FACULTY OF ARTS, SCIENCE, COMMERCE, MANAGEMENT AND HUMANITIES

UNDER GRADUATE PROGRAMME

B.Sc., MICROBIOLOGY

(I to VIII SEMESTERS)

REGULATIONS -2025

CHOICE BASED CREDIT SYSTEM (CBCS)

NATIONAL EDUCATION POLICY-2020

Effective from the Academic Year 2025-2026

IGNITE • INSPIRE • INNOVATE

ST. PETER'S INSTITUTE OF HIGHER EDUCATION AND RESEARCH

(Deemed to be University)

Established under Section 3 of UGC Act, 1956

(Accredited with A+ Grade by NAAC & ISO 9001:2015 Certified)

AVADI, Chennai - 600054

St. Peter's Institute of Higher Education and Research

REGULATIONS 2025

B.Sc. MICROBIOLOGY

CHOICE BASED CREDIT SYSTEM

NATIONAL EDUCATION POLICY-2020

VISION & MISSION OF THE INSTITUTION

Vision

To achieve, Academic Excellence in Engineering, Technology and Science through Teaching, Research and Extension to Society

Mission

By generating, preserving and disseminating knowledge through rigorous academic study, inquisitiveness to understand and explore nature, entrepreneurship with creativity and innovation

VISION & MISSION OF THE DEPARTMENT

VISION

- To emerge as a dynamic center of excellence in Microbiology and to flourish in both national and international scene

MISSION

- To conduct high quality research in Microbiology
- To effectively transform our theoretical knowledge and practical skills in Microbiology to the industry and to the common public.
- To impart technical skills with integrity and ethical standards in students.

Faculty of Arts, Science, Commerce, Management and Humanities Undergraduate Degree Programs

Graduate Attributes

Types of learning outcomes:

(A) Disciplinary / multidisciplinary / interdisciplinary / trans disciplinary areas of learning
(B) Generic learning outcomes

GRADUATE ATTRIBUTES

Graduates should be able to demonstrate the acquisition of

GA1: Comprehensive knowledge and coherent understanding required **in the chosen disciplinary or interdisciplinary fields, their connections to related areas, and current and emerging developments within a broad multidisciplinary context "**

GA2: Practical, professional, and procedural knowledge, essential to perform skilled tasks in the chosen field, including competencies for self-employment, entrepreneurship, product innovation, and enterprise development

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GA3: Specialized skills essential to the chosen disciplinary or interdisciplinary fields, developed within a broad multidisciplinary context, including practical abilities suited to both routine and complex situations.

GA4: Ability to apply learned concepts to real-life and unfamiliar situations, extrapolate knowledge, and use acquired skills to solve specific problems beyond replicating curriculum content.

GENERIC LEARNING OUTCOMES (Program Outcomes)

PO1: Complex problem-solving*:* The graduates should be able to demonstrate the capability tosolve different kinds of problems in familiar and non-familiar contexts and apply the learning to real-life situations

PO2: Critical thinking*:* The graduates should be able to demonstrate the capability to apply analytical thought to analyze and synthesize data from a variety of sources and draw valid conclusions.

PO3: Creativity: The graduates should be able to demonstrate the ability tocreate, perform, or think ‘out of the Box’ in different and diverse ways to complex problems by adopting innovative, imaginative, lateral thinking, interpersonal skills and emotional intelligence.

PO4: Communication Skills: The graduates should be able to demonstrate the skills that enable them tolisten, read texts and research papers, present complex information in a clear and concise technical language related to a field of learning.

PO5: Analytical reasoning/thinking: The graduates should be able to demonstrate the capability toevaluate the reliability, identify logical flaws, analyse and synthesize data from a variety of sources to acquire valid conclusions..

PO6: Research-related skills: Graduates should be able to demonstrate a keen sense of observation and inquiry, the ability to ask relevant questions, design research proposals, define problems, formulate and test hypotheses using quantitative and qualitative data, interpret results to infer cause-and-effect relationships, develop suitable methodologies and data collection tools, apply statistical and analytical techniques appropriately, conduct and report research or experiments effectively, and understand and practice research ethics across disciplines and funding contexts

PO7: Coordinating/collaborating with others: The graduates should be able to act together as a group or a team in the interests of a common cause and work efficiently as a member with diverse teams

PO8: Leadership readiness/qualities: The graduates should be able to formulate an inspiring vision and building a team to achieve by setting direction, motivating and inspiring team members using management skills.

PO9: Lifelong Learning &Technology skills: Graduates should be able to continuously acquire new knowledge for lifelong personal and professional growth, self-directed goals, adapting to Industrial Revolution to access, evaluate, and utilize relevant information sources and software for data analysis by using ICT.

PO10*:* Multicultural competence and inclusive spirit: The graduates should be able to demonstrate cultural awareness, global perspective, respectful engagement in diverse settings, and the ability to lead inclusive teams, show gender sensitivity and empathy toward the differently-abled and those with learning disabilities.

PO11: Value inculcation: Graduates should possess the knowledge and attitude to uphold constitutional, humanistic, and practice responsible global citizenship, maintain integrity, ethical conduct in work, respect intellectual property to actively contribute to environmental sustainability and social responsibility.

PO12: Autonomy, **responsibility, and accountability:** The graduates should be able to demonstrate the ability to apply knowledge and skills independently, manage projects from start to finish, and demonstrate responsibility and accountability in professional and learning contexts, including ensuring workplace safety and security.

PO13: Environmental awareness & Community engagement and service: The graduates should be able to apply the knowledge, skills, attitudes, and values necessary to address environmental degradation, climate change, and pollution, while promoting effective waste management, biodiversity and sustainable development activities for promoting the well-being of society

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PEO-1: Introduce advanced techniques and ideas required in developing area of Microbiology

PEO-2: Enhance the students' ability to develop interdisciplinary knowledge.

PEO-3: Gain the knowledge of Microbiology through theory and practical

PEO-4: Understand and apply the knowledge of Microbiology for understanding the scientific phenomenon in the aspects of Microbiology

PEO-5: Understand and apply analytical techniques for evaluating the various biochemical systems.

PEO-6: Understand good laboratory practices (GLP) and biosafety.

PEO-7: Develop research oriented skills.

PEO-8: Make aware and handle the sophisticated instruments/equipments.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO-1: Ability to understand the concepts and applications in the field of advanced techniques andideas required in developing area of Microbiology

PSO-2: Ability to understand the scientific phenomenon in microbial enzymes, metabolism and proteins

PSO- 3: Ability to apply the learning from the courses and develop applications for real world research problems**.**

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Curriculum framework for UG Program, FASCMH for the Academic Year 2025-2026 and onwards

Credit Framework

S. No.	Particulars	Credit (s)	Instruction hours	Remarks
01	Theory	1	14-15 h / semester	
02	Practical / Workshop	1	28-30 h / semester	
03	Tutorial	1	14-15 h / semester	
04	Experiential learning	1	45 / semester	
05	Skill courses	1	28-30 h / semester	
06	Internship / Apprenticeship	3.3	One month	(i.e.) 3 month internship can award 10 credits
07	Project	3.3	One month	(i.e.) 3 month project can award 10 credits

Credits validity

a. General / lifelong learning / cognitive learning: Lifetime validity
b. Conceptual learning with detailed skills: 7 years validity
c. Conceptual learning with skills on Future Technologies: 3 years validity

Credit weightage: Lecture: Tutorial: Practical = Credit(s) (L:T:P = C)

Credit course combinations: 2:1:2 = 4; 3:1:0 = 4; 3:0:0 = 3; 1:0:4 = 3; 0:0:2 = 1; 0:1:2 = 2; 0:0:16 = 8
No-credit course: 0:0:0 = 0; **Audit course:** 2:0:0=1

The students are permitted to take a break if needed from the study during the period of study but the total duration for completing the program shall not exceed 7 years.

Course category and code for UG (FASCMH)

S. No.	Course category	Course Category Code	Credit(s) (Minimum)	
			3 year	4 year
01	Major (Core courses)	MCC	60	80
02	Minor (Allied subjects)	MNC	24	32
03	Multidisciplinary / Interdisciplinary	MDC	09	09
04	Ability Enhancement Course	AEC	08	08
05	Skill Enhancement Course	SEC	09	09
06	Value Added Course	VAC	10	10
07	Summer Internship	SIC	04	04
08	Research Project / Dissertation	RPC	00	12
Total			**124**	**164**

Semester-wise and broad course category-wise distribution of credits (Certificate to UG Degree (Honours) with Research

Semester	(A) DSC - Core (80)	(B) Minor (32)	(C) IDC / MDC (09)	(D) SEC (09) / Internship (04) Dissertation (12)	(E) AEC (Language) (08)	(F) VAC * (10)	(G) Total Credits (160)	(H) NCrF Level
I	2x3=06 (100)#	1x4=04 (100)	1x3=03	1x3=03	1x2=02	1x2=02	20	4.5
II	2x3=06 (100)	1x4=04 (100)	1x3=03	1x3=03	1x2=02	1x2=02	20	4.5
	Students exiting the program after securing minimum of 40 credits will be awarded UG Certificate in the relevant Discipline /Subject provided they secure 4 credits in work based vocational courses offered during summer term or internship / Apprenticeship in addition to 6 credits from skill-based courses earned during first and second semester							
Certificate	**12**	**08**	**06**	**06**	**04**	**04**	**40**	**4.5**
III	2x4=08 (200)	1x4=04 (200 and above)	1x3=03	1x3=03	1x2=02	1x2=02	22	5.0
IV	3x4=12 (200)	1x4=04 (200 and above)	-	-	1x2=02	2x2=04	22	5.0
	Students exiting the program after securing minimum of 80 credits will be awarded UG Diploma in the relevant Discipline /Subject provided they secure additional 4 credits in skill based vocational courses offered during first year or second year summer term.							
Diploma	**32**	**16**	**09**	**09**	**08**	**10**	**84**	**5.0**
V	3x4=12 (300)	1x4=04 (200 and above)		Internship 1x4=04	-	-	20	5.5
VI	4x4=16 (300)	1x4=04 (200 and above)	-	-	-	-	20	5.5

	Sport, NCC, NSS, Yoga, Club Activity, Red Ribbon Club, mentoring school students etc.						Good / Satisfactory	-
	Students who want to undertake 3-year UG program will be awarded UG Degree in the relevant Discipline /Subject upon securing minimum of 120 credits							
UG Degree	**60**	**24**	**09**	**13**	**08**	**10**	**124**	**5.5**
VII	4x4=16 (400)	1x4=04 (300 and above)	-	-	-	-	20	6.0
VIII	1x4=04 (400)	1x4=04 (300 and above)	-	Research Project@ 1x12=12	-	-	20	6.0
UG Degree (Honours) with Research	**80**	**32**	**09**	**25**	**08**	**10**	**164**	**-**

Note:

(A) ***Value Added Course (VAC) to be offered within first two years**

(i) Environmental Studies (Mandatory common course for all UG program) 25EVSU001
(ii) Introduction to Indian Knowledge Systems (IKS) (Mandatory common course for all UG program) and discipline specific course on Indian Knowledge Systems (IKS) (from the list given by the University) 25IKSU001
(iii) Universal Human Values (UHV) (Mandatory common course for all UG program) 25UHVU001
(iv) Digital and Technological Solutions or Health and wellness or Yoga or fitness 25VACU001
(v) Sports, NCC, NSS etc. 25NACU001
(To offer Value Added Courses by the department, the respective Deans may suggest the appropriate semester based on the workload of the faculty and the department)

(B) A course can have a combination of lecture credits, tutorial credits, and practicum credits. (Department may have an option to offer embedded course)

(C) Multidisciplinary / Interdisciplinary may be selected form the pool of Open Elective Courses offered by other departments

General guidelines to be considered while framing the UG syllabus

1. An Entrepreneurship related core course
2. A course on research methodology to be offered in the 4th year students
3. Project work are related to major discipline /domain based and field based learning with socio-economic contexts

4. To ensure that the Undergraduate (UG) degree program is structured in a way that fulfils all the Program Outcomes (POs) as per UG Regulation 2025
5. A well-structured curriculum should include a balanced combination of introductory, intermediate, higher-level, and advanced level courses to ensure a progressive development of knowledge and skills of the students
6. The course content should align with the National Credit Framework (NCrF) levels 4.5 to 6.0

#2x3=06 (100): First number – Number of Course(s), Second – Number of Credits, Third number – Total Credits Number in Parenthesis – Course level

@Students are required to take up research projects under the guidance of a faculty member. The research outcomes of their project work may be published in SCOPUS / WoS / peer-reviewed journals or may be presented in conferences / seminars or may be patented.

Students may be permitted to take a break from the study during the period of study but the total duration for completing the program shall not exceed 7 years.

DSC - Discipline Specific Courses; **IDC** - Inter-Disciplinary Courses; **MDC** - Multi-Disciplinary Courses; **AEC** - Ability Enhancement Courses; **VAC**- Value Added Courses

Course Level: 0-99: Pre-requisite Course; 100-199: Foundation or Introductory Course; 200-299: Intermediate-level Course; 300-399 Higher-level Course; 400-499 Advanced Courses

Non-Credit / Audit Course: Students may be permitted to audit course(s) of their choice offered by the HEI provided they meet the pre-requisite for the course. Sport, NCC, NSS, Yoga, Club Activity, Red Ribbon Club, mentoring school students etc.

Skill-based courses or micro-credentials: Skill-based courses or micro-credentials may be NHEQF / NSQF aligned and are integrated as part of the curricular structure of the UG / PG Program or can also be offered as standalone additional courses with credits, not integrated within the curriculum of a UG / PG program over and above their approved curricular structures. The standalone skill-based courses/micro-credentials may be from any stream, irrespective of the curricular stream of the UG/PG Program.

UG Certificate: Students who opt to exit after completion of the first year and have secured minimum of 40 credits will be awarded a UG certificate if, in addition, they complete one vocational course of 4 credits during the summer vacation of the first year. These students are allowed to re-enter the degree Program within three years and complete the degree Program within the stipulated maximum period of seven years.

UG Diploma: Students who opt to exit after completion of the second year and have secured minimum of 80 credits will be awarded the UG diploma if, in addition, they complete one vocational course of 4 credits during the summer vacation of the second year. These students are allowed to re-enter within a period of three years and complete the degree Program within the maximum period of seven years.

UG Degree: Students who wish to undergo a 3-year UG program will be awarded UG Degree in the Major discipline after successful completion of three years, securing minimum of 120 credits and satisfying the minimum credit requirements.

UG Degree (Honours): A four-year UG Honours degree in the major discipline will be awarded to those who complete a four-year degree Program with 160 credits and have satisfied the credit requirements.

UG Degree (Honours with Research): Students who secure minimum 7.5 CGPA or 75% marks and above in the first six semesters and wish to undertake research at the undergraduate level can choose a research stream in the fourth year. They should do a research project or dissertation under the guidance of a faculty member of the University/College. The research project/dissertation will be in the major discipline. The students, who secure 160 credits, including 12 credits from a research project / dissertation, are awarded UG Degree (Honours with Research).

UG Degree Programs with Single Major: A student has to secure a minimum of 50% credits from the major discipline for the 3-year/4-year UG degree to be awarded a single major. For example, in a 3-year UG program, if the total number of credits to be earned is 120, a student of Physics with a minimum of 60 credits will be awarded a B.Sc. in Physics with a single major. Similarly, in a 4-year UG program, if the total number of credits to be earned is 160, a student of Physics with a minimum of 80 credits will be awarded a B.Sc. (Hons./ Hon. with Research) in Physics in a 4-year UG program with single major.

UG Degree Programs with Double Major: A student has to secure a minimum of 40% credits from the second major discipline for the 3-year/4-year UG degree to be awarded a double major. For example, in a 3-year UG program, if the total number of credits to be earned is 120, a student of Physics with a minimum of 48 credits will be awarded a B.Sc. in Physics with a double major. Similarly, in a 4-year UG program, if the total number of credits to be earned is 160, a student of Physics with a minimum of 64 credits will be awarded a B.Sc. (Hons./ Hon. with Research) in Physics in a 4-year UG program with double major

Interdisciplinary UG Programs: The credits for core courses shall be distributed among the constituent disciplines/subjects so as to get core competence in the interdisciplinary Program. For example, a degree in Econometrics requires courses in economics, statistics, and mathematics. The total credits to core courses shall be distributed so that the student gets full competence in Econometrics upon completion of the Program. The degree for such students will be awarded as B.Sc. in Econometrics for a 3-year UG program or B.Sc. (Honours) / B.Sc. (Honours with Research) in Econometrics for a 4-year UG program.

Multidisciplinary UG Programs: In the case of students pursuing a multidisciplinary Program of study, the credits to core courses will be distributed among the broad disciplines such as Life sciences, Physical Sciences, Mathematical and Computer Sciences, Data Analysis, Social Sciences, Humanities, etc., For example, a student who opts for a UG program in Life sciences will have the total credits to core courses distributed across Botany, Zoology and Human biology disciplines. The degree will be awarded as B.Sc. in Life Sciences for a 3-year program and B.Sc. (Honours) in Life Sciences or B.Sc. (Honours with Research) for a 4-year program without or with a research component respectively.

DEPARTMENT OF MICROBIOLOGY
FACULTY OF ARTS, SCIENCES, COMMERCE, MANAGEMENT, HUMANITIES
UG PROGRAM (CBCS) - MICROBIOLOGY
(2025–2026 Batch and onwards)

SEMESTER-I

Semester	Course Code	Title of the Course	Course Category	NCrF level	SDG Goal	Instruction Hours / week			Credit(s)	Marks		
						L	T	P		CIA	ESE	Total
I	25MBU101	General Microbiology	DSC	4.5	3,6,9	4	0	0	4	40	60	100
I	25MBU111	General Microbiology lab	DSC	4.5	3,6,9	0	0	4	2	40	60	100
I	25BCU131	Biochemistry-I	Minor	4.5	4,9	2	0	0	2	40	60	100
I	25BCU113	Biochemistry-I Lab	Minor	4.5	4,9	0	0	4	2	40	60	100
I	25MBU102	Recombinant DNA Technology	SEC	4.5	3,4,9	3	0	0	3	40	60	100
I	25MBU103	Cell Biology	MDC	4.5	4	3	0	0	3	40	60	100
I	25TAU1--/ 25HIU1--/ 25TEU1--/ 25FRU1--	Tamil/Hindi/Telugu/ French	AEC	4.5	4	3	0	0	2	40	60	100
I	25EVSU001	Environmental Studies	VAC	4.5	13, 15	2	0	0	2	40	60	100
Semester Total						**17**	**0**	**8**	**20**	**320**	**480**	**800**

Minor Stream - I

Course Code	Course Title	Hrs/Week			Credit	Marks		
		L	T	P		CIA	ESE	Total
25BCU131- A	Biochemistry-I	2	0	0	2	40	60	100
25BCU131- B	Bioorganic Chemistry-I	2	0	0	2	40	60	100

*respective lab will be chosen for 2 Credits

Multidisciplinary Course-1

Course Code	Course Title	Hrs/Week			Credit	Marks		
		L	T	P		CIA	ESE	Total
25MBU103-A	Cell Biology	3	0	0	3	40	60	100
25MBU103-B	Fermentation Technology	3	0	0	3	40	60	100

SEMESTER-II

Semester	Course Code	Title of the Course	Course Category	NCrF level	SDG Goal	Instruction Hours / week			Credit(s)	Marks		
						L	T	P		CIA	ESE	Total
II	25MBU201	Immunology	DSC	4.5	3,4,9	4	0	0	4	40	60	100
II	25MBU211	Immunology Lab	DSC	4.5	3,4,9	0	0	4	2	40	60	100
II	25BCU231	Biochemistry-II	Minor	4.5	4,9	3	0	0	2	40	60	100
II	25BCU213	Biochemistry-II Lab	Minor	4.5	4,9	0	0	4	2	40	60	100
II	25MBU202	Computational Biology	SEC	4.5	4,9	3	0	0	3	40	60	100
II	25BOU231	Fermentation Technology	MDC	4.5	4,9	3	0	0	3	40	60	100
II	25ENU2--	English – I	AEC	4.5	4	2	0	0	2	40	60	100
II	25IKSU001	Introduction to Indian Knowledge Systems	VAC	4.5	4	2	0	0	2	40	60	100
Semester Total						**17**	**0**	**8**	**20**	**320**	**480**	**800**

Minor Stream - II

Course Code	Course Title	Hrs/Week			Credit	Marks		
		L	T	P		CIA	ESE	Total
25BCU231- A	Biochemistry-II	2	0	0	2	40	60	100
25BCU231- B	Plant Bioactive compound in traditional medicine	2	0	0	2	40	60	100

*respective lab will be chosen for 2 Credits

Multidisciplinary Course-II

Course Code	Course Title	Hrs/Week			Credit	Marks		
		L	T	P		CIA	ESE	Total
25BOU231- A	Fermentation Technology	3	0	0	3	40	60	100
25BOU231- B	Plant Biotechnology	3	0	0	3	40	60	100

SEMESTER-III

Semester	Course Code	Title of the Course	Course Category	NCrF level	SDG Goal	Instruction Hours / week			Credit(s)	Marks		
						L	T	P		CIA	ESE	Total
III	25MBU301	Microbial Genetics	DSC	5.0	3,4,9	4	0	0	4	40	60	100
III	25MBU302	Microbial physiology	DSC	5.0	3,4,9	4	0	0	4	40	60	100
III	25BCU331	Bioinstrumentation	Minor	5.0	4,9	3	0	0	2	40	60	100
III	25BCU313	Bioinstrumentation Lab	Minor	5.0	4,9	0	0	4	2	40	60	100
III	25MBU303	Biotechnology	SEC	5.0	4,9	3	0	0	3	40	60	100
III	25BOU331	Plant Biotechnology	MDC	5.0	4,9	3	0	0	3	40	60	100
III	25TAU3--/ 25HIU3--/ 25TEU3--/ 25FRU3--	Tamil/Hindi/Telugu/ French	AEC	5.0	4	2	0	0	2	40	60	100
III	25UHVU001	Universal Human Value	VAC	5.0	4	2	0	0	2	40	60	100
Semester Total						**21**	**0**	**4**	**22**	**320**	**480**	**800**

Minor Stream - III

Course Code	Course Title	Hrs/Week			Credit	Marks		
		L	T	P		CIA	ESE	Total
25BCU331-A	Bioinstrumentation	3	0	0	2	40	60	100
25BCU331-B	Nutritional Biochemistry	3	0	0	2	40	60	100

*respective lab will be chosen for 2 Credits

Multidisciplinary Course-II

Course Code	Course Title	Hrs/Week			Credit	Marks		
		L	T	P		CIA	ESE	Total
25BOU331-A	Plant Biotechnology	3	0	0	3	40	60	100
25BOU331-B	Animal Biotechnology	3	0	0	3	40	60	100

SEMESTER-IV

Semester	Course Code	Title of the Course	Course Category	NCrF level	SDG Goal	Instruction Hours / week			Credit(s)	Marks		
						L	T	P		CIA	ESE	Total
IV	25MBU401	Molecular biology	DSC	5.0	3,4,9	4	0	0	4	40	60	100
IV	25MBU411	Molecular biology lab	DSC	5.0	3,4,9	0	0	4	2	40	60	100
IV	25MBU402	Soil and Agricultural Microbiology	DSC	5.0	4,9	4	0	0	4	40	60	100
IV	25MBU412	Soil and Agricultural Microbiology lab	DSC	5.0	4,9	0	0	3	2	40	60	100
IV	25MBU403	Biostatistics	Minor	5.0	4,9	4	0	0	4	40	60	100
IV	25ENU4--	English – II	AEC	5.0	4	2	0	0	2	40	60	100
IV	25IKSU008	Ayurveda - Principles and Applications	VAC	5.0	4	2	0	0	2	40	60	100
IV	25-----	Open Elective course	VAC	5.0	4	2	0	0	2	40	60	100
Semester Total						**18**	**0**	**7**	**22**	**320**	**480**	**800**

