological control of bacterial infection (*Staphylococcus* and *Mycobacterium*), viral diseases (Influenza and hepatitis), and prion infections.

Unit V: Immunity against Fungal and Parasite Infections

Immune responses and immunological control of fungal infection (Candida and aspergillosis) and parasitic diseases (Malaria, leishmaniasis, schistosomiasis, and filariasis).

Text Books:

1. Ananthanarayan, R.and Paniker, C.K.J. (2005). Textbook of Microbiology. University Press Publication, 7thed.
2. Willey, J.M., Sherwood, L.M. and Woolverton, C.J. (2013). Prescott'Microbiology.

Reference Books:

1. Brooks GF, Carroll KC, Bute lJS and Morse SA. (2013). Jawetz, Melnick and Adelberg's medical microbiology. McGraw Hill Publication, 26thed.
2. Goering, R., Dockrell,H.,Zuckerman ,M.andWakelin,D.(2007).Mims'Medical microbiology. Elsevier, London, 4thed.
3. Madigan,M.T.,Martinko,J.M.,Dunlap,P.V.andClark,D.P.(2014).Brockbiologyofmicroorganisms.

Pearson International Edition, 14th ed.

Course outcomes (COs):

Upon successful completion of the course, a student will be able to

CO1	Define and memorize Infectious Agents, Immune Regulation of Infection, Immune Responses to Infection, Immunity against Bacterial, Viral, and Prions Infections, Immunity against Fungal and Parasite Infections.
CO2	Discuss infection and its types, Infectious agents, pathogenicity, etc., Immunological basis of infection; Immunity against Bacterial, Viral, and prion infections, Immunity against Fungal and Parasite Infections.
CO3	Write and explain about the basic concepts of infection and immunity, such as infection, immunological basis of infection, immunity against various infections, etc.
CO4	Explain about infection, types, infectious agents, immunogenicity of pathogens, Immunological basis of infection; Immunity against Bacterial, Viral, and prion infections, Immunity against Fungal and Parasite Infections.
CO5	Summarize the idea of infection, infectious agents, Immune Responses to Infection, Immunity against Bacterial, Viral, and Prions Infections, Immunity against Fungal and Parasite Infections.
CO6	Express the concept of infection and immunity.

CO- PSO-PO Mapping:

Course	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. Microbiology

Course code	**: MICDL-602(Discipline Specific Course)**
Course Name	**: Lab Course Based on MICDC-602**
Semester	**: VI**

L	T	P	C
0	0	2	2

Practicals

a. Study of the mechanism of exosmosis and endosmosis.
b. Effect of isotonic, hypotonic, and hypertonic solutions on the cell.
c. Separation and preservation of serum and plasma.
d. Determination of blood group and Rh factor.
e.Demonstration of agglutination reaction of bacterial cultures by slide.
f. Quantitative estimation of antigen by radialimmuno diffusion.

g. Detectionandquantificationofeitherantibodyorantigenbyouchterlonydoublediffusionmethod
h. Determination of concentration of antigen by rocket immune electrophoresis.
i. Determination of the presence of a specific antibody for its antigen by the Dot-ELISA method.

Course outcomes (COs):

Upon successful completion of the course, a student will be able to

CO1	Define and Bacterial Viral Infections,
CO2	Discuss infection and its types, Infectious agents, pathogenicity, etc., Immunological basis of infection; Immunity against Bacterial, Viral, and prion infections, Immunity against Fungal and Parasite Infections.
CO3	Write and explain about the basic concepts of infection and immunity, such as infection, immunological basis of infection, immunity against various infections, etc.
CO4	Explain about infection, types, infectious agents, immunogenicity of pathogens, Immunological basis of infection; Immunity against Bacterial, Viral, and prion infections, Immunity against Fungal and Parasite Infections.
CO5	Summarize the Immunological tools, ELISA, RIA, etc.
CO6	Create the Effect of isotonic, hypotonic, and hypertonic solutions on a cell.

CO- PSO-PO Mapping:

Course	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. Microbiology

Course code	**: MICDC- 603(Discipline Specific Course)**
Course Name	**: Genomics & Proteomics**
Semester	**: VI**

L	T	P	C
3	0	0	3

Course objectives: The broad objective of the course is to make students aware of the changing paradigm in genetics, medicine, and agriculture. The specific objectives of the course are as follows:

1. To introduce the basic concepts of genomics and next-generation sequencing.
2. To acquaint students with various genome databases and their applications.
3. To make students aware of the applications of genomics in various industries.
4. To make the techniques of proteome analysis diverse applications and the benefits of genome and proteome analysis.

UNIT I

Introduction to Genomics, DNA sequencing methods – manual & automated: Maxam & Gilbert and Sanger method. Pyrosequencing, Genome Sequencing: Shotgun & Hierarchical (clone contig) Methods, Computer tools for sequencing projects: Genome sequence assembly software.

UNIT II

Managing and Distributing Genome Data: Web-based servers and software for genome analysis: ENSEMBL, VISTA, UCSC Genome Browser, NCBI genome. Selected Model Organisms' Genomes and Databases.

UNIT III

Introduction to protein structure, Chemical properties of proteins. Physical interactions that determine the properties of proteins. Short-range interactions, electrostatic forces, van der Waals interactions, hydrogen bonds, Hydrophobic interactions. Determination of sizes (Sedimentation analysis, gel filtration, SDS-PAGE); Native PAGE, Determination of covalent structures – Edman degradation.

UNIT IV

Introduction to Proteomics, Analysis of proteomes. 2D-PAGE. Sample preparation, solubilization, reduction, and resolution. Reproducibility of 2D-PAGE. Mass spectrometry based methods for protein identification. *De novo* sequencing using mass spectrometric data.

SUGGESTED READING AND TEXT BOOKS

1. Genes IX by Benjamin Lewin, Johns and Bartlett Publisher, 2006.
2. Modern Biotechnology, 2nd Edition, S.B. Primrose, Blackwell Publishing, 1987.
3. Molecular Biotechnology: Principles and Applications of Recombinant DNA, 4th Edition, B.R.
4. Molecular Cloning: A Laboratory Manual (3rd Edition) Sambrook and Russell Vol. I to III, 1989.
5. Principles of Gene Manipulation 6th Edition, S.B. Primrose, R.M. Twyman and R.W. Old. Blackwell Science, 2001.
6. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.
7. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition. Benjamin Cummings.
8. Russell, P. J. (2009). *I* Genetics- A Molecular Approach. III Edition. Benjamin Cummings.
9. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
10. Pevsner, J. (2009). Bioinformatics and Functional Genomics. II Edition. John Wiley & Son.

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description
CO1	Understand key principles of genomics and DNA sequencing technologies, structure, interactions, Determination of sizes (Sedimentation analysis), Analysis of proteomes and genomes, and protein sequencing.
CO2	Differentiate genome sequencing strategies and apply computational tools.
CO3	Explore genome databases and web-based tools for genomic data analysis and protein sequencing.
CO4	Interpret protein chemistry and structural properties using experimental techniques
CO5	Analyze protein-protein interactions and molecular forces in structural biology.
CO6	Apply proteomic technologies for protein identification and characterization.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc Microbiology

Course code	**: MICDL- 603(Discipline Specific Course)**
Course Name	**: Genomics & Proteomics**
Semester	**: VI**

L	T	P	C
0	0	2	2

1. Web based servers and soft wares for genome analysis.
2. Reterival of data by NCBI.
3. Study of protein structure by Rasmole Software.
4. Sequencing of ompc protein of *Salmonella sp*. by SPVD Software.
5. Study of NCBI Web PAGE.

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description
CO1	Utilize genome analysis tools and web-based resources
CO2	Retrieve and analyze biological datasets from NCBI
CO3	Study and visualize protein structures using computational software
CO4	Apply SPVD software for targeted protein sequencing and genome and protein sequencing.
CO5	Evaluate and use NCBI web interfaces for bioinformatics research
CO6	Integrate software platforms to interpret genomic and proteomic data

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc Microbiology

Course code	**: MICDE- 603a(Discipline Specific Elective)**
Course Name	**: MUSHROOM CULTURE TECHNOLOGY**
Semester	**: VI**

L	T	P	C
3	0	0	3

Course Objectives: The objectives of this course are

To equip learners with comprehensive knowledge and practical skills in the scientific cultivation, processing, and commercialization of edible and medicinal mushrooms, with emphasis on:

1. Understanding mushroom biology and taxonomy
2. Mastering laboratory techniques for spawn production
3. Establishing mushroom cultivation units
4. Promoting entrepreneurship and sustainable practices

Course Content

UNIT-1

Introduction, history of mushroom cultivation; biology of mushrooms; Nutritional value:(Proteins, amino acids, mineral elements, carbohydrates, fibers, vitamins) Medicinal value of mushrooms; Poisonous and non-poisonous mushrooms, edible and non-edible Mycorrhizal mushrooms and their role in plant growth, mushrooms cultivation in India and world.

UNIT-II

Cultivation of button Mushroom, morphology raising a pure culture & spawn preparation of compost &cultivation of Agaricus bisporus, Pleurotus flabeltus, harvest.

Unit-III

Cultivation Technology: Infrastructure equipment and substrates in mushroom cultivation: Polythene bags, vessels, inoculation hook, inoculation loop, love cost stove, sieves, culture racks, mushroom unit or mushroom house, water sprayer, tray, boilers, driers, pure culture, Spawn:typesofspawn,preparationofspawn,mushroombedpreparationandfactorsaffectingmushrombedpreparation;Compost:materials used for compost preparation, compost technology in mushroom production.

Unit-IV

Pests and disease of edible Mushroom, Environmental, Fungal, Bacterial, Viral insect pest and Nematodes disease.

Unit -V

Storage and food preparation from mushrooms: Methods of storage of mushroom cultivation ,Long term and short term storage of mushrooms Foods/recipes from mushrooms; Mushroom research centers/farms: National level and regional level, Marketing of mushrooms in India and world.

Text Books:

1. Arora, David (1991). All That the Rain Promises and More...: A Hip Pocket Guide to Western Mushrooms. Berkeley: Ten Speed Press. ISBN 978-0-89815-388-0.
2. Marrone, Teresa (2016). Mushrooms of the Northeast: A Simple Guide to Common Mushrooms. Cambridge, MN: Adventure Publications. ISBN 978-1591935919.
3. Marrone, Teresa(2014).Mushrooms of the Upper Midwest: A Simple Guide to Common Mushrooms. Cambridge, Minnesota: Adventure Publications, Inc. ISBN 978-1591934172.

Reference Books

1.Mushroom Cultivation Technology, R. Gogoi, Y.R athaiah, T.R. Borah Scientific Publishers, 2019

2 Kimbrough, James (2000). Common Florida Mushrooms. Gainesville, FL: University of Florida, Extension Institute of Food and Agricultural Sciences. ISBN 978-0916287306.

3.Metzler, Susan (1992). Texas Mushrooms: A Field Guide. Austin: University of Texas Press. ISBN 978-0292751262.

Course outcomes (COs):

Upon successful completion of the course, a student will be able to

CO1	Describe the biology, nutritional, and medicinal properties of mushrooms
CO2	Demonstrate techniques for mushroom cultivation and spawn preparation
CO3	Apply infrastructure and technology in mushroom production
CO4	Identify and manage major pests and diseases in edible mushrooms

CO5	Evaluate mushroom preservation and value-added product development
CO6	Explore mushroom research and marketing in national and global contexts

CO- PSO-PO Mapping:

Course	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. Microbiology

Course code	**: MICML- 603a(Discipline Specific Elective)**
Course Name	**: Lab Course based on MICMC- 603a**
Semester	**: VI**

L	T	P	C
0	0	2	2

1. Identify the methods of mushroom storage, nutritional value, diseases, and marketing strategies in India and around the world.
2. Understand the methods for controlling pests and diseases in edible mushrooms, along with techniques for their storage.
3. Study the fundamental principles of mushroom culture technology.
4. Explore national and regional mushroom research centers and farms.