Minor Stream - IV

Course Code	Course Title	Hrs/Week			Credit	Marks		
		L	T	P		CIA	ESE	Total
25MBU403-A	Biostatistics	4	0	0	4	40	60	100
25MBU403-B	Bioinformatics	4	0	0	4	40	60	100

SEMESTER-V

Semester	Course Code	Title of the Course	Course Category	NCrF level	SDG Goal	Instruction Hours / week			Credit(s)	Marks		
						L	T	P		CIA	ESE	Total
V	25MBU501	Industrial Microbiology	DSC	5.5	3,4,9	5	0	0	4	40	60	100
V	25MBU511	Industrial Microbiology lab	DSC	5.5	3,4,9	0	0	4	2	40	60	100
V	25MBU502	Bioentrepreneurship & Startup	DSC	5.5	4,9	4	0	0	4	40	60	100
V	25MBU503	Genetic Engineering Lab	DSC	5.5	4,9	0	0	4	2	40	60	100
V	25MBU504	Bioethics and Biosafety	Minor	5.5	4,9	4	0	0	4	40	60	100
V	25MBU581	Internship	Intern	5.5	9, 17	0	0	4	4	40	60	100
Semester Total						**13**	**0**	**12**	**20**	**240**	**360**	**600**

Minor Stream – V

Course Code	Course Title	Hrs/Week			Credit	Marks		
		L	T	P		CIA	ESE	Total
25MBU504-A	Bioethics and Biosafety	4	0	0	4	40	60	100
25MBU504-B	Microbial Metabolism	4	0	0	4	40	60	100

SEMESTER-VI

Semester	Course Code	Title of the Course	Course Category	NCrF level	SDG Goal	Instruction Hours / week			Credit(s)	Marks		
						L	T	P		CIA	ESE	Total
VI	25MBU601	Medical Bacteriology and Medical Virology	DSC	5.5	3,4,9	5	0	0	4	40	60	100
VI	25MBU611	Medical Bacteriology and Medical Virology Lab	DSC	5.5	3,4,9	0	0	4	2	40	60	100
VI	25MBU602	Food and Dairy Microbiology	DSC	5.5	4,9	4	0	0	4	40	60	100
VI	25MBU612	Food and Dairy Microbiology Lab	DSC	5.5	4,9	0	0	4	2	40	60	100
VI	25MBU603	Microbial Nanotechnology	DSC	5.5	4,9	4	0	0	4	40	60	100
VI	25MBU604	Clinical Laboratory Technology	Minor	5.5	4,9	4	0	0	4	40	60	100
Semester Total						**17**	**0**	**8**	**20**	**240**	**360**	**600**

Minor Stream - VI

Course Code	Course Title	Hrs/Week			Credit	Marks		
		L	T	P		CIA	ESE	Total
25MBU604-A	Clinical Laboratory Technology	4	0	0	4	40	60	100
25MBU604-B	Biological infectious disease	4	0	0	4	40	60	100

SEMESTER-VII

Semester	Course Code	Title of the Course	Course Category	NCrF level	SDG Goal	Instruction Hours / week			Credit(s)	Marks		
						L	T	P		CIA	ESE	Total
VII	25MBU701	Environmental Microbiology	DSC	6.0	3,4,9	5	0	0	4	40	60	100
VII	25MBU711	Environmental Microbiology Lab	DSC	6.0	3,4,9	0	0	4	2	40	60	100
VII	25MBU702	Medical Mycology and Parasitology	DSC	6.0	4,9	4	0	0	4	40	60	100
VII	25MBU712	Medical Mycology and Parasitology Lab	DSC	6.0	4,9	0	0	4	2	40	60	100
VII	25MBU703	Microbiological Research	DSC	6.0	4,9	4	0	0	4	40	60	100
VII	25MBU704	Nanobiotechnology	Minor	6.0	4,9	4	0	0	4	40	60	100
Semester Total						**17**	**0**	**8**	**20**	**240**	**360**	**600**

Minor Stream - VII

Course Code	Course Title	Hrs/Week			Credit	Marks		
		L	T	P		CIA	ESE	Total
25MBU704-A	Nanobiotechnology	4	0	0	4	40	60	100
25MBU704-B	Microbial Biotechnology	4	0	0	4	40	60	100

SEMESTER-VIII

Semester	Course Code	Title of the Course	Course Category	NCrF level	SDG Goal	Instruction Hours / week			Credit(s)	Marks		
						L	T	P		CIA	ESE	Total
VIII	25MBU801	Microbial Pathogenicity	DSC	6.0	3,4,9	4	0	0	4	40	60	100
VIII	25MBU802	Intellectual Property Rights	Minor	6.0	4,8,9	4	0	0	4	40	60	100
VIII	25MBU891	Research Project	Project	6.0	9, 17	0	0	17	12	40	60	100
Semester Total						**8**	**0**	**17**	**20**	**120**	**180**	**300**

Minor Stream - VIII

Course Code	Course Title	Hrs/Week			Credit	Marks		
		L	T	P		CIA	ESE	Total
25MBU802-A	Intellectual Property Rights	4	0	0	4	40	60	100
25MBU802-B	Stem cell biology	4	0	0	4	40	60	100

Total Credits offered: 164

SEMESTER-I

25MBU101 **General Microbiology** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0

Marks: Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives:

1. Educate students to learn about history and scope of Microbiology
2. Enable students to gain knowledge about Microscopy and its applications.
3. Explore students to understand the importance of nutritional requirement of microorganisms and its optimization process.
4. Introduce students to learn the techniques and principles of controlling the microorganisms.
5. Equip students to gain knowledge on industrially important microorganisms and their applications.

Program Outcomes (POs)

PO1: Complex problem-solving
PO2: Critical thinking
PO3: Creativity
PO4: Communication Skills
PO5: Analytical reasoning/thinking
PO6: Research-related skills
PO9: Lifelong Learning &Technology skills
PO13: Environmental awareness & Community engagement and service

Course Outcomes (COs)

COs	Course Outcomes	Knowledge level
CO1	Describe history and invention of Microbiology and classification of Microorganisms	K1
CO2	Discuss types of microscope and its application for studying the structure of cells	K2
CO3	Interpret growth media of microorganisms, media types and growth optimizing process	K3
CO4	Explain effective controlling measurements against various microorganism	K4
CO5	List industrially important microorganisms for the production of commercially and medicinally important products	K1

Articulation Matrix

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO9	PO13	PSO1	PSO2	PSO3
CO1	2	2	1	2	2	1	2	1	2	-	3
CO2	2	3	2	2	3	2	3	1	3	-	3
CO3	3	3	2	2	3	3	3	2	2	1	2
CO4	3	3	2	2	3	3	3	3	-	-	2
CO5	2	2	3	2	2	3	3	2	3	3	-

UNIT I: History & Scope of Microbiology

History and Scope of Microbiology-Spontaneous generation theory-Major contributions of Microbiologists - Classification & Nomenclature of Microorganisms -Structure of Prokaryotic & Eukaryotic cell

UNIT II: Microscopy & its Applications

Microscopy-Principle & Applications-Simple & Compound microscope-Bright & Dark field-Phase contrast-Electron microscope-SEM-TEM-Fluorescence-Staining techniques-Specimen preparation for electron microscopy

UNIT III: Microbial growth & Nutrition

Culture media-Types of media: simple media, enriched media, selective media, differential media, transport media. Classification of media-Components of media and its role in microbial growth-Growth curve- Pure culture techniques-preservation of microorganisms

UNIT IV: Control of Microorganisms

Sterilization techniques-Principle-Methods of sterilization-Physical & Chemical- mode of action-Phenol co-efficient test

UNIT V: Applications of Microorganism in Industry

An introduction to Microbes in industry-Food-fermentation, Textile-enzymes, Antibiotics- penicillin, Biogas-Biofertilizer-VAM, blue green algae, Bioremediation, Biopesticide

SUGGESTED READINGS

Text Books

1. Prescott LM, Harley JP and DA Klein (2005). Microbiology. Sixth edition, International edition, McGraw Hill.
2. Pelczar TR, Chan ECS and Kreig NR (2006). Microbiology. Fifth edition, Tata McGraw-Hill INC. New York.
3. Dubey RC and Maheswari DK (2012). A text of Microbiology (Revised edition). S. Chand and Company Ltd., New Delhi.
4. Robert F Boyd (1984). General Microbiology. Times mirror / Mosby college publishers.

Reference books

1. Davis BD, Delbecco R, Eisen HN and Ginsburg HS (1990). Microbiology. Fifth edition, Harper & Row, New York.
2. Heritage J, Evans EGV and Killington RA (1996). Introductory Microbiology. Cambridge University Press.
3. Larry Mc Kane and Judy Kandel (1996). Microbiology- Essentials and applications. Second edition, Mc Fraw Hill Inc, Newyork.

Alternative NPTEL/SWAYAM Course

1. General Microbiology (https://onlinecourses.swayam2.ac.in/cec25_bt18/preview)

25MBU111 **General Microbiology Lab** **4H – 2C**

Instruction Hours / week: L: 0 T: 0 P: 4

Marks: Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives:

1. Equip students to gain practical knowledge on Sterilization and bacterial media preparation.
2. Provide students to gain practical facts on isolation techniques of microorganisms.
3. Demonstrate students to gain practical knowledge on the principles of Microscopy and various staining techniques.
4. Explore students to get practical understanding to identify various microorganisms.
5. Provide students to gain practical knowledge on identifying unknown microorganisms.

Program Outcomes (POs)

PO1: Complex problem-solving
PO2: Critical thinking
PO3: Creativity
PO4: Communication Skills
PO5: Analytical reasoning/thinking
PO6: Research-related skills
PO9: Lifelong Learning &Technology skills
PO13: Environmental awareness & Community engagement and service

Course Outcomes (COs)

COs	Course Outcomes	Knowledge level
CO1	Prepare various growth media for bacterial culture	K3
CO2	Demonstrate pure culture techniques for microbial growth culture	K3
CO3	Operate various Microscopes for bacterial visualization	K3
CO4	Analyze morphology of various microorganisms by various methods	K4
CO5	Examine biochemical characteristics of bacteria and maintenance of culture media	K4

Articulation Matrix

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO9	PO13	PSO1	PSO2	PSO3
CO1	2	2	1	2	2	3	2	1	2	-	3
CO2	2	3	2	2	3	3	3	1	1	1	3
CO3	3	3	2	2	3	3	3	2	3	1	2
CO4	3	3	2	2	3	3	3	3	2	-	2
CO5	2	2	3	2	3	3	3	2	1	2	2

UNIT I: Sterilization and Media Preparation

Cleaning of glass wares, Sterilization principle and methods- moist heat- dry heat and filtration methods. Media preparation: liquid media, solid media, agar slants, agar plates, basal, enriched, selective media preparation- quality control of media, growth supporting properties, sterility check of media.

UNIT II: Bacterial culture preparation

Pure culture techniques: streak plate, pour plate, decimal dilution. Culture characteristics of microorganisms: growth on different media, growth characteristics and description. Demonstration of pigment production.

UNIT III: Microscopy and Staining methods

Microscopy: light microscopy, bright field microscopy, dark field microscopy. Motility demonstration: hanging drop, wet mount preparation, dark field microscopy, semi-solid agar, Craigie's tube method. Staining techniques: smear preparation, simple staining, Gram's staining, acid fast staining, staining of Metachromatic granules.

UNIT IV: Study of Morphology of microorganisms

Morphology of microorganisms: morphological variations in algae, morphology of fungi, slide culture technique. Antibiotic sensitivity testing: Disc diffusion test- quality control with standard strains. Micrometry: Demonstration of size of yeast and fungal filaments

UNIT V: Biochemical characterization

Biochemical characteristics of bacteria and bacterial maintenance: IMViC test, H_2S, Oxidase, catalase, urease test. Carbohydrate fermentation test, maintenance of pure culture, paraffin method, stab culture, maintenance of mold culture.

SUGGESTED READINGS

Text Books

1. Prescott LM, Harley JP and DA Klein (2005). Microbiology. Sixth edition, International edition, McGraw Hill.
2. Pelczar TR, Chan ECS and Kreig NR (2006). Microbiology. Fifth edition, Tata McGraw-Hill INC. New York.
3. Dubey RC and Maheswari DK (2012). A text of Microbiology (Revised edition). S. Chand and Company Ltd., New Delhi.
4. Robert F Boyd (1984). General Microbiology. Times mirror / Mosby college publishers.

Reference books

1. Davis BD, Delbecco R, Eisen HN and Ginsburg HS (1990). Microbiology. Fifth edition, Harper & Row, New York.
2. Heritage J, Evans EGV and Killington RA (1996). Introductory Microbiology. Cambridge University Press.
3. Larry Mc Kane and Judy Kandel (1996). Microbiology- Essentials and applications. Second edition, Mc Fraw Hill Inc, Newyork.

Alternative NPTEL/SWAYAM Course

1. General Microbiology (https://onlinecourses.swayam2.ac.in/cec25_bt18/preview)

25BCU131 **Biochemistry-I** **2H – 2C**

Instruction Hours / week: L: 2 T: 0 P: 0

Marks: Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives:

1 Educate students to acquire knowledge about the structure and function of carbohydrates
2 Explore students to understand the basics of aminoacids
3 Equip students to gain knowledge on the structure and function of Proteins
4 Introduce students to gain knowledge about properties of lipids.
5 Educate students to acquire knowledge on various nucleic acids.

Program Outcomes (POs)

PO1: Complex problem-solving
PO2: Critical thinking
PO3: Creativity
PO4: Communication Skills
PO5: Analytical reasoning/thinking
PO6: Research-related skills
PO9: Lifelong Learning &Technology skills
PO13: Environmental awareness & Community engagement and service

Course Outcomes (COs)

COs	Course Outcomes	Knowledge level
CO1	Describe structure and classification of carbohydrates.	K1
CO2	Show structure and classification of amino acids.	K2
CO3	Explain structure and classification of proteins.	K2
CO4	Describe structure and classification of lipid	K1
CO5	Draw structure and chemical properties of nucleic acids	K3

Articulation Matrix

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO9	PO13	PSO1	PSO2	PSO3
CO1	3	3	2	1	3	3	2	1	1	3	2
CO2	3	3	2	1	3	3	2	1	1	3	2
CO3	3	3	2	1	3	3	2	1	1	3	2
CO4	3	3	2	1	3	3	2	1	1	3	2
CO5	3	3	2	1	3	3	2	1	1	3	2

UNIT I: Chemistry of Carbohydrates

Definition and Classification of carbohydrates, linear and ring forms (Haworth formula) Formonosaccharides for glucose and fructose. Disaccharides – sucrose and lactose. Physical properties – muta rotation and kilianicynohydrin synthesis. Chemical properties-Oxidation, reduction, osazoneformation. Disaccharide-sucrose and lactose - occurrence, structure; Physical and chemical properties. Polysaccharides: starch and cellulose-occurrence, structure, physical and chemical properties

UNIT II: Chemistry of aminoacids

Definition and classification of aminoacids, common properties of aminoacids, amphoteric nature, isoelectric point, isoelectric pH and Zwitter ion. Reaction with ninhydrin, 1-fluoro-2, 4-dinitronitrobenzene (FDNB) and Sieg Fried-s carbamino reaction

UNIT III: Chemistry of Proteins

Classifications-shape and size, solubility and physical properties and functional properties. Physical properties: salting in and salting out, denaturation, peptide bond. Structure of protein: primary, secondary, tertiary and quaternary. N-terminal determination-Edman-s and Dansyl chloride method. C-terminal determination-Van-Slyke reaction, Phosgene reaction

UNIT IV: Chemistry of Lipids

Definition, classification and functions. Occurrence, chemistry and biological functions- simple lipids: tertiary compound lipids (e.g. phospholipids), derived lipids: steroids (e.g. cholesterol). Saturated fatty acids: Butyric, arachidic and stearic acid. Unsaturated fattyacids: Oleic, linoleic and linolenic acid. Physical property - emulsification. Chemical properties-saponification, rancidity, definition of acid number, saponification number, iodine number and Reichert-Meissl number. Bile acid and bile salt functions.

UNIT V: Chemistry of Nucleic acids

Definition, nucleoside, nucleotide and polynucleotide. Double helical model of DNA and its biological functions. Structure of RNA: tRNA, mRNA and rRNA-occurrence, chemistry and its biological functions. Differences between DNA and RNA properties: cot curve and cot value, Tm, hypo and hyperchromicity.

SUGGESTED READINGS

Text Books

1. Murray RK, Grammer DK. Harper's Biochemistry. Twenty fifth edition, McGraw Hill, Lange Medical Books.
2. Kannan C. Biomolecules. MJP Publishers, Chennai.
3. Jain JL, Sunjay Jain, Nitin Jain. Fundamentals of Biochemistry. S. Chand & Company.
4. Amit Krishna De. Biochemistry. S. Chand & Co., Ltd.

Reference books

1. Nelson DL, Lehninger MM. Principles of Biochemistry. Cox, Macmillan Worth Publishers.
2. Voet D and Voet JG (2011). Biochemistry. Fourth edition, CBS Publishers and Distributors.

Alternative NPTEL/SWAYAM Course

1. Introductory Organic chemistry (https://onlinecourses.nptel.ac.in/noc25_cy45/preview)

25BCU113 **BIOCHEMISTRY - I LAB** **4H – 2C**

Instruction Hours / week: L: 0 T: 0 P: 4

Marks: Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives:

1. Equip students with the ability to prepare standard solutions and perform various biochemical estimations.
2. Familiarize students with titrimetric and colorimetric analysis methods.
3. Provide hands-on practice for the estimation of biomolecules, acids, bases, metals, and vitamins.
4. Train students to perform experiments with precision, care, and adherence to lab safety protocols.
5. Develop data analysis skills to interpret experimental results accurately.

Program Outcomes (POs)

PO1: Complex problem-solving
PO2: Critical thinking
PO3: Creativity
PO4: Communication Skills
PO5: Analytical reasoning/thinking
PO6: Research-related skills
PO9: Lifelong Learning &Technology skills
PO13: Environmental awareness & Community engagement and service

Course Outcomes (COs)

COs	Course Outcomes	Knowledge level
CO1	Apply titrimetric methods for acid-base estimations using standard and link solutions.	K3
CO2	Perform redox titrations for the quantitative estimation of metals like iron and copper.	K3
CO3	Estimate carbohydrates quantitatively using colorimetric assays and identify them qualitatively.	K3,K4
CO4	Quantify amino acids and proteins using titration and colorimetric techniques.	K4
CO5	Estimate vitamins and antioxidants using titrimetric and spectrophotometric methods.	K4,K5

Articulation Matrix

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO9	PO13	PSO1	PSO2	PSO3
CO1	3	3	2	1	3	3	2	1	1	3	2
CO2	3	3	2	1	3	3	2	1	1	3	2
CO3	3	3	2	1	3	3	2	1	1	3	2

CO4	3	3	2	1	3	3	2	1	1	3	2
CO5	3	3	2	1	3	3	2	1	1	2	2

UNIT I: Estimation of Acids and Base

Standardization of NaOH using oxalic acid as primary standard. Estimation of Hydrochloric acid (HCl) using Na_2CO_2 as link and NaOH as primary standard. Estimation of acetic acid in vinegar using NaOH.

UNIT II: Redox Titrations for Metal Estimation

Standardization of potassium permanganate using oxalic acid. Estimation of iron in ferrous ammonium sulphate using potassium permanganate as link solution and oxalic acid as primary standard.

UNIT III: Carbohydrate Estimations

Estimation of glucose by Benedict's method. Estimation of reducing sugars by DNS method. Qualitative tests for carbohydrates (Molisch's, Fehling's, Barfoed's tests)

UNIT IV: Amino Acid and Protein Estimation

Estimation of glycine by formal titration. Estimation of protein by Biuret method.3. Estimation of tyrosine by Folin-Ciocalteu reagent.

UNIT V: Vitamin and Antioxidant Estimations

Estimation of ascorbic acid using iodine titration. Estimation of ascorbic acid by DCPIP method. Estimation of phenolic content using Folin-Ciocalteu reagent.

SUGGESTED READINGS

Text Books

1. Jayaraman, J. Laboratory Manual in Biochemistry. 1981Wiley Eastern Ltd.
2. Plummer, D.T. An Introduction to Practical Biochemistry, 1988. 3rd Edition, McGraw Hill.
3. S. Sadasivam & A. Manickam, Biochemical Methods, 2008 (2nd Edition), New Age International Publishers
4. Rodney F. Boyer, Biochemistry Laboratory: Modern Theory and Techniques, 2011 (2nd Edition) Pearson Education

Reference books

1. Sadasivam, S., & Manickam, A. (2005). Biochemical Methods. New Age International.
2. Wilson, K., & Walker, J. (2010). Principles and Techniques of Biochemistry and Molecular Biology. Cambridge University Press.

Alternative NPTEL/SWAYAM Course

1. Introductory Organic chemistry (https://onlinecourses.nptel.ac.in/noc25_cy45/preview)

25MBU102 **Recombinant DNA Technology** **3H – 3C**

Instruction Hours / week: L: 3 T: 0 P: 0

Marks: Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives:

1 Provide students with a comprehensive learning about concepts of rDNA Technology and its history
2 Introduce students to gain knowledge on the features and types of restriction enzymes
3 Educate students to learn about vector DNA and its various types
4 Equip students to gain knowledge on rDNA technology
5 Explore students to understand various applications of rDNA technology

Program Outcomes (POs)

PO1: Complex problem-solving
PO2: Critical thinking
PO3: Creativity
PO4: Communication Skills
PO5: Analytical reasoning/thinking
PO6: Research-related skills
PO9: Lifelong Learning &Technology skills
PO13: Environmental awareness & Community engagement and service

Course Outcomes (COs)

COs	Course Outcomes	Knowledge level
CO1	Discuss rDNA technology and its history	K2
CO2	Explain restriction enzymes and its features and various types	K2
CO3	Recognize structure of vector DNA and its important types	K1
CO4	Explain gene transfer methods for screening and selection of recombinants	K2
CO5	Outline various applications of rDNA technology	K1

Articulation Matrix

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO9	PO13	PSO1	PSO2	PSO3
CO1	1	2	1	2	1	3	2	-	2	-	3
CO2	1	3	2	2	3	3	3	-	1	-	3
CO3	1	3	2	2	3	3	3	-	3	-	2
CO4	1	3	2	2	3	3	3	3	2	2	2
CO5	1	2	3	2	3	3	3	3	1	2	2

UNIT I: INTRODUCTION TO rDNA TECHNOLOGY

Recombinant DNA Technology - Definition, Objectives, History and usage of various tools in rDNA technology

UNIT II: RESTRICTION ENZYMES

Restriction enzymes - Nomenclature, Types - Endonucleases and Exonucleases, Features, types of cuts - blunt end, Sticky end.

UNIT III: VECTOR DNA

Vector DNA - Types, Characteristics and plasmid features, pBR322, Ti plasmid - structure and properties.

UNIT IV: rDNA TECHNOLOGY

Recombinant DNA Technology - Procedure, Gene transfer technology, Screening and Selection of Recombinants.

UNIT V: APPLICATIONS OF rDNA TECHNOLOGY

Applications - Genetically modified products -Bt cotton, Therapeutic products - Human insulin, Disease diagnosis - Gene therapy.

SUGGESTED READINGS

Text Books

1. Lodish, Harvey et al. (2005). Molecular Cell Biology. Fifth edition.
2. Cooper GM and Hansman RE (2007). The Cell: A Molecular Approach. Fourth edition, ASM Press.
3. Alberts Bruce et al. (2002). Molecular Biology of the Cell. Fourth edition, Garland Science (Taylors Francis).
4. Brown TA (2020). Gene Cloning and DNA Analysis: An Introduction. Eighth edition, Wiley Blackwell.

Reference books

1. Clark DP and Pazdernik NJ (2015). Biotechnology. Second edition. Academic Cell.
2. Monika Jain (2012). Recombinant DNA technology. First edition, Alpha Science International.
3. Keya Chaudhuri (2012). Recombinant DNA Technology. The Energy and Resources Institute, TERI.

Alternative NPTEL/SWAYAM Course

1. Genetic Engineering: Theory and Application (https://onlinecourses.nptel.ac.in/noc25_bt53/preview)

25MBU103-A **Cell Biology** **3H – 3C**

Instruction Hours / week: L: 3 T: 0 P: 0

Marks: Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives:

1. Educate students to learn the structure of Prokaryotic and Eukaryotic Cell
2. Introduce students to gain knowledge about structure, function & localization of cellular organelles
3. Provide students with a comprehensive learning about concepts of cell division and its regulation
4. Equip students to gain knowledge on the Structure and functions of macromolecules.
5. Explore students to understand cell signalling and cell-cell communication.

Program Outcomes (POs)

PO1: Complex problem-solving
PO2: Critical thinking
PO3: Creativity
PO4: Communication Skills
PO5: Analytical reasoning/thinking
PO6: Research-related skills
PO9: Lifelong Learning &Technology skills
PO13: Environmental awareness & Community engagement and service

Course Outcomes (COs)

COs	Course Outcomes	Knowledge level
CO1	Describe structural organization of Prokaryotic and Eukaryotic cell	K1
CO2	Interpret structure and functions of various cell organelles	K2
CO3	Define the concepts in Prokaryotic and Eukaryotic cell cycle and its regulation	K1,K2
CO4	Interpret structure and functions of macromolecules	K2,K4
CO5	Explain cell signalling and cell interactions	K2

Articulation Matrix

CO / PO	PO1	PO2	PO4	PO5	PO6	PO9	PO13	PSO1	PSO2	PSO3
CO1	2	-	2	2	3	2	1	1	3	2
CO2	2	2	2	3	3	3	1	1	3	2
CO3	2	2	2	3	3	3	2	1	3	2
CO4	2	2	2	3	3	3	3	1	3	2
CO5	2	2	2	3	3	3	2	1	3	2

UNIT I: CELL STRUCTURE

Prokaryotic and Eukaryotic Cell organization, structure of organelles, extra cellular matrix and cell junctions. Cell motility and shape, Biomembranes and the sub-cellular organization of eukaryotic cells, various types of transport across cell membrane.

UNIT II: CELL ORGANELLES AND FUNCTION

Structure, Functions and Localization of Nucleus, Mitochondria, Lysosomes, Endoplasmic reticulum, Golgi apparatus, vesicles, centrosomes, cell membranes, ribosomes, cytosol, chloroplasts, flagella, cell wall.

UNIT III: CELL DIVISION

Prokaryotic and Eukaryotic cell cycle; cell growth and extracellular signals, molecular basis of cell cycle regulation and division – mitosis, meiosis, cell cycle regulation, Cancer cells and apoptosis. Oncogenes and proto-Oncogenes. Signal Transduction, cell to cell interaction

UNIT IV: MACROMOLECULES

Structure, Functions and Localization of Nucleic acids, Proteins, Carbohydrates and Lipids – basic units, architectural hierarchy and organization

UNIT V: CELL SIGNALLING

Cell signalling-Hormone-receptor interactions, G protein-coupled receptors and their effectors, Second messengers, Receptor tyrosine kinases, MAP kinase pathways.

SUGGESTED READINGS

Text Books

1. Cooper GM and Hansman RE (2007). The Cell: A Molecular Approach. Fourth edition, ASM Press.
2. Alberts, Bruce et al. (2002). Molecular Biology of the Cell, Fourth edition, Garland Science (Taylors Francis).
3. Sadava DE (2004). Cell Biology: Organelle Structure and Function, Panima Publishing.
4. Cooper GM and Hansman RE (2007). The Cell: A Molecular Approach. Fourth edition, ASM Press.

Reference books

1. Lodish H, Berk A, Zipursky SL, Matsudaira P, Baltimore D and Darnell J (2012). Molecular Cell Biology. Seventh edition, WH Freeman & Company (New York).
2. Wallace Marshall, Janet Iwasa and Gerald Karp (2019). Karp's Cell and Molecular Biology. Ninth edition, Wiley Publishers (New York).

Alternative NPTEL/SWAYAM Course

1. Introduction of Cell Biology (https://onlinecourses.nptel.ac.in/noc25_bt69/preview)

25EVSU001 **Environmental Studies** **2H – 2C**

Instruction Hours / week: L: 2 T: 0 P: 0

Marks: Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives:

1. Understand the concept of the environment, its significance, and the structure and function of ecosystems
2. Understand the concepts of renewable and non-renewable energy sources, and to explore the significance of natural resources
3. Explain the concept of biodiversity, including its genetic, species, and ecosystem diversity and the conservation of endangered and endemic species in India through in-situ and ex-situ methods.
4. Understand the definition, causes, effects, and control measures of various types of pollution (air, water, soil, marine, noise, and nuclear), along with the importance of solid waste management.
5. Understand the causes, effects, and solutions to environmental issues such as climate change, global warming, acid rains, ozone layer depletion and explore the various environmental protection laws

Program Outcomes (POs)

PO1: Complex problem-solving
PO2: Critical thinking
PO3: Creativity
PO4: Communication Skills
PO5: Analytical reasoning/thinking
PO6: Research-related skills
PO9: Lifelong Learning &Technology skills
PO13: Environmental awareness & Community engagement and service

Course Outcomes (COs)

COs	Course Outcomes	Knowledge level
CO1	Explain the scope, significance of environment and the structure, function and types of ecosystems, identify the roles of producers, consumers, and decomposers, and describe energy flow in food chains, food webs, and ecological pyramids	K2
CO2	Differentiate the renewable and non-renewable energy sources and identify various natural resources, and analyze the environmental problems caused by their overuse and depletion.	K2,K4
CO3	Define biodiversity, explain its different levels (genetic, species, and ecosystem), and understand the significance of biodiversity conservation at global, national, and local levels, including methods for conserving endangered and endemic species in India.	K1,K2
CO4	Identify and analyze the causes and effects of different types of pollution, propose control measures, and the significance of sustainable practices in solid waste management, disaster management, and water conservation techniques like rainwater harvesting and watershed management.	K4,K5
CO5	Identify key environmental issues such as climate change, global warming, acid rains, ozone layer depletion, significance of legal frameworks in protecting the environment, and analyze the role of environmental protection laws in safeguarding ecosystems, wildlife, and forests.	K2,K4

Articulation Matrix

CO / PO	PO2	PO3	PO4	PO6	PO9	PO13	PSO3
CO1	1	1	2	3	2	3	2
CO2	2	2	2	3	1	3	2
CO3	2	2	2	3	1	3	2
CO4	3	2	2	3	2	3	3
CO5	3	3	2	3	2	3	3

UNIT I: Environment and Ecosystem

Environment – Definition, scope and significance - Public awareness: Ecosystem - concept - structure and function of an ecosystem- producers, consumers and decomposers - Energy flow in the ecosystem -Food chain - Food web - Ecological pyramids - Forest, Grassland, desert and aquatic ecosystem

UNIT II: Natural resources

Renewable and non-renewable energy sources. Forest resources, water resources, mineral resources, food resources, energy and land resources. Natural resources and associated problems.

UNIT III: Biodiversity and its Conservation

Introduction to Biodiversity - Definition - genetic, species and ecosystem diversity - Values and uses of biodiversity - biodiversity at global, national (India) and local levels, Endagnered and endemic species of India - conservation of biodiversity – *In-situ* & *Ex-situ*.

UNIT IV: Environmental Pollution and Management

Definition, causes, effects and control measures of air, water, soil, marine, noise and nuclear pollution. Solid waste management and disaster management. Water conservation, rain water, and harvesting and watershed management.

UNIT V: Environmental protection

Climate change-Global warming, acid rains, ozone layer depletion, nuclear accidents- Environment protection act, wildlife protection act. and forest conservation act.

SUGGESTED READINGS

Text Books

1. Bharucha, E. Text Book of environmental Studies for undergraduates, University Press (India) Pvt. Ltd. 2005
2. Rajan Misra, A Text Book on environmental Studies. University Science Press. New Delhi. 2009
3. Sinha andSaradha , Text Book of Environmental Studies, AITBS Publication. 2005
4. Erach Bharucha “Textbook of Environmental Studies for Undergraduate Courses” Orient Blackswan Pvt. Ltd. 2013

Reference books

1. Anubha Kaushik and C. P. Kaushik’s “Perspectives in Environmental Studies”, 6th Edition, New Age International Publishers, 2018.
2. Dharmendra S. Sengar, ‘Environmental law’, Prentice hall of India PVT. LTD, New Delhi, 2007.

Alternative NPTEL/SWAYAM Course

1. Environmental Studies (https://onlinecourses.swayam2.ac.in/ini25_es02/preview)

SEMESTER-II

25MBU201 **Immunology** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0

Marks: Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives:

1 Educate students to learn about immunological cells involved in immune response
2 Explore students to understand mechanism of immune responses
3 Introduce students to gain knowledge on the various immune techniques
4 Equip students to gain knowledge on basics of immune response
5 Provide students with a comprehensive understanding about vaccines and its various types

Program Outcomes (POs)

PO1: Complex problem-solving
PO2: Critical thinking
PO3: Creativity
PO4: Communication Skills
PO5: Analytical reasoning/thinking
PO6: Research-related skills
PO9: Lifelong Learning &Technology skills
PO13: Environmental awareness & Community engagement and service

Course Outcomes (COs)

COs	Course Outcomes	Knowledge level
CO1	Explain basics of human immune system and its types	K2
CO2	Interpret immune response against various antigens	K2,K4
CO3	Outline applications of antigen antibody interactions	K2,K3
CO4	Discuss various abnormal immune responses and its mechanisms	K2,K4
CO5	Describe vaccination, transplantation and tumor immunology.	K1,K2

Articulation Matrix

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO9	PO13	PSO1	PSO2	PSO3
CO1	2	3	-	2	2	3	2	1	2	2	3
CO2	2	3	2	2	3	3	3	1	1	1	3
CO3	3	3	2	2	3	3	3	2	3	2	2
CO4	3	3	3	2	3	3	3	3	2	2	2
CO5	2	2	3	2	3	3	3	2	1	2	2

UNIT I: INTRODUCTION TO IMMUNOLOGY

Immunology organs & cells of immunesystem, Types of immunity-Innate, Acquired, Humoral & cell mediated immunity. Antigens–properties.

UNIT II: MECHANISM OF IMMUNE RESPONSES

Immunity to different organisms- defence strategy, antigen presentation. Complement pathways – Classical and Alternate; Immunoglobulins-types – structure and functions. Theory of antibody formation

UNIT III: IMMUNOTECHNIQUES

Antigen-Antibody reactions - agglutination, precipitation, immuno-electrophoresis, Coomb's test, Blood grouping, ELISA, RIA.

UNIT IV: IMMUNE RESPONSE

Hyper sensitivity reactions – types. Autoimmunity - mechanism, autoimmune diseases. Major histocompatibility complex – structure and types, HLA tissue typing

UNIT V: VACCINES

Vaccines: Principles, types, preparation and immunization schedules. Immuno deficiency diseases, Transplantation immunology and tumor immunology

SUGGESTED READINGS

Text Books

1. Ajoy Paul (2018). Text Book of Immunology, Books & Allied Pvt. Ltd.
2. Dubey RC & Maheshwari DK (2010). A text Book of Microbiology. S. Chand & Co.
3. Tizard IR (2017). Immunology - An Introduction. Tenth edition, WB Saunders, Philadelphia.
4. Janis Kuby (2019). Immunology. Eighth edition, WH Freeman, NY

Reference books

1. Delves PJ, Martin SJ, Burton DR, Roitt IM. (2011). Roitt's Essential Immunology. Twelfth edition, Wiley-Blackwell.
2. Travers J (1997). Immunobiology - the immune system in health and disease. Third edition, Current Biology Ltd. London.
3. Clark WR. (1991). The Experimental Foundations of Modern Immunology. Third edition. John Wiley and Sons Inc.
4. Rose NR, Friedman H and Fahey JL. 1986. Manual of Clinical Laboratory Immunology. Third edition. ASM.

Alternative NPTEL/SWAYAM Course

1. Immunology (https://onlinecourses.swayam2.ac.in/cec25_bt20/preview)

25BCU231 **Biochemistry-II** **2H – 2C**

Instruction Hours / week: L: 2 T: 0 P: 0

Marks: Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives:

1 Educate students to learn about significance of biomolecules in biological systems.
2 Provide students with a comprehensive learning about important biochemical diseases.
3 Introduce students to gain knowledge on biochemistry of enzymes.
4 Educate students to learn the basics of molecular biology.
5 Explore students to understand various functions of vitamins and minerals.

Program Outcomes (POs)

PO1: Complex problem-solving
PO2: Critical thinking
PO3: Creativity
PO4: Communication Skills
PO5: Analytical reasoning/thinking
PO6: Research-related skills
PO9: Lifelong Learning &Technology skills
PO13: Environmental awareness & Community engagement and service

Course Outcomes (COs)

COs	Course Outcomes	Knowledge level
CO1	Classify various metabolic cycle and its biosynthesis	K1,K2
CO2	Discuss different types of Metabolic disorders	K2,K4
CO3	Outline properties, structure, function of enzymes and its kinetics	K2
CO4	Describe nucleic acids and its function	K1,K2
CO5	Explain occurrence and biological function of Vitamins and minerals	K2

Articulation Matrix

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO9	PO13	PSO1	PSO2	PSO3
CO1	3	3	2	1	3	3	2	1	1	3	2
CO2	3	3	2	1	3	3	2	1	1	3	2
CO3	3	3	2	1	3	3	2	1	1	3	2
CO4	3	3	2	1	3	3	2	1	1	3	2
CO5	3	3	2	1	3	3	2	1	1	3	2

UNIT I: Metabolic cycle

Glycolysis, TCA cycle, HMP shunt and its energy yield. Deamination, transamination reaction, SGOT and SGPT. Urea cycle, Biosynthesis of fatty acids, beta oxidation.

UNIT II: Metabolic Disorders

Jaundice, hypoxia, glycogen storage diseases, pentosuria, ketosis, lipidosis, edema, gout. Dehydration: definition,causes, symptom and prevention.

UNIT III: Enzymes

Definition, classification of enzymes with one example. Mechanism of enzyme action. Lock and key mechanism, induced fit theory. Property: specificity. Isoenzyme: Definition with one example. Factors affecting enzyme activity: pH, temperature and substrate concentration. Michaleis- Menton equation. Enzyme inhibition: competitive, uncompetitive and non competitive. Biological functions of enzymes.

UNIT IV: Molecular Biology

Replication: Definition, types, mode of action of replication, mechanism of replication. General mechanism of transcription and translation. Genetic code. DNA and RNA act as genetic material.

UNIT V: Vitamins and Minerals

A brief outline of occurrence and biological function of Vitamins and minerals (Na, K, Cl, Ca, P, I , Fe, Mg & S)

SUGGESTED READINGS

Text Books

1. Murray RK, Grammer DK. Harper's Biochemistry. Twenty fifth edition, McGraw Hill, Lange Medical Books.
2. Kannan C. Biomolecules. MJP Publishers, Chennai.
3. Jain JL, Sunjay Jain, Nitin Jain. Fundamentals of Biochemistry. S. Chand & Company.
4. Amit Krishna De. Biochemistry. S. Chand & Co., Ltd.

Reference books

1. Nelson DL, Lehninger MM. Principles of Biochemistry. Cox, Macmillan Worth Publishers.
2. Voet D and Voet JG (2011). Biochemistry. Fourth edition, CBS Publishers and Distributors.

Alternative NPTEL/SWAYAM Course

1. Introductory Organic chemistry II (https://onlinecourses.nptel.ac.in/noc25_cy45/preview)

25MBU211 **Immunology Lab** **4H – 2C**

Instruction Hours / week: L: 0 T: 0 P: 4 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives:

1 Equip students to gain practical knowledge about agglutination and precipitation reactions
2 Provide students to gain practical facts on immunological techniques
3 Demonstrate students to gain practical knowledge on various immune techniques
4 Explore students to get practical understanding on basics of immune response
5 Demonstrate students to handling the tests of hypersensitivity reaction

Program Outcomes (POs)

PO1: Complex problem-solving
PO2: Critical thinking
PO3: Creativity
PO4: Communication Skills
PO5: Analytical reasoning/thinking
PO6: Research-related skills
PO9: Lifelong Learning &Technology skills
PO13: Environmental awareness & Community engagement and service

Course Outcomes (COs)

COs	Course Outcomes	Knowledge level
CO1	Demonstrate various techniques of agglutination and precipitation	K3
CO2	Examine immune cells by immunoassay and diagnostic test	K4
CO3	Prepare different types of immune cells in the immune system and enumeration of its various types	K3,K4
CO4	Evaluate antibody production and Identification of Immune response in laboratory animals	K5
CO5	Examine egg proteins, bacterial and fungal antigens by hypersensitivity reactions	K4

Articulation Matrix

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO9	PSO1	PSO2	PSO3
CO1	3	3	3	2	3	3	2	2	2	2
CO2	3	3	3	2	3	3	2	1	2	2
CO3	3	3	3	2	3	3	2	3	1	2
CO4	3	3	3	2	3	3	2	2	1	2
CO5	3	3	3	2	3	3	2	1	3	2

UNIT I: Techniques of Agglutination and Precipitation

Blood groups and typing - Coombs's test. Precipitation reaction in Gel-Outchelony double diffusion, Single Radial Immuno diffusion. VDRL, RPR. Agglutination reactions: Slide and Tube methods, RBC agglutination IHA, TPHA Bacterial.

UNIT II: Immunoassay

Complement fixation test. Demonstration of amboceptor titration and complement. Demonstration of Immuno fluorescene and ELISA techniques

UNIT III: Immune cells

Isolation of Buffy coat, using heparin lymphocytes (T cells, B cells), Enumeration of different cell types, Peripheral blood cell counts, absolute cell counts.

UNIT IV: Production and Identification of Immune response

Antibody productions in rabbits against sheep RBC and Demonstration of its titration. Anaphylactic reactions in guinea pigs. Demonstration of Arthus reaction in rabbits.

UNIT V: Hypersensitivity reactions

Skin tests, Immediate and Delayed hypersensitivity reactions to egg proteins, bacterial and fungal antigens

SUGGESTED READINGS

Text Books

1. Olwyn MR Westwood, Frank C Hay (2008). Practical Immunology. Fourth edition, Wiley-Blackwell Publishers
2. Tobili Y Sam - Yellowe (2021). Immunology: Overview and Laboratory Manual First edition, Springer
3. Tizard IR (2017). Immunology An Introduction. Tenth edition, WB Saunders, Philadelphia.
4. Janis Kuby (2019). Immunology. Eighth edition, WH Freeman, NY

Reference books

1. Janice Speshock (2021). Immunology Lab Manual. Third edition., Kendall Hunt Publishing Company
2. Clark WR (1991). The Experimental Foundations of Modern Immunology Third edition. John Wiley and Sons Inc.

Alternative NPTEL/SWAYAM Course

1. Immunology (https://onlinecourses.swayam2.ac.in/cec25_bt20/preview)

25MBU202 **Computational Biology** **3H – 3C**

Instruction Hours / week: L: 3 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives:

1 Equip students to gain knowledge on the history and scope of computational biology
2 Educate students to learn about the molecular basis of biomolecules
3 Provide students with a comprehensive learning of protein structure and its databases
4 Introduce students to gain knowledge on the basic algorithms in computational biology
5 Explore students to understand the various applications of computational biology

Program Outcomes (POs)

PO1: Complex problem-solving
PO2: Critical thinking
PO3: Creativity
PO4: Communication Skills
PO5: Analytical reasoning/thinking
PO6: Research-related skills
PO9: Lifelong Learning &Technology skills
PO13: Environmental awareness & Community engagement and service

Course Outcomes (COs)

COs	Course Outcomes	Knowledge level
CO1	Explore the importance of Computational biology and its scope and nucleotide sequence databases	K2
CO2	Explain central dogma of Computational biology and database of Nuclotides	K2
CO3	Describe structure of protein and its various database	K1,K2
CO4	Explain basic algorithms involved in computational biology	K2,K3
CO5	List out various applications of computational biology	K1

Articulation Matrix

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO9	PSO1	PSO2	PSO3
CO1	2	3	2	2	2	3	3	3	3	3
CO2	2	3	2	2	3	3	3	3	3	3
CO3	3	3	2	2	3	3	3	3	3	2
CO4	3	3	2	2	3	3	3	2	3	2
CO5	2	2	2	2	3	3	3	1	3	2

UNIT 1: INTRODUCTION

Introduction to Computational Biology and Bioinformatics: Nature and scope of Computational Biology and Bioinformatics, Bioinformatics databases, Type of databases, Nucleotide sequence databases, Primary nucleotide sequence databases-EMBL, GenBank, DDBJ; Secondary nucleotide sequence databases

UNIT 2: CHROMOSOME-GENOME-GENES-DATABASES

Biomolecules- DNA, RNA, Protein and amino acids, Chargaff's Rules, Codon bias, GC content. Central Dogma: Replication, Transcription, Translation, Post transcriptional & post translational modifications, RNA processing, RNA splicing and RNA editing. Sense/coding and anti-sense/template strands, Genetic code, wobble hypothesis, Nucleotide sequence databases – NCBI

UNIT 3: PROTEINS AND DATABASES

Protein structure and function, Protein Primary structure, Amino acid residues, Secondary, Tertiary, Quaternary Structure of Protein, Protein sequence databases- SwissProt/ TrEMBL, PIR, Sequence motif databases -Pfam, PROSITE, Protein Data Bank-SCOP, CATH, KEGG, Chembank, Sequence, structure and function relationship.

UNIT 4: BASIC ALGORITHMS

Basic algorithms in Computational Biology, Introduction to sequence alignment - Local and global, pair wise and multiple, BLAST.

UNIT 5: APPLICATIONS

Toxicogenomics, Pharmacogenomics- Pharmacogenetics, SNP, Personalized medicine, Metagenomics, Comparative genomics, Functional genomics, structural genomics, QTL, HGP

SUGGESTED READINGS

Text Books

1. Olwyn MR Westwood, Frank C Hay (2008). Practical Immunology. Fourth edition, Wiley-Blackwell Publishers
2. Tobili Y Sam - Yellowe (2021). Immunology: Overview and Laboratory Manual First edition, Springer
3. Tizard IR (2017). Immunology An Introduction. Tenth edition, WB Saunders, Philadelphia.
4. Janis Kuby (2019). Immunology. Eighth edition, WH Freeman, NY

Reference books

1. Janice Speshock (2021). Immunology Lab Manual. Third edition., Kendall Hunt Publishing Company
2. Clark WR (1991). The Experimental Foundations of Modern Immunology Third edition. John Wiley and Sons Inc.