CO1	Define the biology of mushrooms, Pests and diseases of edible mushrooms, and Methods of storage of mushrooms.
CO2	Identify the Methods of storage of mushrooms. Nutritional value, diseases, and Marketing of mushrooms in India and the world.
CO3	Apply the knowledge of Nutritional value and Marketing of mushrooms in India and the world, and knowledge about Pests and diseases of edible mushrooms.
CO4	Illustrate the method of storage of mushrooms, and also knowledge about of Nutritional value of diseases.
CO5	Summarize the Principles of Mushroom culture technology and Mushroom research centers/farms at the national and regional levels.
CO6	Justify the concept of Photogrammetry, Geoinformatics, Image Interpretation, and Digital Image Processing.

CO- PSO-PO Mapping:

Course	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc Microbiology

Course code	**: MICDE- 603b(Discipline Specific Elective)**
Course Name	**: Bio-Analytical Tools**
Semester	**: VI**

L	T	P	C
3	0	0	3

To make students aware of the importance and significance of the diverse tools and techniques used to study and understand the biological world.

Specific Objectives:

1. To introduce the basic principles, types, and applications of microscopy.
2. To study the concepts, applications, and types of centrifugation.
3. To acquaint students with chromatography and spectroscopy techniques.
4. To help students understand the techniques of electrophoresis and blotting.

UNIT I

Simple microscopy, phase contrast microscopy, florescence and electron microscopy (TEM and SEM), pH meter, absorption and emission spectroscopy.

UNIT II

Principle and law of absorption fluorimetry, colorimetry, spectrophotometry (visible, UV, infrared),

centrifugation, cell fractionation techniques, isolation of sub-cellular organelles and particles.

UNIT III

Introduction to the principle of chromatography. Paper chromatography, thin layer chromatography, column chromatography: silica and gel filtration, affinity and ion exchange chromatography, gas chromatography, HPLC.

UNIT IV

Introduction to electrophoresis. Starch-gel, polyacrylamide gel (native and SDS-PAGE), agarose-gel

electrophoresis, pulse field gel electrophoresis, immuno- electrophoresis, isoelectric focusing,

Western blotting. Introduction to Biosensors and Nanotechnology and their applications**.**

SUGGESTED READING AND TEXT BOOKS

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley& Sons. Inc.

2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006.Cell and Molecular Biology.8th edition. Lippincott Williams and Wilkins, Philadelphia.

3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition.ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.

4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009 The World of the Cell.7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description
CO1	Demonstrate an understanding of various microscopy techniques (simple, phase contrast, fluorescence, electron) and analytical instruments like pH meters and spectroscopic tools used in biological research.
CO2	Apply principles of absorption and emission spectroscopy, including fluorimetry, colorimetry, and spectrophotometry across visible, UV, and infrared ranges, for qualitative and quantitative biological analysis.
CO3	Explain the theory, applications, and laws of centrifugation, and employ cell fractionation techniques for the isolation and characterization of sub-cellular organelles.
CO4	Analyze chromatographic methods such as paper, TLC, column (silica, gel filtration, affinity, ion exchange), gas chromatography, and HPLC to separate and identify biomolecules.
CO5	Evaluate various electrophoresis techniques—including starch-gel, PAGE, agarose-gel, and pulse-field—alongside blotting techniques like Western blotting, immuno-electrophoresis, and isoelectric focusing, for molecular diagnostics.
CO6	Investigate the principles and applications of biosensors and nanotechnology in modern biological and medical research.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. Microbiology

Course code	**: MICDE- 603b(Discipline Specific Elective)**
Course Name	**: Lab Course Based on MICDE- 603b**
Semester	**: VI**

L	T	P	C
0	0	2	2

1.To determine the pH of the given sample.
2.Demonstration of Beer Lambert Law.
3.To determine the Rf value of given sample.
4.To perform the TLC in the given sample.
5.To perform the paper chromatography.
6. To lean the principle of SDSPAGE Electrophoresis.

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description
CO1	Determine the pH of a given sample using appropriate techniques and interpret its chemical significance.
CO2	Demonstrate the Beer-Lambert Law and relate absorbance to concentration in spectrophotometric analysis.
CO3	Calculate the Rf value of a compound and analyze its mobility in chromatographic systems.
CO4	Perform Thin Layer Chromatography (TLC) and evaluate sample separation based on polarity and solubility.
CO5	Conduct paper chromatography and interpret the separation of biomolecules.
CO6	Understand the principle of SDS-PAGE electrophoresis and its role in protein separation and analysis.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. (Hons.) Microbiology (Generic Elective)

Course code	**: MICGE-604**
Course Name	**: Pharmaceutical Biotechnology & Drug Designing**
Semester	**: VI**

L	T	P	C
4	0	0	4

Course Objectives: The objectives of this course are

1. To understand the Concept, Need, and Importance of Biotechnology in Pharmaceutical Biotechnology & Drug Designing.
2. To demonstrate the scientific method and the use of problem-solving within the field of Pharmaceutical Biotechnology & Drug Designing.
3. To develop scientific knowledge regarding vaccines and the role of biotechnology in the development of pharmaceutical drugs.
4. To demonstrate the scientific method and the use of Drug targeting and drug delivery systems.

Couse Contents

Unit 1

Delivery considerations of biotechnological products: Introduction, Stability profile, Barriers to proteins and peptide delivery, Delivery of protein & peptide drugs, Lymphatic transportation of proteins, Site-specific protein modification(protein engineering), Toxicology profile characterization.

Unit 2

Drug targeting and drug delivery systems: Introduction, Historical perspectives, Drug targeting, Cellular-level events in targeting. Ligands as means of targeting, Blood cell receptors for endogenous compounds, Carrier systems for targeting, Vesicular systems for ligand-mediated drug targeting, Specialized liposomes for cellular drug targeting.

Unit 3

Vaccines: Introduction, Multivalent subunit vaccines, Purified macromolecules, Synthetic peptide vaccines, Immuno-adhesions, Recombinant antigen vaccines, Vector vaccines,

Unit 4

Introduction to drug design cycle: Structure Activity Relationship (SAR), Rational Drug Design, Pharmacophoric patterns, Quantitative Structure-Activity Relationship. (Q SAR) & Hans equation.

Unit 5

Introduction to molecular modeling: Quantum mechanical and molecular orbital methods, Introduction to semiempirical, molecular mechanics, and ab initio techniques. Potential energy surface, Docking and modeling substrate–receptor interactions. Introduction to s/w tools for CADD.

Suggested Reading and Text Books

1. Leon Lachman. Theory and Practice of Industrial Pharmacy, 3 Edition, Lea and Febiger, 1986 .
2. Remington's Pharmaceutical Science, Mark Publishing and Co.

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description
CO1	Explain the principles and challenges in the delivery of biotechnological products, including protein and peptide drugs, their stability, barriers to delivery, and toxicological profiling.
CO2	Analyze various drug targeting strategies and delivery systems, including ligand-mediated targeting, blood cell receptors, and specialized vesicular carriers.
CO3	Evaluate different types of vaccines, including multivalent subunit vaccines, synthetic peptide vaccines, recombinant antigen vaccines, and vector-based vaccines.
CO4	Apply concepts of the drug design cycle, including SAR, pharmacophoric patterns, QSAR, and Hans equation, to rational drug development.

CO5	Utilize molecular modeling techniques such as quantum mechanics, molecular mechanics, docking, and CADD tools to simulate drug-receptor interactions and predict molecular behavior. Applications in health, agriculture, and the environment, along with associated social and environmental issues.
CO6	Integrate knowledge across biotechnological drug delivery, targeting systems, vaccine development, rational drug design, and molecular modeling to propose innovative therapeutic solutions.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. Microbiology

Course code	**: MICSC-605(Skill Enhancement Course)**
Course Name	**: Basics of Forensic Science**
Semester	**: VI**

L	T	P	C
2	0	0	2

Course objectives: This is an introductory course on forensic sciences with the following objectives:

1. To familiarize students with the fundamental principles and scope of forensic science.
2. To impart knowledge on the assessment of injuries and causes of death in forensic investigations.
3. To help students understand the process and significance of forensic documentation.
4. To provide insights into the role and importance of cybersecurity in forensic science.

Unit I

Introduction and principles of forensic science, forensic science laboratory and its organization and service, tools and techniques in forensic science, branches of forensic science, causes of crime, role of modus operandi in criminal investigation. Classification of injuries and their medico-legal aspects, method of assessing various types of deaths.

Unit II

Classification of fire arms and explosives, introduction to internal, external and terminal ballistics. Chemical evidence for explosives. General and individual characteristics of handwriting, examination and comparison of handwritings and analysis of ink various samples.

Unit III

Role of the toxicologist, significance of toxicological findings, Fundamental principles of fingerprinting, classification of fingerprints, development of finger print as science for personal identification,

Unit IV

Principle of DNA fingerprinting, application of DNA profiling in forensic medicine, Investigation Tools, eDiscovery, Evidence Preservation, Search and Seizure of Computers, Introduction to Cyber security.

SUGGESTED READING AND TEXT BOOKS

1. Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
2. B.B. Nanda and R.K. Tiwari, Forensic Science in India: A Vision for the Twenty First Century, Select Publishers, New Delhi (2001). _
3. M.K. Bhasin and S. Nath, Role of Forensic Science in the New Millennium, University of Delhi, Delhi (2002). _
4. S.H. James and J.J. Nordby, Forensic Science: An Introduction to Scientific and Investigative Techniques, 2nd Edition, CRC Press, Boca Raton (2005).
5. W.G. Eckert and R.K. Wright in Introduction to Forensic Sciences, 2nd Edition, W.G. Eckert (ED.), CRC Press, Boca Raton (1997).
6. R. Saferstein, Criminalistics, 8th Edition, Prentice Hall, New Jersey (2004).
7. **W.J. Tilstone, M.L. Hastrup and C. Hald, Fisher's Techniques of Crime Scene** Investigation, CRCPress, Boca Raton (2013).

COURSE OUTCOMES(CO): On completion of this course, the students will be able to:

CO	Description
CO1	Explain the fundamental principles of forensic science, its organizational structure, tools and techniques, branches, and the role of modus operandi in criminal investigations.
CO2	Assess various types of injuries and deaths, and interpret their medico-legal significance in forensic contexts.
CO3	Classify firearms and explosives, and analyze ballistic evidence and handwriting samples using forensic techniques.
CO4	Evaluate toxicological evidence and apply fingerprint classification and identification methods in forensic investigations.
CO5	Apply the principles of DNA fingerprinting and profiling in forensic medicine, and utilize digital tools for cyber forensic investigations.
CO6	Integrate knowledge of physical, chemical, biological, and digital forensic techniques to solve complex criminal cases and ensure evidence integrity.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Degree Course in Honours Microbiology [B.Sc. (Hons.) Microbiology]

B. Sc. (Hons.) MICROBIOLOGY

Course code	**: MICDC- 701(Discipline Specific Course)**
Course Name	**: NANOBIOTECHNOLOGY**
Semester	**: VII**

L	T	P	C
3	0	0	3

Course Objectives: The objectives of this course are

To develop knowledge and understanding of the core concepts in the discipline of Nanobiotechnology.

Unit I Nanotechnology Definition and concepts; Cellular Nanostructures; Nanopores; Biomolecular motors; Criteria for suitability of nanostructures for biological applications.

Unit II Basic characterization techniques Electron microscopy; Atomic force microscopy; Photon correlation Spectroscopy.

Unit III Thin films; Colloidal nanostructures Nanovesicles; Nanospheres; Nanocapsules.

Unit IV Health Care Nanotechnology Nanostructures for diagnostics and biosensors; Nanoparticles for diagnostics and imaging, Future perspectives of nanoscience and nanotechnology.

Unit IV Optical (UV-Vis/Fluorescence), X-ray diffraction, Imaging and size (Electron microscopy, light scattering, Zetapotential), Surface and composition (ECSA, EDAX, AFM/STM etc), Vibrational (FT-IR and RAMAN), SERS, Magnetic, Electrical and Electrochemical.

Texts/References: 1. Multilayer Thin Films, Editor(s): Gero Deche, Joseph B. Schlenoff Publisher: Wiley-VCH Verlag GmbH & Co. KGaA ISBN: 3527304401.

2. Bionanotechnology: Lessons from Nature Author: David S. Goodsell Publisher: Wiley- Liss ISBN: 047141719X.

3. Biomedical Nanotechnology Editor: Neelina H. Malsch Publisher: CRC Press ISBN: 0- 8247-2579-4. 4. Springer Handbook of Nanotechnology- B Bhusan

References:

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

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

COURSE OUTCOMES(CO): On completion of this course, the students will be able to:

CO	Description
CO1	Define key concepts of nanotechnology and explain the structure and function of cellular nanostructures, nanopores, and biomolecular motors in biological systems.
CO2	Describe and apply basic characterization techniques such as electron microscopy, atomic force microscopy, and photon correlation spectroscopy for analyzing nanomaterials.
CO3	Classify and evaluate various colloidal nanostructures including thin films, nanovesicles, nanospheres, and nanocapsules for biomedical and industrial applications
CO4	Analyze the role of nanostructures in healthcare, including their use in diagnostics, biosensors, and imaging, and discuss future trends in nanoscience.
CO5	Apply advanced analytical techniques such as UV-Vis, fluorescence, XRD, FT-IR, Raman, SERS, and electrochemical methods to characterize nanomaterials.
CO6	Integrate knowledge of nanostructure design, characterization, and application to propose innovative solutions in biotechnology, medicine, and materials science.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. (Hons.) Microbiology

Course code	**: MICDC-702(Discipline Specific Course)**
Course Name	**: Advances in Genetic Engineering**
Semester	**: VII**

L	T	P	C
3	0	0	3

Course Objectives: The objectives of this course are

To give an overview of advance technology in Genetic Engineering.

1. Understand Modern Genetic Tools and Techniques.
2. Explore Applications in Medicine, Agriculture, and Industry.
3. Analyze Ethical, Legal, and Social Implications (ELSI).
4. Develop Skills for Experimental Design and Data Interpretation

UNIT I: ENZYMES AND VECTORS USED IN GENE CLONING Restriction enzymes, DNA polymerases, reverse transcriptase, terminal transferase, alkaline phosphatase, polynucleotide kinase, ligase, DNases, RNases, and topoisomerase. Plasmid vectors, phage vectors, BAC vectors and plasmid incompatibility, and vectors for cloning in yeast, and mammalian cells.

UNIT II: POLYMERASE CHAIN REACTION: PCR, factors affecting PCR, design of gene-specific and degenerate primers, semi quantitative Reverse transcriptase-PCR, real-time PCR with SYBR and TaqMan probe, site directed mutagenesis by PCR, LAMP-PCR

UNIT II: GENE CLONING METHODS: Cohesive end cloning, blunt end cloning, checking the direction of cloning by PCR and restriction digestion, cloning using adapters, and cloning adding restriction site by PCR. TA cloning, TOPO-TA cloning. Ligation independent cloning and single step cloning of multiple fragments by Gibson Assembly

UNIT IV: GENE & PROMOTER ISOLATION: Construction of cDNA library, genomic DNA library, screening the libraries using heterologous probes, functional screening, screening by complementation. Constitutive and inducible promoters, tissue specific promoters, promoter identification from gene expression data, reporter genes for promoter deletion studies, promoter deletion studies

UNIT V: EXPRESSON OF RECOMBINANT PROTEINS: Components of an expression plasmid vector, strategies for cloning in proper reading frame, codon optimization, optimization of induction of protein expression, factors affecting inclusion body formation, factors affecting protein folding, solubilizing recombinant protein in inclusion bodies, purification of recombinant proteins with and without purification ligands. Immobilization of recombinant proteins.

Suggested Readings

1. Brown TA. (2006). Gene Cloning and DNA Analysis. 5th edition. Blackwell Publishing, Oxford, U.K.
2. Clark DP and Pazdernik NJ. (2009). Biotechnology-Applying the Genetic Revolution. Elsevier Academic Press, USA.
3. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
4. Sambrook J, Fritsch EF and Maniatis T. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.
5. Wiley, J.M., Sherwood, L.M. and Woolverton, C.J. Prescott, Harley and Klein's microbiology. McGraw-Hill, New York.
6. Primrose, S.B. Introduction to modern virology. John Wiley and Sons, New Jersey.
7. Cappucino, J. and Sherman, N. Microbiology: A laboratory manual. Benjamin/Cummings Publishing Company, San Francisco.
8. Prescott, L.M. and Harley, J.P. Laboratory exercises in microbiology. William C. Brown, Dubuque.
9. Atlas, R.M., Brown, A.E. and Parks, L.C. Laboratory manual of experimental microbiology. Mosby College Publishing Company, St. Louis

Upon successful completion of the course a student will be able to

CO 1	Identify and explain the roles of various enzymes and vectors used in gene cloning, including their mechanisms and applications in different host systems.
CO 2	Apply principles of Polymerase Chain Reaction (PCR) to design primers, optimize reaction conditions, and perform advanced PCR techniques such as RT-PCR, real-time PCR, and LAMP-PCR.
CO 3	Demonstrate proficiency in diverse gene cloning methods including cohesive and blunt end cloning, TA cloning, TOPO-TA cloning, and Gibson Assembly, with validation strategies.
CO 4	Construct and screen cDNA and genomic libraries, and analyze promoter elements using gene expression data and reporter assays for functional characterization.
CO 5	Design and optimize expression systems for recombinant protein production, including codon usage, induction strategies, folding, solubilization, and purification techniques.
CO6	Integrate molecular cloning, PCR, promoter analysis, and protein expression techniques to develop genetic engineering solutions for research and biotechnology applications.

CO- PSO-PO Mapping:

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. (Hons.) Microbiology

Course code	**: MICDL-702(Discipline Specific Course)**
Course Name	**: Advances in Genetic Engineering LAB**
Semester	**: VII**

L	T	P	C

0	0	2	2

Course Objectives: The objectives of this course are

To develop knowledge and understanding of isolation and MW determination of the sample, and the common Molecular techniques.

1. Molecular weight determination of isolated DNA samples.

2. Molecular weight determination of isolated protein samples.
3. Restriction digestion of DNA
4. To study about preparation of competent cells
5. Transformation of competent cells.
6. Demonstration of PCR.
7. Demonstration of mutagenesis

Upon successful completion of the course, a student will be able to

CO 1	Demonstrate the ability to isolate DNA and determine its molecular weight using appropriate analytical techniques.
CO 2	Perform isolation and molecular weight determination of proteins using electrophoretic or spectroscopic methods.
CO 3	Apply restriction digestion techniques to analyze DNA fragments and understand enzyme specificity.
CO 4	Explain and execute the preparation of competent cells for transformation experiments.
CO 5	Carry out transformation of competent cells and assess efficiency and success of gene uptake.
CO6	Understand and demonstrate key molecular techniques such as PCR and mutagenesis for gene amplification and modification.

CO- PSO-PO Mapping:

Course	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	1	2	2	1	1	1	2	2	1	2	2	2	2	3	2
CO3	2	1	1	1	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	1	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. (Hons.) MICROBIOLOGY

Course code	**: MICDC-703(Discipline Specific Course)**
Course Name	**: MICROBIAL ANALYSIS OF AIR &WATER**

Semester	**: VII**

L	T	P	C
3	0	0	3

Course Objectives: The objectives of this course are

1. To develop an understanding of airborne microorganisms and their impact on human health.
2. To gain knowledge about waterborne pathogens, associated diseases, and microbiological methods for water analysis.
3. To foster curiosity and awareness about controlling air and water pollution.

Course Content

Unit I: Aeromicrobiology

Bioaerosols: Airborne microorganisms (Bacteria, viruses, and fungi) and their impact on Human health and environment: Significance in food and pharma industries and operations theatres; Allergens.

Unit II: Collection and Analysis of Air Sample

Bioaerosol sampling; Air samplers; Methods of sampling and analysis; Culture media for bacteria and fungi; Identification characteristics.

Unit III: Water Microbiology

Water-borne pathogens; Water-borne diseases

Unit IV: Microbiological Analysis of Water

Sample collection, Treatment and safety of drinking (potable) water, Water purification, Methods to detect potability of water samples: (a) Standard qualitative procedure (MPN test) (b)Membrane filter technique and (c)Presence/absence tests
UnitV: Control Measures

Air: Fate of bioaerosols; I (U.V. light, H.E.P.A filters, desiccation and incineration); Water: Precipitation, Chemical disinfection, Filtration, High temperature and U.V. light treatment.

Text Books:

TB1. Atlas, R.M. and Bartha, R. Microbiology: Fundamentals and applications. Benjamin /Cummings Science Publishing, USA.

TB2. Evans, and John, J.C.F. Environmental biotechnology: Theory and applications. John Wiley and Sons, New York.

Reference Books:

RB1. Da Silva,N.,Taniwaki,M.H.,Junqueira,V.C.,Silveira,N.,Nascimento,M.S.,Gomes, R.A. Microbiological examination methods of food and water: laboratory manual. CRC Press, Boca Raton.

RB2. Madigan, M.T., Martinko, J.M., and Parker, J. Brock Biology of Microorganisms. Prentice Hall, New Jersey.

RB3. Mitchell, and Gu, J.D. Environmental Microbiology. Wiley-Blackwell, New Jersey.

RB4. Maier, R., Pepper, I., and Gerba, C. Environmental Microbiology. Academic Press, SanDiego.

RB5. Hurst, C.J., Crawford, R.L., Garland, J.L., Lipson, D.A., Mills, A.L., and Stetzenbach, L.D. Manual of Environmental Microbiology. ASM Press, Washington, D.C.

Upon successful completion of the course, a student will be able to

CO 1	Identify and examine airborne microorganisms through air and water sample analysis, and evaluate appropriate control measures.
CO 2	Summarize the impact of airborne and waterborne pathogens on human health and the environment.
CO 3	Determine effective sampling and collection methods, along with control strategies, for airborne and waterborne pathogens.
CO 4	Explain the characteristics and transmission of airborne and waterborne pathogens.
CO 5	Evaluate various sampling, collection, and control techniques for managing airborne and waterborne microorganisms.
CO6	Generalize the fundamental concepts of air and water microbiology and their relevance to public health.

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

B. Sc. (Hons.) MICROBIOLOGY

Course code	**: MICDL-703(Discipline Specific Course)**
Course Name	**: MICROBIAL ANALYSIS OF AIR &WATER**
Semester	**: VII**

L	T	P	C
0	0	2	2

1. Isolate, identify, and examine airborne microorganisms using air and water samples; assess appropriate control measures for microorganisms present in the air.
2. Study the characteristics, transmission, and impact of airborne and waterborne pathogens.
3. Understand and apply methods for the collection and sampling of airborne and waterborne microorganisms.
4. Identify and analyze airborne microorganisms through appropriate microbiological techniques.

Upon successful completion of the course, a student will be able to

CO 1	Identify and examine airborne microorganisms through air and water sample analysis, and evaluate appropriate control measures.
CO 2	Summarize the impact of airborne and waterborne pathogens on human health and the environment.
CO 3	Determine effective sampling, collection methods, and control strategies for airborne and waterborne pathogens.
CO 4	Explain the characteristics, transmission, and significance of airborne and waterborne pathogens.
CO 5	Evaluate various sampling, collection, and control techniques for managing airborne and waterborne microorganisms.
CO6	Generalize the core concepts of air and water microbiology and their applications in public health and environmental monitoring.