Alternative NPTEL/SWAYAM Course

1. Fundamentals of Computational Biology (https://onlinecourses.swayam2.ac.in/nou25_bt09/preview)

25BOU231 **Fermentation Technology** **3H – 3C**

Instruction Hours / week: L: 3 T: 0 P: 0

Marks: Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives:

1 Educate students to learn about history and scope of fermentation technology
2 Introduce students to gain knowledge in general requirements of fermentation processes
3 Educate students to learn the various types of fermentors
4 Provide students with a comprehensive learning of different phases of bacterial cell growth
5 Equip students to gain knowledge on various applications of Fermentation technology

Program Outcomes (POs)

PO1: Complex problem-solving
PO2: Critical thinking
PO3: Creativity
PO4: Communication Skills
PO5: Analytical reasoning/thinking
PO6: Research-related skills
PO9: Lifelong Learning &Technology skills
PO13: Environmental awareness & Community engagement and service

Course Outcomes (COs)

COs	Course Outcomes	Knowledge level
CO1	Outline history and scope of fermentation technology	K2
CO2	Explain general requirements of fermentation processes	K2
CO3	Describe basic instrumentation of fermentors and its various types	K1,K2
CO4	Interpret various phases of cell growth and product formation	K2,K4
CO5	List applications of fermentation technology to produce industrial bio-products	K1

Articulation Matrix

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO9	PSO1	PSO2	PSO3
CO1	2	1	1	2	2	3	2	2	2	3
CO2	2	2	2	2	3	3	3	1	2	3
CO3	2	1	2	2	3	3	3	3	2	2
CO4	2	3	2	2	3	3	3	2	2	2
CO5	2	2	3	2	3	3	3	1	3	2

UNIT 1: Introduction

History and scope of Fermentation technology, an overview of traditional and modern applications, various (up-stream and down-stream) unit operations involved in fermentation process.

UNIT 2: Fermentation & Microbial Growth

General requirements of fermentation processes, main parameters to be monitored and controlled in fermentation processes, aerobic and anaerobic fermentation processes, Phases of cell growth, Growth associated (primary) and non- growth associated (secondary) product formation

UNIT 3: Fermentors

Fermentors - basic instrumentation, types - Air lift fermentors, Stirred tank, Packed bed fermentors.

UNIT 4: Production of Microbial enzymes & Organic acids

Production of microbial enzymes (Amylase, protease and pectinase) applications, production of organic solvents (Ethanol, Methanol) – production of organic acids (Citric acid, Acetic acid)

UNIT 5: Commercial fermentation products

Production of beverages (beer, wine) Production of milk products – Curd, cheese, yogurt, and flavoured milk, Bakery products – Bread making

SUGGESTED READINGS

Text Books

1. Patel AH (2011). Industrial Microbiology. Second edition, Laxmi Publications
2. Stanbury PF and Whitaker A (1984). Principles of fermentation Technology. Pergamon Press.
3. Shuler ML and Kargi F (2002). Bioprocess engineering – Basic concepts. Prentice Hall of India.
4. Casida LE (2022). Industrial Microbiology. Second edition, New Age International Publishers.

Reference books

1. Robert W. Hutkins (2018). Microbiology and Technology of Fermented Foods. Second edition, Wiley Blackwell
2. El-mans EMT and Bryce CFA (2002). Fermentation microbiology and Biotechnology. Taylor and Francis group.

Alternative NPTEL/SWAYAM Course

1. Industrial Microbiology (https://onlinecourses.nptel.ac.in/noc25_bt56/preview)

SEMESTER-III

25MBU301 **Microbial Genetics** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0

Marks: Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives:

1 Introduce students to gain knowledge about the history of DNA and its structural properties
2 Educate students to learn the basics of chromosomes and genes
3 Equip students to gain knowledge about plasmids and its different types
4 Educate students to learn about mutations and its characterization
5 Explore students to understand mechanism and control of molecular recombination

Program Outcomes (POs)

PO1: Complex problem-solving
PO2: Critical thinking
PO3: Creativity
PO4: Communication Skills
PO5: Analytical reasoning/thinking
PO6: Research-related skills
PO9: Lifelong Learning &Technology skills
PO13: Environmental awareness & Community engagement and service

Course Outcomes (COs)

COs	Course Outcomes	Knowledge level
CO1	Outline history of DNA and structural properties of DNA	K1,K2
CO2	Describe organization of genes, gene operons and chromosomes	K1,K2
CO3	Explain plasmids, types of plasmids and its gene transfer mechanisms	K3,K3
CO4	Review mutagenesis, carcinogenicity and its mechanisms	K4
CO5	Discuss recombination, transposition and genetic mapping	K2,K4

Articulation Matrix

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO9	PO13	PSO1	PSO2	PSO3
CO1	2	2	1	2	2	3	2	1	2	-	3
CO2	2	3	2	2	3	3	3	1	1	1	3
CO3	3	3	2	2	3	3	3	2	3	1	2
CO4	3	3	2	2	3	3	3	3	2	-	2
CO5	2	2	3	2	3	3	3	2	1	2	2

UNIT 1: Introduction of DNA

Historical perspectives of microbial genetics. Nucleic acid as genetic information carriers: experimental evidence. DNA – types, structure and properties- topology, super helicity, linking number

UNIT 2: Chromosomes

Organization of genes and chromosomes: Definition of gene. Operon – Lac operon, Trp operon. Structure of chromatin and chromosomes - unique and repetitive DNA, heterochromatin, euchromatin, transposons.

UNIT 3: Plasmids

Plasmids as extrachromosomal genetic elements; types and properties. Structure and replication of different plasmids: Col E1, F1 and Ti plasmids. Plasmid amplification and curing; Gene transfer mechanisms: Transformation, conjugation and transduction.

UNIT 4: Mutation

Mutation and Mutagenesis – mechanisms, biochemical basis, mutagens. Molecular basis of spontaneous and induced mutations. Reversion and suppression. Environmental Mutagenesis and toxicity testing; Carcinogenecity - chemical carcinogenesis and their testing

UNIT 5: Recombination

Molecular recombination - Mechanism, control and models. Transposition; regulatory sequences and transacting factors. Genetic mapping in *E. coli* and Yeast. Genetics of Lambda, M13, Mu, T4 and OX174. Genetic systems of yeast and Neurospora.

SUGGESTED READINGS

Text Books

1. Old R and Primrose SB (1995). Principles of Gene Manipulation: An Introduction to Genetic Engineering. Fifth edition. Blackwell Scientific Publications, Oxford.
2. Malacinski GM (2015). Freifelder's Essentials of Molecular Biology. Fourth edition, Jones and Bartlett.
3. Veer Bala Rastogi (2020). Elements of Genetics. Eleventh Revised & Enlarged Edition, KNRN Publications, Meerut.
4. Verma PS and Agarwal VK (1995). Genetics. Eighth edition, S. Chand & Co., New Delhi.

Reference books

1. Klug WS (2011). Concepts of Genetics. Tenth edition, Pearson publications, UK.
2. Winter PC, Hickey GJ and Fletcher HL (2000). Instant notes in Genetics. Viva books Ltd.
3 Gardener EJ (2006). Principles of Genetics. Eighth edition, Wiley - India Student Edition.
4 LewinB(2000). Genes VII. Oxford University Press, Oxford.

Alternative NPTEL/SWAYAM Course

1. Basic Genetics (https://onlinecourses.swayam2.ac.in/ini25_bt11/preview)

25MBU302 **Microbial physiology** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives:

1. Introduce students to gain knowledge about the Photosynthetic microorganisms and its photosynthesis
2. Educate students to learn about bacterial aerobic respiration and anaerobic respiration
3. Equip students to gain knowledge about bacterial permeation of various biomolecules
4. Educate students to learn about Sporulating bacteria and its sporulation
5. Explore students to understand Bacterial Chemolithotrophy and its groups

Program Outcomes (POs)

PO1: Complex problem-solving
PO2: Critical thinking
PO3: Creativity
PO4: Communication Skills
PO5: Analytical reasoning/thinking
PO6: Research-related skills
PO9: Lifelong Learning &Technology skills
PO13: Environmental awareness & Community engagement and service

Course Outcomes (COs)

COs	Course Outcomes	Knowledge level
CO1	Explain Bacterial photosynthesis and its various metabolic steps	K2,K3
CO2	Describe Bacterial aerobic Respiration and anaerobic respirations	K1,K2
CO3	Outline Structure and function of membrane and various permeation strategies	K2
CO4	Review various stages of Bacterial Sporulation and metabolic changes during sporulation	K4
CO5	Discuss various Physiological groups of chemolithotrophs	K2

Articulation Matrix

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO9	PO13	PSO1	PSO2	PSO3
CO1	2	2	1	2	2	3	2	1	2	3	3
CO2	2	3	2	2	3	3	3	1	1	2	3
CO3	3	3	2	2	3	3	3	2	3	2	2
CO4	3	3	2	2	3	3	3	3	2	1	2
CO5	2	2	3	2	3	3	3	2	1	2	2

UNIT 1: Bacterial photosynthesis

Photosynthetic microorganisms, photosynthetic pigments, and generation of reducing power by cyclic and non-cyclic photophosphorylation, electron transport chain in photosynthetic bacteria. Carbon dioxide fixation pathways

UNIT 2: Bacterial Respiration

Bacterial aerobic respiration, components of electron transport chain, free energy changes and electron transport, oxidative phosphorylation and theories of ATP formation, Bacterial anaerobic respiration: Introduction. Nitrate, carbonate and sulfate as electron acceptors.

UNIT 3: Bacterial Permeation

Structure and function of membrane fluid mosaic model of membrane. Methods to study diffusion of solutes in bacteria, passive diffusion, facilitated diffusion, different mechanisms of active diffusion. Transport of aminoacids and inorganic ions in microorganisms and their mechanisms

UNIT 4: Bacterial Sporulation

Sporulating bacteria, molecular architecture of spores, induction and stages of sporulation, Influence of different factors on sporulation. Cytological and macromolecular changes during sporulation. Heat resistance and sporulation

UNIT 5: Bacterial Chemolithotrophy

Physiological groups of chemolithotrophs, ammonia oxidation by members of Genus Nitroso group, nitrite oxidation by Nitro group of genera. Oxidation of molecular hydrogen by *Hydrogenomonas* species. Ferrous and sulfur/sulfide oxidation by *Thiobacillus* species

SUGGESTED READINGS

Text Books

1. Caldwell D.R. (1995), Microbial Physiology and Metabolism, Brown Publishers
2. Moat A.G. and Foster J. W. 1999. Microbial Physiology, Wiley publisher
3. Brun. Y.V. and Shimkets L.J. (2000). Prokaryotic Development by ASM Press.

Reference books

1. Madigan, M.T., Martinko, J.M (2021), Brock Biology of Microorganisms, 16th edition, Pearson Education
2. Byung Hong Kim, Geoffrey Michael Gadd (2019), Cambridge University Press

25BCU331 **Bioinstrumentation** **3H – 2C**

Instruction Hours / week: L: 3 T: 0 P: 0

Marks: Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives:

1. Understand of biochemical solutions and their significance in maintaining and studying biological systems.
2. Explain the fundamental principles of centrifugation and its role in the separation of biological molecules.
3. Gain basic knowledge on chromatographic techniques and their applications in biochemical analysis.
4. Understand the basic principles of electrophoresis and its applications in biochemical research.
5. Develop knowledge on calorimetry and spectrophotometry uses in biochemical and molecular analysis.

Program Outcomes (POs)

PO1: Complex problem-solving
PO2: Critical thinking
PO3: Creativity
PO4: Communication Skills
PO5: Analytical reasoning/thinking
PO6: Research-related skills
PO9: Lifelong Learning &Technology skills

Course Outcomes (COs)

COs	Course Outcomes	Knowledge level
CO1	Analyze the concept of biochemical solutions, buffer systems, and pH-related mechanisms, including the application of the Henderson-Hasselbalch equation and Donnan membrane equilibrium in biological systems.	K3,K4
CO2	Explain the fundamentals of centrifugation techniques, including differential and density gradient methods, and preparative and analytical ultracentrifugation and its applications.	K2
CO3	Discuss the principles of various chromatographic techniques such as paper chromatography, TLC, ion exchange, affinity, gel permeation, HPLC, and GLC in biochemical separation and analysis.	K2,K4
CO4	Describe the basic principles of electrophoretic techniques and factors influencing electrophoretic mobility, with a focus on SDS-PAGE, agarose gel electrophoresis, and isoelectric focusing.	K2
CO5	Demonstrate the ability to use colorimetry and spectrophotometry, including the principles of Beer-Lambert law and the instrumentation involved in UV-Visible analysis for biochemical applications.	K3

Articulation Matrix

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO9	PSO1	PSO2	PSO3
CO1	1	2	1	2	2	3	2	2	1	3
CO2	2	3	2	2	3	3	3	2	2	3
CO3	2	3	2	2	3	3	3	3	2	2
CO4	2	3	2	2	3	3	3	2	2	2
CO5	2	2	3	2	3	3	3	2	2	2

UNIT 1 Concepts of Biochemical solutions

Biological importance of Buffers, Major body buffer systems. pH, pOH, glass electrode and hydrogen electrode, Oxygen electrode. Donnan membrane equilibrium and its applications. Henderson Hasselbalch equation.

UNIT 2 Centrifugation

Basic principles of centrifugation, RCF, Types of Rotors, Principle, procedure and applications of differential and density-gradient centrifugation, Preparative and analytical ultracentrifugation.

UNIT 3 Chromatography

General principles - adsorption and partition chromatography. Paper chromatography, Thin layer chromatography, Ion exchange, Affinity chromatography, Gel permeation chromatography, HPLC and GLC.

UNIT 4 Electrophoretic Techniques

Electrophoresis **-** General principles, Factors affecting electrophoretic mobility. Tisselius moving boundary electrophoresis. Electrophoresis with paper, cellulose acetate and starch. Principle, instrumentation and applications of agarose gel electrophoresis and SDS-PAGE. Isoelectric focusing.

UNIT 5 Colorimetry & Spectrophotometry

Basics of Electromagnetic Radiations - Energy, wavelength, wavenumber and frequency. Absorption and emission spectra. Light absorption and its transmittance, Beer-Lambert law. Colorimetry- Principle, instrumentation and applications. Visible and UV spectrophotometry – Principle, instrumentation and applications.

SUGGESTED READINGS

Text Books

1. AvinashUpadhyay D K (2016). Biophysical Chemistry. Himalaya Publishing house.
2. Wilson/Walker (2018). Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology. Cambridge University Press
3. Veerakumari L (2009). Bioinstrumentation. First edition, MJP Publishers.

Reference books

1. Dua S (2010). Biochemical Methods of Analysis: Theory and Applications. Narosa.
2. White BJ (2015). Biochemical Techniques - Theory And Practice. CBS Publishers Distributors.

Alternative NPTEL/SWAYAM Course

1. Biomedical Instrumentation (https://onlinecourses.nptel.ac.in/noc25_bt49/preview)

25BCU313 **Bioinstrumentation Lab** **4H – 2C**

Instruction Hours / week: L: 0 T: 0 P: 4 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives:

1 Equip students to gain practical knowledge on the determination of pH, pKa values etc.,
2 Provide students to gain practical facts about the chromatography and electrophoresis techniques.
3 Demonstrate students to gain practical knowledge on the principles of UV spectroscopy.
4 Explore students to get practical understanding of estimation of organic compounds.
5 Demonstrate students to gain working experience on the PCR and Fermentor

Program Outcomes (POs)

PO1: Complex problem-solving
PO2: Critical thinking
PO3: Creativity
PO4: Communication Skills
PO5: Analytical reasoning/thinking
PO6: Research-related skills
PO9: Lifelong Learning &Technology skills

Course Outcomes (COs)

COs	Course Outcomes	Knowledge level
CO1	Determinate pH and pKa among the samples of aminoacids	K4,K3
CO2	Handle chromatography and electrophorsis for the separation of biomolecules	K2
CO3	Prepare UV absorption spectra of macromolecules such as protein and Nucleic acid	K2,K4
CO4	Demonstrate quantitative estimation of hydrocarbon and pesticides	K2
CO5	Handle the molecular instruments PCR and DNA sequencer	K3

Articulation Matrix

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO9	PSO1	PSO2	PSO3
CO1	2	2	1	2	2	3	2	2	3	3
CO2	2	3	2	2	3	3	3	1	2	3
CO3	3	3	2	2	3	3	3	3	2	2
CO4	3	3	2	2	3	3	3	2	3	2
CO5	2	2	3	2	3	3	3	1	2	2

UNIT 1: pH Titration

Studies on pH titration curves of amino acids and determination of pKa values and Handerson- Hasselbach equation.

UNIT 2: Chromatography methods

Separation of bacterial lipids/amino acids/sugars/organic acids by TLC or Paper Chromatography. Separation of serum protein by horizontal submerged gel electrophoresis.

UNIT 3: Estimation of Macromolecules

Study of UV absorption spectra of macromolecules (protein, nucleic acid, bacterial pigments).

UNIT 4: Quantitative estimation of various chemical agents

Quantitative estimation of hydrocarbons/pesticides/organic solvents /methane by Gas chromatography.

UNIT 5: Demonstration of Analytical Instruments

Demonstration of PCR, DNA sequencer, Fermentor, Flow Cytometry.

SUGGESTED READINGS

Text Books

1. Instrumental Methods of Analysis. 6th Edition byH.H. Willard, L.L. Merritt Jr. and others. 1986. CBS Publishers and Distributors.
2. Instrumental Methods of Chemical Analysis. 1989 by Chatwal G and Anand, S.Himalaya Publishing House, Mumbai

Reference books

1. Dua S (2010). Biochemical Methods of Analysis: Theory and Applications. Narosa.
2. White BJ (2015). Biochemical Techniques - Theory And Practice. CBS Publishers Distributors.

Alternative NPTEL/SWAYAM Course

1. Biomedical Instrumentation (https://onlinecourses.nptel.ac.in/noc25_bt49/preview)

25MBU303 **Biotechnology** **3H – 3C**

Instruction Hours / week: L: 3 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives:

1 Educate students to learn the basic concepts and terms in biotechnology
2 Explore students to understand the various steps of genetic engineering
3 Introduce students to gain knowledge about plant tissue culture, plant vectors & transgenic plants
4 Educate students to learn about animal tissue culture, animal vectors & stem cells
5 Provide students with a comprehensive learning of various applications of biotechnology

Program Outcomes (POs)

PO1: Complex problem-solving
PO2: Critical thinking
PO3: Creativity
PO4: Communication Skills
PO5: Analytical reasoning/thinking
PO6: Research-related skills
PO9: Lifelong Learning &Technology skills
PO13: Environmental awareness & Community engagement and service

Course Outcomes (COs)

COs	Course Outcomes	Knowledge level
CO1	Outline biotechnology and its various concepts and terms in gene cloning	K2
CO2	Discuss various steps involved in gene transfer methods and clone identification	K2,K4
CO3	Describe plant growth media and vectors used in transgenic plant production	K2
CO4	Explain animal cell lines and vectors and methods used in transgenic animal cells	K2
CO5	List out various applications of Biotechnology including enzymes, GE foods, antibiotics and proteins	K1

Articulation Matrix

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO9	PO13	PSO1	PSO2	PSO3
CO1	2	2	1	2	2	3	2	2	2	1	3
CO2	2	3	2	2	3	3	1	2	1	2	3
CO3	2	3	2	2	3	3	1	2	3	2	2
CO4	2	3	2	2	3	3	2	3	2	2	2
CO5	2	2	3	2	3	3	2	3	1	3	2

UNIT 1: Introduction to Biotechnology

Biotechnology: Definition and scope, types and branches of biotechnology. Recombinant DNA technology- Definition, restriction endonucleases- types and role, cleavage pattern, vectors- plasmid, cosmid, phage. Enzymes used in rDNA technology, linkers, homopolymer tailing, end labeling and Synthetic oligonucleotides.

UNIT 2: Steps in Genetic engineering

Gene transfer methods- transformation, conjugation, transduction, microinjection and electroporation. Selection- selectable markers, Chromogenic substrate and screening of clones- colony hybridization, screening with antibodies.

UNIT 3: Plant Biotechnology

Plant tissue culture- basic requirements for culture, M S medium, callus culture, protoplast culture. Vectors – Ti plasmid (co-integration vector and binary vector), Viral vectors- TMV, CaMV and their applications. Transgenic plants – pest resistant, herbicide resistant and stress tolerant plants.

UNIT 4: Animal Biotechnology

Vectors for gene transfer in animal cells - SV 40 Vector. Basics of transfection methods calcium phosphate precipitation, DEAE- dextran mediated transfection. Transgenic mice retro viral transfer and stem cell mediated transfer, applications. Embryonic stem cell definition, ES cell culture to produce differentiated cells, applications

.

UNIT 5: Applications of Biotechnology

Applications of Biotechnology. Production of ethanol, Single cell protein, GE foods, antibiotic- streptomycin, Enzyme - Proteases, Biogas and Biodiesel.

SUGGESTED READINGS

Text Books

1. Brown TA (1999).Gene Cloning. Third edition. Chapman and Hall Publications, U.S.A.
2. Thieman WJ and Palladino MA (2014). Introduction to Biotechnology. Third edition, Pearson publications
3. Dubey RC (2014). Text book of Biotechnology. Fifth edition, S. Chand & Co.

Reference books

1. Watson JD, Caudy AA, Myers RM, Witkowski J (2006). Recombinant DNA: Genes and Genomes - a Short Course. Third edition, W.H.Freeman & Co
2. Glick BR, Pasternak JJ and Patten CL (2010). Molecular Biotechnology: Principles and Applications of Recombinant DNA. Fourth edition, ASM Press (Washington C).

Alternative NPTEL/SWAYAM Course

1. Industrial Biotechnology (https://onlinecourses.nptel.ac.in/noc25_bt56/preview)
2. Environmental Biotechnology (https://onlinecourses.swayam2.ac.in/nou25_es16/preview)
3. Marine Biotechnology (https://onlinecourses.swayam2.ac.in/cec25_bt08/preview)

25BOU331 **Plant Biotechnology** **3H – 3C**

Instruction Hours / week: L: 3 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives:

1 Educate students to learn about genetic organisation of plant genome
2 Equip students to gain knowledge on the techniques of plant genetic engineering
3 Educate students to learn about transgenic plants and its applications
4 Provide students with a comprehensive learning about the regulation of plant gene expression
5 Introduce students to gain knowledge about the various plant tissue culture techniques

Program Outcomes (POs)

PO1: Complex problem-solving
PO2: Critical thinking
PO3: Creativity
PO4: Communication Skills
PO5: Analytical reasoning/thinking
PO6: Research-related skills
PO9: Lifelong Learning &Technology skills
PO13: Environmental awareness & Community engagement and service

Course Outcomes (COs)

COs	Course Outcomes	Knowledge level
CO1	Explain plant genome and its organization in chloroplast and mitochondria	K2
CO2	Describe mechanisms of plant derived vectors and its functions.	K2
CO3	Interpret transgenic plants and its applications	K4
CO4	List out various plant hormones and its role in regulation of plant gene expression	K1
CO5	Discuss plant tissue culture and its various types	K2

Articulation Matrix

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO9	PO13	PSO1	PSO2	PSO3
CO1	1	2	1	2	2	3	-	1	2	2	3
CO2	1	2	1	2	3	3	1	1	1	2	3
CO3	2	2	2	2	3	3	2	2	3	2	2
CO4	2	2	1	2	3	3	2	3	2	2	2
CO5	2	2	3	2	3	3	1	2	1	2	2

UNIT 1: Introduction to Plant Biotechnology

Plant genome: Organization, structure of representative plant genes and gene families in plants – organization of chloroplast and mitochondrial genome.