CO- PSO-PO Mapping:

Course	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**: MICDC- 704a(Discipline Specific Elective)**
Course Name	**: Bioprocess Technology**
Semester	**: VII**

Course objectives: The specific objective of the course are as follows:

1. To impart knowledge on the cultivation techniques and growth kinetics of microorganisms.
2. To help students understand the basic concepts of sterilization and the components of a bioreactor.
3. To teach the industrial applications of bioprocess technology.
4. To enable students to understand the thermal death kinetics of microorganisms.

UNIT I

Introduction to bioprocess technology. Basic principle components of fermentation technology. Types of microbial culture and its growth kinetics– Batch, Fed batch and Continuous culture.

UNIT II

Airlift; Cyclone Column; Packed Tower and their application in production processes.
Principles of upstream processing – Media preparation, Inoculation development and sterilization.

UNIT III

Introduction to oxygen requirement in bioprocess; mass transfer coefficient; factors affecting KLa.
Bioprocess measurement and control system with special reference to computer aided process control.

UNIT IV

Introduction to downstream processing, product recovery and purification. Effluent treatment.
Microbial production of ethanol, amylase, lactic acid, and Single Cell Proteins.

SUGGESTED READING AND TEXT BOOKS

1. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.

2. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.

3. Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.

4. Stanbury PF, Whitaker A, and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.

Course Outcomes(COs): On completion no this course, the students will be:

CO	Description
CO1	Define the fundamental concepts of bioprocess technology and describe the basic components of fermentation systems, including types of microbial cultures and their growth kinetics (batch, fed-batch, and continuous). Bioprocess, Bioprocess measurement, and Microbial production.
CO2	Explain the design and operational principles of bioreactor types such as airlift, cyclone column, and packed tower, and their applications in industrial production processes.
CO3	Demonstrate understanding of upstream processing techniques, including media preparation, inoculum development, and sterilization methods.

CO4	Analyze oxygen requirements in bioprocesses, interpret mass transfer coefficients, and evaluate factors affecting the volumetric oxygen transfer coefficient (KLa).
CO5	Examine bioprocess measurement and control systems, with emphasis on computer-aided process control and instrumentation.
CO6	Illustrate downstream processing steps, including product recovery, purification, and effluent treatment; and describe microbial production of ethanol, amylase, lactic acid, and single-cell proteins.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**: MICDL- 704a(Discipline Specific Elective)**
Course Name	**: Bioprocess Technology**
Semester	**: VII**

L	T	P	C
0	0	2	2

Course objectives: The specific objectives of the course are as follows:

1. To impart knowledge on the cultivation techniques and growth kinetics of microorganisms.
2. To help students understand the basic concepts of sterilization and the components of a bioreactor.
3. To teach the industrial applications of bioprocess technology.
4. To enable students to understand the thermal death kinetics of microorganisms.

Course content-

1. To study the preparation of the Inoculum.
2. To study the various preservation Techniques.
3. To study the preservation techniques.
4. Production of an enzyme by a microorganism.
5. To study the growth kinetics of microorganisms in batch culture.
6. Identify different types of bacteria and fungi based on different staining techniques

Course Outcomes(COs): On completion no this course, the students will be:

CO 1	Demonstrate the preparation of microbial inoculum and understand its role in bioprocess applications.
CO 2	Explain and apply various microbial preservation techniques to maintain culture viability and purity.
CO 3	Compare and evaluate different preservation methods for long-term storage of microorganisms.
CO 4	Perform microbial enzyme production and analyze factors influencing yield and activity.
CO 5	Analyze microbial growth kinetics in batch culture and interpret growth curve data.
CO 6	Identify different types of bacteria and fungi using appropriate staining techniques and microscopic observation.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. (Hons.) MICROBIOLOGY

Course code : MICDE-704b(Discipline Specific Elective)
Course Name: MOLECULAR VIROLOGY &INFECTION
Semester : VII

L	T	P	C
3	0	0	3

Course Objectives: The objectives of this course are

1. To provide foundational knowledge of virus structure, classification, and replication strategies at the molecular level.
2. To explain the mechanisms of viral entry, genome expression, and host-cell interactions during infection.
3. To explore the molecular basis of viral pathogenesis and immune evasion strategies employed by different viruses.
4. To introduce diagnostic techniques and molecular tools used in the detection and study of viral infections.
5. To examine current approaches in antiviral therapy, vaccine development, and emerging viral threats in public health.

Course Content

UNIT – I

History of Virology and Biosafety: History and principles of virology, virus taxonomy. Structures of animal and plant virus and their morphology. Principles of biosafety, containment facilities, maintenance and handling of laboratory animals, and requirements of a virology laboratory.

UNIT – II

Virus Replication: Structure and replication strategies of bacteriophages - T7, λ, ΦX174,

and plant viruses - ssRNA virus (TMV) and dsDNA virus (CaMV). Structure and replication strategies of animal viruses - Influenza virus, Adeno virus, and Retrovirus, and Coronavirus. Induction of interferon. Antiviral agents (chemical and biological) and their mode of action.

UNIT – III

Interferon and Antiviral Agents: Viral Interference and Interferons. Nature and source of interferons, Classification of interferons. Induction of interferon. Antiviral agents (chemical and biological) and their mode of action.

UNIT – IV

Cultivation of Viruses and Viral Vaccines : Cultivation of viruses in embryonated egg, tissue culture, and laboratory animals. Conventional vaccines are killed and attenuated. Modern vaccines: recombinant proteins, subunits, DNA vaccines, peptides, immunomodulators (cytokines). Vaccine.

UNIT – V

Virological Methods: Methods for purification of viruses with special emphasis on ultracentrifugation methods. Quantitative diagnostic methods-Haemagglutination, complement fixation, neutralization, Nucleic acid-based diagnosis-PCR, microarray, and nucleotide sequencing. Application of Microscopic techniques.

Text Books:

1. Rothman, K.J. and Greenland, S. Modern epidemiology. Lippincott-Raven, Philadelphia.
2. Dockrell, H., Zuckerman, M., Roitt, I.M.andChiodini, P.L.Mim'smedicalmicrobiology.Elsevier, London
3. Gordis, L. Epidemiology. Saunders, Philadelphia.
4. Anderson,R.M.andMay,R.M.Infectiousdiseasesofhumans:Dynamicsandcontrol.Oxford University Press, Oxford

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Reference Books

1. Giesecke, J. Modern infectious disease epidemiology. Edward Arnold, London
2. Clayton,D.andHills,M.Statisticalmodelsinepidemiology.OxfordUniversityPress,Oxford.
3. RothmanK.J.,Greenland,S.andLash,T.L.Modernepidemiology.LippincottWilliamsand Wilkins,Philadelphia

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Describe the history, principles, and taxonomy of viruses, and explain biosafety practices, containment facilities, and laboratory requirements for virology research.
CO2	Explain the structure and replication strategies of bacteriophages, plant viruses, and animal viruses including TMV, CaMV, Influenza virus, Adenovirus, Retrovirus, and Coronavirus.
CO3	Analyze the role of interferons in viral interference, classify types of interferons, and evaluate the mechanisms of action of chemical and biological antiviral agents.
CO4	Demonstrate understanding of virus cultivation techniques using embryonated eggs, tissue culture, and laboratory animals, and differentiate between conventional and modern vaccine strategies.
CO5	Apply knowledge of virological purification methods, especially ultracentrifugation, and interpret quantitative diagnostic techniques such as haemagglutination, complement fixation, and neutralization assays.
CO6	Evaluate nucleic acid-based diagnostic tools including PCR, microarray, and sequencing, and understand the application of microscopic techniques in virology.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. (Hons.) Microbiology

Course code	**: MICDL-705 (Discipline Specific Elective)**
Course Name	**: MOLECULAR VIROLOGY &INFECTION LAB**
Semester	**: VII**

L	T	P	C
0	0	2	2

Course Objectives: The objectives of this course are

To develop knowledge and understanding of viral isolation and cultivation methods, and the common serological techniques followed in laboratory diagnosis of viral infection.

1. To isolate coliphages from a sewage water sample and study their lytic activity on host bacteria.
2. To isolate microorganisms from leaf surfaces and examine their potential viral associations.
3. To study the morphological characteristics and detection methods of various viral diseases.
4. To analyze viral proteins using SPVD software for structural and functional insights.
5. To demonstrate animal cell culture techniques used for viral cultivation and propagation.

PRACTICALS

1. Isolation of coliphages from a sewage water sample.
2. Isolation of microorganisms from a containerized water sample.
3. Study of morphological features for the detection of various viral diseases
4. Analysis of viral proteins using SPVD software
5. Demonstration of animal cell culture techniques
6. Demonstrate of CPF of the given sample.
7. Isolation of viral DNA for the given sample.
8. Characterization of viral DNA.
9. Agarose Gel Electrophoresis of the given sample.
10. Study of animal cell culture and uses.

Upon successful completion of the course, a student will be able to

CO 1	Apply microbiological techniques to isolate coliphages and microorganisms from environmental and containerized water samples.
CO 2	Examine and interpret morphological features for the diagnosis of viral diseases using microscopy and staining methods.

CO 3	Analyze viral protein structures and functions using SPVD software and bioinformatics tools.
CO 4	Demonstrate proficiency in animal cell culture techniques and explain their significance in virology and biomedical research.
CO 5	Perform isolation, quantification, and characterization of viral DNA using CPF and agarose gel electrophoresis.
CO6	Integrate molecular and cellular approaches to study viral infections and evaluate their applications in diagnostics, therapeutics, and vaccine development.

CO- PSO-PO Mapping:

Course	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. (Hons.) Microbiology

Course code : MICDE- 705(Discipline Specific Elective)
Course Name: Bio-Entrepreneurship
Semester : VII

L	T	P	C
3	0	0	3

Course Objectives: The objectives of this course are

1. To introduce key concepts of entrepreneurship, innovation, and business development within the context of biotechnology and life sciences.
2. To explore the Process of Translating Scientific Ideas into Commercial Ventu Examine how research findings and biotechnological innovations can be transformed into viable products, services, or start-ups.
3. To Equip students with tools for market analysis, financial planning, intellectual property management, and regulatory compliance in biotech enterprises.
4. To encourage creativity, risk-taking, and strategic thinking to identify and seize opportunities in the biotech sector.
5. To provide exposure to successful bio-entrepreneurs and startup journeys to understand challenges, solutions, and best practices in the industry.

Unit 1

Starting a venture; Assessment of feasibility of a given venture/ new venture; Approach a bank for a loan; Sources of financial assistance; Making a business proposal/ Plan for seeking loans from financial institution & Banks;

Funds from bank for capital expenditure and for working; Statutory and legal requirements for starting a company/venture; Budget planning and cash flow management.

Unit 2

Basics in accounting practices: concepts of balance sheet, P&L account, and double entry bookkeeping. Estimation of income, expenditure, profit. Assessment of market demand for potential product(s) of interest; Market conditions, segments; Prediction of market changes.

Unit 3

Services Marketing Negotiations/Strategy with financiers, bankers, Government/ law enforcement authorities; with companies/Institutions for technology transfer; Dispute resolution skills. Human Resource Development (HRD): Leadership skills; Managerial skills.

Unit-4 Role of knowledge centre and R&D. Knowledge centres like universities and research institutions; Role of technology and upgradation; Assessment of scale of development of Technology; Managing Technology Transfer; Regulations for transfer of foreign technologies; Technology transfer agencies. Case Studies.

Suggested Reading and Text Books

1. Handbook of Bioentrepreneurship Vol 4. by Holger Patzelt & Thomas Brenner (ed) Springer(2008)
2. Handbook of Entrepreneurship Research, 2005. Zoltan J. Acs and David B. Audretsch (eds.)
3. Handbook of Entrepreneurship Research: Interdisciplinary Perspectives, 2005. Sharon A. Alvarez, Rajshree Agarwal, and Olav Sorenson (eds.):
4. The Life Cycle of Entrepreneurship Ventures, 2005.Simon Parker (ed.)
5. Handbook of Bioentrepreneurship, Holger Patzelt and Thomas Brenner (eds.)