UNIT 2: Plant genetic engineering

Agrobacterium and crown gall tumors – Mechanism of T-DNA transfer to plants, Ti Plasmid vectors and its utility – Plant viral vectors. Symbiotic nitrogen fixation in Rhizobia.

UNIT 3: Transgenic Plants

Seed storage proteins. Regeneration of gene expression in plant, transgenic plants and applications – plant vaccine and plant development.

UNIT 4: Regulation of Gene Expression in plants

Plant Hormones – IAA, GA and cytokinins – molecular basis of action – phytochrome – role in photomorphogeneisis – Regulation of gene expression – abscisic acid – and stress – induced promoter switches in the control of gene expression – Ethylene and fruit ripening.

UNIT 5: Plant Tissue Culture

Plant tissue culture – suspension cultured cells – haploid plants – Cloning of hosts – micropropagation – somatic embryogenesis – protoplast isolation and applications.

SUGGESTED READINGS

Text Books

1. Chrispeels M J and sadava DF (1994). Plants, genes and agriculture. Jones and Bartlett.
2. Narayanaswamy S (1994). Plant cell and tissue culture. Tata McGraw Hill Publishing Company limited, New Delhi.
3. Grierson and Covey (1988). Plant Molecular biology. Blackie.

Reference books

1. Trigiano RN and Gray DJ (1996). Plant tissue culture concepts and laboratoryexercise. CRC Press. BocaRatin, New York.
2. Street HE (1977). Plant tissue culture. Blackwell Scientific Publications oxford, London.

Alternative NPTEL/SWAYAM Course

1. Plant Biochemistry and Plant Biotechnology (https://onlinecourses.swayam2.ac.in/cec25_bt19/preview)

SEMESTER-IV

25MBU401 **Molecular biology** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0

Marks: Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives:

1 Provide students with a comprehensive learning about concepts and history of DNA.
2 Educate students to learn the concepts of DNA, RNA synthesis and regulation.
3 Equip students to gain knowledge about processing of mRNA
4 Introduce students to achieve knowledge on the gene regulation of transcription and translation
5 Educate students to learn the various methods involved in molecular biology

Program Outcomes (POs)

PO1: Complex problem-solving
PO2: Critical thinking
PO3: Creativity
PO4: Communication Skills
PO5: Analytical reasoning/thinking
PO6: Research-related skills
PO9: Lifelong Learning &Technology skills

Course Outcomes (COs)

COs	Course Outcomes	Knowledge level
CO1	Outline conceptual background of Biomolecules and its basic structure	K2
CO2	Interpret DNA replication strategies and RNA processing	K4
CO3	Describe molecular mechanisms involved in transcription and translation.	K2
CO4	Review gene regulation in prokaryotes and eukaryotes.	K2,K4
CO5	Interpret methods of Purification and Separation of DNA	K4

Articulation Matrix

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO9	PSO1	PSO2	PSO3
CO1	2	2	1	2	2	3	2	2	2	3
CO2	2	3	2	2	3	3	3	1	2	3
CO3	3	3	2	2	3	3	3	3	3	2
CO4	2	3	2	2	3	3	3	2	2	2
CO5	2	2	3	2	3	3	3	1	2	2

UNIT 1: Historical and conceptual background

Discovery of DNA as genetic material, Griffith's experiment, Hershey and Chase experiment, Chargaff's rule, Structure of DNA, RNA and Protein

UNIT 2: DNA, RNA synthesis and processing

Basic mechanism of replication, DNA repair, transcription, formation of initiation complex, transcription activators and repressors, RNA polymerases, capping, elongation and termination, RNA processing, RNA editing, splicing, polyadenylation, post transcriptional regulation.

UNIT 3: Transcriptional and Translational regulation

Structure and function of different types of RNA, Eukaryotic transcription factors, enhancers, silencers, insulators, chromatin structure. Translation and its regulation in prokaryote and eukaryotes, Post translational modification and protein stability.

UNIT 4: Gene Regulation

Gene regulation in prokaryotes and eukaryotes, positive regulation, negative regulation, attenuation, gene regulation in lambda phage life cycle.

UNIT 5: Methods in Molecular biology

Purification and Separation of nucleic acids, DNA amplification: PCR and Cell based DNA Cloning. Nucleic Acid Hybridization : Principle and application - Southern blotting, northern blotting, western blotting and microarrays

SUGGESTED READINGS

Text Books

1. Brown TA (2020). Gene Cloning and DNA Analysis: An Introduction. Eighth edition, Wiley Blackwell.
2. Click BR and Pasternark JJ (2010). Molecular Biotechnology: Principles and Applications of Recombinant DNA. Fourth edition, American Society for Microbiology
3. Malacinski GM (2015). Freifelder's Essentials of Molecular Biology. Fourth edition, Jones and Bartlett.

Reference books

1. Lodish H, Berk A, Zipursky SL, Matsudaira P, Baltimore, D and Darnell J (2012). Molecular Cell Biology. Seventh edition, W.H. Freeman & Company (New York).
2. Marshall W, Iwasa J and Karp G (2019). Karp's Cell and Molecular Biology. Ninth edition, Wiley Publishers (New York).

Alternative NPTEL/SWAYAM Course

1. Cell and Molecular biology (https://onlinecourses.nptel.ac.in/noc25_bt57/preview)

25MBU411 **Molecular biology lab** **4H – 2C**

Instruction Hours / week: L: 0 T: 0 P: 4 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives:

1 Equip students to gain practical knowledge on the methods of Nucleic acid estimation.
2 Provide students to gain practical facts on the technique of isolation of DNA.
3 Demonstrate students to gain practical knowledge on isolation of antibiotic resistant mutants.
4 Explore students to receive practical understanding on the bacterial DNA transformation
5 Demonstrate students to understand the transformation techniques of bacteria.

Program Outcomes (POs)

PO1: Complex problem-solving
PO2: Critical thinking
PO3: Creativity
PO4: Communication Skills
PO5: Analytical reasoning/thinking
PO6: Research-related skills
PO9: Lifelong Learning &Technology skills

Course Outcomes (COs)

COs	Course Outcomes	Knowledge level
CO1	Evaluate nucleic acids estimation from bacterial cells	K5
CO2	Prepare plasmid DNA from prokaryotic and eukaryotic cells	K3
CO3	Demonstrate techniques of microbial RNA isolation and antibiotic resistant mutant isolation	K3
CO4	Practice transformation of *E. coli* via competent cell preparation	K3
CO5	Identify recombinant bacterial strain through Blue and white method	K4

Articulation Matrix

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO9	PSO1	PSO2	PSO3
CO1	2	2	1	2	2	3	2	2	-	3
CO2	2	3	2	2	3	3	3	1	-	3
CO3	3	3	2	2	3	3	3	3	-	2
CO4	3	3	2	2	3	3	3	2	1	2
CO5	2	2	3	2	3	3	3	1	2	2

UNIT 1: Isolation of Nucleic acids

Isolation and Estimation of DNA by diphenylamine method, Isolation and Estimation of RNA by Orcinol method.

UNIT 2: Isolation of Plasmid and Eukaryotic DNA

Isolation of Plasmid DNA by Alkali lysis method, Isolation of Chromosomal DNA from Eukaryotic cells. Eg. Leaves and animal meat

UNIT 3: Purification of Nucleic acid and Isolation of resistant bacteria

Isolation of RNA from yeast, Purification of DNA and RNA, Isolation of antibiotic resistant mutants in the MH Agar

UNIT 4: DNA Transformation

Preparation of competent cells, Transformation of *E. coli*., Target DNA isolation and Purification

UNIT 5: Identification of recombinant strains

Identification of recombinant bacterial strain, Blue and White method, Screening and Confirmation of Recombinant bacteria

SUGGESTED READINGS

Text Books

1. Vennison SJ (2009). Laboratory Manual for Genetic Engineering. First Edition. PHI Publications
2. Rajan S, Selvi R (2018). Experimental Procedures in Life Sciences.CBS Publishers

Reference books

1. Masroor Ellahi Babar (2011). A Laboratory Manual of Molecular Biology, Lambert Academic Publishing Company.

Alternative NPTEL/SWAYAM Course

1. Cell and Molecular biology (https://onlinecourses.nptel.ac.in/noc25_bt57/preview)

25MBU402 **Soil and Agricultural Microbiology** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives:

1 Introduce students to gain knowledge about the importance of soil and soil micro organisms
2 Educate students to learn various microbial associations in phytosphere
3 Explore students to understand various knowledge about biogeochemical cycles
4 Provide students with a comprehensive learning of microbial interactions and its application
5 Students can understand the various infections that affecting plant

Program Outcomes (POs)

PO1: Complex problem-solving
PO2: Critical thinking
PO3: Creativity
PO4: Communication Skills
PO5: Analytical reasoning/thinking
PO6: Research-related skills
PO13: Environmental awareness & Community engagement and service

Course Outcomes (COs)

COs	Course Outcomes	Knowledge level
CO1	Describe soil microorganisms and its wide distribution in soil.	K2
CO2	Explain microbial associations in phytosphere and its types	K2
CO3	Outline biogeochemical cycles and its biochemistry	K2
CO4	List out various applications of microbial interactions in agriculture	K1
CO5	Explain different plant infections and integrated pest management	K2

Articulation Matrix

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO13	PSO1	PSO2	PSO3
CO1	1	2	2	2	2	3	1	2	1	3
CO2	2	2	2	2	2	3	1	1	2	3
CO3	2	1	2	2	2	3	2	3	3	3
CO4	2	2	2	2	1	3	3	2	3	3
CO5	2	1	2	2	3	3	2	1	2	3

UNIT 1: Microbes and Lithosphere

Microbes and Lithosphere: introduction to soil microbes, Soil Formation and Characterization (Physical and Chemical), Soil types and their microflora, Quantification of soil microorganisms (Bacteria, Fungi, Algae and Protozoa), Methods of studying ecology of soil Microflora.

UNIT 2: Microbial associations in phytosphere

Microbial associations in phytosphere: rhizosphere – phyllosphere – spermosphere. Mycorrhiza – types and importance to agriculture – organic matter decomposition – humus formation

UNIT 3: Biogeochemical cycles

Biogeochemical cycles : Biogeochemical cycles – carbon, nitrogen, phosphorus, sulphur cycles; nitrogen fixers – root nodule formation – nitrogenase, hydrogenase – biochemistry of nitrogen fixation

UNIT 4: Applications of microbial interactions

Applications of microbial interactions: Decomposition, Biofertilizer - Plant response to biofertilizers application. Mass production of blue green algae, *Azolla*. Bioaccumulation, Bio pesticides, Biomining, Microbially induced corrosion, Xenobiotics.

UNIT 5: Plant infections

Principles of plant infection and defense mechanisms. Disease Symptoms, Etiology, Epidemiology and Management of the following plant diseases: Mosaic disease of tobacco; Bunchy top of banana; Leaf roll of potato; Bacterial blight of paddy; Angular leaf spot of cotton, Late blight of potato; Powdery mildew of cucurbits; Leaf rust of coffee; Blight of maize/sorghum; Leaf spot of paddy, Grassy shoot of sugarcane.

SUGGESTED READINGS

Text Books

1. Cambell R (1983). Microbial Ecology.Second edition, Blackwell Scientific Publications, London.
2. Subba Rao NS (2017). Soil Microbiology. Fourth edition, Oxford and IBH Publishing Company
3. Mitchell R (1974).Introduction to Environmental Microbiology. Prentice–Hall. Inc. New Jersey.

Reference books

1. Lynch J Mand Poole NJ (1979). Microbial Ecology: A. Conceptual Approach. Blackwell, Scientific Publications, London.
2. Tate RL (2020). Soil Microbiology. First edition, John Wiley & Sons, New Jersey

Alternative NPTEL/SWAYAM Course

1. Environmental, Food, and Dairy Microbiology (https://onlinecourses.swayam2.ac.in/cec25_bt17/preview)

25MBU412 **Soil and Agricultural Microbiology Lab** **4H – 2C**

Instruction Hours / week: L: 0 T: 0 P: 3

Marks: Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives:

1 Equip students to gain practical knowledge about the importance of soil and soil microbes
2 Provide students to gain practical facts on identification of microbial enzymes
3 Demonstrate students to gain practical knowledge on root nodule bacteria
4 Explore students to get practical understanding on various microbial interactions
5 Demonstrate students to understand on the various infections affecting plant

Program Outcomes (POs)

PO1: Complex problem-solving
PO2: Critical thinking
PO3: Creativity
PO4: Communication Skills
PO5: Analytical reasoning/thinking
PO6: Research-related skills
PO9: Lifelong Learning &Technology skills
PO13: Environmental awareness & Community engagement and service

Course Outcomes (COs)

COs	Course Outcomes	Knowledge level
CO1	Demonstrate isolation and enumeration of soil microorganisms	K3
CO2	Apprise soil microorganisms to produce various soil enzymes	K4
CO3	Demonstrate isolation and enumeration of root nodule bacteria such as *Rhizobium* sp	K3
CO4	Test soil microorganisms for its antagonistic activity	K4
CO5	Evaluate soil micro organisms among the various plant infections	K5

Articulation Matrix

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO9	PO13	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	3	2	1	2	-	3
CO2	3	3	2	2	3	3	3	1	1	3	3
CO3	3	3	2	2	3	3	3	2	3	-	3
CO4	3	3	2	2	3	3	3	3	2	2	3
CO5	2	2	3	2	3	3	3	2	1	1	3

UNIT 1: Microbes and Lithosphere

Methods to study soil microorganisms - Isolation and enumeration of Bacteria, Fungi, Bacteriophages, Algae, Protozoa etc., Microbiological test for fertility - Bacterial and Fungal

UNIT 2: Identification of Soil enzymes

Microbiological demonstration of soil enzymes – Amylase, Protease, Lipase and Gelatinase

UNIT 3: Isolation and identification of root nodule bacteria

Isolation and identification of root nodule bacteria-*Rhizobium* (symbiotic), demonstration of *rhizobium* in the root nodule (CS of root nodule) Isolation and identification of *Azotobacter* (Asymbiotic).

UNIT 4: Antagonistic activity of soil microbes

Isolation and identification of nitrogen fixing Cyanobacteria-*Anabaena, Nostoc*, etc., Demonstration of Azolla, Demonstration of antagonistic activity –bacterial and fungal.

UNIT 5: Plant infections

Study of the following diseases: Tobacco mosaic; Bacterial blight of paddy; Downy mildew of bajra; Powdery mildew of cucurbits; Head smut of sorghum; Leaf rust of coffee; Leaf spot of paddy, Red rot of sugar cane, Root knot of mulberry.

SUGGESTED READINGS

Text Books

1. Cambell R (1983). Microbial Ecology. Second edition. Blackwell Scientific Publications, London.
2. Lynch JM and Poole NJ (1979).Microbial Ecology: A. Conceptual Approach. Blackwell Scientific Publications, London.
3. Rheinheimer G (1980). Aquatic Microbiology. Secondedition, JohnWiley & Sons, NewYork.
4. Subhashini Vallabhaneni (2012) Soil Microbiology- A laboratory manual. LAP Lambert Academic Publishers

Alternative NPTEL/SWAYAM Course

1. Environmental, Food, and Dairy Microbiology (https://onlinecourses.swayam2.ac.in/cec25_bt17/preview)

25MBU402 **Biostatistics** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives:

1. Educate students to learn the principles of data collection in biological experiments, statistical analysis of data and its presentation.
2. Equip students to gain knowledge on the various variables that affect sample data.
3. Explore students to understand the data probability and its distributions
4. Provide students with a comprehensive learning of concepts in hypothesis testing.
5. Introduce students to gain knowledge on the importance of regression and correlation.

Program Outcomes (POs)

PO1: Complex problem-solving
PO2: Critical thinking
PO3: Creativity
PO4: Communication Skills
PO5: Analytical reasoning/thinking
PO6: Research-related skills
PO9: Lifelong Learning &Technology skills
PO13: Environmental awareness & Community engagement and service

Course Outcomes (COs)

COs	Course Outcomes	Knowledge level
CO1	Design biological experiments, selecting appropriate sampling techniques, estimating sample sizes, and effectively presenting biological data using statistical tools	K6
CO2	Apply various statistical methods, including ANOVA and Student's t-test to analyze variance in biological data	K3
CO3	Interpret probabilities in biological contexts using operations on events, Venn diagrams, conditional probability, and probability distributions	K2
CO4	Perform various types of hypothesis testing and its general concepts	K3
CO5	Apply regression and correlation analyses to examine relationships between biological variables	K3

Articulation Matrix

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO9	PO13	PSO1	PSO2	PSO3
CO1	2	2	1	2	2	3	1	1	2	-	1
CO2	2	3	2	2	3	3	1	1	1	1	2
CO3	3	3	2	2	3	3	2	2	3	1	2
CO4	3	3	2	2	3	3	1	3	2	2	2

CO5	2	2	3	2	3	3	1	2	1	1	2

UNIT 1: Data Collection and Presentation

Data Collection and Presentation: Biological data management using statistical tools. Concepts of population and sample, sampling and designing experiments, Estimation of sample size for biological experiments, sources of errors. Sampling schemes – Simple Random sampling, Systemic sampling, Stratified sampling, Cluster sampling, Non probability sampling; Estimation of mean proportion and standard error in sampling, Types of numerical data; Modes of presenting data: Frequency distributions, Relative frequency.

UNIT 2: Analysis of variance

Analysis of variance: Mean, median, mode; Co-efficient of variation and standard deviation; Range and interquartile range; Grouped mean and grouped variance; Frequency distributions; One-way ANOVA; Two-way ANOVA; AMOVA; student's t-test.

UNIT 3: Probability

Probability: Operations on events, Venn diagrams, Conditional Probability; Probability distributions.

UNIT 4: Hypothesis testing

Hypothesis testing: General concepts: Null hypothesis, alternative hypothesis, Rejection of hypothesis; Type I and Type II errors; P value and sample size estimation.

UNIT 5: Regression and Correlation

Regression and Correlation: Chi Square Test – Observed and expected frequencies, Calculating p values, assumptions of a chi square goodness of fit.

SUGGESTED READINGS

Text Books

1. Pagano M and Gauvreau K (2000). Principles of Biostatistics. Duxbury Thomas learnings.
2. Ramakrishnan P (2017). Biostatistics. Fourth edition, Saras Publications
3. Pranab Kumar Banerjee (2011). Introduction to Biostatistics. Fourth edition, S.Chand & Company ltd.

Reference books

1. Whitlock M and Schluter D (2009). Analysis of Biological Data. Roberts and company publishers.
2. Daniel WW (2009). Biostatistics: A Foundation for Analysis in the Health Sciences. Ninth edition, John Wiley and Sons Inc.

Alternative NPTEL/SWAYAM Course

1. Introduction to Biostatistics (https://onlinecourses.nptel.ac.in/noc25_bt73/preview)

SEMESTER-V

25MBU501 **Industrial Microbiology** **5H – 4C**

Instruction Hours / week: L: 5 T: 0 P: 0

Marks: Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives:

1 Educate students to learn about general concepts of Industrial Microbiology
2 Equip students to gain knowledge about Fermentation equipments and its various types
3 Provide students to gain knowledge on the various fermentation products
4 Explore students to learn about Industrial Production of Microbial derivates
5 Educate students to learn about various Industrial products derived from microbes

Program Outcomes (POs)

PO1: Complex problem-solving
PO2: Critical thinking
PO3: Creativity
PO4: Communication Skills
PO5: Analytical reasoning/thinking
PO6: Research-related skills
PO9: Lifelong Learning &Technology skills
PO13: Environmental awareness & Community engagement and service

Course Outcomes (COs)

COs	Course Outcomes	Knowledge level
CO1	Explain Concepts Principles of industrial microbiology	K2
CO2	Describe various Fermentation equipments and its types	K2
CO3	Highlight various Food fermentations and food produced by microbes	K2
CO4	List out various Industrial Production of Microbial derivates	K1
CO5	List out various Industrial products derived from micro organisms	K1

Articulation Matrix

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO9	PO13	PSO1	PSO2	PSO3
CO1	-	1	1	-	2	3	3	1	2	-	3
CO2	-	2	2	2	3	3	3	1	1	1	3
CO3	1	2	3	2	3	3	2	2	3	3	2
CO4	1	2	3	2	3	3	2	3	2	3	2
CO5	1	2	3	2	3	3	2	2	1	3	2

UNIT 1: Concepts of industrial microbiology

General concepts of industrial microbiology, Principles of exploitation of microorganisms of their products, Screening, Strain development, Immobilization methods, Fermentation media, Raw materials Used in media production, Antifoaming agents, Industrial Sterilization.

UNIT 2: Fermentation

Fermentation equipment and its uses, types of fermentation – single, batch, continuous, multiple, surface, submerged, and solid state fermentation.

UNIT 3: Fermentation products

Food fermentations and food produced by microbes: bread, cheese, malt beverages, vinegar, fermented dairy products and oriental fermented foods. Microbial cells as food – single cell proteins.

UNIT 4: Industrial Production of Microbial derivates

Microbial derivates production: industrial enzymes – amylase, protease, cellulase. Amino acids production: glutamic acid and lysine. Production of antibiotics: penicillin, streptomycin.

UNIT 5: Industrial products by microbes

Industrial products derived from microbes: Vitamins – riboflavin, cyanocobalamin. Vaccines: genetic recombinant vaccines. Organic acids: citric acid, acetic acid. Steroid conversion. Production of alcoholic beverages: beer and wine, biofuels: ethanol, methane, biogas. Disposal of industrial waste.

SUGGESTED READINGS

Text Books

1. Renu Agarwal (2024) Text book of Industrial Microbiology, Springer; 2024th edition
2. Patel A.H. (2016) Industrial Microbiology, 2nd Edn. Laxmi Publications.
3. Anitha.K (2012) Industrial Microbiology; A Text book, Narendra Publishing House
4. Waites M.J. Morgan N.L., Rockey J.S. and Higton G. (2011) Industrial Microbiology. An Introduction, Paperback, WB Publishers.

Reference books

1. Baltz R.H., Demain A.L. and Davies J.E. (2010) Manual of Industrial Microbiology and Biotechnology, ASM Press.
2. Flickinger M.C. and Drew S.W. (1999) Encyclopedia of Bioprocess Technology: Fermentation, Biocatalysis and Bioseparation, (Vol 1-5), Wiley publishers.