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description
CO1	Evaluate the feasibility of launching a biotechnology-based venture and prepare business proposals for financial institutions and banks.
CO2	Identify and access various sources of financial assistance, including capital and working funds, while complying with statutory and legal requirements.
CO3	Apply basic accounting principles to estimate income, expenditure, and profit, and interpret financial documents such as balance sheets and profit & loss accounts.
CO4	Analyze market demand, segment conditions, and predict market trends for biotechnology products and services.
CO5	Demonstrate effective negotiation strategies with stakeholders, including financiers, government bodies, and technology partners, while developing leadership and managerial skills.
CO6	Assess the role of knowledge centers and R&D institutions in technology development and transfer, and evaluate regulatory frameworks for domestic and foreign technology integration.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. (Hons.) Microbiology

Course code	**: MICDL- 705(Discipline Specific Elective)**
Course Name	**: Bio-Entrepreneurship**
Semester	**: VII**

L	T	P	C
0	0	2	2

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Course Objectives: The objectives of this course are

1. To understand the meaning and importance of Entrepreneurship.
2. To understand the various form soil business organization.
3. To analyze the importance off in enterprise.
4. To analyze the importance of marketing management in an enterprise.
5. To understand the meaning of international business.

Course Content-

1. To study the importance of Entrepreneurship.
2. To study the various business organizations.
3. To analyze the importance of in the enterprise.
4. To analyze the importance of marketing management in an enterprise.
5. To understand the meaning of international business.
6. To study the introduction to the proposal-making method.

Course Outcomes (COs): On completion of this course, the students will be:

CO	**Description**
CO1	Explain the significance of entrepreneurship and its role in economic and social development.
CO2	Identify and differentiate between various types of business organizations and their operational structures.
CO3	Analyze the key components and functions of an enterprise, including resource management and strategic planning.
CO4	Evaluate the role of marketing management in business growth and customer engagement.
CO5	Demonstrate an understanding of international business concepts and their relevance in a globalized economy.
CO6	Apply basic principles of proposal writing for business planning and funding acquisition.

CO- PSO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. Microbiology

Course code	**: MICDT 706**
Course Name	**: Dissertation/Project/Educational Tour Report I**
Semester	**: VII**

L	T	P	C
0	0	4	2

Course Objectives: The objectives of this course are

1. To prepare students for deployment in industry, universities, and research institutions.
2. To provide students with opportunities to gain practical, hands-on experience in real-world settings.
3. To enable students to pursue higher education in reputed institutions across the globe.

Project/Internship Guidelines

1. Every student must enroll in a project under the guidance of a faculty member or supervisor from industry or a research organization.
2. Alternatively, students may submit an educational tour report under the supervision of an internal faculty advisor.
3. Students are required to submit their project work, which will be evaluated at the end of the semester through a presentation and viva voce.
4. The thesis will be assessed internally by a panel of examiners.

Suggested Readings: NA

Course Outcome:

CO1.	Demonstrate the ability to apply theoretical knowledge to practical problems through project work or field experience.
CO2.	Collaborate effectively with academic, industrial, or research mentors to execute a project or educational tour.
CO3.	Develop professional documentation and reporting skills through the preparation of a thesis or tour report.
CO4.	Exhibit oral communication and presentation skills during project defense and viva voce.
CO5.	Analyze and interpret data or findings from project work or field visits to draw meaningful conclusions.
CO6.	Reflect on experiential learning to identify opportunities for higher education or career advancement in industry or research.

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. (Hons.) Microbiology

Course code	**: MICDC- 801 Discipline Specific Course)**
Course Name	**: Epidemiology**
Semester	**: VIII**

L	T	P	C
3	0	0	3

Course Objectives: The objectives of this course are

1. To provide in-depth knowledge of molecular and cellular components of the immune system, fostering lifelong learning and disciplinary expertise.
2. To evaluate analytical techniques for disease diagnosis and promote career advancement in molecular diagnostics and health-related solutions.
3. To enhance understanding of immune system structure and function, while emphasizing the role of tools and techniques across diverse scientific fields.
4. To grasp the theoretical and technical aspects of immunology, enabling the application of scientific knowledge in developing medical interventions

Unit 1

Overview of the Immune System. Cells and Organs of the Immune System. Antigens. Haptens & Epitopes.

Unit 2

Immunoglobulins: Structure and Function. Major Histocompatibility Complex. Antigen processing and presentation. Structure and functions of BCR & TCR.

Unit 3

Cytokines. Complement System. Cell-mediated cytotoxicity: Mechanism of T cell & NK cell-mediated lysis. Ab-dependent cell-mediated cytotoxicity (ADCC).

Unit 4

Overview of Hypersensititivity and Introduction to Transplantation. Vaccines: Active and Passive Immunization.

Unit 5

Introduction to Monoclonal Antibodies and polyclonal Antibodies. Antigen-Antibody Interactions RIA, ELISA, Western Blotting, Immuno precipitation, Immuno-fluorescence.

Suggested Reading and Text Books

5. Kuby : Immunology (4th ed.)
6. Roitt, Male &Brostof : Immunology (3rd ed).
7. Elgert & Elgert : Immunology
8. Wilson & Walker: Practical Biochemistry (4thed.)

Upon successful completion of the course, a student will be able to

CO1	Explain the fundamental components of the immune system, including immune cells, organs, antigens, haptens, and epitopes.
CO2	Describe the structure and function of immunoglobulins, MHC molecules, and antigen presentation pathways involving BCR and TCR.
CO3	Analyze the roles of cytokines, the complement system, and mechanisms of cell-mediated cytotoxicity, including ADCC.
CO4	Discuss the types and mechanisms of hypersensitivity reactions and the principles of transplantation immunology.
CO5	Differentiate between active and passive immunization strategies and evaluate the design and function of various vaccines.
CO6	Apply immunological techniques such as RIA, ELISA, Western blotting, immunoprecipitation, and immunofluorescence to study antigen-antibody interactions and antibody production.

CO- PSO-PO Mapping:

Course	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. (Hons.) Microbiology

Course code	**: MICDL- 801 Discipline Specific Course)**
Course Name	**: Epidemiology**
Semester	**: VIII**

L	T	P	C
0	0	2	2

1. Study the composition and application of important differential media for bacterial identification, including EMB agar, MacConkey agar, and Mannitol Salt agar.
2. Examine the bacterial flora of the skin using the swab method.
3. Perform antibacterial sensitivity testing using the Kirby-Bauer method.
4. Identify human blood groups through standard serological techniques.
5. Perform Total Leukocyte Count (TLC) on the given blood sample.
6. Perform Differential Leukocyte Count (DLC) on the given blood sample.

Upon successful completion of the course, a student will be able to

CO1	Demonstrate the ability to prepare and utilize differential media such as EMB agar, MacConkey agar, and Mannitol Salt agar for bacterial identification.
CO2	Apply microbiological techniques to examine the bacterial flora of the skin using the swab method.
CO3	Perform and interpret antibacterial sensitivity testing using the Kirby-Bauer disk diffusion method.
CO4	Identify human blood groups using standard serological procedures and understand their clinical relevance.
CO5	Accurately perform and analyze Total Leukocyte Count (TLC) from blood samples using hemocytometry.
CO6	Conduct a Differential Leukocyte Count (DLC) and interpret the distribution of various white blood cells for diagnostic purposes.

CO- PSO-PO Mapping:

Course	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. (Hons.) Biotechnology

Course code	**: MICDC -802 Discipline Specific Course)**
Course Name	**: Management of Human Microbial Diseases**
Semester	**: VIII**

L	T	P	C
3	0	0	3

Course Objectives: The objectives of this course are

1. To develop awareness about microbial, non-microbial, and human diseases.
2. To create awareness about social issues related to microbial diseases.
3. To understand the causes of disease outbreaks and learn measures for their control and eradication.

Course Content

TOTALHOURS:60

Unit I: Human Diseases

Infectious and non-infectious diseases; Microbial and non-microbial diseases; Deficiency diseases; Occupational diseases; Incubation period; Mortality rate; Nosocomial infections.

Unit II: Microbial Diseases

Respiratory microbial diseases; Gastrointestinal microbial diseases; Nervous system diseases; Skin diseases; Eye diseases; Urinary tract diseases; Sexually transmitted diseases: Types, route of infection, clinical systems and general prevention methods; Mosquito-borne disease: Types and prevention.

Unit III: Disease Outbreaks and Cancer

Study of recent outbreaks of human diseases (SARS, Swine flu, Ebola): Causes, spread, and control; Cancers: Types, Causes, Prevention, Detection, Treatment.

Unit IV: Microbial Diseases and Societal Issues

Importance of personal hygiene (TyphoidMary); Judicious use of antibiotics; Importance of completingantibiotic regimen; Emergence of antibiotic resistance; Current issues of MDR/XDR microbial strains.

UnitV: Vaccines

Importance;Typesofvaccines;Vaccinesavailableagainstmicrobialdiseases;Vaccination schedule(Compulsoryandpreventive)inIndiancontext.

TextBooks:

TB1. Ananthanarayan,R.andPaniker,C.K.J.(2009).Textbookofmicrobiology.Universit yPressPublication,8thed.

ReferenceBooks:

RB1. Brooks,G.F.,Carroll,K.C.,Butel,J.S.,Morse,S.A.andMietzner,T.A.(2013).Jawetz ,MelnickandAdelberg'sMedicalmicrobiology.McGrawHillPublication,26thed.

RB2. Goering,R.,Dockrell,H.,Zuckerman,M.andWakelin,D.(2007).Mims'Medicalmi crobiology.Elsevier, London,4thed.ccc

RB3. Willey,J.M.,Sherwood,L.M.andWoolverton,C.J.(2013).Prescott,HarleyandKlein 'sMicrobiology.McGrawHillHigherEducation,9thed.

RB4. Madigan,M.T.,Martinko,J.M.,Dunlap,P.V.andClark,D.P.(2014).Brockbiologyof microorganisms.PearsonInternationalEdition,14thed.

Upon successful completion of the course, a student will be able to

CO 1	Identify and name Human diseases, microbial diseases, disease outbreaks, social issues related to microbial diseases, and vaccines.
CO 2	Discuss infectious and non-infectious diseases, microbial and non-microbial diseases, disease outbreaks and cancer, social issues, and vaccines related to microbial diseases.
CO 3	Write about the concept of Infectious and non-infectious diseases; Microbial and non-microbial diseases; disease outbreaks, vaccines, and their types.
CO 4	Explain the types of human diseases, microbial diseases, and their prevention, disease outbreaks, and the study of cancer and social issues related to microbial diseases and vaccines.
CO 5	Summarize Human diseases, microbial diseases, disease outbreaks, social issues related to microbial diseases, and vaccines.
CO6	Generalize the concept of management of human microbial diseases

CO- PSO-PO Mapping:

Course	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. (Hons.) Microbiology

Course code	**: MICDL -802 Discipline Specific Course)**
Course Name	**: Management of Human Microbial Diseases**
Semester	**: VIII**

L	T	P	C
0	0	2	2

1. Study of composition and use of important differential media for identification of bacteria: EMB Agar, McConkey agar, Mannitol salt agar, Deoxycholate citrate agar, TCBS

2. Study of bacterial flora of skin by the swab method

3. Perform antibacterial sensitivity by the Kirby-Bauer method

4. Identification of human blood groups.

5. To perform a Total Leukocyte Count of the given blood sample.

6. To perform a Differential Leukocyte Count of the given blood sample.

7. To separate serum from the blood sample (demonstration).

CO1	Identify and memorize the Biosafety guidelines and biosafety levels.
CO2	Production, monitoring, and Estimation of wine.
CO3	Determination of the Isolation, biochemical characterization, and antimicrobial susceptibility of pathogenic bacteria/fungi /clinical specimens.
CO4	Experiment to determine MIC and MBC concentration of antibiotics by the broth dilution test.
CO5	Estimate enzyme production by bacterial and fungal cultures.
CO6	Formulation of media for enzyme production by microbial cultures.