Alternative NPTEL/SWAYAM Course

1. Industrial Microbiology and Immunology (https://onlinecourses.swayam2.ac.in/cec25_bt15/preview)
2. Industrial Biotechnology (https://onlinecourses.nptel.ac.in/noc25_bt56/preview)

25MBU511 **Industrial Microbiology Lab** **4H – 2C**

Instruction Hours / week: L: 0 T: 0 P: 4 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives:

1. Demonstrate students to learn about aseptic techniques and microbial quantification methods relevant to industrial microbiology.
2. Equip students to gain knowledge on principles and operations of various fermentation technologies
3. Provide students to gain experimental knowledge on screening, cultivation, and production of industrially significant microbial metabolites
4. Explore students to gain experimental knowledge on enzyme production, purification, and activity assay from microbial sources
5. Explore students to gain experimental knowledge on Quality control and industrial applications

Program Outcomes (POs)

PO1: Complex problem-solving
PO2: Critical thinking
PO3: Creativity
PO4: Communication Skills
PO5: Analytical reasoning/thinking
PO6: Research-related skills
PO9: Lifelong Learning &Technology skills
PO13: Environmental awareness & Community engagement and service

Course Outcomes (COs)

COs	Course Outcomes	Knowledge level
CO1	Isolate and identify of industrially important micro organisms	K3
CO2	Handle fermentor such as Batch fermentor, fed-batch fermentor, and continuous fermentor	K3
CO3	Test screening and Production of Metabolites from soil micro organisms	K4
CO4	Produce industrial enzymes such as amalyase and Protease by solid and submerged fermentations	K3
CO5	Follow the procedure of microbial quality control for industrial products and its respective preservation methods	K3

Articulation Matrix

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO9	PO13	PSO1	PSO2	PSO3
CO1	-	1	1	-	2	3	3	1	2	-	3
CO2	-	2	2	2	3	3	3	1	1	1	3

CO3	1	2	3	2	3	3	2	2	3	3	2
CO4	1	2	3	2	3	3	2	3	2	3	2
CO5	1	2	3	2	3	3	2	2	1	3	2

UNIT 1: Introduction to Industrial Microbiology Techniques

Aseptic techniques and good laboratory practices; Isolation and maintenance of industrially important microbes; Determination of microbial growth curve. Inoculum Preparation for Fermentation - Standard plate count - Spore count methods

UNIT 2: Fermentation Technology

Design and working of fermenters (lab-scale demonstration); Batch, fed-batch, and continuous fermentation concepts; Small-scale production and purification of fermentation products; Immobilization of microbial cells/enzymes.

UNIT 3: Screening and Production of Metabolites

Screening of Antibiotic Producing Microorganisms from Soil; Microbial Production of Citric Acid; Wine Production; Microbial production of amino acids

UNIT 4: Production of Enzymes

Production of enzymes by Solid State Fermentation; Production of enzymes by Submerged Fermentation; Assay of exracellular Enzymes - Amylase enzyme assay, Protease enzyme assay, Lipase enzyme assay; Purification of Enzyme by filtration Method.

UNIT 5: Quality control and industrial applications

Microbial quality control of industrial products; Determination of MIC (Minimum Inhibitory Concentration); Preservation techniques for industrial microbes (lyophilization, cryopreservation);
Testing of probiotic potential (acid/bile tolerance).

SUGGESTED READINGS

Text Books

1. Patel A.H. (2016) Industrial Microbiology, 2nd Edn. Laxmi Publications.
2. Crueger, W., &Crueger, A. (2000). Biotechnology: A Textbook of Industrial Microbiology (2nd ed.). Panima Publishing.
3. Casida, L.E. (2007). Industrial Microbiology. New Age International.
4. Waites M.J. Morgan N.L., Rockey J.S. and Higton G. (2011) Industrial Microbiology. An Introduction, Paperback, WB Publishers.

Reference books

1. Prescott, S.C., & Dunn, C.G. (2002). Industrial Microbiology. CBS Publishers.
2. Baltz R.H., Demain A.L. and Davies J.E. (2010) Manual of Industrial Microbiology and Biotechnology. ASM Press.

Alternative NPTEL/SWAYAM Course

1. Industrial Microbiology and Immunology (https://onlinecourses.swayam2.ac.in/cec25_bt15/preview)
2. Industrial Biotechnology (https://onlinecourses.nptel.ac.in/noc25_bt56/preview)

25MBU502 **Bioentrepreneurship & Startup** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives:

1 Educate students to learn about the evolution, characteristics, and role of entrepreneurship in society
2 Equip students to gain knowledge about startup ecosystem, including key support systems and government initiatives
3 Provide students to gain knowledge on the techniques for opportunity identification and early-stage startup design
4 Explore students to learn about various tools of Genetic Engineering in Entrepreneurship
5 Educate students to learn about various Cloning and Culture Techniques for Bioentrepreneurs

Program Outcomes (POs)

PO1: Complex problem-solving
PO2: Critical thinking
PO3: Creativity
PO4: Communication Skills
PO5: Analytical reasoning/thinking
PO6: Research-related skills
PO9: Lifelong Learning &Technology skills
PO13: Environmental awareness & Community engagement and service

Course Outcomes (COs)

COs	Course Outcomes	Knowledge level
CO1	Identify different types of entrepreneurs, their mindset, and their contributions to economic development	K1
CO2	Recognize key startup ecosystem stakeholders and government startup policies to support new ventures	K2
CO3	Create innovative business ideas using ideation tools and develop a basic startup design with MVP and financial planning	K6
CO4	Explore useful Molecular tools of Genetic Engineering for Bioentrepreneurs	K3
CO5	Describe Cloning and Culture Techniques useful for Bioentrepreneurs	K2

Articulation Matrix

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO9	PO13	PSO1	PSO2	PSO3
CO1	3	2	1	2	2	3	-	1	2	-	3
CO2	2	3	2	2	3	3	-	1	1	1	3
CO3	3	3	1	2	3	3	1	2	3	1	2
CO4	3	1	2	2	3	3	2	3	2	-	2
CO5	2	1	3	2	3	3	2	2	1	2	2

UNIT 1: Fundamentals of Entrepreneurship

Evolution of Entrepreneurship; concept, significance, and role in economic development and nation-building. Theories and models of entrepreneurship development. Types of entrepreneurs and the entrepreneurial mindset: characteristics, motivation, risk-taking, and leadership. Common entrepreneurial myths, realities, failures, analysis to restart after failure. Case studies of successful Indian and global entrepreneurs with insights.

UNIT 2: Startup Ecosystem and Support Systems

Overview of Local and Global Startup Ecosystem. Entrepreneurial Success in Rural Areas and establishing local entrepreneurial system. Support Institutions and Stakeholders: Incubators, accelerators, venture capitalists, angel investors, Mentors and other stakeholders. Government initiatives and startup policies: Startup India, Atal Innovation Mission, TBI, DST & MSME support schemes and National Innovation Startup Policy (NISP) for HEIs.

UNIT 3: Opportunity Identification and Startup Design

Creativity and innovation techniques: brainstorming, SCAMPER, design thinking, mind mapping. Problem identification, market analysis, and opportunity evaluation. From ideation to execution: idea selection, value proposition, and pitching. Introduction to Business Model Canvas, Minimum Viable Product (MVP) development, customer validation, and financial planning. Techno-economic feasibility and preparing Project Report - Financial Requirements

UNIT 4: Molecular Tools for Bioentrepreneurs

Introduction to Genetic Engineering in Entrepreneurship - DNA Manipulation Techniques - Applications in Diagnostics and Product Development - Recombinant DNA Technology for Product Development: Proteins, Enzymes, Therapeutics - Microbial Engineering: Engineering Probiotics, Biofuels, and Bioplastics - CRISPR and Gene Editing Technologies - Case Study: Successful Startups (e.g., Ginkgo Bioworks, Mammoth Biosciences)

UNIT 5: Cloning and Culture Techniques for Bioentrepreneurs

Plant and Animal Tissue Culture: Concepts and Applications- Somaclonal Variation and Micropropagation in Agri-Business - Cloning Vectors: Selection and Applications - Gene Libraries - Genetically Modified Organisms (GMOs) and Bioethics - Bio-Startup Case Studies: Micropropagation Units, Cloned Gene Products (e.g., insulin, vaccines)

SUGGESTED READINGS

Text Books

1. **Hisrich, R. D., Peters, M. P., & Shepherd, D. A.** *Entrepreneurship*, 11th Edition, McGraw Hill Education, 2022. ISBN: 978-9354600240
2. **S.S. Khanka**, *Entrepreneurial Development*, S. Chand Publishing, Revised Edition, 2023. ISBN: 978-9355013032
3. **Vasant Desai**, *Dynamics of Entrepreneurial Development and Management*, Himalaya Publishing House, 2020. ISBN: 978-9352627171
4. **Bill Aulet**, *Disciplined Entrepreneurship: 24 Steps to a Successful Startup*, Wiley, Updated Edition, 2021. ISBN: 978-1119793242

Reference books

1. **Donald F. Kuratko**, *Entrepreneurship: Theory, Process, and Practice*, 11th Edition, Cengage Learning, 2021. ISBN: 978-0357899580
2. **Eric Ries**, *The Lean Startup*, Penguin Random House, Special Indian Edition, 2021. ISBN: 978-0670921607

Alternative NPTEL/SWAYAM Course

1. Entrepreneurship & Startups (https://onlinecourses.swayam2.ac.in/ntr25_ed103/preview)
2. Entrepreneurship (https://onlinecourses.swayam2.ac.in/ini25_cm03/preview)

25MBU503 **Genetic Engineering Lab** **4H – 2C**

Instruction Hours / week: L: 0 T: 0 P: 4 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives:

1 Demonstrate students to learn about DNA extraction and basic laboratory handling
2 Equip students to gain experimental knowledge on DNA separation and quantification
3 Provide students to gain experimental knowledge on Restriction digestion of plasmid
4 Explore students to gain experimental knowledge bacterial transformation and screening
5 Educate students to learn about Polymerase Chain Reaction

Program Outcomes (POs)

PO1: Complex problem-solving
PO2: Critical thinking
PO3: Creativity
PO4: Communication Skills
PO5: Analytical reasoning/thinking
PO6: Research-related skills
PO9: Lifelong Learning &Technology skills
PO13: Environmental awareness & Community engagement and service

Course Outcomes (COs)

COs	Course Outcomes	Knowledge level
CO1	Demonstrate bacterial and plant DNA extraction and basic laboratory handling	K3
CO2	Perform DNA separation and quantification by agarose gel electrophoresis	K3
CO3	Experiment molecular Restriction digestion of plasmid and check the digested DNA	K4
CO4	Demonstrate bacterial transformation and screening of recombinant bacteria	K3
CO5	Amplify the bacterial DNA using Polymerase Chain Reaction and its result interpretation	K5

Articulation Matrix

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO9	PO13	PSO1	PSO2	PSO3
CO1	2	1	1	2	2	3	-	1	2	-	3
CO2	2	1	2	2	3	3	1	1	1	1	3
CO3	3	2	2	3	3	3	-	2	3	1	2
CO4	3	2	2	3	3	3	2	3	2	-	2
CO5	2	2	3	3	3	3	1	2	1	2	2

UNIT 1: Introduction and Basic Techniques

Nuclear DNA and Plasmid extraction from bacterial cells, Preparation of solutions (buffers, agarose gel, etc.), Use of micropipettes and other lab instruments

UNIT 2: Gel Electrophoresis and DNA Quantification

Agarose gel preparation and electrophoresis of DNA, Estimation of DNA concentration using UV absorbance, Gel documentation and band size estimation

UNIT 3: Restriction Digestion and Ligation

Restriction digestion of plasmid DNA, Analysis of digested DNA by gel electrophoresis, Ligation of DNA inserts- A demonstration

UNIT 4: Bacterial Transformation and Screening

Preparation of competent *E. coli* cells, Transformation with plasmid DNA, Plating on antibiotic-containing media and colony observation

UNIT 5: Polymerase Chain Reaction (PCR)

PCR setup and amplification of target DNA, Analysis of PCR products using agarose gel electrophoresis, Troubleshooting and interpretation of results

SUGGESTED READINGS

Text Books

1. Molecular Cloning: A Laboratory Manual" by Sambrook, J. and Russell, D. W., 2001, 3rd edition
2. Molecular Biology Techniques: A Classroom Laboratory Manual" by Heather Miller, D. Scott Witherow, Sue Carson, 2006
3. Principles of Gene Manipulation and Genomics" by Primrose, S. B. and Twyman, R. M. 2013
4 Introduction to Biotechnology" by William J. Thieman & Michael A. Palladino, 2014

Reference books

1. Molecular Biology of the Cell" by Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter, 6th edition, 2014
2. Bioengineering and Biotechnology: Concepts, Methodologies, Tools, and Applications", Information Resources Management Association, 2019

Alternative NPTEL/SWAYAM Course

1. Genetic Engineering and its recent advancements (https://onlinecourses.swayam2.ac.in/nou25_bt10/preview)

25MBU504 **Bioethics and Biosafety** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0

Marks: Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives:

1 Explore students to gain knowledge on Human rights and its concepts
2 Educate students to learn about the impact of Gene cloning in society
3 Provide students with a comprehensive learning about the importance of Bioethics & Ethical Clearance
4 Educate students to learn about Patents & Rights in the field of Research.
5 Explore students to gain knowledge on Biosafety and risk management

Program Outcomes (POs)

PO1: Complex problem-solving
PO2: Critical thinking
PO3: Creativity
PO4: Communication Skills
PO5: Analytical reasoning/thinking
PO6: Research-related skills
PO9: Lifelong Learning &Technology skills
PO11: Value inculcation
PO13: Environmental awareness & Community engagement and service

Course Outcomes (COs)

COs	Course Outcomes	Knowledge level
CO1	Discuss fundamentals of human rights and its various Commissions and Constitutions	K2
CO2	Relate various impacts of gene cloning with various bio-issues and its bioethic	K3
CO3	Describe ethical issues and guidelines related to experimentation on animals and human	K2
CO4	List out significance of various patents & intellectual property procedures	K1
CO5	Compare various biosafety levels and Good Laboratory practice used in biological research.	K4

Articulation Matrix

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO9	PO11	PO13	PSO1	PSO2	PSO3
CO1	2	2	1	2	2	3	2	1	1	2	-	3
CO2	2	3	2	2	3	3	3	3	1	1	1	3
CO3	3	3	2	2	3	3	3	1	2	3	1	2
CO4	3	3	2	2	3	3	3	-	3	2	-	2
CO5	2	2	3	2	3	3	3	-	2	1	2	2

UNIT 1: Introduction to Human Rights

Human Rights: Definition, Classification and Scope of Human Rights. United Nations Commission for Human Rights, National and State Human Rights Commission. Article 21 of Indian Constitution – UDHR. Social issues of Human rights.

UNIT 2: Gene Cloning & Bioethics

Impact of gene cloning & Bioethics-Issues concerning reproduction, Birth, life and Death - Artificial insemination, egg donation, IVF, embryo transplants, Prenatal diagnosis and sex selection & Abortion.

UNIT 3: Guidelines of Bioethics

Bioethics – ELSI, animal ethics - licensing of animal house - Human cloning - Ethical issues. Ethical clearance norms for conducting studies on animals and human. Guidelines for research in transgenic plants and Animals.

UNIT 4: IPR & Patents

Patents - Introduction -Treaties and Conventions of Patents, TRIPS -Basis of Patentability, Non Patentable Inventions. Patent Application Procedure in India. Other Forms of IPR- Copyright, Trade Mark, Industrial designs. Farmer's Rights - . Patenting of Biotechnology products and processes.

UNIT 5: Biosafety in Risk Management

Biosafety – Biosafety levels, guidelines on biosafety in conducting research. Risk assessment studies-Hazardous materials used in Biotechnology, Handling and Disposal. Good manufacturing practices & Good Laboratory practices, Containment facilities. Regulation on field experiments and release of GMO's - Labelling of GM foods

SUGGESTED READINGS

Text Books

1. Ignacimuthu S. 2009. Bioethics, Narosa Publication House.
2. Sree Krishna V. 2007. Bioethics and Biosafety in Biotechnology, New Age International Private Limited
3. Smith R. 2003. International Human rights, Blackstone Press.
4 Manual of patent practice and procedure. 2005. IPR India.

Reference books

1. Trayer PC, Fredrick R and Koch M. 2002. Biosafety. Michigan State University
2. Beauchamp & Leroy. 1999. Contemporary issues in Bioethics. Wardsworth Pub. Co. Belmont, California.

Alternative NPTEL/SWAYAM Course

1. Awareness on "Biosafety Aspects of GE Plants (https://onlinecourses.swayam2.ac.in/aic20_ge07/preview)

SEMESTER-VI

25MBU601 **Medical Bacteriology and Medical Virology** **5H – 4C**

Instruction Hours / week: L: 5 T: 0 P: 0

Marks: Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives:

1. Explore students to gain knowledge on Classification and general properties of medically important bacteria
2. Educate students to learn about the Infections and Diagnosis of Bacterial Pathogenesis & Laboratory diagnosis
3. Provide students with a comprehensive learning about basic concept of medical virology
4. Educate students to learn about Patents & Rights in the field of Research.
5. Explore students to gain knowledge on Laboratory diagnostic techniques in virology

Program Outcomes (POs)

PO1: Complex problem-solving
PO2: Critical thinking
PO3: Creativity
PO4: Communication Skills
PO5: Analytical reasoning/thinking
PO6: Research-related skills
PO9: Lifelong Learning &Technology skills
PO13: Environmental awareness & Community engagement and service

Course Outcomes (COs)

COs	Course Outcomes	Knowledge level
CO1	Discuss classification and general properties of medically important bacteria	K2
CO2	Explain mechanisms of bacterial pathogenicity and methods of laboratory diagnosis	K2
CO3	Describe Infections and Diagnosis of medically important bacterial species	K2
CO4	Explore Medically important Viruses and its infections	K3
CO5	List out various Diagnostic Techniques in virology	K1

Articulation Matrix

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO9	PO13	PSO1	PSO2	PSO3
CO1	1	2	2	2	2	3	-	1	2	1	3
CO2	2	2	2	2	2	3	2	1	1	2	3
CO3	2	1	2	2	2	3	2	2	3	3	3
CO4	2	2	2	2	1	3	-	3	2	3	3

CO5	2	1	2	2	3	3	3	2	1	2	3

UNIT 1: Introduction to Medical Bacteriology

Classification and general properties of medically important bacteria. Recommendation for collection, transport of specimens, isolation of bacteria from clinical specimens. Primary media for isolation and their quality control – Antibiotic sensitivity discs, testing procedures and their quality control

UNIT 2: Bacterial Pathogenesis & Laboratory diagnosis

Mechanisms of bacterial pathogenicity, including adherence, invasion, toxin production, and host immune response. Specimen collection, staining techniques, culture methods, biochemical tests, and molecular diagnostics.

UNIT 3: Medically important Bacteria

Infections and Diagnosis of species of *Staphylococcus; streptococci* and related catalase negative Gram positive cocci; *Neisseria, B.anthracis, Vibrios, Aeromonas Helicobacteria, Pseudomonas, Salmonella, Shigella, Escherichia, Klebsiella.*

UNIT 4: Virology & Medically important Viruses

General Properties of viruses – Detection of viruses and antigens in clinical specimens – Serological diagnosis of virus infections. Cultivation of Viruses. Arthropod borne and rodent borne virus diseases – Picorna viruses and diseases. Hepatitis viruses: Orthomyxo and Paramyxoviruses.

UNIT 5: Diagnostic Techniques in virology

Laboratory methods in basic virology- detection of viral antigen (fluorescent antibody and solid phase immunoassays). Viral Serology- Special consideration- Hepatitis and AIDS. Subviral agents - Viroids, Prions. Principles of biosafety, containment facilities, maintenance and handling of laboratory animals and requirements of virological laboratory.

SUGGESTED READINGS

Text Books

1. Patrick R. Murray, Ken S. Rosenthal, Michael A. Pfaller, Medical Microbiology, 2020 (8th Edition), Elsevier publisher
2. Michael T. Madigan, John M. Martinko, Kelly S. Bender, Brock Biology of Microorganisms, 2015 (14th Edition), Pearson publisher
3. S. S. Gupte, Medical Bacteriology, 2014 (2nd Edition), Jaypee Brothers Medical Publishers
4 David O. White, Frank J. Fenner, Medical Virology, 2019 (5th Edition), Academic Press

Reference books

1. N.C. Bansal. Concise Medical Microbiology, 2018 (1st Edition), aypee Brothers Medical Publishers
2. M. H. V. Van Gucht, Virology: A Research Guide, 2015 (1st Edition), Wiley-Blackwell publisher

Alternative NPTEL/SWAYAM Course

1. Bacteriology and Virology (https://onlinecourses.swayam2.ac.in/cec25_bt16/preview)

25MBU611 **Medical Bacteriology and Medical Virology Lab** **4H – 2C**

Instruction Hours / week: L: 0 T: 0 P: 4

Marks: Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives:

1 Explore students to gain practical knowledge on the Isolation of clinical bacteria
2 Educate students to gain practical knowledge on identification of clinical bacteria
3 Provide students gain practical knowledge on Isolation of Viral pathogens
4 Educate students to gain practical knowledge on the detection of viral pathogens.
5 Provide students gain practical knowledge on detection of viral antigens

Program Outcomes (POs)

PO1: Complex problem-solving
PO2: Critical thinking
PO3: Creativity
PO4: Communication Skills
PO5: Analytical reasoning/thinking
PO6: Research-related skills
PO9: Lifelong Learning &Technology skills
PO13: Environmental awareness & Community engagement and service

Course Outcomes (COs)

COs	Course Outcomes	Knowledge level
CO1	Demonstrate handling and isolation clinical bacteria	K3
CO2	Identify clinical bacteria by biochemical and Microscopy methods	K4
CO3	Demonstrate handling and isolation Viral pathogens	K3
CO4	Perform methods of detection of viral pathogens.	K3
CO5	Identify Viral pathogens by fluorescent antibody and solid phase immunoassays	K4

Articulation Matrix

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO9	PO13	PSO1	PSO2	PSO3
CO1	1	2	2	2	2	3	1	1	2	1	3
CO2	2	2	2	2	2	3	3	1	1	2	3
CO3	2	1	2	2	2	3	1	2	3	3	3
CO4	2	2	2	2	1	3	2	3	2	3	3
CO5	2	1	2	2	3	3	3	2	1	2	3

UNIT 1: Isolation of clinical bacteria

Growth media and conditions, Isolation and Screening of clinical bacteria, antibiotic susceptibility testing

UNIT 2: Identification of clinical bacteria

Biochemical tests for clinical pathogens, Gram staining and various microscopy methods to identify clinical important bacteria

UNIT 3: Isolation of viral pathogens

Growth Media and cell cultures for Virus isolation, Growth parameters, Polymerase Chain Reaction for Viral species identification,

UNIT 4: Detection of viral pathogens

Viral culture preparation, serological assays, ELISA method, Viral histo pathology methods, Identification viral infected cell

UNIT 5: Detection of Viral antigen

Viral cell line, Detection of viral antigen (fluorescent antibody and solid phase immunoassays). Viral Serology, maintenance and handling of laboratory animals.

SUGGESTED READINGS

Text Books

1. Patrick R. Murray, Ken S. Rosenthal, Michael A. Pfaller, Medical Microbiology, 2020 (8th Edition), Elsevier publisher
2. Michael T. Madigan, John M. Martinko, Kelly S. Bender, Brock Biology of Microorganisms, 2015 (14th Edition), Pearson publisher
3. S. S. Gupte, Medical Bacteriology, 2014 (2nd Edition), Jaypee Brothers Medical Publishers
4 David O. White, Frank J. Fenner, Medical Virology, 2019 (5th Edition), Academic Press

Reference books

1. N.C. Bansal. Concise Medical Microbiology, 2018 (1st Edition), aypee Brothers Medical Publishers
2. M. H. V. Van Gucht, Virology: A Research Guide, 2015 (1st Edition), Wiley-Blackwell publisher

Alternative NPTEL/SWAYAM Course

1. Bacteriology and Virology (https://onlinecourses.swayam2.ac.in/cec25_bt16/preview)

25MBU602 **Food and Dairy Microbiology** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0

Marks: Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives:

1 Explore students to gain knowledge on Importance of Microorganisms in food microbiology
2 Educate students to learn about the Importance of Microorganisms in Dairy technology
3 Provide students with a comprehensive learning about the Food borne infections and intoxifications
4 Educate students to learn about Food borne out breaks
5 Explore students to gain knowledge on Food fermentations in Microbiology

Program Outcomes (POs)

PO1: Complex problem-solving
PO2: Critical thinking
PO3: Creativity
PO4: Communication Skills
PO5: Analytical reasoning/thinking
PO6: Research-related skills

Course Outcomes (COs)

COs	Course Outcomes	Knowledge level
CO1	Discuss various micro organisms in food based technology	K2
CO2	List out various micro organisms in dairy based technology	K1
CO3	Describe Food borne bacteria and its infections	K2
CO4	Explain Food control agencies and regulation	K2
CO5	Explore various aspects of Fermentation microbiology and its products	K3

Articulation Matrix

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	1	1	1	2	1	3	2	-	3
CO2	1	1	1	2	1	3	1	-	3
CO3	2	1	2	2	2	3	3	-	3
CO4	2	2	2	2	1	3	2	1	3
CO5	2	1	2	2	3	3	1	3	3

UNIT 1: Introduction to Food Microbiology

Introduction- sources of micro organisms in food. Importance of Microorganisms in food microbiology- Molds, Yeasts and Bacteria general characteristics, Asepsis- removal of microorganisms, anaerobic conditions, high, low temperatures, drying; Factors influencing microbial growth –Extrinsic and Intrinsic factors, chemical preservatives and food additives.