CO- PSO-PO Mapping:

Course	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO**
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. (Hons.) Microbiology

Course code	**: MICDE -803 Discipline Specific Elective)**
Course Name	**: NURSING AND GARDENING**
Semester	**: VIII**

L	T	P	C
3	0	0	3

Course Objectives:The objectives of this course are

1. To gain knowledge of gardening practices, including cultivation, propagation, and raising seedlings of selected plant species.
2. To understand the methods and procedures involved in preparing a plant nursery.
3. To learn techniques for promoting rooting in stem cuttings.
4. To understand seed storage methods and the optimal soil conditions for seed sowing and seedling growth.
5. To learn the principles and techniques involved in landscape design.

Course Content

Unit 1: Nursery: definition, objectives, and scope, and building up of infrastructure for nursery, planning, and seasonal activities-Planting, seeding, and transplants**.**

Unit 2: Seed: Structure and types- Seed dormancy; causes and methods of breaking dormancy -Seed storage: Seedbanks, factors affecting seed viability, genetic erosion. Seed production technology-seed testing and certification.

Unit 3: Vegetative propagation: air-layering, cutting, selection of cutting, collecting season, treatment of cutting, rooting medium, and planting of cuttings -Hardening of plants – greenhouse-mist-chamber, shed root, shade house, and glasshouse

.

Unit 4: Gardening: definition, objectives, and scope - different types of gardening, landscape and home gardening- park and its components-plant material and design-computer application in landscaping Gardening operations: soil laying, manuring, watering, management of pests and diseases, and harvesting.

Unit5:Sowing/raisingofseedsandseedlings-Transplantingofseedlings-Studyofcultivation of different vegetables: cabbage, brinjal, lady's finger, onion, garlic, tomatoes, and carrots-Storage and market in procedures.

Textbooks

TB1.BoseT.K.&Mukherjee, D.,1972, Gardening in India, Oxford & IBH Publishing, New Delhi.

TB-2 Sandhu, M.K.,1989,PlantPropagation,WileEasternLtd.,Bangalore,Madras.

TB-3 Kumar,N.,1997,IntroductiontoHorticulture,RajalakshmiPublications,Nagercoil.

Reference Book

RB1-Edmond Musser & Andres, Fundamentals of Horticulture, McGraw Hill Book Co , NewDelhi.

RB2- Agrawal, P.K.1993, Hand Book of Seed Technology, Dept. of Agriculturea2ndCooperation,National_SeedCorporationLtd.,NewDelhi.

Upon successful completion of the course, a student will be able to

CO 1	Understand nursery management practices
CO 2	Demonstrate knowledge of seed biology and technology
CO 3	Apply vegetative propagation techniques.
CO 4	Explain and differentiate between nursery and gardening, planting, seed, vegetative propagation, and their types.
CO 5	Summarize the concept of nursery and gardening
CO6	Revise about Nursery, seed, vegetative propagation, and gardening.

CO- PSO-PO Mapping:

Course	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. (Hons.) Microbiology

Course code	**: MICDL -803 Discipline Specific Elective)**
Course Name	**: Lab course based on MICDC803**
Semester	**: VIII**

L	T	P	C
0	0	2	2

1. To gain knowledge of gardening practices, including cultivation, propagation, and raising of seedlings for ornamental plants.
2. To understand the methods and procedures for preparing a plant nursery.
3. To learn techniques for promoting rooting in stem cuttings.
4. To understand seed storage methods and the soil conditions required for seed sowing and healthy seedling growth.
5. To explore the principles and techniques involved in landscape design.

Upon successful completion of the course, a student will be able to

CO 1	Demonstrate understanding of ornamental plant cultivation
CO 2	Apply nursery preparation techniques
CO 3	Implement propagation methods for stem cuttings
CO 4	Manage seed storage and sowing conditions
CO 5	Design basic landscape layouts and Study of application of extra nutrients in plants.
CO6	Integrate gardening operations for plant health and productivity.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. (Hons.) Microbiology

Course code	**: MICDE-804a Discipline Specific Elective)**
Course Name	**: Biomaths, Biostats, Computer Programming & Application**
Semester	**: VIII**

L	T	P	C
3	0	0	3

Course Objectives: The objectives of this course are

1. To learn to define and find the solution of arithmetic mean, median and mode, Quartiles, deciles and percentiles.
2. To demonstrate knowledge of chi square test, t-test, distributions, correlation and regression.
3. To develop the concepts of moments, skewness and kurtosis and determining whether the given distribution is normal or not.
4. To understand and illustrate the theory and applications of the probability.
5. To demonstrate computer programming and components of a computer system.

Unit 1

Relation of Life Science with mathematics, Linear function concept, 0.5 coordinate system, trigonometry relations, differentiation & integration concept, logarithms, complex numbers, Plotting of graphs, matrices.

Unit 2

Importance of statistics in biomedical research. Mean, Mode, median, range, mean deviation, standard deviation, standard error, skewness & kurtosis. Correlation & Regression. Probability: Theorems, Addition rules, multiplication rules, probability applications, probability distributions- Binomial, Poisson & Normal Distributions

Unit 3

Chi square test-characteristics of Chi square test, validity of Chi square test, applications of Chi square test. Test for significance- comparison of means of two samples, comparison of means of three or more samples (f-test, t-test).

Unit 4

Need for computer language, reading C Programs, Introduction to Computers: Mini, micro, mainframe and super computers. Components of a computer system (CPU, I/O units).Data storage device, Memory concepts.Software and types of software.Applications of common packages, Microsoft Office: Microsoft word, Microsoft excel, Microsoft Power Point.

Suggested Reading and Text Books

1. Rajaraman V: Computer Programming in "C". PHI.
2. Yashwant Kanetker: Let us "C" BPB.
3. Peter Norton's: Introduction to Computer.
4. Hoel, P.G: Elementary Statistics John Wiley & Sons, Inc. New York.
5. Mahajan: Methods in Biostatistics (4th ed.) Jaypee Bros. 1984.
6. Sokal & Rohlf: Introduction to Biostatistics, Freeman, Toppan, 1993.
7. D. Rajaraman & V. Rajaraman: Computer primer (2nd ed.) Prentice Hall of India, New Delhi.
8. Roger Hunt & John Shelley: Computer and Commonsense Prentice Hall of India, New Delhi.
9. Norton, Peter: Introduction to Computers (2nd ed.), TMH Publishing Company Ltd., New Delhi.

Upon successful completion of the course, a student will be able to

CO 1	Apply mathematical concepts to life sciences.
CO 2	Utilize statistical tools in biomedical research
CO 3	Analyze relationships using correlation and regression
CO 4	Apply probability theory to biological data
CO 5	Perform hypothesis testing using statistical methods
CO6	Demonstrate basic computer literacy and software application skills

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. (Hons.) Microbiology

Course code	**: MICDL-803a Discipline Specific Elective)**
Course Name	**: Biomaths, Biostats, Computer Programming & Application**
Semester	**: VIII**

L	T	P	C
0	0	2	2

Course Objectives: The objectives of this lab course are

1. To develop an understanding of mathematical principles and their applications in life sciences, enabling students to model biological processes, analyze quantitative data, and apply concepts such as functions, calculus, trigonometry, matrices, and graphing to solve biological problems.
2. To equip students with statistical tools and techniques essential for designing experiments, analyzing biological data, interpreting results, and making informed decisions in biomedical research through concepts like central tendency, dispersion, probability, correlation, regression, and hypothesis testing

3. To introduce students to the fundamentals of computer systems and programming, with a focus on using software tools and languages (such as C and Microsoft Office) for data management, analysis, and presentation in biological and biomedical contexts.

PRACTICALS

1. To apply mathematical concepts to biological problems through hands-on exercises involving functions, calculus, matrices, and graph plotting.
2. To analyze biological data using statistical methods and interpret results for research and experimentation.
3. To develop basic programming skills and use software tools for data analysis and presentation in life sciences.

Upon successful completion of the lab course a student will be able to

CO 1	Describe calculation of central tendencies, standard deviation and coefficient of variation and computer language.
CO 2	Discuss mean, median and mode from grouped and ungrouped data set and Components of a computer system.
CO 3	Develop skewness and kurtosis, curve fitting , Components of a computer system
CO 4	Differentiate correlation and regression.
CO 5	Compare confidence interval and Components of a computer system.
CO6	Express hypothesis test- normal distribution, t-test and chi-square test and types of computer.

CO- PSO-PO Mapping:

Course	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. (Hons.) MICROBIOLOGY

Course code	**: MICDE-804b Discipline Specific Elective)**
Course Name	**: Biomedical Technology**
Semester	**: VII**

L	T	P	C
3	0	0	3

Course Objectives: The objectives of this course are

1. **To provide foundational knowledge of biomedical instruments and technologies** used in the diagnosis, monitoring, and treatment of diseases.
2. **To develop skills in the design, operation, and maintenance of medical devices** and systems used in clinical and research settings.
3. **To understand the integration of engineering principles with biological sciences** for innovation in healthcare solutions and biomedical applications.
4. **To promote awareness of regulatory standards, safety protocols, and ethical considerations** in the development and use of biomedical technologies

Course Content

UNIT I CellularPathology: causes of cellular injury, necrosis, biochemical mechanisms, ischemic and hypoxic injury. Apoptosis (Biochemical features, mechanisms), Immunological basis of diseases: Hypersensitivity(IIV), Autoimmune diseases, Preparation of polyclonal antisera: characterization of antisera, Immuno diagnostic – RIA, ELISA.

UNIT II Mutations and genetic disorders. Single-gene disorders, Receptor proteins (hypercholesterolemia). Cytogenic disorders (Trisomy, Klinefelter's). Mutations in mitochondrial genes (LHDN), Fragile X Syndrome.

UNIT III Types and grading of cancer. Introduction to molecular diagnosis of cancer.(Southern &Northernblotanalysis,PCRbaseddiagnosis).Genetherapy,Immunotherapyandchemotherapy of cancer cells.

UNIT IV Chemical mutagens.Carcinogenic agents and their cellular interactions.Radiation ashealth hazard. (Types,measurements,effects&protective measures)Introduction toDNA damage and Types of DNA repair mechanism.

UNIT V Molecular diagnosis (genetic disease, gene diagnosis, gene tracking & other diagnosticapplication of RDT) Molecular diagnostic- direct gene diagnosis, Linkage analysis.Nucleic acid sequences as diagnostic tools, SNPs, VNTRs, Non-invasive methodology.MRI, CT-SCAN. Reproductive Health Technologies – ICSI,IVE.

Text Books:

1. **1.**Krebs,J.E.,Goldstein,E.S.andKilpatrick,S.T.Lewin'sgenes.JonesandBartlett, Learning Publishers, Sudbury
2. Chaitanya, K.V. Cell and molecular biology: A lab manual. PHI Learning, New Delhi.

Reference book

1. Snustad,D.P.andSimmons,M.J.Principlesofgenetics.JohnWileyandSons,NewYork.
2. Lodish,H.,Berk,A.,Kaiser,C.A.,Krieger,M.,Scott,M.P.,Bretscher,A.,Ploegh,H.and Matsudaira, P. Molecular cell biology. W.H. Freeman and Company, New York.

3. Synder,L.J.,Peters,E.,Henkins,T.M.andChampness,W.Moleculargeneticsofbacteria.ASM Press, Washington, D.C.
4. Maloy,S.R.,Cronan,J.E.andFreifelder,D.M.Microbialgenetics.JonesandBartlettLearning, Sudbury.