UNIT 2: Introduction to Dairy technology

Microflora of raw milk, Preparation, preservation and Sources of contamination of milk; cheese, acidophilus milk, kefir and yoghurt, Nutritional and therapeutic benefits of fermented milk products; Probiotic foods; Spoilage of fermented dairy products.

UNIT 3: Food borne infections

Food borne infections and intoxifications; Bacterial diseases with examples of infective and toxic types – *Brucella, Bacillus clostridium, Escherichia, Salmonella, Shigella, Staphylococcus, Vibrio,Yersinia*, fungi and viruses; Alfatoxins - structures and functions.

UNIT 4: Food control agencies and regulation

Food borne out breaks – laboratory testing procedures; Preventive measures – Sanitation in manufacture; Food control agencies and its regulations, HACCP, ISO standards. Quality control in dairy industry.

UNIT 5: Fermentation Microbiology

Food fermentations; ; prevention and spoilage of cereals, vegetables, fruits, meat and meat products fish and sea products. Foods produced by Microbes – Fermented foods, microbial cells as food (single cell proteins); Mushroom cultivation Industrial enzymes and their uses in food industry –amylases, proteases, cellulases;

SUGGESTED READINGS

Text Books

1. Adams MR and Moss MO. (1995). Food Microbiology, The Royal Society of Chemistry, Cambridge.
2. Andrews AT, Varley J. (1994) Biochemistry of milk products Royal Society of Chemistry.
3. Banwart GJ. (1989), Basic food microbiology, Chapman & Hall, New York.
4 Frazier WC and Westhoff DC. (1988) Food microbiology, TATA McGraw Hill Publishing Company Ltd. New Delhi.

Reference books

1. M. P. Doyle, L. R. Beuchat, T. J. Montville, Food Microbiology: Fundamentals and Frontiers, 2013 (4th Edition), ASM Press
2. K. R. Shetty, V. R. Mahajan, S. P. S. Chauhan, Food and Dairy Microbiology, 2009 (1st Edition), CBS Publishers & Distributors

Alternative NPTEL/SWAYAM Course

1. Environmental, Food and Dairy Microbiology (https://onlinecourses.swayam2.ac.in/cec25_bt17/preview)
2. Industrial Microbiology and Immunology (https://onlinecourses.swayam2.ac.in/cec25_bt15/preview)
3. Industrial Biotechnology (https://onlinecourses.nptel.ac.in/noc25_bt56/preview)

25MBU612 **Food and Dairy Microbiology Lab** **4H – 2C**

Instruction Hours / week: L: 0 T: 0 P: 4

Marks: Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives:

1. Explore students to gain experimental knowledge on preparation of culture media and staining methods for food microorganisms
2. Educate students to learn experimental knowledge on Microbial Analysis of Food
3. Provide students with a experimental knowledge on Isolation and Detection of food pathogens
4. Educate students to learn experimental knowledge on milk-borne microorganisms
5. Explore students to learn experimental knowledge on food Preservation techniques

Program Outcomes (POs)

PO1: Complex problem-solving
PO2: Critical thinking
PO3: Creativity
PO4: Communication Skills
PO5: Analytical reasoning/thinking
PO6: Research-related skills

Course Outcomes (COs)

COs	Course Outcomes	Knowledge level
CO1	Demonstrate basic methods in Food Microbiology	K3
CO2	Test microbiological analysis of food products	K3
CO3	Isolate and Identify food pathogens	K4
CO4	Identify microorganisms involved in milk fermentation	K4
CO5	Handle Preservation techniques and valuation of food products	K3

Articulation Matrix

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	1	1	1	2	1	3	2	-	3
CO2	1	1	1	2	1	3	1	-	3
CO3	2	1	2	2	2	3	3	-	3
CO4	2	2	2	2	1	3	2	1	3
CO5	2	1	2	2	3	3	1	3	3

UNIT 1: Basic methods in Food Microbiology

Preparation and sterilization of culture media, culture transfer techniques: Solid to solid (streaking), liquid to solid (spreading), liquid to liquid, solid to liquid and determine CFU/ml, Food borne bacteria by staining method: Methyleneblue and Gram's staining

UNIT 2: Microbial Analysis of Food

Collection and preparation of food sample, Microbiological analysis of food products (meat, vegetables, and processed foods), enumeration of coliforms, yeast, mold, and other pathogens.

UNIT 3: Isolation and Detection of food pathogens

Methods of enrichment, selective, and differential media. Use of biochemical tests (e.g., IMViC tests for coliforms), PCR and ELISA-based methods for pathogen detection. Food-borne illness and outbreak investigations.

UNIT 4: Dairy Microbiology

Identification of Microorganisms involved in milk fermentation (e.g., *Lactococcus*, *Streptococcus*), Milk preservation techniques (pasteurization, sterilization, fermentation), Laboratory tests for milk quality (standard plate count, coliform count)

UNIT 5: Food Preservation and Control of Microbial Growth

Preservation techniques (drying, salting, refrigeration, fermentation), Effectiveness of antimicrobial agents on food-borne pathogens. Shelf-life testing and spoilage monitoring., valuation of food products for microbial contamination and spoilage

SUGGESTED READINGS

Text Books

1. R.C. Ray & R. V. P. S. Rao, Food and Dairy Microbiology Laboratory Manual, 2016, Springer publication
2. M. L. Adams & M. O. Moss, Practical Food Microbiology, 2008, CRC Press
3. S. M. Patwardhan, Dairy Microbiology: A Practical Approach, 2015, Academic Press
4 R.C. Ray & R. V. P. S. Rao, Food and Dairy Microbiology Laboratory Manual, 2016, Springer publication

Reference books

1. R. K. Robinson, Dairy Microbiology: An Introduction, 2016, Springer publication
2. Robert B. Beuchat, Microorganisms in Foods: 7: Microbiological Testing, 2016, Springer publication

Alternative NPTEL/SWAYAM Course

1. Environmental, Food and Dairy Microbiology (https://onlinecourses.swayam2.ac.in/cec25_bt17/preview)
2. Industrial Microbiology and Immunology (https://onlinecourses.swayam2.ac.in/cec25_bt15/preview)
3. Industrial Biotechnology (https://onlinecourses.nptel.ac.in/noc25_bt56/preview)

25MBU603 **Microbial Nanotechnology** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0

Marks: Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives:

1 Explore students to gain knowledge on the Concepts of nanoscience and nanotechnology
2 Educate students to learn knowledge on Microbial synthesis of nanoparticles
3 Provide students with a knowledge on Characterization of Microbially Synthesized Nanoparticles
4 Educate students to gain knowledge applications of Microbial Nanotechnology
5 Discuss students to learn Challenges, Safety, and Future Prospects

Program Outcomes (POs)

PO1: Complex problem-solving
PO2: Critical thinking
PO3: Creativity
PO4: Communication Skills
PO5: Analytical reasoning/thinking
PO6: Research-related skills
PO13: Environmental awareness & Community engagement and service

Course Outcomes (COs)

COs	Course Outcomes	Knowledge level
CO1	Explain the concepts, back ground and application of nanoparticle in Microbiology	K2
CO2	Explore biosynthesis using various microorganisms such as bacteria, fungi, algae, and Actinomycetes	K3
CO3	Discuss Characterization biosynthesied nanoparticle by various techniques such as SEM, TEM & AFM etc,	K2
CO4	List out the applications of Microbially Synthesized Nanoparticles in the various fields	K1
CO5	Analyze various Challenges, Safety, and Future Prospects in Microbial Nanotechnology	K4

Articulation Matrix

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO13	PSO1	PSO2	PSO3
CO1	1	2	2	2	2	3	1	2	1	3
CO2	2	2	2	2	2	3	1	1	2	3
CO3	2	1	2	2	2	3	2	3	3	3
CO4	2	2	2	2	1	3	3	2	3	3
CO5	2	1	2	2	3	3	2	1	2	3

UNIT 1: Introduction to Microbial Nanotechnology

Concept of nanoscience and nanotechnology – definitions and scope, Importance of micro organisms in nanoscience, Overview of nanotechnology applications in microbiology, medicine, and environment

UNIT 2: Microbes as Nanofactories

Microbial synthesis of nanoparticles: bacteria, fungi, algae, and actinomycetes. Intracellular vs. extracellular biosynthesis, Mechanisms of microbial nanoparticle synthesis (enzymatic reduction, capping, stabilization), Advantages of microbial synthesis over chemical and physical methods

UNIT 3: Characterization of Microbially Synthesized Nanomaterials

Sample preparation and purification, Microscopic techniques: Scanning Electron Microscope, Transmission Electron Microscope, Atomic Force Microscopy, Particle size and shape analysis: DLS, XRD

UNIT 4: Applications of Microbial Nanotechnology

Medical applications: antimicrobial agents, drug delivery, imaging, biosensors**,** Environmental applications: wastewater treatment, heavy metal removal, pollutant degradation, Agricultural applications: nano-fertilizers, nano-pesticides, Food industry applications: packaging, preservation, pathogen detection

UNIT 5: Challenges, Safety, and Future Prospects

Microbial Toxicity and Biocompatibility issues of nanoparticles, Future prospects of microbial nanotechnology in healthcare, environment, and various industries

SUGGESTED READINGS

Text Books

1. Shanmugam, S., Sathishkumar, G., Se-Kwon Kim (2020), Nanobiotechnology, Springer Nature
2. Chad Mirkin, Christof M. Niemeyer (2020), Handbook of Nanobiotechnology, Wiley-VCH
3. David S. Goodsell, Nanotechnology: Principles and Practices (2018)

Reference books

1. David S. Goodsell, Bionanotechnology: Concepts and Applications (2018)
2. Al-Dhabi, Naif A., Arasu, Mariadhas V. (2020) Microbial Nanotechnology: Green Synthesis and Applications

Alternative NPTEL/SWAYAM Course

1. Environmental Nanotechnology and Applications (https://onlinecourses.nptel.ac.in/noc25_ce141/preview)

25MBU604 **Clinical Laboratory Technology** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0

Marks: Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives:

1 Explore students to gain knowledge on basic Clinical Laboratory practices
2 Educate students to learn about biological specimen collection
3 Equip students to gain knowledge on examination of tissues and cells
4 Provide students with a comprehensive learning about Coagulation
5 Educate students to learn about Quality Standards in Health Laboratories

Program Outcomes (POs)

PO1: Complex problem-solving
PO2: Critical thinking
PO3: Creativity
PO4: Communication Skills
PO5: Analytical reasoning/thinking
PO6: Research-related skills

Course Outcomes (COs)

COs	Course Outcomes	Knowledge level
CO1	Describe basic procedures and handling methods in clinical laboratories	K2
CO2	Explain biological samples collection and processing	K2
CO3	List out methods of examination of tissues and cells	K1
CO4	Discuss techniques in Coagulation and other strategies in Haematology	K2
CO5	Explain Quality Standards in Health Laboratories	K3

Articulation Matrix

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	2	2	1	2	3	3	2	-	3
CO2	2	2	1	2	2	3	2	-	3
CO3	2	1	2	2	2	3	3	-	2
CO4	2	2	2	2	3	3	2	2	3
CO5	3	1	2	2	3	3	1	-	3

UNIT 1: Introduction to Clinical Laboratory Science

Basic laboratory principles - Code of conduct for medical laboratory personnel -Organization of clinical laboratory and role of medical laboratory technician - Safety measures. Assessment of a patient and brief history of collection. Maintenance of Hygiene & Infection Control Practices

UNIT 2: Specimen collection and processing

Blood, urine, stool, sputum CSF, amniotic fluid and bile. Separation of serum and plasma, Handling of specimens for testing, preservation of specimens, transport of specimens and factors affecting the clinical results.

UNIT 3: Introduction to histopathology

Methods of examination of tissues and cells, Fixation of tissues: Classification and properties of fixatives. Tissue processing - Collection of specimens, Labeling and fixation, Dehydration, Clearing, Impregnation, Embedding - Paraffin block making, Section Cutting, Microtomes – types and mounting of sections.

UNIT 4: Introduction to Haematology-

Laboratory methods used in the investigation of coagulation disorders - coagulation tests, Routine coagulation tests, (prothrombin time, plasma recalcification time, partial thromboplastin time, activated partial thromboplastin time, thrombin time), Laboratory diagnosis of bleeding disorders. Estimation of fibrinogen, Assay of coagulation factors.

UNIT 5: Quality Standards in Health Laboratories

Development and implementation of standards, Accreditation Boards –NABL, ISO, CAP, COLA, Performing quality assessment - pre-analytical, analytical, and post-analytical phases of testing.

SUGGESTED READINGS

Text Books

1. Mukharji KL. 2000. Medical Laboratory Techniques, Vol - I, II & III, 5th Edition. Tata McGraw Hill
2. Ochei A, Kolhatkar. A. 2000. Medical Laboratory Science: Theory and Practice, McGraw Hill Education
3. Ramnik Sood. 2015. Concise Book of Medical Laboratory Technology: Methods and Interpretation, 2nd Edition, Jaypee Brothers Medical Publishers

Reference books

1. Rutherford BH, Gradwohl AC, Jarett SL. Gradwohls. 2000. Clinical Laboratory Methods and Diagnosis, Vol-I, 8th Edition, Mosby.
2. Baker FJ, Silverton RE, and Pallister J. 1998. An Introduction to Medical Laboratory Technology, 7th Edition, CBS Publishers and Distributors Pvt. Ltd.

VII-SEMESTER

25MBU701 **Environmental Microbiology** **5H – 4C**

Instruction Hours / week: L: 5 T: 0 P: 0

Marks: Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives:

1. Explore students to gain knowledge on the organization of the biosphere and various components of ecosystems
2. Educate students to learn about basic concepts and various types of Microbial interactions
3. Equip students to gain knowledge on micro organisms living in the Air and its measurement methods
4. Provide students with a comprehensive learning about aquatic microorganisms
5. Educate students to learn about Microbiology of waste water and various effluent treatment processes

Program Outcomes (POs)

PO1: Complex problem-solving
PO2: Critical thinking
PO3: Creativity
PO4: Communication Skills
PO5: Analytical reasoning/thinking
PO6: Research-related skills
PO9: Lifelong Learning &Technology skills
PO13: Environmental awareness & Community engagement and service

Course Outcomes (COs)

COs	Course Outcomes	Knowledge level
CO1	Describe biosphere and its various components in the ecosystems	K2
CO2	Explain Microbial interactions and its various types	K2
CO3	Explore microflora of Air and its significant diseases	K3
CO4	Describe microflora of water, water quality and its control measures	K2
CO5	Discuss Waste water management by the process of recycling, bioremediation and biodegradation	K3

Articulation Matrix

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO9	PO13	PSO1	PSO2	PSO3
CO1	2	2	1	2	2	3	1	3	2	-	3
CO2	2	2	1	2	3	3	2	3	1	2	3
CO3	3	2	2	2	3	3	2	3	3	-	2
CO4	3	2	2	2	3	3	2	3	2	-	2
CO5	2	2	3	2	3	3	2	3	1	2	2

UNIT 1: Introduction to Microbial Ecology

Introduction: Organization of the biosphere and components of ecosystem, Natural habitats of microorganisms, Microbial life in extreme environments: Effect of temperature, pH, Pressure, salt and heavy metals. Growth in nutrient limited environment – mechanism of adaptations, Microbes in space.

UNIT 2: Microbial interactions

Microbial ecology: basic concepts, types and microbial habitats, factors affecting microbial population. Microbial interactions: competition, commensalism, parasitism, mutualism, commensalisms, synergism.

UNIT 3: Microbiology of Air

Microbiology of air: microorganism of air, enumeration of air micro flora. Significance of air micro flora. Brief account of air borne transmission of bacteria, fungi, pollens and viruses. Air borne diseases and their prevention.

UNIT 4: Water Microbiology

Water microbiology: aquatic microorganisms; fresh water and sea water microflora. Microorganisms and water quality, water pollution. Water purity test and indicator organisms, method used in environmental studies –BOD, COD, DO. Common water born disease and their control measure. Water purification: flocculation, chlorination and purification.

UNIT 5: Waste water management

Microbiology of waste water and effluent treatments, aerobic process: primary, secondary and tertiary treatment: trickle filter, oxidation ponds and stabilization ponds, principle of aerobic digestion. Recycling of liquid and soild wastes – Composting – Biogas – Biodegradation. Bioremediation, Bioleaching, Xenobiotic degradation. Microbial corrosion- Biofilms degradation of petroleum products. Microbes in mineral leaching and metal concentration, Microbial enhanced oil recovery.

SUGGESTED READINGS

Text Books

1. Varnam A H, Evans M G. 2000, Environmental Microbiology .Manson Publishing Ltd
2. Okafor N. 1stedition, 2010, Environmental Microbiology of Aquatic & Waste systems Springer, New York
3. Jjemba P K, 2004, Environmental Microbiology: Principles and Applications Science Publishing Inc.
4 Maier R, Pepper I, Gerba C. 2004, 2nd edition. Environmental Microbiology .Academic Press

Reference books

1. Ian L. Pepper, Charles P. Gerba, Terry J. Gentry, 2015, Environmental Microbiology, 3rd edition, Academic Press (Elsevier)
2. Eugene Madsen, 2015, Environmental Microbiology: From Genomes to Biogeochemistry, 2nd edition, Wiley-Blackwell press
3 Bruce E. Rittmann, Perry L. McCarty, 2001, Environmental Biotechnology: Principles and Applications, McGraw-Hill Publication

Alternative NPTEL/SWAYAM Course

1. Environmental, Food and Dairy Microbiology (https://onlinecourses.swayam2.ac.in/cec25_bt17/preview)

25MBU711 **Environmental Microbiology Lab** **4H – 2C**

Instruction Hours / week: L: 0 T: 0 P: 4

Marks: Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives:

1. Provide students to gain experimental knowledge on Basic Microbial Techniques for Environmental Samples
2. Equip students to gain experimental knowledge on Identification of Coliforms
3. Provide students to gain experimental knowledge on the Enumeration of total heterotrophic microbes
4. Explore students to gain experimental knowledge on Enumeration and identification of airborne microbes
5. Educate students gain experimental knowledge on hydrocarbon-degrading bacteria from contaminated sites

Program Outcomes (POs)

PO1: Complex problem-solving
PO2: Critical thinking
PO3: Creativity
PO4: Communication Skills
PO5: Analytical reasoning/thinking
PO6: Research-related skills
PO9: Lifelong Learning &Technology skills
PO13: Environmental awareness & Community engagement and service

Course Outcomes (COs)

COs	Course Outcomes	Knowledge level
CO1	Demonstrate Microbial Techniques for environmental samples	K3
CO2	Test Microbial Analysis of Water Quality by Most Probable Number method	K3
CO3	Isolate and Identify various bacteria for the extraction of soil enzymes	K4
CO4	Isolate and Identify Air micro organisms	K4
CO5	Isolate and identify degrading bacteria from contaminated sites	K4

Articulation Matrix

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO9	PO13	PSO1	PSO2	PSO3
CO1	2	2	1	2	2	3	1	3	2	-	3
CO2	2	2	1	2	3	3	2	3	1	1	3
CO3	3	2	2	2	3	3	2	3	3	3	2
CO4	3	2	2	2	3	3	2	3	2	-	2
CO5	2	2	3	2	3	3	2	3	1	1	2

UNIT 1: Basic Microbial Techniques for Environmental Samples

Collection, transport, and storage of environmental samples (soil, water, air), Preparation and use of selective/differential media for environmental isolates

UNIT 2: Microbial Analysis of Water Quality

Detection of coliforms by Most Probable Number (MPN) method, Biochemical tests for identification of coliforms and fecal streptococci

UNIT 3: Soil Microbiology Techniques

Enumeration of total heterotrophic bacteria, actinomycetes, and fungi from soil, Soil enzyme activity assays (dehydrogenase, urease)

UNIT 4: Air Microbiology Techniques

Enumeration and identification of airborne bacteria and fungi**,** Indoor vs. outdoor microbial load comparison

UNIT 5: Bioremediation and Environmental Monitoring

Isolation of hydrocarbon-degrading bacteria from contaminated sites, Screening of microbes for heavy metal tolerance, Microbial degradation of dyes or industrial effluents (lab-scale).

SUGGESTED READINGS

Text Books

1. Cindy Hagedorn, Ian L. Pepper, Charles P. Gerba **(**2014) Manual of Environmental Microbiology , Academic Press (Elsevier)
2. C.A. Reddy, T.J. Beveridge, J.A. Breznak, G. Marzluf (2015) Methods for General and Molecular Microbiology – (3rd Edition), ASM publisher
3. Michael J. Leboffe, Burton E. Pierce **(**2022), Microbiology: Laboratory Theory and Application ,

Reference books

1. Elizabeth Bagley, Janet C. Luchansky **(**2017) Practical Environmental Microbiology, CRC Press, Taylor & Francis

Alternative NPTEL/SWAYAM Course

1. Environmental, Food and Dairy Microbiology (https://onlinecourses.swayam2.ac.in/cec25_bt17/preview)

25MBU702 **Medical Mycology and Parasitology** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives:

1 Explore students to gain knowledge on structure of fungi its classifications
2 Educate students to learn about laboratory procedure to handle fungal pathogens
3 Provide students with a comprehensive learning of Fungal pathogencity in humans
4 Explore students to gain knowledge on the life cycles of various human parasites and its classifications
5 Educate students to learn about laboratory procedure to handle human parasites

Program Outcomes (POs)

PO1: Complex problem-solving
PO2: Critical thinking
PO3: Creativity
PO4: Communication Skills
PO5: Analytical reasoning/thinking
PO6: Research-related skills
PO9: Lifelong Learning &Technology skills
PO13: Environmental awareness & Community engagement and service

Course Outcomes (COs)

COs	Course Outcomes	Knowledge level
CO1	Describe the morphology, reproduction and classifications of fungi	K2
CO2	Identify various fungal pathogens by optimized laboratory procedure	K4
CO3	Explain various Fungal infections and its pathogenicity	K2
CO4	Discuss Classification of human parasites and its interaction with livings host cells	K2
CO5	Explain various laboratory methods and procedures to handle human parasites	K3

Articulation Matrix

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO9	PO13	PSO1	PSO2	PSO3
CO1	1	2	2	2	2	3	2	3	2	-	3
CO2	1	2	1	2	3	3	2	3	1	1	3
CO3	2	2	2	2	3	3	2	3	3	1	3
CO4	2	2	2	2	3	3	2	3	2	-	3
CO5	2	2	3	2	3	3	2	3	1	-	2

UNIT 1: Introduction to Fungi

The morphology and reproduction of fungi and antimycotic agents, Classification of fungi, Contaminant and pportunistic fungi.

UNIT 2: Laboratory methods of Mycology

Laboratory methods in Mycology –Collection and transport of clinical specimens –Direct Microscopic examination, culture media and incubation, Serological tests for fungi – Antifungal susceptibility testing

UNIT 3: Fungal Pathogenicity

Mycology: superficial infections- Dermatopytes- Microsporum – Trichophyton, Epidermophyton- Maduramycosis- Opportunistic fungal pathogens- *Candida Albicans, Aspergillus Mucor*.

UNIT 4: Medical Parasitology

Brief introduction of medical parasitology- host parasitic interaction, Effect of parasitism in the host, Sources of parasitic infections, Classification. Mode of infection and disease cycle of Parasitic Agents- *Plasmodium vivax, Giardia, Taenia solium, Ancylostoma, Ascaris, Wuchereria bancrofti, Enterobius, Trichuris trichura.*

UNIT 5: Laboratory methods in Parasitology

Laboratory methods for parasitic infections – Diagnostic techniques for faecal, gastrointestinal and urinogenital specimen. Identification of Intestinal Protozoa –Amoeba, Blood protozoa – Malaria, Intestinal Helminthes and Blood Helminthes.

SUGGESTED READINGS

Text Books

1. Ananthanarayan, R. and Jeyaram Paniker, C.K. (1994) Text Book of Microbiology, 6th Edn. Orient Longman, Chennai.
2. Alexopoulus CJ and C W. Mims.(1993).Introductory Mycology (3rd edition) WileyEastern Ltd, New Delhi.
3. Burton Bogitsh, Clint Carter and Thomas Oeltmann(2012). Human Parasitology 4th Edition. Academic Press.
4 Chatterjee (1986) Medical Parasitology. Tata McGraw Hill, Calcutta

Reference books

1. Chatterjee K.D. (2009) Parasitology: Protozoology and Helminthology, 13th Edn. CBS Publishers & Distributors Pvt. Limited.
2. Brooks G., Carrol K.C., Butel J. and Morse S. (2012) Jawetz Melnick and Adelberg Medical Microbiology, 26th Edn. Lange Medical Publications.
3 Reiss E. Shadomy H.J. and Lyon G.M. (2011) Fundamental Medical Mycology, Wiley-Blackwell.

25MBU712 **Medical Mycology and Parasitology Lab** **4H – 2C**

Instruction Hours / week: L: 0 T: 0 P: 4

Marks: Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives:

1. Explore students to gain practical knowledge on biosafety levels for handling fungal and parasitic pathogens
2. Equip students to gain experimental knowledge on Culture Methods for Pathogenic Fungi
3. Provide students to gain experimental knowledge on the Microscopic identification of Yeast and Moulds
4. Explore students to gain experimental knowledge on the Identification of intestinal protozoa
5. Educate students gain experimental knowledge on diagnostic methods of parasitic infections

Program Outcomes (POs)

PO1: Complex problem-solving
PO2: Critical thinking
PO3: Creativity
PO4: Communication Skills
PO5: Analytical reasoning/thinking
PO6: Research-related skills
PO9: Lifelong Learning &Technology skills
PO13: Environmental awareness & Community engagement and service

Course Outcomes (COs)

COs	Course Outcomes	Knowledge level
CO1	Demonstrate Laboratory Safety and Sample collection for handling fungal and parasitic pathogens	K3
CO2	Prepare fungal culture media and grow for its morphology study	K3
CO3	Identify various medically important Yeasts and Moulds	K4
CO4	Isolate and Identify medically important intestinal protozoa	K4
CO5	Analyze Blood and Tissue Parasites via serological methods to find out parasitic infections	K5

Articulation Matrix

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO9	PO13	PSO1	PSO2	PSO3
CO1	1	2	2	2	2	3	2	3	2	-	3
CO2	1	2	1	2	3	3	2	3	1	1	3
CO3	2	2	2	2	3	3	2	3	3	1	3
CO4	2	2	2	2	3	3	2	3	2	-	3
CO5	2	2	3	2	3	3	2	3	1	-	2

UNIT 1: Laboratory Safety and Sample collection

Biosafety levels for handling fungal and parasitic pathogens, Collection, transport, and processing of clinical specimens (skin scrapings, hair, nail, stool, urine, blood)

UNIT 2: Culture Methods for Pathogenic Fungi

Preparation of Sabouraud's Dextrose Agar (SDA) and other fungal media, Slide culture technique for fungal morphology, Identification of common pathogenic fungi

UNIT 3: Identification of Yeasts and Moulds

Carbohydrate assimilation and fermentation tests for yeasts, Microscopic identification of *Aspergillus*, *Penicillium*, *Mucor*, dermatophytes

UNIT 4: Parasitology: Helminths and Protozoa

Identification of intestinal protozoa: *Entamoeba histolytica*, *Giardia lamblia*, *Balantidium coli,* Preparation of permanent mounts of parasites

UNIT 5: Blood and Tissue Parasites

Examination of thick and thin blood smears for *Plasmodium* spp. (malaria), Introduction to serological methods for parasitic infections (ELISA, rapid diagnostic tests – demonstration only)

SUGGESTED READINGS

Text Books

1. Medical Parasitology: A Practical Approach (2016) John W. Ridley, CRC Press, Taylor & Francis publication
2. Larone's Medically Important Fungi: A Guide to Identification (2018) Davise H. Larone, ASM press
3. Practical Guide to Diagnostic Parasitology (2020) Lynne Shore Garcia, ASM press

25MBU703 **Microbiological Research** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0

Marks: Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives:

1 Explore students to gain the knowledge on the background of Microbiological Research
2 Educate students to learn about various tools and techniques in Microbiological Research
3 Equip students to gain knowledge on Research approaches and its various methods
4 Provide students with a comprehensive learning about writing Research Report & preparation of thesis
5 Educate students to learn about the guidelines for preparing an article and submission

Program Outcomes (POs)

PO1: Complex problem-solving
PO2: Critical thinking
PO3: Creativity
PO4: Communication Skills
PO5: Analytical reasoning/thinking
PO6: Research-related skills
PO9: Lifelong Learning &Technology skills
PO13: Environmental awareness & Community engagement and service

Course Outcomes (COs)

COs	Course Outcomes	Knowledge level
CO1	Explore background, scope and history Microbiological Research	K2
CO2	Apply various tools and techniques in Microbiological Research	K2
CO3	Describe Research Methodology and its various types, design and data collection	K2
CO4	Explore consolidation of Research Report and Thesis preparation	K3
CO5	Explain research publications and its various guidelines and manuscript preparation	K4

Articulation Matrix

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO9	PO13	PSO1	PSO2	PSO3
CO1	-	-	1	2	-	3	-	3	2	-	3
CO2	2	2	2	2	3	3	3	3	1	2	3
CO3	2	2	2	2	3	3	2	3	3	-	2
CO4	3	2	2	2	2	3	2	3	2	-	2
CO5	2	2	3	2	3	3	2	3	1	-	2

UNIT 1: Introduction to Microbiological Research

Scope and significance of research in microbiology, History and evolution of microbiological research, Types of microbiological research: Basic, applied, clinical, industrial, environmental, Role of research in solving microbial challenges (e.g., antimicrobial resistance, emerging pathogens), Ethics in microbiological research

UNIT 2: Tools and Techniques in Microbiological Research

Microscopy (light, fluorescence, electron), Culture techniques: Selective media, differential media, Molecular tools: PCR, gel electrophoresis, DNA/RNA extraction, Microbial identification techniques: Biochemical tests, MALDI-TOF, Use of bioinformatics in microbial research

UNIT 3: Research Methodology

Research Methodology - Meaning and objectives and types of research. Research approaches – research Process. Defining the research problem - research design. Sampling – types and design. Data collection - methods - processing and analysis of data. Testing of Hypothesis. Fundamentals of Bioethics.

UNIT 4: Writing the Research Report & Thesis

Writing the Research Report & Thesis: Components of research report - Title, Authors, Addresses, Abstract, Keywords, Introduction, Materials and Methods, Results, Discussion, Summary, Acknowledgements and Bibliography, Case studies in medical, environmental, industrial microbiology, Viva-voce on research understanding and findings

UNIT 5: Research Publication

Guidelines for preparing an article - ISSN, ISBN, impact factor, citation index, downloading index, h-index, i-index, Google scholar, Scopus, Thomson &Reuters, Web of Science and Science Citation Index (SCI) of Web of Science (WOS). Plagiarism and its software

SUGGESTED READINGS

Text Books

1. Gerard J. Tortora, Berdell R. Funke, Christine L. Case, Microbiology, 13th Edition (2018), Pearson Education
2. C.R. Kothari, Gaurav Garg, Research Methodology: Methods and Techniques, 4th Edition (2019), New Age International Publishers
3. John L. Ingraham and Catherine Ingraham, Laboratory Techniques in Microbiology, 1st Edition (2004), Brooks/Cole press

Reference books

1. Joanne M. Willey, Linda Sherwood, Christopher J. Woolverton, Prescott's Microbiology, 2016 (10th Edition), McGraw-Hill Education,
2. Karen C. Carroll, Manual of Clinical Microbiology, 2019 (12th Edition), ASM Press,
3 Angelika H. Hofmann, Scientific Writing and Communication: Papers, Proposals, and Presentations, 2016, Oxford University Press

Alternative NPTEL/SWAYAM Course

1. Basic course in Biomedical Research (https://onlinecourses.nptel.ac.in/noc22_md01/preview)

25MBU704 **Nanobiotechnology** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives:

1 Explore students to gain knowledge on the basic concepts in frontier of nanobiotechnology.
2 Educate students to learn about on the Synthesis and characterization of nanomaterials
3 Equip students to gain knowledge on Nano biotechnology in detection and imagination system
4 Provide students with a comprehensive learning about Nano biotechnology for drug delivery
5 Educate students to learn about Nano biotechnology in environmental and food sciences

Program Outcomes (POs)

PO1: Complex problem-solving
PO2: Critical thinking
PO3: Creativity
PO4: Communication Skills
PO5: Analytical reasoning/thinking
PO6: Research-related skills
PO9: Lifelong Learning &Technology skills
PO13: Environmental awareness & Community engagement and service

Course Outcomes (COs)

COs	Course Outcomes	Knowledge level
CO1	Explain about basic concepts in nanobiotechnology	K2
CO2	Illustrate about nanoparticle synthesis and their characterization	K2
CO3	Apply use of nanoparticles in detection system	K3
CO4	Prepare workflow for the drug delivery through nanocarriers	K4
CO5	Sketch use nanoparticles in quality assessment analysis in environmental and food sciences	K3

Articulation Matrix

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO9	PO13	PSO1	PSO2	PSO3
CO1	-	2	2	1	2	3	1	-	2	-	3
CO2	2	2	2	2	3	3	2	-	1	-	3
CO3	3	2	3	1	3	3	2	1	3	-	2
CO4	3	2	3	2	3	3	2	-	2	-	2
CO5	2	2	3	2	3	3	2	3	1	2	2

UNIT 1: Introduction, History and Development

Definition, Nanobiotechnology. Introduction to Nanoscience and basic concepts; Interaction of surface molecules and its chemical and physical properties; Nanoprocessess in nature - lotus effect, colour patterns in butterflies, adhesive pads in lizards; Different types of nanoparticles - metallic nanoparticles - Gold/silver, titanium based, non-metallic nanoparticles - carbon and silicon based. Application of nanoparticles in nanolithography and in biological fields.

UNIT 2: Synthesis and characterisation of nanomaterials

Synthesis-physical, chemical and biological methods-role of metabolites in the formation of metallic nanoparticles –Top down and bottom up approaches- Advantages and disadvantages. Characterisation of nanomaterial – Spectroscopy (UV-VIS, FTIR, DLS), surface analysis (XRD, AFM), Microscopy (SEM, TEM).

UNIT 3: Nano biotechnology in detection and imagination system

History and development of Sensors-biosensors-components of biosensors-application of biosensors in various fields-Detection of pathogens-enzyme based and enzyme free method. Aptamer based detection of pathogens DNA probe. Imaging technique; fluorophores, quantum dots and magnetic nanoparticles, Implants: orthopaedic and vascular

UNIT 4: Nano biotechnology for drug delivery

Drug analysis & delivery. Route of drug delivery–rate of delivery- surface modification –bioconjugation, peglyation drug carriers- liposomes, nanoshells, micelles, dendrimers and hydrogels; functionalization of nanomaterials and Targeted drug delivery. Bionanosensors: nano cantilevers based on single stranded DNA methods to coat drug over the nanomaterial for effective delivery- targeted mode of delivery, fate of the nanoparticles after drug delivery.

UNIT 5: Nano biotechnology in environmental and food sciences

Nanotechnology in food industry -Food contaminants detection – pathogen detection –opportunities for Nanobiotechnology in food industry-Risk analysis of nanotechnology in food industries. Nanotechnology In environment - Health and environmental issues about nanoparticles. Nanotoxicology, Immune response to nanoparticles, Safety concerns about using nanotechnology. Guidelines for working with nanomaterials

SUGGESTED READINGS

Text Books

1. Balaji, S. 2010. Nanobiotechnology. MJP Publications, New Delhi
2. Chattopadhyay KK. 2009. Introduction to nanotechnology and nanosciences, PHI Learning Pvt Ltd.
3. Gabor L. Hornyak, H.F. Tibbals, Joydeep Dutta, John J. Moore, 2008, Introduction to Nanoscience and Nanotechnology, CRC Press
4 Oded Shoseyov, Ilan Levy, Nanobiotechnology: BioInspired Devices and Materials of the Future, 2007, Humana Press (Springer)

Reference books

1. Bhatia, M. 2010. Nanotechnology. Anmol Publications Pvt.Ltd., New delhi.
2. Niemeyer, C.M. and Mirkin, C.A. 2006. Nanobiotechnology: Concepts, Application and properties. Wiley, VCH Publishers.
3 Pradeep, T. 2011. Nano: The Essentials. Tata Mc Graw Education Private Ltd., New Delhi

Alternative NPTEL/SWAYAM Course

1. Biomedical Nanotechnology (https://onlinecourses.nptel.ac.in/noc25_bt70/preview)
2. Environmental Nanotechnology and Applications (https://onlinecourses.nptel.ac.in/noc25_ce141/preview)

SEMESTER-VIII

25MBU801 **Microbial Pathogenicity** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0

Marks: Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives:

1 Explore students to gain knowledge on Microbial pathogenicity and virulence.
2 Educate students to learn about on the various stages of Molecular microbial pathogenicity
3 Equip students to gain knowledge on direct and indirect spread of microbial community
4 Provide students with a comprehensive learning about Mechanisms of emergence of new pathogens
5 Educate students to learn about various methods to identify microbial pathogenicity

Program Outcomes (POs)

PO1: Complex problem-solving
PO2: Critical thinking
PO3: Creativity
PO4: Communication Skills
PO5: Analytical reasoning/thinking
PO6: Research-related skills
PO9: Lifelong Learning &Technology skills
PO13: Environmental awareness & Community engagement and service

Course Outcomes (COs)

COs	Course Outcomes	Knowledge level
CO1	Explain about basics of classical and molecular microbial pathogenicity.	K2
CO2	Explore regulation and signalling of Molecular microbial pathogenicity	K2
CO3	Discuss the spread of microbes through body, their strategies and mechanism to cause the damage.	K2
CO4	Illustrate emerging and re-emerging new pathogens by their transmission scenario	K3
CO5	Outline methods of detection of microbial pathogenicity	K1

Articulation Matrix

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO9	PO13	PSO1	PSO2	PSO3
CO1	2	2	1	2	2	3	1	3	2	2	3
CO2	2	2	1	2	3	3	2	3	1	3	3
CO3	3	2	2	2	3	3	2	3	3	2	2
CO4	3	2	2	2	3	3	2	3	2	1	3
CO5	2	2	3	2	3	3	2	3	1	2	3

UNIT 1: Classical view of microbial pathogenicity

Define pathogenicity and virulence; Quantitative measures of pathogenicity: minimal lethal dose (MLD), LD50, ID50, TCID50. Virulence determinants: colonization, toxins, enzymes and invasiveness. Facultative / obligate intracellular pathogens.

UNIT 2: Molecular microbial pathogenicity

Molecular Koch's postulates, multiplicity of virulence determinants, coordinated regulation of virulence genes, and environmental regulation of virulence determinants by two component signal transudation systems, antigenic variation; clonal and panmictic nature of microbial pathogens, type three secretion system (TTSS, T3SS), Role of biofilms and quorum sensing in microbial pathogenecity.

UNIT 3: Microbial transmission

The spread of microbes through the body: direct and indirect spread, microbial factor promoting spread, spread via lymphatic, blood and via other pathways. Microbial strategies in relation to immune responses, Mechanisms of tissue inquiry in relation to bacterial infection

UNIT 4: Emerging and re-emerging pathogens

Illustrate emerging and re-emerging pathogens using V. cholerae 0139, *M. tuberculosis, Helicobacter pylori, Enterohaemorrhagic E. coli (EHEC)*, and opportunistic fungal pathogens. Mechanisms of emergence of new pathogens: horizontal gene transfer (HGT) and pathogenicity islands (PAI).

UNIT 5: Methods of detection of microbial pathogenicity

Nucleic acid probes in diagnostic microbiology, nucleic acid amplification methods, Real-time PCR, Lateral flow assays, diagnostic sequencing and mutation detection, automated instruments for detection / diagnosis of infectious agents (BACTAC and Vitek-2).

SUGGESTED READINGS

Text Books

1. Carroll KC, Hobdon JA, Miller S, Morse SA, Mietzner TA. (2015), 27th edition. Jawetz, Melnick, & Adelberg's Medical Microbiology Lange Publication
2. Edward DJ and Holt KE. (2013) Beginner's guide to comparative genome analysis using next generation sequence data. Microbial Informatics and Experimentation
3. Wilson BA, Salyers AA, Whitt DD and Winkler ME. (2011), Bacterial Pathogenesis: A molecular approach. 3rd edition. American Society for Microbiology Press, Washington, DC USA
4 Locht C and Simonet M. (2012) Bacterial Pathogenesis: Molecular and Cellular Mechanisms. Caister Academic Press

Reference books

1. Persing DH, Tenover FC, Hayden R, Leven M, Miller MB, Nolte FS, Tang YW, Belkum AAV. (2016) Molecular Microbiology: Diagnostic Principles and Practice. 3rd edition. Washington, American Society for Microbiology Press.
2. Nelson KE and Williams CM. Infectious Disease Epidemiology: Theory and Practice. 4th edition. Jones and Bartlett.

25MBU802 **Intellectual Property Rights** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives:

1 Explore students to gain the knowledge on Definition and concepts of Intellectual Property Rights
2 Educate students to learn about the patentable subject matter in Microbiology
3 Equip students to gain knowledge on the concepts of Copyrights, Trademarks & Trade Secrets
4 Provide students with a comprehensive learning about Biosafety, Bioethics and Regulatory Framework
5 Educate students to learn about the concepts of IPR Management and Technology Transfer

Program Outcomes (POs)

PO1: Complex problem-solving
PO2: Critical thinking
PO3: Creativity
PO4: Communication Skills
PO5: Analytical reasoning/thinking
PO6: Research-related skills
PO9: Lifelong Learning &Technology skills
PO11: Value inculcation
PO13: Environmental awareness & Community engagement and service

Course Outcomes (COs)

COs	Course Outcomes	Knowledge level
CO1	Explore terms and concepts of Intellectual Property Rights and its various organizations	K2
CO2	Describe Patentable subject matter in Microbiology and its filling processes	K2
CO3	Explain Copyrights, Trademarks & Trade Secrets in Microbiology and Biotechnology	K2
CO4	Explore terms and concepts of Biosafety, Bioethics and Regulatory Framework and its various committees and protocols	K3
CO5	Apply Commercialization of research and its various stages from laboratory to Industry	K3

Articulation Matrix

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO9	PO11	PO13	PSO1	PSO3
CO1	-	2	2	2	2	2	1	3	3	2	3
CO2	2	1	1	1	1	2	2	2	3	1	3
CO3	1	2	2	2	1	3	2	1	3	3	2
CO4	2	2	2	2	2	3	2	1	3	2	2
CO5	2	2	3	2	3	3	2	1	3	1	2

UNIT 1: Introduction to Intellectual Property Rights

Definition and concept of IPR, Patentable and non-patentables, Types of IPR: Patents, Trademarks, Copyrights, Industrial Designs, Trade Secrets, Importance of IPR in microbiology and biotechnology, Evolution and history of IPR, International organizations: World Intellectual Property Organization (WIPO) and World Trade Organization (WTO) Agreement

UNIT 2: Patents in Microbiology

Patentable subject matter: Genes, enzymes, microorganisms, GMOs, Type of Patents- Utility and Design, Patent laws in India and globally (USPTO, EPO), Process of patent filing: Searching a patent, Drafting of a patent, Filing of a patent, Provisional and complete specification, Case studies on patents in microbiology (e.g., PCR, CRISPR)

UNIT 3: Copyrights, Trademarks & Trade Secrets

Copyrights: Definition, need, coverage and duration, Scope, duration, and importance in scientific work, Trademarks: Definition. Rights of trademark, signs that can be used as trademarks, types of trademark. Relevance in pharma and biotech industries, Trade secrets and know-how: Protection strategies, Industrial designs and geographical indications, Differences between various forms of IPR

UNIT 4: Biosafety, Bioethics and Regulatory Framework

Biosafety levels and handling of genetically modified organisms (GMOs), Bioethical issues in microbial research and biotechnology, Regulatory bodies: DBT, ICMR, GEAC, NBA (India), Biosafety guidelines – Government of India, Cartagena Protocol, Nagoya Protocol (access and benefit sharing), Role of Institutional Biosafety Committees (IBSC)

UNIT 5: IPR Management and Technology Transfer

Commercialization of research: Licensing, startups, spin-offs, Technology transfer mechanisms, TRL levels, Prototypes, Patent infringement and litigation, Intellectual property management in research institutions, Case studies: Successful biotech startups & licensing models

SUGGESTED READINGS

Text Books

1. S. S. Rattan, Intellectual Property Rights: Concepts, Types, and Applications, 2nd Edition (2013), PHL Learning publication
2. Adrian C. D. S. Thomas, Craig A. R. Wood, Intellectual Property Rights and the Life Sciences, 1st Edition (2007), Cambridge University Press
3. T. R. K. Rao, Intellectual Property Rights: A Practical Guide for Researchers, 1st Edition (2017), Universities Press
4 Prathiba M. Singh, Biotechnology and Intellectual Property: Patents and Other Legal Rights, 1st Edition (2007), Wiley-India

Reference books

1. Ajit Parulekar, Intellectual Property Rights in Biotechnology, 1st Edition (2010), M. S. K. India publisher
2. James C. Boyle, Intellectual Property and Biotechnology: Biological Inventions, 2nd Edition (2015), Wiley-Blackwell

Jonathan L. Johnson, Patent Law and Practice, 4th Edition (2014), Wolters Kluwer Press

Alternative NPTEL/SWAYAM Course

1. Intellectual Property Rights (https://onlinecourses.swayam2.ac.in/ntr25_ed87/preview)
2. Intellectual Property Rights and Competition law (https://onlinecourses.nptel.ac.in/noc25_mg132/preview)