Course outcomes (COs):
Upon successful completion of the course a student will be able to

CO- PSO-PO Mapping:

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

CO	Description
CO1	Demonstrate the ability to separate and preserve serum and plasma for diagnostic and research applications.
CO2	Accurately determine blood group and Rh factor using standard serological techniques.
CO3	Perform and interpret agglutination reactions in bacterial cultures using the slide agglutination method.
CO4	Quantify antigen concentration using radial immunodiffusion and analyze diffusion-based immunological interactions.
CO5	Detect and quantify antibodies or antigens using the double diffusion technique and understand their diagnostic relevance.
CO6	Determine antigen concentration using rocket immune electrophoresis and evaluate its efficiency in immunodiagnostics.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. (Hons.) MICROBIOLOGY

Course code	**: MICDL-804b Discipline Specific Elective)**
Course Name	**: Biomedical Technology**
Semester	**: VII**

L	T	P	C
0	0	2	2

Course Objectives: The objectives of this course are

1. To develop hands-on proficiency in operating biomedical instruments **used for diagnostic and therapeutic applications, such as spectrophotometers, centrifuges, and imaging systems.**
2. To train students in molecular biology techniques **including ELISA, RIA, PCR, and blotting methods for disease diagnosis and research.**
3. To enable students to perform immunological assays and analyze cellular responses **related to hypersensitivity, autoimmune conditions, and apoptosis.**
4. To cultivate skills in interpreting experimental data and troubleshooting biomedical equipment**, while adhering to safety, ethical, and regulatory standards in laboratory practice.**

Course content

1. Separation and preservation of serum and plasma.
2. Determination of blood group and Rh factor.
3. Demonstration of agglutination reaction in bacterial cultures using the slide agglutination test.
4. Quantitative estimation of antigen using radial immunodiffusion.
5. Detection and quantification of antibody or antigen using the double diffusion technique.

   method.
6. Determination of concentration of antigen by rocket immune electrophoresis.

Course outcomes (COs):
Upon successful completion of the course a student will be able to

CO1	Explain the causes and mechanisms of cellular injury, necrosis, apoptosis, and the immunological basis of diseases including hypersensitivity and autoimmune disorders.
CO2	Analyze genetic mutations and disorders, including single-gene, cytogenetic, and mitochondrial abnormalities, and understand the role of receptor proteins in disease.
CO3	Classify types and grades of cancer and describe molecular diagnostic techniques such as blotting methods and PCR, along with therapeutic approaches like gene therapy and immunotherapy..
CO4	Evaluate the effects of chemical mutagens, carcinogens, and radiation on cellular systems, and explain DNA damage and repair mechanisms.
CO5	Apply molecular diagnostic techniques for genetic diseases, including direct gene diagnosis, linkage analysis, and use of nucleic acid markers like SNPs and VNTRs.
CO6	Demonstrate understanding of advanced diagnostic and reproductive health technologies such as MRI, CT scan, ICSI, and IVF, and their applications in clinical practice.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. Microbiology

Course code	**: MICDE 806 Discipline Specific Elective)**
Course Name	**: Green Chemistry**
Semester	**: VIII**

L	T	P	C
3	0	0	3

Course objectives: The course aims to teach the principles of green chemistry. The specific objectives of the course are:

1. **To promote the design and development of chemical processes and products** that reduce or eliminate the use and generation of hazardous substances.
2. **To encourage sustainable practices in chemical manufacturing** by minimizing waste, energy consumption, and environmental impact.
3. **To understand the principles of atom economy, renewable feedstocks, and safer solvents** in the context of eco-friendly chemical synthesis.
4. **To foster innovation in green technologies** that support environmental protection, regulatory compliance, and industrial efficiency.

UNITI: Introduction and principles

Introduction to green chemistry and its guiding principles; green chemistry and industry; waste minimization and atom economy; reduction of material use, reduction of energy requirement; energy efficiency improvements; alternative energy sources; alternative solvents.

UNIT II: Green chemistry and sustainable development

The concept of sustainability, green chemistry, and sustainability's parameters: sustainable use of chemical feedstock; sustainable use of water; sustainable use of energy; environmental resilience; life-cycle assessment: Identification of more sustainable products and processes.

UNIT III: Biocatalysis

Introduction to biocatalysis; chemical production by biocatalysis: bulk chemicals, pharmaceuticals, flavor and fragrance compounds, carbohydrates, enantiomerically pure synthons, polymers; green biocatalytic processes: biocatalysis in supercritical CO_2, biocatalysis in wastewater treatment, bio desulfurisation.

UNITIV: Photochemistry, electrochemistry, and fuel cells

Impact of green process technology on the chemical industry; heterogeneous catalysis in practice; homogeneous catalysis in practice; renewable as chemical feed stock and biocatalysis use of renewable feed stock for the production of chemicals; bio production of chemicals in industry.

Photons as clean reagents; reduced usage of reagents; photochemical reactors; introduction to green electrochemistry; electrochemical cells; electrochemical waste minimization; recovery and re cycling of metal ions; fuel cell electrochemistry; fuel cell applications.

SUGGESTED READIND AND TEXTBOOKS

1. Clark,JandMacquarrie,D2002.HandbookofGreenChemistryandTechnology,1st ed.BlackwellScienceLtd.
2. Lancaster,M2010.GreenChemistry:AnIntroductoryText,1st ed.RoyalSocietyofChemistry.
3. Sharma,SKandMudhoo,A2010.GreenChemistryforEnvironmentalSustainability,1st ed.CRCPress, BocaRaton.
4. Torok,BandDransfield,T2017.GreenChemistry:AnInclusiveApproach,1st ed.Elsevier.

Course outcomes (COs):
Upon successful completion of the course a student will be able to

CO1	Understand the principles of green chemistry and evaluate its role in minimizing waste, improving atom economy, and reducing energy consumption.
CO2	Analyze the relationship between green chemistry and sustainable development, including life-cycle assessment and resource efficiency.
CO3	Apply the principles of biocatalysis to chemical production and assess its environmental and industrial benefits.
CO4	Examine the use of supercritical CO_2 and wastewater treatment in green biocatalytic processes.
CO5	Explore the role of photochemistry and electrochemistry in green chemical processes and assess their impact on waste reduction and energy efficiency.
CO6	Investigate the use of renewable feedstocks and fuel cell technologies in sustainable chemical manufacturing.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	1	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	1	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	1	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. Microbiology

Course code	**: MICML803b Discipline Specific Elective)**
Course Name	**: Lab Course Based on MICME803b**
Semester	**: III**

L	T	P	C
0	0	2	2

Practicals

1 –Prevent Waste
2–Maximize Incorporation of Materials; Atom Economy
3–Use and Generate LessToxic Materials; Less Hazardous Chemical Syntheses
4 –Design Safer Chemicals
5–Safer Solvents and Auxiliaries
6–Minimize energy use; Design for Energy Efficiency
7–Renewable Feedstocks
8–Reduce Derivatives
9– Use catalysts
10– Real-Time Monitoring to Prevent Pollution

Upon successful completion of the course a student will be able to

CO1	Define Basic Aspects of maximize incorporation of material , Introduction to chemistry ,use of generate less toxic materials.
CO2	Summarize basic structure and function of real time monitoring to prevent pollution.
CO3	Write about prevent waste, arom economy, design safer chemicals.
CO4	Explain the basic concept of renewable feedstocks and catalysts use .
CO5	Summarize the concept of Real-Time Monitoring to Prevent Pollution .
CO6	Compile and write about the study of photochemistry.

CO- PSO-PO Mapping:

Course	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. Microbiology

Course code	**: MICDT 805**
Course Name	**: Dissertation/Project/Educational Tour Report II**
Semester	**: VIII**

L	T	P	C
	0	4	2

Course Objectives: The objectives of this course are

1. To make the students industry, university and research institute deployable.
2. To provide an opportunity to students to gain practical knowledge.
3. To provide an opportunity to pursue higher education in reputed organization across the globe.

Every student must enroll for project/ under the guidance of faculty member/supervisor from industry/research organizations or submit an educational tour report by the guidance of internal supervisor. Students will have to submit project work and will be evaluated at the end of the semester followed by presentation and viva. The thesis will be evaluated internally by a panel of examiner.

Suggested Readings: NA
Course Outcome:

CO1.	demonstrate the analytical, practical training and understand the scope and importance of Biotechnology through exposure.
CO2.	**Explain** basic concepts interpretation and organization of data.
CO3.	**Illustrate the** develop thesis writing skills and Project/Educational Tour Report.
CO4.	**Explain the** features of develop thesis writing skills and Project/Educational Tour Report.
CO5.	**Summarize the** features of develop thesis writing skills and Project/Educational Tour Report.
CO6.	**Create the** develop thesis writing skills and Project/Educational Tour Report.

CO- PSO-PO Mapping:

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Degree Course in Microbiology with Research

B. Sc Microbiology with Research

Course code	**: MICDC- 701 Discipline Specific Course)**
Course Name: Research Methodology	
Semester	**: VII**

L	T	P	C
3	0	0	3

Course Objectives: The objectives of this course are

1. To introduce with meaning, functions of research and research process.
2. To highlights the various postulates of research problems, research Design, interpretation and report writing.
3. To expose the student to concepts of measure of central tendency and variation and their application to analyze the statistical data.
4. To acquire the knowledge of correlation, regression, data analysis and hypothesis testing using suitable test of statistical significance.

UNIT-I: Meaning &Functions of Research

Meaning of Research, Characteristics of Research, Steps involved in Research, Research in Pure and Applied Sciences, Inter Disciplinary Research, Trans disciplinary research, Significance of Research, Research and scientific methods, Research Process, Criteria of good Research, Problems encountered by Researchers, Literature review.

UNIT –II: Research Problem and Research Design

Selecting the Research problem, Necessity of defining the problem, Goals and Criteria for identifying problems for research, Perception of Research problem, Formulation of Research design, Need for Research design, Features of good design, Basic principles of experimental designs, Computer and internet in designs.

UNIT- III: Interpretation and Report Writing

Meaning and Technique of interpretation, Precautions in interpretation, Significance of report writing, Different steps in writing a report, Layout of a Research report, Types of report, Mechanics of writing a research report, Precautions for writing a research report

UNIT-IV: Statistical Techniques and Tools -I

Introduction of statistics, frequency distribution, Graphical representation of data, Measures of central tendency, Mean, Median, Mode, Standard deviation, Co-efficient of variation, Probability & distribution

UNIT-V: Statistical Techniques and Tools –II

Correlation, coefficient of correlation, Scatter diagram, Regression, Sampling distribution, Standard error, Hypothesis testing, Level of significance, Degree of freedom, Chi Square, T-test, Analysis of variance (ANOVA)

Suggested readings:

1. KothariC.R.,Research Methodology Methods & Techniques,New Age international Publishers.
2. GuptaG. and GuptaM., Research Methodology, PHI Learning Private Ltd.
3. GuptaS.C. and Kapoor V.K., Fundamentals of Mathematical statistics, , Sultan Chand & Sons, New Delhi.

Course Outcome

CO1.	Understand the meaning, characteristics, and significance of research, and explain the steps involved in conducting research across pure, applied, interdisciplinary, and transdisciplinary domains.
CO2.	Identify and define research problems, and formulate effective research designs using appropriate principles and digital tools.
CO3.	Apply techniques of interpretation and report writing, and demonstrate the ability to structure and present research findings in various report formats.

CO4.	Use basic statistical tools such as frequency distribution, graphical methods, measures of central tendency, and dispersion to analyze research data.
CO5.	Perform advanced statistical analyses including correlation, regression, hypothesis testing, and ANOVA to interpret complex data sets.
CO6.	Integrate statistical reasoning with research methodology to draw valid conclusions and support evidence-based decision-making in scientific research.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. Microbiology with Research

Course code	**: MICDC- 702 Discipline Specific Course)**
Course Name	**: Research Publication and Ethics**
Semester	**: VII**

L	T	P	C
3	0	0	3

Course Objectives: The objectives of this course are

1. **To understand the principles and practices of ethical research conduct**, including integrity, plagiarism prevention, and responsible authorship.
2. **To develop skills in writing and publishing scientific papers**, including manuscript preparation, peer review process, and journal selection.
3. **To promote awareness of intellectual property rights, copyright laws, and ethical issues** related to data sharing, collaboration, and publication.
4. **To encourage adherence to national and international guidelines** for ethical research involving human and animal subjects, and ensure compliance with institutional review boards

UNIT-I: Meaning &Functions of Research

Philosophy: Definition, introduction of concept, branches of Philosophy, Introduction of Metaphysics, Epistemology, Ethics/ Moral, Political and Aesthetics Philosophy

Moral philosophy, nature of moral judgments and reactions.

UNIT –II: Research Problem and Research Design

Ethics: Definition with respect to science and research, Intellectual honesty and research integrity

Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP), Redundant publications: duplicate and overlapping publications, salami slicing, Selective reporting and misrepresentation of data

UNIT- III: Interpretation and Report Writing

Publication ethics: Definition, introduction and importance, Best practices/ standards setting initiatives and guidelines: COPE, WAME, etc., Conflicts of interest, Publication misconduct: Definition, concept, Introduction

about authorship and contributor ship, Violation of Publication Ethics, Identification of publication, complaints and appeals

UNIT-IV: Statistical Techniques and Tools -I

Introduction about Journals & Publishers, Predatory publishers and journals, Quality of Journals & Publication, Introduction about Scopus/SCI,eSCI/Web of Science Indexing (Scopus.com) etc., Software tool to identify predatory publications developed by SPPU Plagiarism tools , Journal finder/ Journal suggestion tools viz. JANE, Elsevier Journal finder, Springer Journal Suggester, etc.

Suggested readings:

1. Dutta, Sumanta, Research and Publication Ethics, Bharti Publications.
2. Yadav S.K., Research and Publication Ethics, Anne Publications.

Course Outcome

CO1.	Understand the meaning, functions, and philosophical foundations of research, including branches of philosophy such as metaphysics, epistemology, ethics, political philosophy, and aesthetic philosophy.
CO2.	Identify and formulate research problems and designs while adhering to ethical principles, intellectual honesty, and research integrity.
CO3.	Recognize and evaluate scientific misconduct such as falsification, fabrication, plagiarism, redundant
CO4.	Explain the principles of publication ethics, including authorship, contributorship, conflicts of interest, and standards set by organizations like COPE and WAME.
CO5.	Detect and address publication misconduct, violations of ethical standards, and manage complaints and appeals related to research publications..
CO6.	Evaluate the quality of journals and publications using indexing databases (Scopus, SCI, Web of Science), and utilize tools for plagiarism detection and journal selection (e.g., JANE, Elsevier Journal Finder, Springer Journal Suggester).

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc Microbiology with Research

Course code	**: MICRM- 703**
Course Name	**: Review of Literature/ Minor Project**
Semester	**: VII**

L	T	P	C
0	0	0	9

Course Objectives: The objectives of this course are

1. This course intends to expose the student to new dimensions of research & development.
2. The course enhances different aspects of scientific reading and writing.
3. The course also ensures that the student to learn practical science-based skills.

At the beginning of the 4th year (7th semester), students are required to undertake a review of literature as a part of their minor project. Its progress will be assessed at the end of the 7th semester. The title of the project work may be extended in the 8th semester as a major project. At the end of the 8th semester, the dissertation is to be submitted in the department. If a student opts to carry out his/her project (major/minor) from an industry or research organization/Institute, then he/she may be allowed to the same, but the dissertation copy is to be submitted to the department, and an internal supervisor will be required from the university

Suggested readings:

3. Dutta, Sumanta, Research and Publication Ethics, Bharti Publications.
4. Yadav S.K., Research and Publication Ethics, Anne Publications.

Course Outcome.

CO1.	Identify and define a research problem through a comprehensive exploration of existing literature in the chosen domain.
CO2.	Demonstrate the ability to search, select, and organize relevant scholarly sources using databases, journals, and digital libraries.
CO3.	Critically analyze and synthesize existing research findings to identify gaps, trends, and future directions.
CO4.	Apply appropriate research methodology and theoretical frameworks to structure the minor project effectively.
CO5.	Develop academic writing skills to present a coherent and well-structured literature review and project report.
CO6.	Exhibit ethical research practices, including proper citation, avoidance of plagiarism, and adherence to publication standards.

CO- PSO-PO Mapping:

Course	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. (Hons.) Microbiology

Course code	**:**	**MICRS 704**
Course Name	**:**	**Research Seminar Presentation-I**
Semester	**:**	**VII**

L	T	P	C
0	0	0	5

Course Objectives: The objectives of this course are

1. To demonstrate technical skills for effective preparation of presentations, write-ups through participant in academic and extracurricular activities.
2. To exhibit good communication and presentation skills.
3. To acquire critical thinking ability to analyze and interpret observations, recent scientific developments, etc.

Each student has to participate in any one of the following mentioned academic activity. A power point presentation will be presented by each student pertaining to the activity in which the student has participated. A hard copy of the presentation will be submitted in the department. Evaluation will be done based upon the presentation and report submitted.

Activities:

(i) Participation in seminar / conference / workshop

Poster presentation/ oral presentation in any other academic event (beside seminar / conference) organized by departmental clubs / College / University / research institute.

Suggested Readings: NA

Course Outcome.

CO1.	Demonstrate technical skills for effective preparation of presentations and write-ups through participation in academic and extracurricular activities.
CO2.	Exhibit strong communication and presentation skills in academic settings.
CO3.	Develop critical thinking abilities to analyze and interpret observations and recent scientific developments.
CO4.	Conduct a detailed and comprehensive study related to the research seminar topic and present findings effectively.
CO5.	Summarize the key concepts, mechanisms, and properties relevant to the research seminar presentation.
CO6.	Design and deliver a well-structured research seminar presentation based on independent study and analysis.

CO- PSO-PO Mapping:

Course	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. (Hons.) Microbiology

Course code	**: MICRR-801**
Course Name	**: Research-IPR**
Semester	**: VIII**

L	T	P	C
3	0	0	3

Course Objectives: The objectives of this course are

1. To explain about Intellectual Property and Copyrights
2. To explain about software patents and their importance.
3. To gain knowledge about trade marks
4. To layout design of integrated circuits and Industrial Designs
5. To Illustrate layout design and Different International Agreements

UNIT-I:

Introduction to Intellectual Property: Historical Perspective, Different Types of IP, Importance of protecting IP.

Copyrights: Introduction, how to obtain, Differences from Patents.

UNIT –II:

Trade Marks: Introduction, how to obtain, Different types of marks – Collective marks, certification marks, service marks, Trade names, etc. Differences from Designs.

Patents: Historical Perspective, Basic and associated right, WIPO, PCT system, Traditional Knowledge, Patents and Healthcare – balancing promoting innovation with public health, Software patents and their importance for India.

UNIT- III:

Geographical Indications: Definition, rules for registration, prevention of illegal exploitation, importance to India.

Industrial Designs: Definition, how to obtain, features, international design registration.

Layout design of integrated circuits: Circuit Boards, Integrated Chips, Importance for electronic industry.

UNIT-IV:

Trade Secrets: Introduction and Historical Perspectives, Scope of Protection, Risks involved and legal aspects of Trade Secret Protection. Word Trade Organization (WTO): (i) General Agreement on Tariffs & Trade (GATT), Trade Related Intellectual Property Rights (TRIPS) agreement (ii) General Agreement on Trade related Services (GATS), (iii) Madrid Protocol (iv) Berne Convention, (v) Budapest Treaty (b) Paris Convention WIPO and TRIPS, IPR and Plant Breeders Rights, IPR and Biodiversity IP Infringement issue and enforcement-Role of Judiciary, Role of law enforcement Agencies-Police, Customs etc. Economic Value of Intellectual Property – Intangible assets and their valuation, Intellectual Property in the Indian Context – Various laws in India Licensing and technology transfer.

Suggested Readings:

1. Acharya, N.K.: Textbook on intellectual property rights, Asia Law House.
2. Guru, M,&Rao, M.B., Understanding Trips: Managing Knowledge in Developing Countries, Sage Publications.
3. Ganguli, P., Intellectual Property Rights: Unleashing the Knowledge Economy, Tata McGraw-Hill.
4. Miller,A, R,Micheal H.Davis; Intellectual Property: Patents, Trademarks and Copyright in a Nutshell, West Group Publishers.
5. Watal, J., Intellectual property rights in the WTO and developing countries, Oxford University Press, Oxford

Course Outcome:

CO1.	Acquire knowledge about Intellectual property rights, copyrights, trademarks and patents.
CO2.	Appraise about geographical indications, industrial designs, trade secrets and different international agreements including Paris convention, Budapest treaty etc
CO3.	Analyse layout designs of integrated circuits, risks involved in trade secret protection, international design registration, rules for registration of geographical indications etc.
CO4.	Anaylze to Research-IPR.Assess introduction and historical perspectives of trade secrets, working of WTO, Madrid protocol, different type of IPs, trademarks, copyrights etc.
CO5.	Summarize the properties of mechanism of Research-IPR.
CO6.	Create the Research-IPR.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. (Hons.) Microbiology

Course code	**: MICMP 802**
Course Name	**: Major Project/ Internship**
Semester	**: VIII**

L	T	P	C
0	0	0	12

Course Objectives: The objectives of this course are

4. To make the students industry deployable.
5. To provide an opportunity to students to gain practical knowledge.
6. To provide an opportunity to pursue higher education in reputed organization across the globe.

Every student must enroll for project/dissertation under the guidance of faculty member/supervisor from industry/research organizations. Students will have to submit project work and will be evaluated at the end of the semester followed by presentation and viva. The thesis will be evaluated internally by a panel of examiner.

Suggested Readings: NA

Course Outcome:

CO1.	Demonstrate analytical and practical training.
CO2.	Interpretation and organization of data
CO3.	Develop thesis writing skills.
CO4.	Anaylze the study related to Major Project/ Internship.
CO5.	Summarize the properties of mechanism of Major Project/ Internship.
CO6.	Create the Major Project/ Internship.

CO- PSO-PO Mapping:

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

B. Sc. (Hons.) Microbiology

Course code	**:**	**MICRS 803**
Course Name	**:**	**Research Seminar Presentation-II**
Semester	**:**	**VIII**

L	T	P	C
0	0	0	5

Course Objectives: The objectives of this course are:

1. To demonstrate technical skills for effective preparation of presentations, write-ups through participant in academic and extracurricular activities.
2. To exhibit good communication and presentation skills.
3. To acquire critical thinking ability to analyze and interpret observations, recent scientific developments, etc.

Each student has to participate in any one of the following mentioned academic activity. A power point presentation will be presented by each student pertaining to the activity in which the student has participated. A hard copy of the presentation will be submitted in the department. Evaluation will be done based upon the presentation and report submitted.

Activities:

(i) Participation in seminar / conference / workshop

(ii) Poster presentation/ oral presentation in any other academic event (beside seminar / conference) organized by departmental clubs / College / University / research institute.

OR

If student opts internship, it is compulsory to complete 4 weeks internship between 7th and 8th semester in any industry/ research institute/ various agencies/ other organizations and to submit internship report in department will be evaluate in department through presentation and internship report.

Suggested Readings: NA

Course Outcome:

CO1.	Demonstrate technical skills for effective preparation of presentations, write-ups through participant in academic and extracurricular activities.
CO2.	Exhibit good communication and presentation skills.
CO3.	Acquire critical thinking ability to analyze and interpret observations, recent scientific developments, etc.
CO4.	Analyze a study related to Major Project/Research Seminar Presentation.
CO5.	Summarize the properties of mechanism of Major Project/ Major Project/Research Seminar Presentation.
CO6.	Create a Major Project/ Major Project/Research Seminar Presentation.

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3	2
CO3	2	3	2	2	2	1	1	2	2	1	2	2	3	3	3	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2	2	2	3	3
CO5	2	2	2	2	1	1	1	2	2	1	2	2	2	2	2	2
CO6	2	2	2	2	2	1	1	2	2	1	2	2	2	2	2	2

CO- PSO-PO Mapping:

Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated