સૌરાષ્ટ્ર યુનિવર્સિટી

એકેડેમિક વિભાગ

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તા.23/૦૬/૨૦૨૫

બી.એસસી.(માઈક્રોબાયોલોજી)

પરિપત્ર:-

સૌરાષ્ટ્ર યુનિવર્સિટીની લાઈફ સાયન્સીસ વિદ્યાશાખા હેઠળની સ્નાતક કક્ષાના બી.એસસી.(માઈક્રોબાયોલોજી)ના અભ્યાસક્રમ ચલાવતી સર્વે સંલગ્ન કોલેજોના આચાર્યશ્રીઓને આથી જાણ કરવામાં આવે છે કે, માઈક્રોબાયોલોજી વિષયની અભ્યાસ સમિતિનાં ચેરપર્સનશ્રી તથા લાઈફ સાયન્સીસ વિદ્યાશાખાનાં ડીનશ્રી દ્વારા બી.એસસી.(માઈક્રોબાયોલોજી) સેમેસ્ટર - ૦૫ અને ૦૬ SOP મુજબનો અભ્યાસક્રમ અધિકાર મંડળોની બહાલીની અપેક્ષાએ મંજુરી આપવા માન.કુલપતિ સાહેબને ભલામણ કરેલ જે માન.કુલપતિશ્રીએ મંજુર કરેલ છે. જેથી સંબંધિત તમામે તે મુજબ તેની અમલવારી કરવી.

(મુસદ્દો કુલસચિવશ્રીએ મંજુર કરેલ છે.)

સહી/-

(ડૉ.આર.જી.પરમાર)

I/C કુલસચિવ

બિડાણ:- ઉક્ત અભ્યાસક્રમ (સોફ્ટ કોપી)

રવાના કર્યું

23/6/25

એકેડેમિક ઓફીસર

પ્રતિ,

(૧) લાઈફ સાયન્સીસ વિદ્યાશાખા હેઠળની બી.એસસી.(માઈક્રોબાયોલોજી) વિષય ચલાવતી સ્નાતક કક્ષાની સર્વે સંલગ્ન કોલેજોના આચાર્યશ્રીઓ તથા અનુસ્નાતક ભવનનાં અધ્યક્ષશ્રીઓ તરફ.

(૨) માઈક્રોબાયોલોજી વિષયની અભ્યાસ સમિતિનાં સર્વે સભ્યશ્રીઓ

(૩) ડીનશ્રી, લાઈફ સાયન્સીસ વિદ્યાશાખા

નકલ જાણ અર્થે રવાના:-

૧. માન.કુલપતિશ્રી/કુલસચિવશ્રીના અંગત સચિવ

નકલ રવાના (યોગ્ય કાર્યવાહી અર્થે):-

૧. પરીક્ષા વિભાગ

૨. પી.જી.ટી.આર.વિભાગ

૩. જોડાણ વિભાગ

SAURASHTRA UNIVERSITY

FACULTY OF SCIENCE

Course Structure and Syllabus for Science FYUGP – Semester - 5

B.Sc. Honours/ Honours with Research in Microbiology

Based on

UGC's guidelines NEP-2020 "Curriculum and Credit Framework for Undergraduate Programmes- CCFUP" and

Education Department, Government of Gujarat's
Uniform Credit Structure for all HEIs of Gujarat State and
Implementation of the Common Curriculum and Credit Framework under the National Education Policy-2020
(No: KCG/admin/2023-24/0607/kh.1 Sachivalaya, Gandhinagar dated 11/07/2023) and

Standard Operating Procedure for Implementation of NEP-2020 for the State of Gujarat- HEIs of Gujarat
(No: KCG/admin/2023-24/865/ dated 26/07/2023) and

Additional content to be added to SOP published by KCG
(No: KCG/NEP-2020/2023-24/893/ dated 28/07/2023)

General Guidelines for Implementation of **Four Year Under Graduate Programmes** for Saurashtra University (16 pages) published in August 2023
(E-mail from Academic Section Saurashtra University dated Oct 11, 2023)

Effective for students admitted in 2023-24 & onwards

(Submitted in June 2025)

PREFACE

Timely revision of the curriculum to encompass new knowledge and information is a prime criterion of IQAC and a prime need for the college educational systems affiliated with Universities. Under the NEP -2020 and UGC guidelines, a student must be offered the latest courses of varied nature with societal, environmental, and economic implications. The curriculum should offer multiple entry-exit and a choice of vast subjects to choose from to a student to facilitate his learning abilities, aptitude, and inclination.

Microbiology is a foundation subject for Agriculture, Biochemistry, Bioinformatics, Biotechnology, Environmental Science, Genetic engineering, Molecular biology, and Medical Microbiology and hence holds the central position in the curriculum of these subjects. Looking at the rapid inventions and technological developments in the field of Microbiology and keeping in view the recommendations of UGC and NEP-2020, this syllabus has been formulated by the combined and coordinated efforts of all the faculty members of all the Microbiology Departments of Colleges affiliated to Saurashtra University.

The composition of a curriculum for a particular subject requires the following criteria to be considered:

1. Guidelines and Model curriculum were given by the UGC, State Government, and the University
2. Regional needs and Present National and International trends in the subject
3. Geographical parameters of the University and its demographic property
4. Relationship with other related subjects and resources of educational needs.
5. Financial and statuary provisions of the State government

The content of a syllabus should be such that it maintains continuity with the course content of higher secondary classes and post-graduate courses. The current curriculum is made keeping this in mind and is an effort to impart fundamental knowledge of the subject needed at this level.The curriculum is designed per the guidelines of UGC and NEP-2020 and reflects the courses' total credit, teaching hours, and question paper style. The syllabus units are well-defined, and the scope of each is given in detail. A list of reference books is provided at the end of each course. Microbiology being an experimental science, sufficient emphasis is given to training and instrumentation. The following objectives have been considered while formulation the curriculum:

1. To provide an updated, feasible, and modern syllabus to the students, emphasizing knowledge and skill to build up their valuable college education and job-oriented carrier.
2. To frame the syllabus in accordance with the semester system and UGC – NEP 2020 guidelines and in consultation with all stakeholders.
3. To offer the students an array of Core, Interdisciplinary, Multidisciplinary, Skill enhancement, Ability enhancement and Value-added courses to select from and to facilitate his academic, intellectual and social grooming.

The Board of Studies for Microbiology expresses heartfelt gratitude to the Dean, Faculty of Science, Saurashtra University, for valuable guidelines and the Academic Section for much-needed cooperation. The Board wishes all the students pursuing Microbiology a very bright future.

On behalf of the BoS- Microbiology,

Dr. Vasantba J. Jadeja Chairman, BoS- Microbiology Saurashtra University, Rajkot	**Dr. N. D. Pandhi** BoS – Microbiology Saurashtra University, Rajkot

Saurashtra University, Rajkot

MICROBIOLOGY PROGRAMME - B.Sc. (Honours) / B.Sc. (Honours with Research)

Curriculum Framework & Syllabus for A.Y. 2023-2024 & Onwards

GRADUATE ATTRIBUTES
Graduates should be able to demonstrate the acquisition of the following: ○ **Academic excellence**: Comprehensive knowledge and coherent understanding of Microbiology and other interdisciplinary areas of study ○ **Practical, professional, and procedural knowledge** required for carrying out professional or highly skilled work/tasks related to Microbiology, including knowledge required for undertaking self-employment initiatives and knowledge and mindset required for entrepreneurship, improved product development, or a new mode of organization ○ **Critical and Analytical reasoning/thinking and Effective communications**: Analysis and evaluation of information to form a judgment about a subject or idea and ability to communicate the same in a structured form. ○ **Research-related skills**: the ability to understand basic research ethics and skills in practicing/doing ethics in the field/ in personal research work, regardless of the funding authority or field of study. ○ **Leadership qualities and Teamwork abilities:** The graduates should be able to demonstrate the capability for mapping out the tasks of a team and setting direction and inspiring vision, and building a team that can help achieve the goals ○ **Global Citizenship**: Mutual understanding with others from diverse cultures, perspectives, and backgrounds by embracing and practicing constitutional, humanistic, ethical, and moral values in life, including universal human values of truth, righteous conduct, peace, love, nonviolence, and scientific temper. ○ **Life Long Learning**: Ready to imbibe new knowledge, values, and skills with an open mind and willing to adopt change for constructive development.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)		
This program will produce Graduates who will attain the following PEOs after a few years.		
PEO 1	**:**	**Core subject competency:** will acquire the competency to pursue higher education, develop a professional career, or be self-employed with the knowledge and skills of Microbiology and allied sciences.
PEO 2	**:**	**Application of knowledge**: will show the ability to apply the knowledge of Microbiology to independently design and execute minor research problems for societal and human welfare.
PEO 3	**:**	**Overall Preparedness: I** will have the ability to undertake any assignment as a leader or team member and will be able to contribute to academics, entrepreneurship, and research, with good communication skills.
PEO 4	**:**	**Professionalism:** will possess strong professional ethics to fulfill moral duties towards his profession, community, society, and the nation.
PEO 5	**:**	**Learning environment:** will show readiness for lifelong learning to meet personal, professional, social, and global demands through knowledge and skills.

PROGRAM OUTCOMES: (POs)		
After completion of the B.Sc. Microbiology program, the Student will be able to:		
PO 1	**:**	**Specific Disciplinary knowledge:** Demonstrate an understanding of fundamental principles, scope, and applications of Microbiology and can appreciate the beneficial and harmful role of microorganisms
PO 2	**:**	**Problem analysis:** Accurately identify and critically analyze problems in various domains of Biological sciences.
PO 3	**:**	**Designing viable solutions:** Search for and successfully arrive at viable conclusions/solutions about various aspects of life sciences using the right approach and appropriate tools and techniques
PO 4	**:**	**Scientific aptitude:** Ability to solve local, regional, national, or global problems scientifically using logical thinking and advanced techniques.
PO 5	**:**	**Modern tool usage:** Understand standard operating procedures and safety measures and acquire in-depth technical competence to handle the basic laboratory instruments and retrieve scientific information with modern data search tools.
PO 6	**:**	**Global citizen:** Demonstrate the ability to understand the needs of changing world from a Microbiology perspective and with an insight into his constructive role for the societal benefits honestly and consistently with a strong sense of ethics and values.
PO 7	**:**	**Environment and sustainability:** Can be an ambassador for Environmental protection and advocate for the need to advocate for sustainable development.
PO 8	**:**	**Ethics:** Commitment to professional and social ethics and work accordingly
PO 9	**:**	**Individual and team work:** Exhibit the potential to effectively accomplish tasks as a leader or a member of a team as well as independently in multidisciplinary settings.
PO 10	**:**	**Communication:** Possess practical Communicate skills in spoken and written forms for practical idea sharing with the scientific community, society, and colleagues.
PO 11	**:**	**Scientific Innovations and fund management:** Ability to design a research project and manage its execution to generate new scientific insights, innovations, and revenues with proper time and fund management.
PO 12	**:**	**Life-long learning:** Ready to undertake life-long learning to periodically update scientific knowledge and its application.

PROGRAM SPECIFIC OUTCOMES (PSOs) for B. Sc. Microbiology program

After completion of the program, the Graduate will:		
PSO1	**:**	Acquire sound knowledge about the fundamentals of Microbiology to develop a solid base to enable the understanding of emerging and advanced concepts in life sciences.
PSO2	**:**	Be equipped with knowledge, skill, and inspiration to pursue higher education and research in Microbiology and allied fields to answer urgent global problems.
PSO3	**:**	Use Microbiology principles and applications to find innovative solutions for environment, agriculture, and health-related issues at local and global levels.
PSO4	**:**	Acquire the skill and the required knowledge to be an entrepreneur/self-employed and serve the scientific community and society by generating problem solutions and employment.
PSO5	**:**	Become competent and eligible to appear in various competitive exams, placement in government and private sectors of academia, research, and industries, and become a successful Microbiologist serving the Nation.

B.Sc. Honours/ Honours with Research in Microbiology

(NCrF Level- 5.5 Third Year – B.Sc. in Microbiology)

Semester V

SN	Course Category As per GoG- NEP-SOP - July 2023& additional content 28/7/23	Course Title	Credit			Hrs./ Week		Evaluation - Weightage CCE: SEE = 50:50				
			T	P	Total	T	P	CCE Marks		SEE Marks		Total Marks
								T	P	T	P	
1	**Major (Core) 11** (Microbiology)	**Microbiology-11: Medical Microbiology (IKS Based) (4- Credit Course** including Theory & Practical components)	**3**	**1**	**4**	**3**	**2**	**25**	**25**	**50**	**-**	**100**
2	**Major (Core) 12** (Microbiology)	**Microbiology-12: Immunology (4- Credit Course** including Theory & Practical components)	**3**	**1**	**4**	**3**	**2**	**25**	**25**	**50**	**-**	**100**
3	**Major (Core) 13** (Microbiology)	**Microbiology-13: Industrial Microbiology – II (4- Credit Course** including Theory & Practical components)	**3**	**1**	**4**	**3**	**2**	**25**	**25**	**50**	**-**	**100**
4	**Minor -4** (Microbiology)	(As per GoG- NEP-SOP July 2023& additional content 28/7/23 – Clause 3.3.2) **Discipline Specific Minor – Microbial Quality Control in Food and Pharmaceutical Industries (4- Credit Course** including Theory & Practical components)	**2**	**2**	**4**	**2**	**4**	**-**	**50**	**50**	**-**	**100**
5	**Minor -5** (Microbiology)	(As per GoG- NEP-SOP July 2023& additional content 28/7/23 – Clause 3.3.2) **Discipline Specific Minor – Biosafety- (4- Credit Course** including Theory & Practical components)	**2**	**2**	**4**	**2**	**4**	**-**	**50**	**50**	**-**	**100**
6	**Skill Enhancement Course-5** (SEC-5)	(As per GoG- NEP-SOP July 2023& additional content 28/7/23 – Clause 3.3.5) **(2- Credit Course** including Theory & Practical components) **Skill based Course-5: AI Tools for Biologists**	**1**	**1**	**2**	**1**	**2**	**-**	**25**	**25**	**-**	**50**
Total Credits and Marks (Semester-V)			**14**	**08**	**22**	**14**	**16**	**75**	**200**	**275**	**-**	**550**

Evaluation Scheme: (As per GoG- NEP-SOP July 2023& additional content 28/7/23 – Chapter-7: Evaluation Reforms)

The evaluation process should be formulated to make a systematic evaluation of students' progress based on UGC guidelines. The evaluation must be designed with learner attributes in mind. These attributes have clear linkages to Programme Education Objectives and Outcomes. The evaluation consists of the following two components:

1. Continuous and Comprehensive Evaluation (CCE)- Formative
2. Semester End Evaluation (SEE)- Summative

CCE carries 50% of the total marks allotted to a subject and the other 50% being assigned to the SEE.

In each course, every credit carries 25 marks, of which 50% marks is assigned for CCE and rest 50% marks for SEE. The 50% marks assigned to the CCE is distributed between the continuous classroom evaluation and mid-term evaluation. The pattern may be as follow:

SN	Evaluation	*T-3 + P-1 = Total 4 credit subjects (Marks)	* T-1 + P-1 = Total 2 credit SEC# (Marks)	*T-2 + P-2 = Total 4 credit Minor# (Marks)
1	**CCE (50%)** Classroom/Lab & Mid-Term/Course End Evaluation	**T-25 + P- 25**	**P- 25**	**P- 50**
2	**SEE (50%)**	**50**	**T- 25**	**T- 50**
	Total	**100**	**50**	**100**

***T = Theory; P= Practical**

Continuous and Comprehensive Evaluation (CCE)

Subject–wise CCE will be undertaken by the concerned faculty member. The mode of evaluation will be decided by the faculty member concerned with the subject. Normally CCE consists of class participation, case analysis and presentation, assignment, tutorials, slip tests (announced/ surprised), quizzes, attendance etc. or any combination of these. The students are expected to submit their answer scripts/ reports of internal evaluation within the stipulated time. Failure to do so may result in the script not being valued. Another part of CCE consists of mid-term written evaluation, which is compulsory for all students. It can be done in a scheduled manner. The duration of the mid-term evaluation shall be one hour.

Semester End Evaluation (SEE)

The SEE carries 50% of the marks assigned to a course. SEE shall be of 2 ½ hours for 3/4 credit course and 2 hours in case of 1/2 credit courses. The controller of the examination will conduct these examinations. Paper setting and evaluation will be done by the external examiners to an extent of 50% of the evaluation process. This examination shall be conducted as per a schedule which shall be notified in advance.

The backlog exam will be conducted twice a year just after the result declared of the semester evaluation. Students shall have a second chance to clear their backlog and avoid the burden to carry forward the backlog with the next semester exam.

Appearance in all the evaluations is mandatory and no exemption can be granted except in the following case:

1. In case of inability to attend the exam due to reasons considered genuine by the controller of examination in consultation with the Director/Board.

2. In case of medical emergency, a certificate from the registered medical practitioner must be produced before the commencement of exams. The evaluation board will then take final decision on the recommendation for exemption.

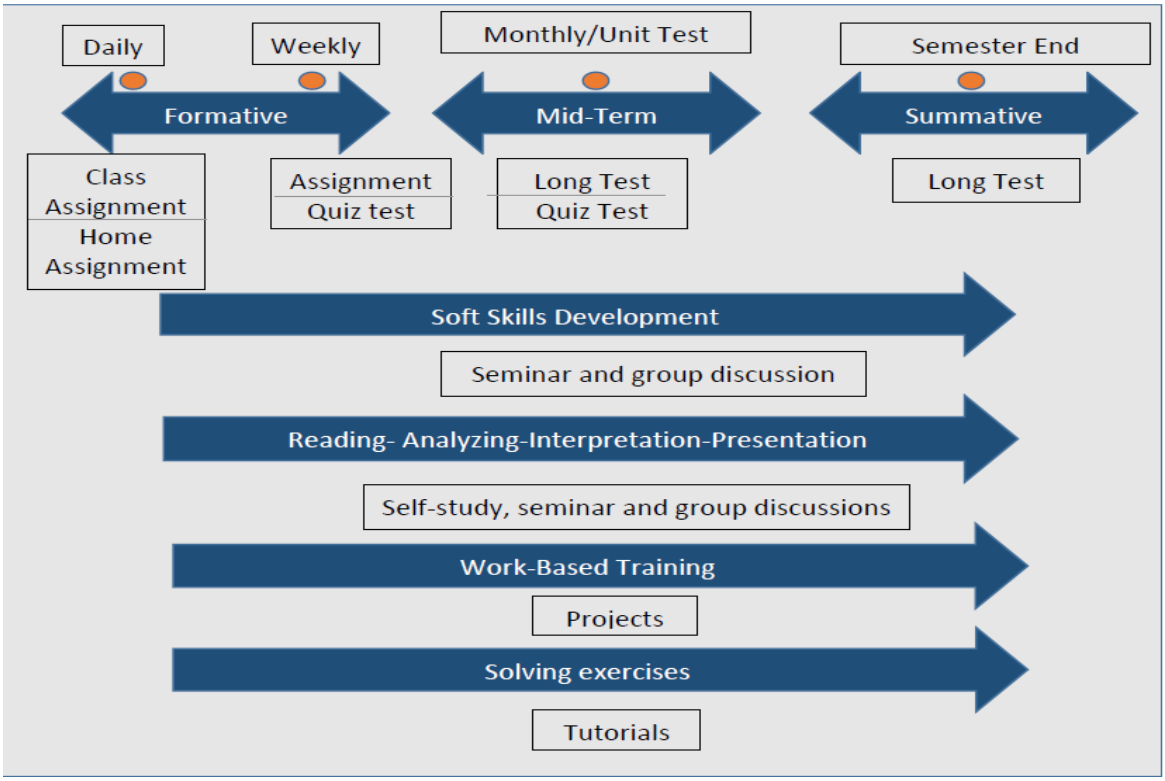
Eligibility Criteria to appear in SEE

To be able to appear for the SEE, a student must comply with the following conditions:

1. Should have at least 75% of attendance in all the courses put together.
2. Should have at least 70% of attendance in each course/subject.
3. Should not have any disciplinary proceedings pending against him/her.
4. Should have no pending due.

Continuum of Evaluation

Evaluation must be continuous which may include both formative and summative components in a timely manner for continuous feedback as follow:



Mode of Evaluation

A wide range of modes of evaluation for evaluating students is available for the teachers/ institutions to use. A suitable compendium of such a mode needs to be carefully chosen for a particular program

depending on its nature, objectives, and available resources. The mode of evaluation can be as below:

Written Mode	Oral Mode	Practical Mode	Integrated Mode
Semester Exam Class Test Open book exam/test Open note exam/test Self-test/Online test Essay/Article writing Quizzes/Objective test Class assignment Home assignment Reports writing Research/Dissertation Class Studies	Viva/Oral exam Group Discussion Role Play Authentic Problem Solving Quiz Interview	Lab work Computer simulation/virtual labs Craft work Co-curricular work	Paper presentation/Seminar Field Assignment Poster Presentation

Written Mode		
Evaluation Type	**Nature**	**Objective**
Semester Exam	Traditionally essay type, with objective / short answer questions to evaluate Lower Order Thinking (LOT) OBE skills	For depth and planned preparation
Class test	Traditionally essay type	Fixed date forces students to learn
Open book test	Allowed choice of reference book	Measures what students can do with resources, less stress on memory
Open note test	To get used to the system	Encourage good note taking
Self-test	For subjective and objective items	Mastery learning occurs with proper feedback
Article/essay writing	Individual long written assignment	Individual expression and creativity
Quizzes/Objective test	Short duration structured test	Excellent validity as greater syllabus coverage
Class assignment	With defined time	Student's performance to make decision
Home assignment	With undefined time	Reinforce learning and facilitate mastery of specific skills
Reports Writing	On activities performed or event observed	Develop a key transferable skill
Research/Dissertation	Detailed research-based report	To judge creativity and research skills
Case Studies	Analyse a given case (real or fictional)	To assess thinking, value, and attitude

Oral Mode		
Evaluation Type	**Nature**	**Objective**
Viva/Oral exam	Individually or in small group	Practical experience towards job interview situation
Group discussion	Small group of 2-5 members work on a joint task	Encourage teamwork
Role Play	Small group of 2-5 members work on a joint task	Develop personality
Authenticate problem solving	Small group of 2-5 members work on a joint task	Communication of ideas
Quiz	Small group of 2-5 members work on a joint task	Assess memory power
Interview	Individually	Judge the personal confidence level

Practical Mode		
Evaluation Type	**Nature**	**Objective**
Lab work	Component of working with one's hand	Keep the students on the task
Computer simulation/virtual labs	Component of working with one's hand	To understand the practical exposure
Craft work	Component of working with one's hand	Encourage application of concepts learnt
Co-curricular work	Component of working with one's hand	For immediate feedback

Integrated Mode		
Evaluation Type	**Nature**	**Objective**
Paper presentation/Seminar	Group or individual work	Learn from others presentation
Field Assignment	Field visit with report	Develop observation and recording skills
Poster presentation	Group or individual work	Develop research, creativity, and discussion skills
Paper presentation/Seminar	Group or individual work	Learn from others presentation

Models of Evaluation

Based on the types of evaluation, various models of evaluation implementation are suggested for theory, practical, self-study and work-based learning. The focus of these models is to encourage the students to improve on skills and performance.

Evaluation Norms & Question Paper Pattern for Theory & Practical Courses: Please refer General Guidelines for Implementation of **Four Year Under Graduate Programmes** for Saurashtra University (16 pages) published in August 2023.

Model for 4 Credit Course (Theory-3 + Practical-1)
CCE-50% (50 Marks) SEE-50% (50 Marks)

Exam Pattern		Marks
Continuous and Comprehensive Evaluation (CCE) – Theory + Practical		**50**
Components of CCE & Weightage – Theory – 25 marks		
1	Class Test / Open Book Test / Slip Test	**10**
2	Assignment (One)	**05**
3	Attendance	**05**
4	Quiz / Presentation / Field visit report / Active Learning- PBL/CSBL/Seminar/Flipped Class Room etc. OBE evaluation tools.	**05**
Components of CCE & Weightage – Practical – 25 marks		
1	Performance / Experiments	**15**
2	Viva voce and Certified journal / Lab quiz	**10**
Semester-End Evaluation (SEE) – THEORY		**50**

Model for Theory Courses- Theory-2+ Practical-2= 4 Credit Course	
CCE-50% (50 Marks) SEE-50% (50 Marks)	
Exam Pattern – SoP- OBE	**Marks**
Written : Lab batch wise Test Objective/MCQ	10
Journal writing / Assignment	05
Course End Practical Exam & Viva Voce by Internal & External Examiners (3 Hrs.)	30 + 5
Continuous and Comprehensive Evaluation	**P-50**
Semester-End Evaluation	**T-50**

Model for 2 Credit Skill Enhancement Course (Theory-1 + Practical -1)		
CCE-50% (25 Marks) SEE-50% (25 Marks) – Time: 1hr 30mins		
Exam Pattern		**Marks**
Continuous and Comprehensive Evaluation (CCE) – Practical – 25 Marks		
1	Performance / Experiments or Project based Assessment and Attendance	15
2	Viva voce / Lab quiz and certified journal	10
Semester-End Evaluation – 25 Marks		**25**

Saurashtra University, Rajkot

Question Paper Pattern for 4 Credit Course (Theory) FYUGP-B.Sc. Microbiology Sem – V

Time: 2 hrs. **Max. Marks: 50**

Ques.1 A. Descriptive	05
B. Descriptive	05
OR	
Ques.1 A. Objective:	(3x1 = 03)
a.	
b.	
c.	
B. Descriptive	07
Ques.2 A. Descriptive	05
B. Descriptive	05
OR	
Ques.2 A. Objective:	(3x1 = 03)
a.	
b.	
c.	
B. Descriptive	07
Ques.3 A. Descriptive	05
B. Descriptive	05
OR	
Ques.3 A. Objective:	(3x1 = 03)
a.	
b.	
c.	
B. Descriptive	07
Ques.4 A. Descriptive	05
B. Descriptive	05
OR	
Ques.4 A. Objective:	(3x1 = 03)
a.	
b.	
c.	
B. Descriptive	07
Ques.5 A. Descriptive	05
B. Descriptive	05
OR	
Ques.5 A. Objective:	(3x1 = 03)
a.	
b.	
c.	
B. Descriptive	07

Suggested Question Paper Format for 2 Credit Course (Theory)

Time: 1 Hour **Marks: 25**

Q. 1. Unit I	(A) 5 Objective, each of 1 mark	05
	(B) Descriptive	05
	OR	
	(A) 5 Objective, each of 1 mark	05
	(B) Descriptive	05
Q. 2. Unit II	(A) 5 Objective, each of 1 mark	05
	(B) Descriptive	05
	OR	
	(A) 5 Objective, each of 1 mark	05
	(B) Descriptive	05
Q. 3. Unit III	(A) Descriptive	05
	OR	
	(A) Descriptive	05

Semester End Exam Question Paper Pattern for SEC Theory: -

Time: 1 Hour **Marks: 25**

Q. 1	**10 Marks**
(A) **Objective:** Attempt any 06 Out of 10 MCQs, carrying 01 mark each (B) **Short Answer Question**: Attempt ant 02 Out of 04, carrying 02 mark each	06 Marks 04 Marks
Q. 2	**10 Marks**
(A) **Objective:** Attempt any 06 Out of 10 MCQs, carrying 01 mark each (B) **Short Answer Question**: Attempt ant 02 Out of 04, carrying 02 mark each	06 Marks 04 Marks
Q. 3	**05 Marks**
Descriptive: Attempt any 01 Out of 03, carrying 05 marks	05 Marks

B.Sc. Honours/ Honours with Research in Microbiology

(NCrF Level- 5.5 - Third Year – B.Sc. Microbiology)

Semester – V

Course Category	**Major-11**
Title of the Course	**Microbiology -11: Medical Microbiology (IKS Based)**
Course Credit	**03 – Theory + 1 – Practical = Total – 4**
Teaching Hours per Sem.	**45 – Theory + 30 – Practical**
Total Marks	**CCE- 50 + SEE- 50 = Total – 100**

1	Employability/Entrepreneurship/Skill Development પર કેન્દ્રિત થયેલ છે કે નહિ ?					Yes/~~No~~
2	Value added Courses Imparting Transferable and Life Skills ના ગુણો ધરાવે છે?					Yes/~~No~~
3	Major		Yes/~~No~~	Minor		~~Yes~~/No
	Skill Enhancement Courses		~~Yes~~/No	Ability Enhancement Courses		~~Yes~~/No
	Value Added Courses		~~Yes~~/No	Exit/ Vocational Courses		~~Yes~~/No
4	Holistic Education	Yes/~~No~~	Multidisciplinary	Yes/~~No~~	Interdisciplinary	Yes/~~No~~
5	દિવ્યાંગ માટે વિષય અંતર્ગત આનુસાંગિક જોગવાઈ કરાયેલ છે ?					Yes/~~No~~
6	New India Literacy Programme (NILP) મુજબ નો વિષય છે?					Yes/~~No~~
7	Swayam પ્લેટફોર્મપરના MOOC વિષય પર આધારિત આ વિષય છે ?					Yes/~~No~~
8	ઇન્ડીયન નોલેજ સીસ્ટમ (IKS) પર આધારિત વિષય છે ?					Yes/~~No~~

Course Outcomes:

By the end of the course, students will be able to:

1. Understand the basic principles of disease development, host defense mechanisms, and the dynamics of host-parasite interactions.
2. Identify major bacterial pathogens and explore traditional remedies used for their treatment.
3. Study key eukaryotic pathogens and compare their management through modern medicine and traditional health systems.
4. Examine viral infections and evaluate the role of Ayurvedic formulations in enhancing host immunity.
5. Examine viral infections and evaluate the role of Ayurvedic formulations in enhancing host immunity.

Course Content	Hours	Marks
Unit 1: Fundamentals of Disease and Host-Parasite Interaction	**9 hrs**	**10**
• Signs, symptoms, and disease stages; modern vs. Ayurvedic (Shatkriyakala) view. • Types and classification of infections; *Nija* vs. *Agantuka* Roga. • Bacteremia, septicemia, etc., with Ayurvedic concept of *Dhatudushti*. • Disease spread (endemic to pandemic); traditional prevention (*Dinacharya*, *Ritucharya*).		
Unit 2: Pathogenic Bacteria and Traditional Remedies	**9 hrs**	**10**
• Key features, lab diagnosis, and treatment of *Salmonella* and *Shigella*. • Identification and management of *Staphylococcus*, *Streptococcus*, and *Mycobacterium tuberculosis*. • Indigenous infection control: *Srotoshodhana* (cleansing), *Dhoopana* (fumigation), and traditional water purification. • Antibacterial role of *Neem (Azadirachta indica)*, *Turmeric (Curcuma longa)*, and *Tulsi (Ocimum sanctum)*: phytochemistry and Ayurvedic applications.		
Unit 3: Parasites, Fungi, and Helminths in Modern and Traditional Contexts	**9 hrs**	**10**
• Lab diagnosis and morphology of *Plasmodium*, *Entamoeba*, and *Treponema*. • *Candida* species: features and treatment. • Ayurvedic view of *Krimi Roga—Nija* vs. *Agantuka* origins. • Traditional use of *Vidanga*, *Palasha*, and *Ajamoda* as anthelmintics.		
Unit 4: Viral Diseases and Ayurvedic Immunomodulators	**9 hrs**	**10**
• Key viral infections: symptoms, diagnosis, and treatment (e.g., Hepatitis, Influenza, AIDS). • Ayurvedic view: *Agantuka Roga*, *Ojas*, *Vyadhikshamatva*, and *Nidan Parivarjan*. • Antiviral herbs: *Bhumyamalaki*, *Guduchi*, *Ashwagandha*, *Tulsi*, *Kalmegh*, *Neem*. • Post-viral care with *Rasayana* and *Panchakarma*.		
Unit 5: Diagnostic & Therapeutic Advances with IKS Perspective	**9 hrs**	**10**
• Sample collection, transport, and processing of pathogens; use of molecular and rapid methods for pathogen detection. • Chemotherapeutics: Mechanism of antimicrobial agents, resistance, and bioavailability issues. • Ayurvedic Formulations: Drug delivery through *Bhasma*, *Arka*, *Kwatha*, and *Sneha Kalpana*; enhancing bioavailability using traditional carriers like *Ghee* and *Honey*. • Translational Microbiology: Gene therapy basics, Ayurvedic pharmaceutics for personalized medicine, and integration of *Ayurgenomics*.		

Text Books

- Ananthanarayan & Paniker's Textbook of Microbiology, 8th Edition, Orient Longman (Modern microbiology foundation)
- Charaka Samhita and Sushruta Samhita (Selected sections relevant to infectious diseases and herbs)
- Foundations of Ayurveda by Vasant Lad or equivalent for contemporary interpretation

Reference Books

- Tortora, G.J., Funke, B.R., Case, C.L. – *Microbiology: An Introduction*, 10th Ed.
- Chakraborty, P. – *A Textbook of Microbiology*, 2nd Ed.
- Sharma, P. V.– *Dravyaguna Vijnana* (Vol 1 & 2), Chaukhambha Bharati
- Singh, R. H. – *Foundations of Ayurveda and Integrative Medicine*
- K. Ryan and C. G. Ray, Sherri 's Medical Microbiology: an Introduction to infectious diseases. (2004) McGraw hill Publication 4 th edition

Suggested reading / E-resources

- CDC Website: Stages of Infection
- IKS Division of MoE: https://iksindia.org
- National Medicinal Plants Board: https://www.nmpb.nic.in
- https://www.cdc.gov/dpdx/
- https://www.csir.res.in/tkdl

Suggested MOOCs

- https://www.swayam.gov.in
- https://www.nptel.ac.in
- https://www.futurelearn.com
- https://www.ayush.gov.in
- https://ugcmoocs.inflibnet.ac.in/index.php/courses/view_ug/248
- https://pll.harvard.edu/course/medical -microbiology?delta=0
- https://www.mooc-list.com/tags/microbiology

B.Sc. Honours/ Honours with Research in Microbiology

(NCrF Level- 5.5 - Third Year – B.Sc. in Microbiology)

Semester – V

Course Category	**Major Practical -11**
Title of the Course	**Microbiology -11P: Medical Microbiology**
Course Credit	**01**
Teaching Hours per Sem.	**30**
Total Marks	**CCE – 25**

1	Employability/Entrepreneurship/Skill Development પર કેન્દ્રિત થયેલ છે કે નહિ?					Yes/~~No~~
2	Value added Courses Imparting Transferable and Life Skills નાગુણોધરાવેછે?					Yes/~~No~~
3	Major		Yes/~~No~~	Minor		~~Yes~~/No
	Skill Enhancement Courses		Yes/~~No~~	Ability Enhancement Courses		Yes/~~No~~
	Value Added Courses		~~Yes~~/No	Exit/ Vocational Courses		~~Yes~~/No
4	Holistic Education	Yes/~~No~~	Multidisciplinary	~~Yes~~/No	Interdisciplinary	~~Yes~~/No
5	દિવ્યાંગમાટેવિષયઅંતર્ગતઆનુસાંગિકજોગવાઈકરાયેલછે ?					Yes/~~No~~
6	New India Literacy Programme (NILP) મુજબ નો વિષય છે?					Yes/~~No~~
7	Swayam પ્લેટફોર્મપરના MOOC વિષય પર આધારિત આ વિષય છે?					~~Yes~~/No
8	ઇન્ડીયન નોલેજ સીસ્ટમ (IKS) પર આધારિત વિષય છે ?					Yes/~~No~~

Course Outcomes

By the end of the course, students will be able to:

- Develop skills in analyzing clinical samples to detect signs of infection through physical, chemical, and microscopic evaluation.
- Acquire competence in isolating and identifying key clinical pathogens using selective media and standard identification tools like Bergey's Manual.
- Understand the colony morphology and biochemical characteristics of pathogens grown on specific media for accurate identification.
- Learn the method of preparing plant extracts and evaluating their antibacterial efficacy using the agar well diffusion technique.
- Assess the antimicrobial effectiveness of traditional herbal fumigation through pre- and post-exposure microbial counts.
- Understand the traditional Ayurvedic approach to enhancing turmeric bioavailability using natural carriers like ghee and honey.

Major 11 P MAJOR 11: Medical Microbiology (IKS BASED)
1. Physical, Chemical and Microscopic examination of any one Clinical sample – urine/stool/pus/ sputum 2. Isolation, identification of following pathogens from clinical Samples*: E. coli, Salmonella spp., Pseudomonas spp., Proteus spp., Shigella spp., Staphylococcus spp, Streptococcus spp*. (for identification use of keys as well as Bergey's Manual is recommended) 3. Study of growth characters of isolated pathogens on following media: Mannitol Salt Agar, Wilson Blair agar, Salmonella Shigella agar, Glucose azide medium, Cetrimide agar, TSI agar 4. Prepare aqueous/ethanolic Herbal extracts and test antibacterial activity using agar well diffusion. 5. Demonstration of Dhoopana (herbal fumigation) in a microbial environment (before and after fumigation plate exposure 6. Demonstration of Enhanced Solubility (Bioavailability) of turmeric powder using traditional ayurvedic carriers: Ghee and Honey

Reference book

1. Broude AI: Medical Microbiology and Infectious Diseases, WB Saunders Co.
2. Jawetz, Melnick &Adelberg's: Medical Microbiology, 26th Edition, Mc Graw Hill Companies, a LANGE medical book.
3. Chapel and Haeney: Essentials of Clinical Immunology, Blackwell Scientific Publications.
4. Forbes BA, Sahm DF and Weissfeld AS: Bailey & Scott's Diagnostic Microbiology, Mosby

E-resources:

- Bergey's Manual Online (Institutional Access Required): https://www.bergeys.org
- AYUSH Research Portal: https://www.ayushportal.nic.in
- NPTEL (National Programme on Technology Enhanced Learning): https://nptel.ac.in
- SWAYAM Portal: https://swayam.gov.in
- WHO Laboratory Training Resources: https://www.who.int/publications/

Suggested MOOCs:

- "Clinical Microbiology" – NPTEL/SWAYAM

- “Drug Discovery and Development” – Coursera
- “Medicinal Plants” – edX
- “Introduction to Ayurveda” – SWAYAM
- “Herbal Medicine” – Coursera
- “Infection Prevention and Control (IPC)” – WHO

B.Sc. Honours/ Honours with Research in Microbiology

(NCrF Level- 5.5 - Third Year – B.Sc. in Microbiology)

Semester – V

Course Category	**Major-12**
Title of the Course	**Microbiology -12: Immunology**
Course Credit	**03 – Theory + 1 – Practical = Total – 4**
Teaching Hours per Sem.	**45 – Theory + 30 – Practical**
Total Marks	**CCE- 50 + SEE- 50 = Total – 100**

1	Employability/Entrepreneurship/Skill Development પર કેન્દ્રિત થયેલ છે કે નહિ ?					Yes/~~No~~
2	Value added Courses Imparting Transferable and Life Skills ના ગુણો ધરાવે છે?					Yes/~~No~~
3	Major		Yes/~~No~~	Minor		~~Yes~~/No
	Skill Enhancement Courses		~~Yes~~/No	Ability Enhancement Courses		~~Yes~~/No
	Value Added Courses		~~Yes~~/No	Exit/ Vocational Courses		~~Yes~~/No
4	Holistic Education	Yes/~~No~~	Multidisciplinary	Yes/~~No~~	Interdisciplinary	Yes/~~No~~
5	દિવ્યાંગ માટે વિષય અંતર્ગત આનુસાંગિક જોગવાઈ કરાયેલ છે ?					Yes/~~No~~
6	New India Literacy Programme (NILP) મુજબનો વિષય છે?					Yes/~~No~~
7	Swayam પ્લેટફોર્મ પર ના MOOC વિષય પર આધારિત આ વિષય છે ?					Yes/~~No~~
8	ઇન્ડીયન નોલેજ સીસ્ટમ (IKS) પર આધારિત વિષય છે ?					Yes/~~No~~

Course Outcomes:

After successfully completing this course the student should be able to:

1. Demonstrate a comprehensive and practical understanding of basic immunological principles involved in protection mechanism.
2. Differentiate between different types of immunity & responses
3. Identify the role of different immune system cells.
4. Differentiate between humoral and cell mediated immunity.
5. Discuss Dysfunctional immunity and its consequences, Process of infection and vaccination.
6. Application of Principle of various immune reactions in research and diagnosis

Course Content
Unit 1: Immunity and Immunogen
• Types of immunity: Natural, Acquired, herd, Innate, specific • Structure & functions of Cells of immune system • Structure&functions of organs of immune system • Antigen: Immunogenicity versus antigenicity, Factors influencing Immunogenicity, Adjuvant, Epitopes and Haptens
Unit 2: Immune response and Antibody
• Immune responses, Structure&functions of MHC molecules • Antigen processing and presentation (Endogenous and Exogenous Antigens) • Antibody: Basic structure of Antibody, classes and their Biological activities • Clonal Selection Theory, Overview of Antibody Diversity & Monoclonal Antibody
Unit 3: Dysfunctional Immunity
• Immunodeficiency Diseases • Hypersensitivity • Autoimmune diseases • Overview of Transplantation immunity
Unit 4: Infection and Prophylaxis
• Introduction to the normal flora of healthy human host • Process of Infection: Host – microbes interaction, Penetration of epithelial cell layers, Events in infection following penetration • Microbial virulence factors • Vaccines: Conventional and Modern
Unit - 5: Haematology and Serology
• Discovery of human blood group system, Principle, significance and procedure of blood transfusion, Blood coagulation (Hemostasis) • Precipitation Reactions: (in fluid and gel) • Agglutination reactions: Haemagglutination, Bacterial Agglutination, Passive Agglutination and agglutination inhibition • Other reactions: Radioimmunoassay, ELISA, Western Blot, Immunoflourescence

Text Books:

- J.Kuby, R. A. Goldsby ,T.J.Kindt , B.A. Osborne (2013). Immunology 7thedition. W.H. Freeman and Company , New York (UNIT – 1,2.4,5)
- P.M. Lyolyard , A. Whelan, M.W. Fanger. (2011) Instant Notes in Immunology. 3rd edition. Garland Science Taylor and Francis Group, Newyork (UNIT-3)

Reference Books:

- C.A.Janeway, P.Travers, M. Walport, M.J. Shlomchick. (2005). Immunology – the immune system in health and Diseases. 6th edition. Garland Science Taylor and Francis Group, Newyork
- K.Murphy, P.Travers, M. Walport. (2008). Janeway's Immunology. 7th edition. Garland Science Taylor and Francis Group, Newyork
- I.Roitt.(2017). Roitt's Essential Immunology, 13th edition Blackwell Science
- J.M.Cruse, R.E.Lewis. (2009). Illustrated Dictionary of Immunology. 3rd edition. CRC Press Taylor and Francis Group, New York.
- A. K. Abbas, A. H.H.Lichtman, S.Pillai. (2017).Molecular and Cellular Immunity. 9th edition. Elsevier
- R. M. Atlas (2015). Principles of Microbiology. 2nd edition. Wm.C.Brown Publishers
- Prescott , Harley , Klein (2007). Microbiology 5th edition. McGraw-Hill Publishers

Suggested reading / E-resources

- https://www.coursera.org/specializations/immunology
- https://www.my-mooc.com/en/mooc/fundamentals-immunology-part-1-ricex-bioc372-1x-1/

Suggested MOOCs

- https://onlinecourses.swayam2.ac.in/cec20_bt05/preview
- https://www.pasteur.fr/en/education/programs-and-courses/e-learning-mooc/mooc-innate-immunity-institut-pasteur

B.Sc. Honours/ Honours with Research in Microbiology

(NCrF Level- 5.5 – Third Year – B.Sc. in Microbiology)

Semester – V

Course Category	**Major Practical -12**
Title of the Course	**Microbiology -12P: Immunology**
Course Credit	**01**
Teaching Hours per Sem.	**30**
Total Marks	**CCE – 25**

1	Employability/Entrepreneurship/Skill Development પર કેન્દ્રિત થયેલ છે કે નહિ?					Yes/~~No~~
2	Value added Courses Imparting Transferable and Life Skills નાગુણોધરાવેછે?					Yes/~~No~~
3	Major		Yes/~~No~~	Minor		~~Yes~~/No
	Skill Enhancement Courses		Yes/~~No~~	Ability Enhancement Courses		Yes/~~No~~
	Value Added Courses		~~Yes~~/No	Exit/ Vocational Courses		~~Yes~~/No
4	Holistic Education	Yes/~~No~~	Multidisciplinary	~~Yes~~/No	Interdisciplinary	~~Yes~~/No
5	દિવ્યાંગમાટેવિષયઅંતર્ગતઆનુસાંગિકજોગવાઈકરાયેલછે ?					Yes/~~No~~
6	New India Literacy Programme (NILP) મુજબ નો વિષય છે?					Yes/~~No~~
7	Swayam પ્લેટફોર્મપરના MOOC વિષય પર આધારિત આ વિષય છે?					~~Yes~~/No
8	ઇન્ડીયન નોલેજ સીસ્ટમ (IKS) પર આધારિત વિષય છે ?					Yes/~~No~~

Course Outcomes:

On completion of the course, the student shall be able to:

1. Technical skill for enumeration of blood cells and components
2. Ability to perform various serological tests and interpret its results
3. Expertise in handling sensitive in-vitro immunological tests in clinical laboratory.
4. Efficient and effective handling of clinical samples and to perform diagnostic tests of clinical importance.

Major 12 P MAJOR 12: Immunology Practical
1. Total count of RBC
2. Total count of WBC
3. Differential count of WBC
4. Total count of Platelets
5. Isolation of normal flora of Skin&Mouth
6. Study of Agglutination: Blood grouping, Widal test
7. Study of Precipitation: RPR test, Ouchterlony double diffusion method
8. Bleeding time by filter paper method and clotting time by capillary method
9. Blood sugar estimation by GOD-POD method
10. Haemoglobin estimation by Sahli's method.
11. ELISA test.

Reference Books:

1. Broude AI: Medical Microbiology and Infectious Diseases, WB Saunders Co.
2. Jawetz, Melnick &Adelberg's: Medical Microbiology, 26th Edition, Mc Graw Hill Companies, a LANGE medical book.
3. Chapel and Haeney: Essentials of Clinical Immunology, Blackwell Scientific Publications.
4. Forbes BA, Sahm DF and Weissfeld AS: Bailey & Scott's Diagnostic Microbiology, Mosby
5. T.A.Brown, Genome-2, 2nd edition
6. Verma and Agrawal, Cell biology, Genetics, Molecular biology
7. Karp, cell and Molecular biology

Suggested reading / E-resources

- https://www.biointeractive.org/classroom-resources/immunology-virtual-lab
- https://journals.physiology.org/doi/full/10.1152/advan.00116.2018

Suggested MOOCs

https://onlinecourses.swayam2.ac.in/cec20_bt05/preview

B.Sc. Honours/ Honours with Research in Microbiology

(NCrF Level- 5.5 - Third Year – B.Sc. in Microbiology)

Semester – V

Course Category	**Major-13**
Title of the Course	**Microbiology -13: Industrial Microbiology - II**
Course Credit	**03 – Theory + 1 – Practical = Total – 4**
Teaching Hours per Sem.	**45 – Theory + 30 – Practical**
Total Marks	**CCE- 50 + SEE- 50 = Total – 100**

1	Employability/Entrepreneurship/Skill Development પર કેન્દ્રિત થયેલ છે કે નહિ ?					Yes/~~No~~
2	Value added Courses Imparting Transferable and Life Skills ના ગુણો ધરાવે છે?					Yes/~~No~~
3	Major		Yes/~~No~~	Minor		~~Yes~~/No
	Skill Enhancement Courses		~~Yes~~/No	Ability Enhancement Courses		~~Yes~~/No
	Value Added Courses		~~Yes~~/No	Exit/ Vocational Courses		~~Yes~~/No
4	Holistic Education	Yes/~~No~~	Multidisciplinary	Yes/~~No~~	Interdisciplinary	Yes/~~No~~
5	દિવ્યાંગ માટે વિષય અંતર્ગત આનુસાંગિક જોગવાઈ કરાયેલ છે ?					Yes/~~No~~
6	New India Literacy Programme (NILP) મુજબ નો વિષય છે?					Yes/~~No~~
7	Swayam પ્લેટફોર્મ પર ના MOOC વિષય પર આધારિત આ વિષય છે ?					Yes/~~No~~
8	ઇન્ડીયન નોલેજ સીસ્ટમ (IKS) પર આધારિત વિષય છે ?					Yes/~~No~~

Course outcomes

By the end of this course, students will be able to:

- Discuss selective fermentation processes for production of solvents, enzymes, vitamins, antibiotics, and organic acids.
- Introduce immobilization techniques of whole cells and enzymes and their industrial applications.
- Explain the basic concepts and economic importance of downstream processing in fermentation industries.
- Describe various methods for extraction and cell separation techniques.
- Identify suitable product recovery processes
- Understand different purification and finishing

Course Content	Hours	Marks
Unit 1: Selective Fermentation Processes and Product Biosynthesis • Production of organic solvents: Ethyl alcohol • Production of enzymes and Vitamins: Amylases and Riboflavin • Production of antibiotics: Penicillin and organic acids: Citric acid • Introduction to methods to immobilize whole cell and/ or enzymes; Applications	**9**	**10**
Unit 2: Fundamental, economic aspects and technical methods of downstream process • General principles and importance of downstream processing • Economic aspects of Fermentation Industry • Centrifugation and its application in product recovery • Filtration and its application in product recovery	**9**	**10**
Unit 3: Cell Separation and Extraction Techniques • Overview of method extraction • Methods of Cell separation: Broth conditioning, Precipitation, Sedimentation • Mechanical cell disruption technique • Non mechanical cell disruption method	**9**	**10**
Unit 4: Product recovery methods • Criteria for the choice of recovery process • Product Recovery by Liquid-Liquid extraction and Solvent recovery • Two Phase aqueous extraction • Super critical fluid extraction	**9**	**10**
Unit 5: Product purification and finishing • Overview of Dialysis, precipitation • Overview of Chromatographic techniques • Physical, Chemical and Biological assay of fermentation products • Overview of finishing products: Drying and crystallization	**9**	**10**

Text books:

1. Stanbury, P.F., Whittaker, A. (1984). Principles of Fermentation Technology, 2nd Edition. Pergamon Press.
2. Patel, A.H. (2011). Industrial Microbiology, 2nd Edition: Laxmi publication.

Reference Books:

1. Casida, L.E. (1968). Industrial Microbiology. New Delhi: New Age International Pub. (P) Ltd.
2. Joshi, V.K., Pandey, A. (1999). Biotechnology: Food Fermentation Microbiology,
3. Biochemistry and Technology. Volume 2. Emakulam: Educational Publishers & Distributors.

4. Prescott, S.C., Dunn, C.G., Reed, G. (1982). Prescott & Dunn's Industrial Microbiology. Westport: AVI Publication.
5. Crueger, W., Crueger, A. (1990). A text book of Industrial Microbiology, 2nd edition: Sunderland, Mass.: Sinauer Associates

Suggested reading / E-resources

- https://www.youtube.com/watch?v=V0BzQQCCwgo
- https://www.youtube.com/watch?v=pQnfildQNwI

Suggested MOOCs

- https://online-learning.tudelft.nl/courses/industrial-biotechnology/
- https://onlinecourses.nptel.ac.in/noc19_bt20/preview

B.Sc. Honours/ Honours with Research in Microbiology

(NCrF Level- 5.5 - Third Year – B.Sc. in Microbiology)

Semester – V

Course Category	**Major Practical -13**
Title of the Course	**Microbiology -13P: Industrial Microbiology – II**
Course Credit	**01**
Teaching Hours per Sem.	**30**
Total Marks	**CCE – 25**

1	Employability/Entrepreneurship/Skill Development પર કેન્દ્રિત થયેલ છે કે નહિ?					Yes/~~No~~
2	Value added Courses Imparting Transferable and Life Skills નાગુણોધરાવેછે?					Yes/~~No~~
3	Major		Yes/~~No~~	Minor		~~Yes~~/No
	Skill Enhancement Courses		Yes/~~No~~	Ability Enhancement Courses		Yes/~~No~~
	Value Added Courses		~~Yes~~/No	Exit/ Vocational Courses		~~Yes~~/No
4	Holistic Education	Yes/~~No~~	Multidisciplinary	~~Yes~~/No	Interdisciplinary	~~Yes~~/No
5	દિવ્યાંગમાટેવિષયઅંતર્ગતઆનુસાંગિકજોગવાઈકરાયેલછે ?					Yes/~~No~~
6	New India Literacy Programme (NILP) મુજબ નો વિષય છે?					Yes/~~No~~
7	Swayam પ્લેટફોર્મપરના MOOC વિષય પર આધારિત આ વિષય છે?					~~Yes~~/No
8	ઇન્ડીયન નોલેજ સીસ્ટમ (IKS) પર આધારિત વિષય છે ?					Yes/~~No~~

Course Outcomes:

On completion of the course, the student shall be able to:

1. Develop Technical skill for operation of various typical fermentation processes
2. Understand the principle and mechanism of some important product separation, and purification techniques

Major Practical:

Microbiology -13P: Industrial Microbiology – Practical

1. Isolation and cultivation of microbes producing ethyl alcohol/antibiotic/amylase
2. Centrifugation of fermentation broth and evaluation of biomass separation efficiency.
3. Filtration of fermentation broth and assessment of fungal biomass/purity removal.
4. Demonstration of partial Protein Purification: Dialysis and Ammonium Sulfate Precipitation of Amylase from Bacillus sp.
5. Study of non-mechanical cell disruption techniques using Chemical lysis (Detergent) or enzymatic digestion (Lysozyme)
6. To Demonstrate mechanical bacterial cell disruption using homogenizer/sonicator/bead mill

(any one)

7. Extraction of antibiotics from Bacillus sp. using liquid-liquid extraction.
8. Antimicrobial assay of fermentation products using an agar well diffusion/disc diffusion.
9. Analysis of fermentation product using Thin Layer Chromatography (TLC).
10. Industrial visit

Reference Books:

1. Jayaraman, J. (2011). Laboratory Manual in Biochemistry: New Age International Private Limited. India
2. Sawhney S.K., Singh, R. (2005). Introductory Practical Biochemistry: Alpha Science International.
3. Cuppuccino, J.G., Sherman, N. (2004). International student edition: Microbiology- A laboratory Manual 4th edition: Benjamin Cummings publications.
4. Baker, F.J., Breach, M.R. (1967). Handbook of Bacteriological Technique: Butterworth & Co Publishers Ltd.

Suggested reading / E-resources

- https://www.youtube.com/watch?v=V0BzQQCCwgo
- https://www.youtube.com/watch?v=pQnfildQNwI

Suggested MOOCs

- https://online-learning.tudelft.nl/courses/industrial-biotechnology/
- https://onlinecourses.nptel.ac.in/noc19_bt20/preview

B.Sc. Honours/ Honours with Research in Microbiology

(NCrF Level- 5.5 Third Year – B.Sc. in Microbiology)

Semester V

Course Category	**Skill Enhancement Course (SEC) – 5**
Title of the Course	**AI tools for Biologists**
Course Credit	**02 (1T + 1P)**
Teaching Hours per Sem.	**15 hrs. Theory + 30 hrs. Practical**
Total Marks	**CCE-25 marks + Theory SEE-25 marks**

1	Employability/Entrepreneurship/Skill Development પરકેન્દ્રિતથયેલછેકેનહિ ?					Yes/~~No~~
2	Value added Courses Imparting Transferable and Life Skillsનાગુણોધરાવેછે?					Yes/~~No~~
3	Major		~~Yes~~/No	Minor		~~Yes~~/No
	Skill Enhancement Courses		Yes/~~No~~	Ability Enhancement Courses		Yes/~~No~~
	Value Added Courses		~~Yes~~/No	Exit/ Vocational Courses		~~Yes~~/No
4	Holistic Education	Yes/~~No~~	Multidisciplinary	Yes/~~No~~	Interdisciplinary	Yes/~~No~~
5	દિવ્યાંગમાટેવિષયઅંતર્ગતઆનુસાંગિકજોગવાઈકરાયેલછે ?					Yes/~~No~~
6	New India Literacy Programme (NILP) મુજબનોવિષયછે ?					Yes/~~No~~
7	Swayam પ્લેટફોર્મપરના MOOC વિષયપરઆધારિતઆવિષયછે ?					~~Yes~~/No
8	ઇન્ડીયનનોલેજસીસ્ટમ (IKS) પરઆધારિતવિષયછે ?					Yes/~~No~~

Course Outcomes:

At the end of the course, the student shall be able to:

1. Understand the Core Concepts of AI in Life Sciences
2. Identify and Discuss Ethical Implications of AI Use in Biology
3. Effectively Communicate with AI Tools Using Prompt Engineering
4. Utilize AI based Learning and Presentation Tools for Scientific Communication
5. Integrate AI Tools to Support Research and Study in the Life Sciences.

Course Content	Hours
Unit 1: Fundamentals of AI for Life Sciences • What is Artificial Intelligence (AI)? Understanding AI, Machine Learning (ML), and Deep Learning (DL) with simple examples. • Historical development and current trends in AI. • Real-life applications of AI in Biology: Disease detection, protein structure prediction, bioinformatics, etc. • Introduction to ethical concerns: Data privacy, algorithm bias, and misuse. • Basics of "Prompt Engineering" – how to communicate with AI tools.	**5**
Unit 2: Hands-on with AI Chat Tools • Introduction to ChatGPT. • Introduction to Gemini. • Introduction to Claude. • Prompt writing practice with examples: Literature summaries, quiz generation, hypothesis suggestions.	**5**
Unit 3: AI Tools for Learning and Presentation • Kahoot & Quizlet: Making interactive quizzes and flashcards for biological terms. • Gamma.ai: Creating smart, AI-assisted presentations. • Quillbot & Grammarly: Editing and rewriting scientific writing. • Canva: Designing biology posters or infographics. • Litmaps: Using AI to visualize and manage literature reviews.	**5**

Practical **30 Hours**

1. Prompt Practice – Create biology-specific prompts and run them on ChatGPT.
2. Prompt Practice – Create biology-specific prompts and run them on Gemini.
3. Quizzing with AI – Build a biology quiz using Kahoot or Quizlet.
4. Presentation Creation – Make an AI-assisted presentation using Gamma.ai.
5. Research Mapping – Search for a topic in Litmaps and map the literature.

Text Books:

1. Chowdhary, K. (2020). Fundamentals of artificial intelligence. In Springer eBooks. https://doi.org/10.1007/978-81-322-3972-7

2. Marvels of artificial and computational intelligence in life sciences. (2023). In BENTHAM SCIENCE PUBLISHERS eBooks. https://doi.org/10.2174/9789815136807123010 1

Reference Books:

1. Choudhary, A., Fox, G., & Hey, T. (2022). Artificial Intelligence for science. In WORLD SCIENTIFIC eBooks. https://doi.org/10.1142/13123
2. Ramsundar, B., Eastman, P., Walters, P., & Pande, V. (2019). *Deep Learning for the Life Sciences: Applying Deep Learning to Genomics, Microscopy, Drug Discovery, and More* (1st ed.). Shroff Publishers & Distributors Pvt. Ltd.

Suggested reading / E-resources

- https://www.ncbi.nlm.nih.gov/books/NBK614606/
- https://chatgpt.com/
- https://gemini.google.com/
- https://claude.ai
- https://kahoot.com/
- https://quizlet.com/
- https://gamma.app/
- https://quillbot.com/
- https://app.grammarly.com/
- https://www.litmaps.com/
- https://www.canva.com/en_in/

B.Sc. Honours/ Honours with Research in Chemistry

(NCrF Level- 5.5 Third Year – B.Sc. in Microbiology)

Semester V

Course Category	**Minor-4**
Title of the Course	**Microbial Quality Control in Food and Pharmaceutical Industries**
Course Credit	**02 Theory + 02 Practical = Total 4 credit**
Teaching Hours per Sem.	**30 (T) + 60 (P)**
Total Marks	**CCE- 50 + SEE- 50 = 100 Marks**

1	Employability/Entrepreneurship/Skill Development પર કેન્દ્રિત થયેલ છે કે નહિ ?					Yes/~~No~~
2	Value added Courses Imparting Transferable and Life Skills ના ગુણો ધરાવે છે?					Yes/~~No~~
3	Major		~~Yes~~/No	Minor		Yes/~~No~~
	Skill Enhancement Courses		~~Yes~~/No	Ability Enhancement Courses		~~Yes~~/No
	Value Added Courses		~~Yes~~/No	Exit/ Vocational Courses		~~Yes~~/No
4	Holistic Education	Yes/~~No~~	Multidisciplinary	Yes/~~No~~	Interdisciplinary	Yes/~~No~~
5	દિવ્યાંગ માટે વિષય અંતર્ગત આનુસાંગિક જોગવાઈ કરાયેલ છે ?					Yes/~~No~~
6	New India Literacy Programme (NILP) મુજબ નો વિષય છે?					Yes/~~No~~
7	Swayam પ્લેટફોર્મ પર ના MOOC વિષય પર આધારિત આ વિષય છે ?					Yes/~~No~~
8	ઇન્ડીયન નોલેજ સીસ્ટમ (IKS) પર આધારિત વિષય છે ?					Yes/~~No~~

Course Outcomes:

At the end of the course, the student shall be able to:

1. Explain the basic concepts of quality management systems and the roles of national and international regulatory agencies.
2. Apply the principles of Total Quality Management (TQM), self-inspections, and Hazard Analysis and Critical Control Points (HACCP) to identify and mitigate risks in food and pharmaceutical industries.
3. Demonstrate an understanding of Quality Assurance (QA) and Quality Control (QC) frameworks in both food and pharmaceutical sectors, including their importance in maintaining product quality and regulatory compliance.
4. Evaluate food products using microbiological testing methods such as microscopic counts, plate counts, and the detection of specific pathogens.
5. Perform and interpret pharmaceutical quality control tests including antimicrobial effectiveness, microbial examination of sterile and non-sterile products, and bacterial endotoxin testing in accordance with regulatory standards.

Course Content	Hours	Marks
Unit 1: Basic concept of Quality and Regulatory agencies. ● Basic concept of Total quality management. ● Self inspections & assessments and Introduction to Hazard analysis of critical control point (HACCP). ● Brief introduction of USFDA and ISO 9001 & 22000 ● Brief introduction of Food Standard & Safety Authority of India and Central Drugs Standard Control Organization.	**10**	**17**
Unit 2: Quality Control in Food Industries. ● Introduction of Quality Assurance(QA) & Quality Control in Food Industries. ● FSSAI Regulations for Food Labelling & Packaging. ● Microbiological testing methods in the food industry: Microscopic Counts & Plate Counts. ● Microbiological testing methods in the food industry: Detection of Coliforms, *Listeria monocytogenes*, vibrios, *Staphylococcus aureus* & *Pseudomonas aeruginosa*.	**10**	**17**
Unit 3: Quality Control in Pharmaceutical Industries. ● Introduction of Quality Assurance(QA) & Quality Control in Pharmaceutical Industries. ● Antimicrobial Effectiveness testing. ● Microbial examination of non sterile products & Sterile products. ● Bacterial Endotoxin testing.	**10**	**16**

Text Books:

1. Harrigan WF (1998) Laboratory Methods in Food Microbiology, 3rd ed. Academic Press
2. Garg N, Garg KL and Mukerji KG (2010) Laboratory Manual of Food Microbiology I K International Publishing House Pvt. Ltd.
3. Baird RM, Hodges NA and Denyer SP (2005) Handbook of Microbiological Quality control in Pharmaceutical and Medical Devices, Taylor and Francis Inc.
4. Quality Assurance in Microbiology by Rajesh Bhatia, Rattan Lal Ihhpunjani. CBS publishers & distributors, New Delhi.
5. Good manufacturing practices for Pharmaceuticals By Sydney H. Willing, Murray M. Tuckerman, Willam S. Hitchings IV. Second edition Mercel Dekker NC New York.
6. Kar, A. (2007). *Pharmaceutical microbiology*. New Age International Publishers.

Reference Book

1. Vyas S. P., Dixit V. (2007) Pharmaceutical Biotechnology, CBS Publishers & Distributors
2. Stephen P. D., Norman A. H., Sean P. G., Brendan F. G. (2011) Hugo & Russell Pharmaceutical Microbiology 8th Ed. Wiley-Blackwell Publishing house
3. John S. Wolfson and David C. Hooper, (1989) Quinolone antimicrobial agents. American Society for Microbiology, Washington.
4. Cooper M. S. (1972) Quality control in the Pharmaceutical Industry Vol.2 Academic Press Inc.
5. Sidney H.W. Murray M. Tuckerman, W., S. Hitchings IV. Mercel D.,(2007) Good Manufacturing Practices for Pharmaceuticals, Second Edition, NC New York

Suggested reading / E-resources

1. https://www.fda.gov/
2. https://www.iso.org/iso-22000-food-safety-management.html
3. https://www.iso.org/standard/62085.html
4. https://www.fda.gov/media/88801/download
5. https://fssai.gov.in/
6. https://cdsco.gov.in/opencms/opencms/en/Home/
7. https://fssai.gov.in/upload/uploadfiles/files/Manual%20on%20Microbiological%20Examination%20of%20Food%20and%20Water_compressed.pdf

Suggested MOOCs
https://onlinecourses.swayam2.ac.in/cec25_ge05/preview

B.Sc. Honours/ Honours with Research in Chemistry

(NCrF Level- 5.5 third Year – B.Sc. in Microbiology)

Semester V

Course Category	**Minor Practical -4**
Title of the Course	**Minor -4P: Microbial Quality Control in Food and Pharmaceutical Industries**
Course Credit	**02**
Teaching Hours per Sem.	**60**
Total Marks	**CCE- 50 marks**

1	Employability/Entrepreneurship/Skill Development પર કેન્દ્રિત થયેલ છે કે નહિ?					Yes/~~No~~
2	Value added Courses Imparting Transferable and Life Skills નાગુણોધરાવેછે?					Yes/~~No~~
3	Major		Yes/~~No~~	Minor		~~Yes~~/No
	Skill Enhancement Courses		Yes/~~No~~	Ability Enhancement Courses		Yes/~~No~~
	Value Added Courses		~~Yes~~/No	Exit/ Vocational Courses		~~Yes~~/No
4	Holistic Education	Yes/~~No~~	Multidisciplinary	~~Yes~~/No	Interdisciplinary	~~Yes~~/No
5	દિવ્યાંગમાટેવિષયઅંતર્ગતઆનુસાંગિકજોગવાઈકરાયેલછે ?					Yes/~~No~~
6	New India Literacy Programme (NILP) મુજબ નો વિષય છે?					Yes/~~No~~
7	Swayam પ્લેટફોર્મપરના MOOC વિષય પર આધારિત આ વિષય છે?					~~Yes~~/No
8	ઇન્ડીયન નોલેજ સીસ્ટમ (IKS) પર આધારિત વિષય છે ?					Yes/~~No~~

Course Outcomes:

At the end of the course, the student shall be able to:

1. Demonstrate proficiency in analyzing food and pharmaceutical products for compliance with regulatory standards and microbiological quality.
2. Apply microbiological techniques for the detection of pathogens and evaluation of antimicrobial effectiveness in food and Pharmaceutical products.

Minor Practical- 4:

Minor -4P: Microbial Quality control in Food and Pharmaceutical – Practical

1. Analysis of labels of food products and discuss it as regulation of FSSAI.

2. Microscopic examination of food products.
3. Aerobic plate counts of the given food products.
4. Testing for pathogens in food products.(name of the pathogen/s)
5. Antimicrobial effectiveness testing.
6. Sterility testing of pharmaceutical Product.

Reference Books

1. Bacteriological Analytical Manual, 8th Edition, Revision A, 1998. https://www.fda.gov/food/laboratory-methods-food/bacteriological-analytical-manual-bam
2. *Manual of Methods of Analysis of Microbiological Examination of Food and water*. (2024). Food Safety and Standards Authority of India. https://fssai.gov.in/upload/uploadfiles/files/Manual%20on%20Microbiological%20Examination%20of%20Food%20and%20Water_compressed.pdf

Suggested reading / E-resources

- https://fssai.gov.in/upload/uploadfiles/files/Manual%20on%20Microbiological%20Examination%20of%20Food%20and%20Water_compressed.pdf
- https://www.fda.gov/food/laboratory-methods-food/bam-chapter-3-aerobic-plate-count
- https://www.youtube.com/watch?v=v2ZiqFLuAg4

B.Sc. Honours/ Honours with Research in Chemistry

(NCrF Level- 5.5 Third Year – B.Sc. in Microbiology)

Semester V

Course Category	**Minor- 5**
Title of the Course	**Biosafety**
Course Credit	**04 (2T + 2P)**
Teaching Hours per Sem.	**30 hrs. Theory + 60 hrs. Practical**
Total Marks	**CCE-50 + SEE-50 = 100 Marks**

1	Employability/Entrepreneurship/Skill Development પર કેન્દ્રિત થયેલ છે કે નહીં?					Yes/~~No~~
2	Value added Courses Imparting Transferable and Life Skills ના ગુણો ધરાવે છે?					Yes/~~No~~
3	Major		~~Yes~~/No	Minor		Yes/~~No~~
	Skill Enhancement Courses		~~Yes~~/No	Ability Enhancement Courses		~~Yes~~/No
	Value Added Courses		~~Yes~~/No	Exit/ Vocational Courses		~~Yes~~/No
4	Holistic Education	Yes/~~No~~	Multidisciplinary	Yes/~~No~~	Interdisciplinary	Yes/~~No~~
5	દિવ્યાંગ માટે વિષય અંતર્ગત આનુસંગિક જોગિાઈ કરાયેલ છે?					Yes/~~No~~
6	New India Literacy Programme (NILP) મુજબનો વિષય છે?					Yes/~~No~~
7	Swayam પ્લેટફોમ પરના MOOC વિષય પર આધારિત આ વિષય છે?					Yes/~~No~~
8	ઇન્ડીયનનોલેજસીસ્ટમ (IKS) પર આધારિત વિષયછે ?					Yes/~~No~~

Course Outcomes

By the end of the course, students will be able to:

1. Define and explain the fundamental principles of biosafety and biosecurity.
2. Classify biological agents based on risk levels and apply appropriate biosafety levels in lab settings.
3. Identify containment strategies and demonstrate safe laboratory practices using PPE and equipment.
4. Evaluate biosafety issues in specialized settings including medical labs, GMOs, and environmental studies.

Course Content	Hours	Marks
Unit 1: Introduction to Biosafety • Definition, scope, and historical background of biosafety • Importance of biosafety in laboratories, industry, and research • Classification of biological agents by risk group (RG1–RG4) • Principles of biosafety and biosecurity	**10**	**10**
Unit 2: Biosafety Levels and Containment • Biosafety levels (BSL-1 to BSL-4): Features and practices • Primary and secondary containment strategies • Laboratory design and equipment (e.g., biosafety cabinets, autoclaves) • Personal Protective Equipment (PPE) and waste management	**10**	**10**
Unit 3: Biosafety in Specialized Contexts • Biosafety in medical and clinical settings • Biosafety in agriculture (GM crops) • Biosafety in environment (field trials) • Dual-use research and bioethics	**10**	**10**

Reference Books:

1. Biosafety in Microbiological and Biomedical Laboratories (BMBL) – U.S. Department of Health and Human Services, CDC & NIH
2. Biosafety and Bioethics – M. K. Sateesh
3. Laboratory Biosafety Manual (3rd Edition) – World Health Organization (WHO)
4. Biotechnology: Biosafety and Bioethics – R. C. Dubey
5. Guidelines for Safety in Biotechnology – Department of Biotechnology (DBT), India
6. Biosafety Regulations of India – Ministry of Environment, Forest and Climate Change (MoEF & CC)

Pedagogic tools:

- Chalk and Board
- PPT and Videos.
- Assignment

- Class Activity: Think-Pair-Share / Class Test

E-resources:

1. **WHO: Laboratory Biosafety Guidance**
   https://openwho.org
2. **FAO eLearning: Biosafety Resource Centre**
   http://www.fao.org

Suggested MOOCs

1. **Coursera – Introduction to Bioethics**
   Offered by Georgetown University
   https://www.coursera.org/learn/bioethics
2. **Swayam – Bioethics and Biosafety**
   Government of India platform
   https://swayam.gov.in
3. **edX – The Science and Practice of Biotechnology**
   Includes sections on biosafety and ethics
   https://www.edx.org

B.Sc. Honours/ Honours with Research in Chemistry

(NCrF Level- 5.5 third Year – B.Sc. in Microbiology)

Semester V

Course Category	**Minor Practical -5**
Title of the Course	**Minor -5P: Overview of IPR**
Course Credit	**02**
Teaching Hours per Sem.	**60**
Total Marks	**CCE- 50 marks**

1	Employability/Entrepreneurship/Skill Development પર કેન્દ્રિત થયેલ છે કે નહીં?					Yes/~~No~~
2	Value added Courses Imparting Transferable and Life Skills ના ગુણો ધરાવે છે?					Yes/~~No~~
3	Major		~~Yes~~/No	Minor		Yes/~~No~~
	Skill Enhancement Courses		~~Yes~~/No	Ability Enhancement Courses		~~Yes~~/No
	Value Added Courses		~~Yes~~/No	Exit/ Vocational Courses		~~Yes~~/No
4	Holistic Education	Yes/~~No~~	Multidisciplinary	Yes/~~No~~	Interdisciplinary	Yes/~~No~~
5	દિવ્યાંગ માટે વિષય અંતર્ગત આનુસંગિક જોગિાઈ કરાયેલ છે?					Yes/~~No~~
6	New India Literacy Programme (NILP) મુજબનો વિષય છે?					Yes/~~No~~
7	Swayam પ્લેટફોમ પરના MOOC વિષય પર આધારિત આ વિષય છે?					Yes/~~No~~
8	ઇન્ડીયનનોલેજસીસ્ટમ (IKS) પર આધારિત વિષયછે ?					Yes/~~No~~

Course Outcomes

By the end of the course, students will be able to:

- Classify common lab microorganisms into appropriate Risk Groups (RG1–RG4) based on their pathogenicity and risk to humans.
- Analyze real-world lab-acquired infection incidents to understand core principles of biosafety and prevention strategies.
- Demonstrate the correct use and working of Biological Safety Cabinets (BSCs) to ensure safe laboratory practices.
- Validate the effectiveness of an autoclave through biological or chemical indicators to ensure proper sterilization.
- Assess biosafety and ecological risks of GM crops through critical analysis of a genetically modified crop trial (e.g., Bt cotton).

Minor: Practical Minor 5: Biosafety Practical
1. To classify common lab microorganisms (e.g., *E. coli*, *Salmonella*, *Mycobacterium tuberculosis*) into RG1–RG4. 2. To understand biosafety principles through real-world incidents: lab-acquired infections 3. To learn the types, functioning, and safe usage of BSCs. 4. To validate autoclave function and sterilization. 5. To evaluate risks associated with genetically modified crops: Case analysis of a GM crop trial (e.g., Bt cotton)

Reference Books:

1. Biosafety in Microbiological and Biomedical Laboratories (BMBL) – U.S. Department of Health and Human Services (CDC & NIH)
2. Laboratory Biosafety Manual (4th Edition) – World Health Organization (WHO)
3. Principles of Biosafety – Manmohan Singh (ICMR/National Institute of Virology)
4. Biotechnology Risk Assessment: Biosecurity and Biosafety – Alan Kolok
5. Molecular Biotechnology: Principles and Applications of Recombinant DNA – Bernard R. Glick, Jack J. Pasternak
6. Environmental Biotechnology: Principles and Applications – Bruce E. Rittmann, Perry L. McCarty
7. GM Crops and the Global Divide – Jennifer Thomson

Pedagogic tools:

- Chalk and Board
- PPT and Videos.
- Assignment
- Class Activity: Think-Pair-Share / Class Test

E-resources:

1. **CDC Biosafety Guidelines**
   https://www.cdc.gov/labs/BMBL.html

2. **WHO Laboratory Biosafety Manual**
   https://www.who.int/publications/i/item/9789240011311
3. **FAO/WHO GM Foods Safety Assessments**
   https://www.fao.org/food/food-safety-quality/a-z-index/biotechnology/en/

Suggested MOOCs

- **Coursera – "Laboratory Safety and Risk Management"**
  https://www.coursera.org/learn/lab-safety
- **SWAYAM – "Biosafety and Bioethics"**
  https://swayam.gov.in
- **FutureLearn – "Biosafety for Laboratory Workers"**
  https://www.futurelearn.com

SAURASHTRA UNIVERSITY

FACULTY OF SCIENCE

Course Structure and Syllabus for Science FYUGP – Semester - 6

B.Sc. Honours/ Honours with Research in Microbiology

Based on

UGC's guidelines NEP-2020 "Curriculum and Credit Framework for Undergraduate Programmes- CCFUP" and

Education Department, Government of Gujarat's
Uniform Credit Structure for all HEIs of Gujarat State and
Implementation of the Common Curriculum and Credit Framework under the National Education Policy-2020
(No: KCG/admin/2023-24/0607/kh.1 Sachivalaya, Gandhinagar dated 11/07/2023) and

Standard Operating Procedure for Implementation of NEP-2020 for the State of Gujarat- HEIs of Gujarat
(No: KCG/admin/2023-24/865/ dated 26/07/2023) and

Additional content to be added to SOP published by KCG
(No: KCG/NEP-2020/2023-24/893/ dated 28/07/2023)

General Guidelines for Implementation of **Four Year Under Graduate Programmes** for Saurashtra University (16 pages) published in August 2023
(E-mail from Academic Section Saurashtra University dated Oct 11, 2023)

Effective for students admitted in 2023-24 & onwards

(Submitted in June 2025)

PREFACE

Timely revision of the curriculum to encompass new knowledge and information is a prime criterion of IQAC and a prime need for the college educational systems affiliated with Universities. Under the NEP - 2020 and UGC guidelines, a student must be offered the latest courses of varied nature with societal, environmental, and economic implications. The curriculum should offer multiple entry-exit and a choice of vast subjects to choose from to a student to facilitate his learning abilities, aptitude, and inclination.

Microbiology is a foundation subject for Agriculture, Biochemistry, Bioinformatics, Biotechnology, Environmental Science, Genetic engineering, Molecular biology, and Medical Microbiology and hence holds the central position in the curriculum of these subjects. Looking at the rapid inventions and technological developments in the field of Microbiology and keeping in view the recommendations of UGC and NEP-2020, this syllabus has been formulated by the combined and coordinated efforts of all the faculty members of all the Microbiology Departments of Colleges affiliated to Saurashtra University.

The composition of a curriculum for a particular subject requires the following criteria to be considered:

1. Guidelines and Model curriculum were given by the UGC, State Government, and the University
2. Regional needs and Present National and International trends in the subject
3. Geographical parameters of the University and its demographic property
4. Relationship with other related subjects and resources of educational needs.
5. Financial and statuary provisions of the State government

The content of a syllabus should be such that it maintains continuity with the course content of higher secondary classes and post-graduate courses. The current curriculum is made keeping this in mind and is an effort to impart fundamental knowledge of the subject needed at this level.The curriculum is designed per the guidelines of UGC and NEP-2020 and reflects the courses' total credit, teaching hours, and question paper style. The syllabus units are well-defined, and the scope of each is given in detail. A list of reference books is provided at the end of each course. Microbiology being an experimental science, sufficient emphasis is given to training and instrumentation. The following objectives have been considered while formulation the curriculum:

1. To provide an updated, feasible, and modern syllabus to the students, emphasizing knowledge and skill to build up their valuable college education and job-oriented carrier.
2. To frame the syllabus in accordance with the semester system and UGC – NEP 2020 guidelines and in consultation with all stakeholders.
3. To offer the students an array of Core, Interdisciplinary, Multidisciplinary, Skill enhancement, Ability enhancement and Value-added courses to select from and to facilitate his academic, intellectual and social grooming.

The Board of Studies for Microbiology expresses heartfelt gratitude to the Dean, Faculty of Science, Saurashtra University, for valuable guidelines and the Academic Section for much-needed cooperation. The Board wishes all the students pursuing Microbiology a very bright future.

On behalf of the BoS- Microbiology,

Dr. Vasantba J. Jadeja Chairman, BoS- Microbiology Saurashtra University, Rajkot	**Dr. N. D. Pandhi** BoS – Microbiology Saurashtra University, Rajkot

Saurashtra University, Rajkot

MICROBIOLOGY PROGRAMME - B.Sc. (Honours) / B.Sc. (Honours with Research)
Curriculum Framework & Syllabus for A.Y. 2023-2024 & Onwards

GRADUATE ATTRIBUTES

Graduates should be able to demonstrate the acquisition of the following:

- **Academic excellence**: Comprehensive knowledge and coherent understanding of Microbiology and other interdisciplinary areas of study
- **Practical, professional, and procedural knowledge** required for carrying out professional or highly skilled work/tasks related to Microbiology, including knowledge required for undertaking self-employment initiatives and knowledge and mindset required for entrepreneurship, improved product development, or a new mode of organization
- **Critical and Analytical reasoning/thinking and Effective communications**: Analysis and evaluation of information to form a judgment about a subject or idea and ability to communicate the same in a structured form.
- **Research-related skills**: the ability to understand basic research ethics and skills in practicing/doing ethics in the field/ in personal research work, regardless of the funding authority or field of study.
- **Leadership qualities and Teamwork abilities:** The graduates should be able to demonstrate the capability for mapping out the tasks of a team and setting direction and inspiring vision, and building a team that can help achieve the goals
- **Global Citizenship**: Mutual understanding with others from diverse cultures, perspectives, and backgrounds by embracing and practicing constitutional, humanistic, ethical, and moral values in life, including universal human values of truth, righteous conduct, peace, love, nonviolence, and scientific temper.
- **Life Long Learning**: Ready to imbibe new knowledge, values, and skills with an open mind and willing to adopt change for constructive development.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

This program will produce Graduates who will attain the following PEOs after a few years.

PEO 1	**:**	**Core subject competency:** will acquire the competency to pursue higher education, develop a professional career, or be self-employed with the knowledge and skills of Microbiology and allied sciences.
PEO 2	**:**	**Application of knowledge**: will show the ability to apply the knowledge of Microbiology to independently design and execute minor research problems for societal and human welfare.
PEO 3	**:**	**Overall Preparedness: I** will have the ability to undertake any assignment as a leader or team member and will be able to contribute to academics, entrepreneurship, and research, with good communication skills.
PEO 4	**:**	**Professionalism:** will possess strong professional ethics to fulfill moral duties towards his profession, community, society, and the nation.
PEO 5	**:**	**Learning environment:** will show readiness for lifelong learning to meet personal, professional, social, and global demands through knowledge and skills.

PROGRAM OUTCOMES: (POs)		
After completion of the B.Sc. Microbiology program, the Student will be able to:		
PO 1	**:**	**Specific Disciplinary knowledge:** Demonstrate an understanding of fundamental principles, scope, and applications of Microbiology and can appreciate the beneficial and harmful role of microorganisms
PO 2	**:**	**Problem analysis:** Accurately identify and critically analyze problems in various domains of Biological sciences.
PO 3	**:**	**Designing viable solutions:** Search for and successfully arrive at viable conclusions/solutions about various aspects of life sciences using the right approach and appropriate tools and techniques
PO 4	**:**	**Scientific aptitude:** Ability to solve local, regional, national, or global problems scientifically using logical thinking and advanced techniques.
PO 5	**:**	**Modern tool usage:** Understand standard operating procedures and safety measures and acquire in-depth technical competence to handle the basic laboratory instruments and retrieve scientific information with modern data search tools.
PO 6	**:**	**Global citizen:** Demonstrate the ability to understand the needs of changing world from a Microbiology perspective and with an insight into his constructive role for the societal benefits honestly and consistently with a strong sense of ethics and values.
PO 7	**:**	**Environment and sustainability:** Can be an ambassador for Environmental protection and advocate for the need to advocate for sustainable development.
PO 8	**:**	**Ethics:** Commitment to professional and social ethics and work accordingly
PO 9	**:**	**Individual and team work:** Exhibit the potential to effectively accomplish tasks as a leader or a member of a team as well as independently in multidisciplinary settings.
PO 10	**:**	**Communication:** Possess practical Communicate skills in spoken and written forms for practical idea sharing with the scientific community, society, and colleagues.
PO 11	**:**	**Scientific Innovations and fund management:** Ability to design a research project and manage its execution to generate new scientific insights, innovations, and revenues with proper time and fund management.
PO 12	**:**	**Life-long learning:** Ready to undertake life-long learning to periodically update scientific knowledge and its application.

PROGRAM SPECIFIC OUTCOMES (PSOs) for B. Sc. Microbiology program

After completion of the program, the Graduate will:		
PSO1	**:**	Acquire sound knowledge about the fundamentals of Microbiology to develop a solid base to enable the understanding of emerging and advanced concepts in life sciences.
PSO2	**:**	Be equipped with knowledge, skill, and inspiration to pursue higher education and research in Microbiology and allied fields to answer urgent global problems.
PSO3	**:**	Use Microbiology principles and applications to find innovative solutions for environment, agriculture, and health-related issues at local and global levels.
PSO4	**:**	Acquire the skill and the required knowledge to be an entrepreneur/self-employed and serve the scientific community and society by generating problem solutions and employment.
PSO5	**:**	Become competent and eligible to appear in various competitive exams, placement in government and private sectors of academia, research, and industries, and become a successful Microbiologist serving the Nation.

B.Sc. Honours/ Honours with Research in Microbiology
(NCrF Level- 5.5 Third Year – B.Sc. in Microbiology)
Semester VI

SN	Course Category As per GoG- NEP-SOP - July 2023& additional content 28/7/23	Course Title	Credit			Hrs./ Week		Evaluation - Weightage CCE: SEE = 50:50				
			T	P	Total	T	P	CCE Marks		SEE Marks		Total Marks
								T	P	T	P	
1	**Major (Core) 14** (Microbiology)	**Microbiology-14: Bacterial Metabolism (4- Credit Course** including Theory & Practical components)	**3**	**1**	**4**	**3**	**2**	**25**	**25**	**50**	**-**	**100**
2	**Major (Core) 15** (Microbiology)	**Microbiology-15: Molecular Biology (4-Credit Course** including Theory & Practical components)	**3**	**1**	**4**	**3**	**2**	**25**	**25**	**50**	**-**	**100**
3	**Major (Core) 16** (Microbiology)	**Microbiology-16: Fundamentals of Genetics (4- Credit Course** including Theory & Practical components)	**3**	**1**	**4**	**3**	**2**	**25**	**25**	**50**	**-**	**100**
4	**Minor -6** (Microbiology)	(As per GoG- NEP-SOP July 2023& additional content 28/7/23 – Clause 3.3.2) **Discipline Specific Minor – Intellectual Property Rights (IPR) (4-Credit Course** including Theory & Practical components)	**2**	**2**	**4**	**2**	**4**	**-**	**50**	**50**	**-**	**100**
5	**Ability Enhancement Course -5** (AEC-5)	(As per GoG- NEP-SOP July 2023& additional content 28/7/23 – Clause 3.3.4) **English Language: Communication Skills & Soft skills**	**2**	**-**	**2**	**2**	**-**	**25**	**-**	**25**	**-**	**50**
6	**Internship**	**Domain Specific Compulsory**	**-**	**4**	**4**	**-**	**8**	**-**	**50**	**-**	**50**	**100**
Total Credits and Marks (Semester-VI)			**13**	**09**	**22**	**13**	**18**	**100**	**175**	**225**	**50**	**550**

Evaluation Scheme: (As per GoG- NEP-SOP July 2023& additional content 28/7/23 – Chapter-7: Evaluation Reforms)

The evaluation process should be formulated to make a systematic evaluation of students' progress based on UGC guidelines. The evaluation must be designed with learner attributes in mind. These attributes have clear linkages to Programme Education Objectives and Outcomes. The evaluation consists of the following two components:

1. Continuous and Comprehensive Evaluation (CCE)- Formative
2. Semester End Evaluation (SEE)- Summative

CCE carries 50% of the total marks allotted to a subject and the other 50% being assigned to the SEE.

In each course, every credit carries 25 marks, of which 50% marks is assigned for CCE and rest 50% marks for SEE. The 50% marks assigned to the CCE is distributed between the continuous classroom evaluation and mid-term evaluation. The pattern may be as follow:

SN	Evaluation	*T-3 + P-1 = Total 4 credit subjects (Marks)	* T-1 + P-1 = Total 2 credit SEC# (Marks)	*T-2 + P-2 = Total 4 credit Minor# (Marks)
1	**CCE (50%)** Classroom/Lab & Mid-Term/Course End Evaluation	**T-25 + P- 25**	**P - 25**	**P - 50**
2	**SEE (50%)**	**50**	**T- 25**	**T- 50**
	Total	**100**	**50**	**100**

***T = Theory; P= Practical**

The concept note on Internship - 4 credit major course of semester- 6 is enclosed as an annexure.

Continuous and Comprehensive Evaluation (CCE)

Subject–wise CCE will be undertaken by the concerned faculty member. The mode of evaluation will be decided by the faculty member concerned with the subject. Normally CCE consists of class participation, case analysis and presentation, assignment, tutorials, slip tests (announced/ surprised), quizzes, attendance etc. or any combination of these. The students are expected to submit their answer scripts/ reports of internal evaluation within the stipulated time. Failure to do so may result in the script not being valued. Another part of CCE consists of mid-term written evaluation, which is compulsory for all students. It can be done in a scheduled manner. The duration of the mid-term evaluation shall be one hour.

Semester End Evaluation (SEE)

The SEE carries 50% of the marks assigned to a course. SEE shall be of 2 ½ hours for 3/4 credit course and 2 hours in case of 1/2 credit courses. The controller of the examination will conduct these examinations. Paper setting and evaluation will be done by the external examiners to an extent of 50% of the evaluation process. This examination shall be conducted as per a schedule which shall be notified in advance.

The backlog exam will be conducted twice a year just after the result declared of the semester evaluation. Students shall have a second chance to clear their backlog and avoid the burden to carry forward the backlog with the next semester exam.

Appearance in all the evaluations is mandatory and no exemption can be granted except in the following case:

1. In case of inability to attend the exam due to reasons considered genuine by the controller of examination in consultation with the Director/Board.

2. In case of medical emergency, a certificate from the registered medical practitioner must be produced before the commencement of exams. The evaluation board will then take final decision on the recommendation for exemption.

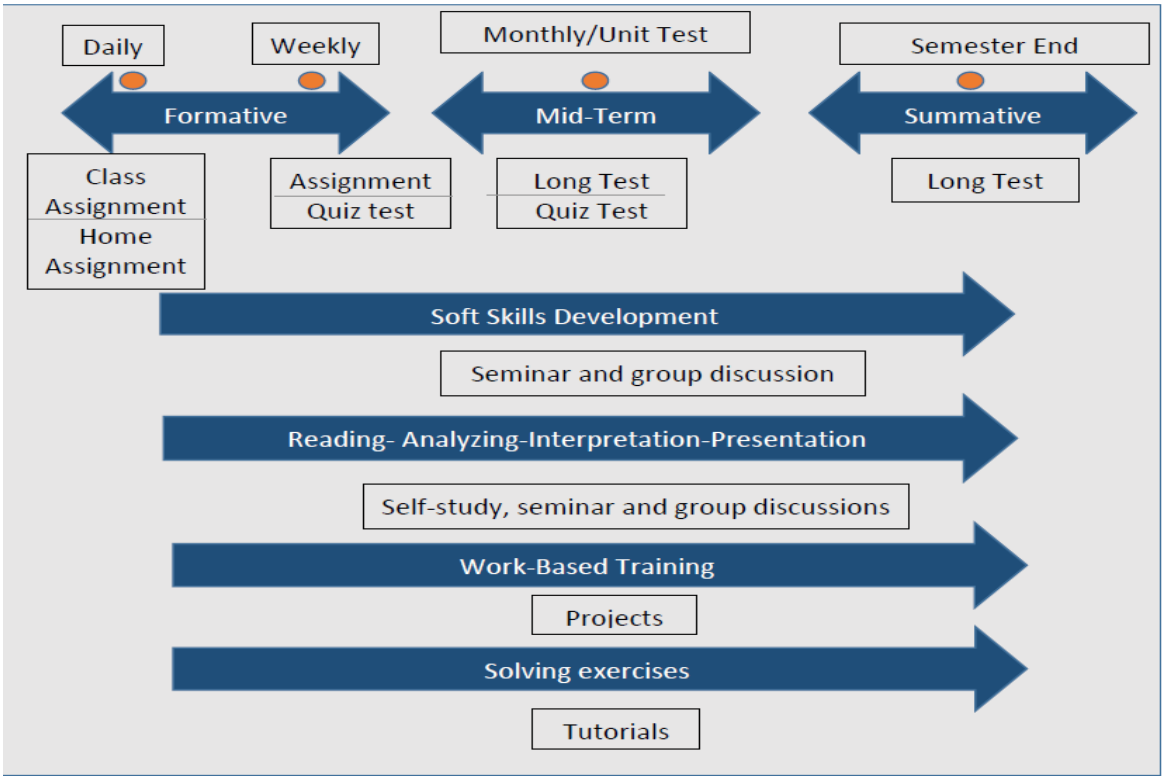
Eligibility Criteria to appear in SEE

To be able to appear for the SEE, a student must comply with the following conditions:

1. Should have at least 75% of attendance in all the courses put together.
2. Should have at least 70% of attendance in each course/subject.
3. Should not have any disciplinary proceedings pending against him/her.
4. Should have no pending due.

Continuum of Evaluation

Evaluation must be continuous which may include both formative and summative components in a timely manner for continuous feedback as follow:



Mode of Evaluation

A wide range of modes of evaluation for evaluating students is available for the teachers/ institutions to use. A suitable compendium of such a mode needs to be carefully chosen for a particular program depending on its nature, objectives, and available resources. The mode of evaluation can be as below:

Written Mode	Oral Mode	Practical Mode	Integrated Mode
Semester Exam Class Test Open book exam/test Open note exam/test Self-test/Online test Essay/Article writing Quizzes/Objective test Class assignment Home assignment Reports writing Research/Dissertation Class Studies	Viva/Oral exam Group Discussion Role Play Authentic Problem Solving Quiz Interview	Lab work Computer simulation/virtual labs Craft work Co-curricular work	Paper presentation/Seminar Field Assignment Poster Presentation

Written Mode		
Evaluation Type	**Nature**	**Objective**
Semester Exam	Traditionally essay type, with objective / short answer questions to evaluate Lower Order Thinking (LOT) OBE skills	For depth and planned preparation
Class test	Traditionally essay type	Fixed date forces students to learn
Open book test	Allowed choice of reference book	Measures what students can do with resources, less stress on memory
Open note test	To get used to the system	Encourage good note taking
Self-test	For subjective and objective items	Mastery learning occurs with proper feedback
Article/essay writing	Individual long written assignment	Individual expression and creativity
Quizzes/Objective test	Short duration structured test	Excellent validity as greater syllabus coverage
Class assignment	With defined time	Student's performance to make decision
Home assignment	With undefined time	Reinforce learning and facilitate mastery of specific skills
Reports Writing	On activities performed or event observed	Develop a key transferable skill

Research/Dissertation	Detailed research-based report	To judge creativity and research skills
Case Studies	Analyse a given case (real or fictional)	To assess thinking, value, and attitude

Oral Mode

Evaluation Type	Nature	Objective
Viva/Oral exam	Individually or in small group	Practical experience towards job interview situation
Group discussion	Small group of 2-5 members work on a joint task	Encourage teamwork
Role Play	Small group of 2-5 members work on a joint task	Develop personality
Authenticate problem solving	Small group of 2-5 members work on a joint task	Communication of ideas
Quiz	Small group of 2-5 members work on a joint task	Assess memory power
Interview	Individually	Judge the personal confidence level

Practical Mode

Evaluation Type	Nature	Objective
Lab work	Component of working with one's hand	Keep the students on the task
Computer simulation/virtual labs	Component of working with one's hand	To understand the practical exposure
Craft work	Component of working with one's hand	Encourage application of concepts learnt
Co-curricular work	Component of working with one's hand	For immediate feedback

Integrated Mode

Evaluation Type	Nature	Objective
Paper presentation/Seminar	Group or individual work	Learn from others presentation
Field Assignment	Field visit with report	Develop observation and recording skills
Poster presentation	Group or individual work	Develop research, creativity, and discussion skills
Paper presentation/Seminar	Group or individual work	Learn from others presentation

Models of Evaluation

Based on the types of evaluation, various models of evaluation implementation are suggested for theory, practical, self-study and work-based learning. The focus of these models is to encourage the students to improve on skills and performance.

Evaluation Norms & Question Paper Pattern for Theory & Practical Courses: Please refer General Guidelines for Implementation of **Four Year Under Graduate Programmes** for Saurashtra University (16 pages) published in August 2023.

Model for 4 Credit Course (Theory-3 + Practical-1)		
CCE-50% (50 Marks) SEE-50% (50 Marks)		
Exam Pattern		**Marks**
Continuous and Comprehensive Evaluation (CCE) – Theory + Practical		**50**
Components of CCE & Weightage – Theory – 25 marks		
1	Class Test / Open Book Test / Slip Test	**10**
2	Assignment (One)	**05**
3	Attendance	**05**
4	Quiz / Presentation / Field visit report / Active Learning- PBL/CSBL/Seminar/Flipped Class Room etc. OBE evaluation tools.	**05**
Components of CCE & Weightage – Practical – 25 marks		
1	Performance / Experiments	**15**
2	Viva voce and Certified journal / Lab quiz	**10**
Semester-End Evaluation (SEE) – THEORY		**50**

Model for Theory Courses- Theory-2+ Practical-2= 4 Credit Course	
CCE-50% (50 Marks) SEE-50% (50 Marks)	
Exam Pattern – SoP- OBE	**Marks**
Written : Lab batch wise Test Objective/MCQ	10
Journal writing / Assignment	05
Course End Practical Exam & Viva Voce by Internal & External Examiners (3 Hrs.)	30 + 5
Continuous and Comprehensive Evaluation	**P-50**
Semester-End Evaluation	**T-50**

Model for 2 Credit Skill Enhancement Course (Theory-1 + Practical -1)		
CCE-50% (25 Marks) SEE-50% (25 Marks) – Time: 1hr 30mins		
Exam Pattern		**Marks**
Continuous and Comprehensive Evaluation (CCE) – Practical – 25 Marks		
1	Performance / Experiments or Project based Assessment and Attendance	15
2	Viva voce / Lab quiz and certified journal	10
Semester-End Evaluation – 25 Marks		**25**

Saurashtra University, Rajkot

Question Paper Pattern for 4 Credit Course (Theory) FYUGP-B.Sc. Microbiology Sem – VI

Time: 2 hrs. **Max. Marks: 50**

Ques.1 A. Descriptive		05
B. Descriptive		05
	OR	
Ques.1 A. Objective:		(3x1 = 03)
a.		
b.		
c.		
B. Descriptive		07
Ques.2 A. Descriptive		05
B. Descriptive		05
	OR	
Ques.2 A. Objective:		(3x1 = 03)
a.		
b.		
c.		
B. Descriptive		07
Ques.3 A. Descriptive		05
B. Descriptive		05
	OR	
Ques.3 A. Objective:		(3x1 = 03)
a.		
b.		
c.		
B. Descriptive		07
Ques.4 A. Descriptive		05
B. Descriptive		05
	OR	
Ques.4 A. Objective:		(3x1 = 03)
a.		
b.		
c.		
B. Descriptive		07
Ques.5 A. Descriptive		05
B. Descriptive		05
	OR	
Ques.5 A. Objective:		(3x1 = 03)
a.		
b.		
c.		
B. Descriptive		07

Suggested Question Paper Format for 2 Credit Course (Theory)

Time: 1 Hour **Marks: 25**

Q. 1. Unit I	(A) 5 Objective, each of 1 mark	05
	(B) Descriptive	05
	OR	
	(A) 5 Objective, each of 1 mark	05
	(B) Descriptive	05
Q. 2. Unit II	(A) 5 Objective, each of 1 mark	05
	(B) Descriptive	05
	OR	
	(A) 5 Objective, each of 1 mark	05
	(B) Descriptive	05
Q. 3. Unit III	(A) Descriptive	05
	OR	
	(A) Descriptive	05

Semester End Exam Question Paper Pattern for SEC Theory: -

Time: 1 Hour **Marks: 25**

Q. 1	**10 Marks**
(A) **Objective:** Attempt any 06 Out of 10 MCQs, carrying 01 mark each (B**) Short Answer Question**: Attempt ant 02 Out of 04, carrying 02 mark each	06 Marks 04 Marks
Q. 2	**10 Marks**
(A) **Objective:** Attempt any 06 Out of 10 MCQs, carrying 01 mark each (B**) Short Answer Question**: Attempt ant 02 Out of 04, carrying 02 mark each	06 Marks 04 Marks
Q. 3	**05 Marks**
Descriptive: Attempt any 01 Out of 03, carrying 05 marks	05 Marks

B.Sc. Honours/ Honours with Research in Microbiology
(NCrF Level- 5.5 - Third Year – B.Sc. Microbiology)

Semester – VI

Course Category	**Major-14**
Title of the Course	**Microbiology -14: Bacterial Metabolism**
Course Credit	**03 – Theory + 1 – Practical = Total – 4**
Teaching Hours per Sem.	**45 – Theory + 30 – Practical**
Total Marks	**CCE- 50 + SEE- 50 = Total – 100**

1	Employability/Entrepreneurship/Skill Development પર કેન્દ્રિત થયેલ છે કે નહિ ?					Yes/~~No~~
2	Value added Courses Imparting Transferable and Life Skills ના ગુણો ધરાવે છે?					Yes/~~No~~
3	Major		Yes/~~No~~	Minor		~~Yes~~/No
	Skill Enhancement Courses		~~Yes~~/No	Ability Enhancement Courses		~~Yes~~/No
	Value Added Courses		~~Yes~~/No	Exit/ Vocational Courses		~~Yes~~/No
4	Holistic Education	Yes/~~No~~	Multidisciplinary	Yes/~~No~~	Interdisciplinary	Yes/~~No~~
5	દિવ્યાંગ માટે વિષય અંતર્ગત આનુસાંગિક જોગવાઈ કરાયેલ છે ?					Yes/~~No~~
6	New India Literacy Programme (NILP) મુજબ નો વિષય છે?					Yes/~~No~~
7	Swayam પ્લેટફોર્મપરના MOOC વિષય પર આધારિત આ વિષય છે ?					Yes/~~No~~
8	ઇન્ડીયન નોલેજ સીસ્ટમ (IKS) પર આધારિત વિષય છે ?					Yes/~~No~~

Course Outcomes:

By the end of the course, students will be able to:

1. Understand the principles of bioenergetics, the role of ATP, reducing power, precursor metabolites and the kinetics of enzyme-catalysed reactions.
2. Describe and differentiate key Metabolism of Carbohydrates in bacteria, including catabolism and anabolism.
3. Explain how bacteria utilize and synthesize different amino acids, Nucleic acids and Lipids.
4. Discuss how bacteria utilize different electron acceptors in aerobic and anaerobic respiration.
5. Evaluate the Selected Aspects of Metabolism in Specific Microbial Systems.

Course Content	Hours	Marks
Unit 1: Introduction to Metabolism, Bioenergetics and Enzyme Kinetics	**9 hrs**	**10**
• Concepts of metabolism: Catabolism, anabolism, metabolic flux • Bioenergetics: The concept of free energy, Determination of ΔG & Energy rich compounds • Energy metabolism: Role of ATP in metabolism, Role of reducing power in metabolism, Role of precursor metabolites in metabolism • Enzyme kinetics: Michaelis-Menten equation, Lineweaver-Burk plot, Conformational changes in Allosteric Enzymes		
Unit 2: Metabolism of Carbohydrates	**9 hrs**	**10**
• Glycolysis Embden-Meyerhof-Parnas (EMP) and its regulation • Entner-Doudoroff (ED) & Pentose Phosphate Pathway (PPP) • Tricarboxylic Acid (TCA) cycle: Steps, regulation, amphibolic nature & Glyoxylate Cycle • Gluconeogenesis		
Unit 3: Metabolism of amino acids, Nucleic acids and Lipids	**9 hrs**	**10**
• Amino acid catabolism: Deamination, transamination, decarboxylation; Stickland Reactions • Biosynthesis of amino acids: Glutamate and Aspartate • Recycling of Purine and Pyrimidine nucleotides by salvage pathways • Oxidation of Fatty Acids: β-oxidation of fatty acids		
Unit 4: Energy Generation and Membrane Transport	**9 hrs**	**10**
• Different modes of ATP generation • Electron transport chain: Introduction, Components of ETC and energy yield, Anaerobic respiration • Bacterial photosynthesis • Types of membrane transport: Passive, active, group translocation (PTS system)		
Unit 5: Selected Aspects of Metabolism in Specific Microbial Systems	**9 hrs**	**10**
• Chemo-autotrophs: Nitrifying Bacteria, Sulfur Oxidizers, The Iron bacteria, The Hydrogen bacteria • The lactic acid bacteria: Patterns of carbohydrate fermentation in lactic acid bacteria • The Enteric group and related Eubacteria: Fermentative patterns of Gram-negative Eubacteria • Archaebacteria: Energy metabolism and Carbon - Assimilation in Methanogens, Photophosphorylation in *Halobacterium*		

Text Books

1. Pelczar, Chan & Krieg – Microbiology, (Tata McGraw-Hill)
2. Prescott's Microbiology by Willey, Sherwood & Woolverton (McGraw-Hill Education)
3. General microbiology by Stanier R.Y. 5thedition.McMillan.

4. Lehninger Principles of Biochemistry by Nelson & Cox (W.H. Freeman & Co.)
5. Microbial Physiology by Albert G. Moat, John W. Foster, Michael P. Spector (Wiley-Liss)

Reference Books

1. The physiology and Biochemistry of Prokaryotes by David white. 2ndedition.OUP USA.
2. Outlines of biochemistry by Conn E.E. and Stumpt P.K. 5thedition. John Wiley and Sons, New York.
3. Biochemistry by Donald Voet & Judith G. Voet. 4th edition. John Wiley & Sons.
4. Brock Biology of Microorganisms by Michael T. Madigan, John M. Martinko.11th – 15th edition. Pearson.

Suggested reading / E-resources

- **https://www.ncbi.nlm.nih.gov/books**
- **https://www.ncbi.nlm.nih.gov/pmc**
- **https://bio.libretexts.org**
- **https://www.khanacademy.org/science/biology/macromolecules**

Suggested MOOCs

- **https://nptel.ac.in/courses/102105034**
- **https://nptel.ac.in/courses/102103015**

B.Sc. Honours/ Honours with Research in Microbiology
(NCrF Level- 5.5 - Third Year – B.Sc. in Microbiology)

Semester – VI

Course Category	**Major Practical -14**
Title of the Course	**Microbiology -14P: Bacterial Metabolism**
Course Credit	**01**
Teaching Hours per Sem.	**30**
Total Marks	**CCE – 25**

1	Employability/Entrepreneurship/Skill Development પર કેન્દ્રિત થયેલ છે કે નહિ?					Yes/~~No~~
2	Value added Courses Imparting Transferable and Life Skills નાગુણોધરાવેછે?					Yes/~~No~~
3	Major		Yes/~~No~~	Minor		~~Yes~~/No
	Skill Enhancement Courses		Yes/~~No~~	Ability Enhancement Courses		Yes/~~No~~
	Value Added Courses		~~Yes~~/No	Exit/ Vocational Courses		~~Yes~~/No
4	Holistic Education	Yes/~~No~~	Multidisciplinary	~~Yes~~/No	Interdisciplinary	~~Yes~~/No
5	દિવ્યાંગમાટેવિષયઅંતર્ગતઆનુસાંગિકજોગવાઈકરાયેલછે ?					Yes/~~No~~
6	New India Literacy Programme (NILP) મુજબ નો વિષય છે?					Yes/~~No~~
7	Swayam પ્લેટફોર્મપરના MOOC વિષય પર આધારિત આ વિષય છે?					~~Yes~~/No
8	ઇન્ડીયન નોલેજ સીસ્ટમ (IKS) પર આધારિત વિષય છે ?					Yes/~~No~~

Course Outcomes

By the end of the course, students will be able to:

1. Understand how temperature affects the rate and efficiency of amylase activity.
2. Determine the optimal pH for amylase and observe its stability across pH ranges.
3. Study how varying enzyme concentrations influence the reaction rate.
4. Calculate enzyme kinetics parameters (Vmax and Km) using Michaelis-Menten and Lineweaver-Burk plots.
5. Isolate and identify lactic acid bacteria from natural sources using selective media and tests.
6. Analyze biphasic growth in *E. coli* due to sequential utilization of carbon sources.
7. Observe microbial diversity and nutrient cycling in a stratified micro-ecosystem.

Major 14 P MAJOR 14: Bacterial Metabolism -
1. Study effect of temperature on amylase activity 2. Study effect of pH on amylase activity 3. Study effect of enzyme concentration on amylase activity 4. Determination of Vmax and Km for amylase enzyme by performing substrate concentration curve with M-M and line weaver Burk plot 5. Isolation and characterization of lactic acid bacteria from suitable sources. 6. Study of Diauxic growth curve in E. coli 7. Preparation of Winogradsky column (Demonstration)

Reference Books:

1. Experimental Microbiology (volume 1 &2) by Rakesh Patel. 3rd Edition
2. "Practical Biochemistry" by Keith Wilson & John Walker
3. "Textbook of Biochemistry with Clinical Correlations" by Thomas M. Devlin
4. "Microbiology: A Laboratory Manual" by James G. Cappuccino & Natalie Sherman
5. "Laboratory Manual in Biochemistry" by J. Jayaraman
6. "Fundamentals of Enzymology" by Nicholas C. Price & Lewis Stevens

E-resources:

1. NCBI Bookshelf: https://www.ncbi.nlm.nih.gov/books/
   Free access to textbooks and protocols in biochemistry and microbiology.
2. PubMed Central (PMC): https://www.ncbi.nlm.nih.gov/pmc/
   Peer-reviewed research articles and experimental procedures.
3. MIT Open Course Ware – Biochemistry & Microbiology: https://ocw.mit.edu
   Offers full course content, lecture notes, and lab manuals.
4. Virtual Labs – Amrita Vishwa Vidyapeetham (India): https://vlab.amrita.edu
   Interactive virtual experiments on enzyme kinetics and microbial techniques.
5. YouTube – JoVE Science Education: https://www.youtube.com/user/JoVEVideo
   Visual protocols for microbial culture, growth curves, enzyme assays, etc.

Suggested MOOCs

- Modules on enzyme kinetics and metabolism with video lectures - https://swayam.gov.in

B.Sc. Honours/ Honours with Research in Microbiology
(NCrF Level- 5.5 - Third Year – B.Sc. in Microbiology)

Semester – VI

Course Category	**Major-15**
Title of the Course	**Microbiology -15: Molecular Biology**
Course Credit	**03 – Theory + 1 – Practical = Total – 4**
Teaching Hours per Sem.	**45 – Theory + 30 – Practical**
Total Marks	**CCE- 50 + SEE- 50 = Total – 100**

1	Employability/Entrepreneurship/Skill Development પરકેન્દ્રિતથયેલછેકેનહિ ?					Yes/~~No~~
2	Value added Courses Imparting Transferable and Life Skillsનાગુણોધરાવેછે?					Yes/~~No~~
3	Major		Yes/~~No~~	Minor		~~Yes~~/No
	Skill Enhancement Courses		~~Yes~~/No	Ability Enhancement Courses		~~Yes~~/No
	Value Added Courses		~~Yes~~/No	Exit/ Vocational Courses		~~Yes~~/No
4	Holistic Education	Yes/~~No~~	Multidisciplinary	Yes/~~No~~	Interdisciplinary	Yes/~~No~~
5	દિવ્યાંગમાટેવિષયઅંતર્ગતઆનુસાંગિકજોગવાઈકરાયેલછે ?					Yes/~~No~~
6	New India Literacy Programme (NILP) મુજબનોવિષયછે?					Yes/~~No~~
7	Swayam પ્લેટફોર્મપરના MOOC વિષયપરઆધારિતઆવિષયછે ?					Yes/~~No~~
8	ઇન્ડીયનનોલેજસીસ્ટમ (IKS) પરઆધારિતવિષયછે ?					~~Yes~~/No

Course Outcomes:

On completion of the course, the student shall be able to:

1. Explain the concept, structure, and functional units of genes in both prokaryotic and eukaryotic systems.
2. Describe the hierarchical organization of the genome and the role of histone proteins and nucleosomes in chromatin structure.
3. Demonstrate understanding of the experimental basis and mechanisms of DNA replication, including the enzymes involved and its regulation in living cells.
4. Understand the processes of transcription and translation, including the molecules and modifications involved in gene expression.

5. Analyze various levels of gene regulation, with a focus on operon models like the lac operon (catabolic) and trp operon (anabolic), and their roles in metabolic control.

Course Content	Hours	Marks
Unit 1: Concept of Gene and Gene structure	**9 hrs**	**10**
• Concept of gene • Units of genetic structure and function • Gene structure architecture of Prokaryotes • Gene structure architecture of Eukaryotes		
Unit 2: Genome Organization	**9 hrs**	**10**
• Basic Logic behind genome organization • Histone proteins: evolutionary trend and structure of nucleosomes • Various levels of genome in organization • Genome organization in Prokaryotes		
Unit 3: DNA replication: Process and regulation	**9 hrs**	**10**
• Experiments supporting DNA as hereditary material • Semi conservative nature of DNA replication • Enzymes involved in DNA replication and Process of DNA replication • Regulation of DNA replication and Models of DNA replication		
Unit 4: Transcription and Translation	**9 hrs**	**10**
• Transcription: Proteins involved and process of transcription • Post transcriptional modification • Translation: Genetic code, Proteins involved, activation of t-RNA and process of translation • Post translational modification		
Unit 5: Regulation of gene expression	**9 hrs**	**10**
• Regulation of gene expression – Need and significance • An overview of Levels and modes of regulation of gene expression • Regulation of catabolic gene e.g. Lac operon • Regulation of anabolic gene e.g. Tryptophan operon		

Text book:

- Microbiology by Pawar and Daginawala – Vol 1&2. Himalaya Publication. India
- Twyman R. M., Advanced Molecular Biology – 1stEdition. Taylor &Fransis Group. UK.
- Verma P.S. & Agarwal V.K., Cell Biology, Genetics, Molecular Biology, Evolution & Ecology – Reprint Edn. 2006 edition. S Chand publications

Reference Book:

- Krebs, J. E.,Goldstein, E. S. et al., Lewin's Genes XII (any recent Edition), Jones and Bartlett Publishers, Inc., USA.
- Atlas. R.M., Principles of Microbiology- 2nd Edition. Wm. C. Brown Publishers.
- Lehninger principles of biochemistry by Nelson, D., and Cox, M. 4th - 8th edition. W.H. Freeman and Company, New York.
- Synder L., Champness, et al. Molecular Genetics of Bacteria –4th Edition. ASM Press, USA.
- Malacinski G. M. & David Freifelder, Essential of Molecular Biology – 3rd Edition. Boston : Jones and Bartlett Publishers, c1998.
- Prescott, Healey and Klein Microbiology - 5th - 10thEdition, Tata-McGraw Hill publications, Delhi.
- Gardner, M. J. Simmons, D. P. Snustad, PRINCIPLES OF GENETICS- 8th Edition. John Wiley & Sons publication.

Pedagogic tools:

- Chalk and Board
- PPT and Videos.
- Assignment

Suggested readings / E-resources

- **https://www.freebookcentre.net/biology-books-download/Cell-and-Molecular-Biology.html**
- **https://www.freebookcentre.net/biology-books-download/Cell-and-Molecular-Biology.html**
- **https://www.thermofisher.com/blog/ask-a-scientist/what-is-molecular-biology/**
- **https://plato.stanford.edu/entries/molecular-biology/**

Suggested MOOCs

- **https://onlinecourses.nptel.ac.in/noc24_bt07/preview**
- **https://www.coursera.org/learn/dna-decoded?**
- **https://onlinecourses.nptel.ac.in/noc24_bt07/preview**
- **https://www.coursera.org/learn/dna-decoded?**
- **https://onlinecourses.swayam2.ac.in/cec20_ma13/preview**

B.Sc. Honours/ Honours with Research in Microbiology
(NCrF Level- 5.5 – Third Year – B.Sc. in Microbiology)

Semester – VI

Course Category	**Major Practical -15**
Title of the Course	**Microbiology -15P: Molecular Biology**
Course Credit	**01**
Teaching Hours per Sem.	**30**
Total Marks	**CCE – 25**

1	Employability/Entrepreneurship/Skill Development પર કેન્દ્રિત થયેલ છે કે નહિ?					Yes/~~No~~
2	Value added Courses Imparting Transferable and Life Skills નાગુણોધરાવેછે?					Yes/~~No~~
3	Major		Yes/~~No~~	Minor		~~Yes~~/No
	Skill Enhancement Courses		Yes/~~No~~	Ability Enhancement Courses		Yes/~~No~~
	Value Added Courses		~~Yes~~/No	Exit/ Vocational Courses		~~Yes~~/No
4	Holistic Education	Yes/~~No~~	Multidisciplinary	~~Yes~~/No	Interdisciplinary	~~Yes~~/No
5	દિવ્યાંગમાટેવિષયઅંતર્ગતઆનુસાંગિકજોગવાઈકરાયેલછે ?					Yes/~~No~~
6	New India Literacy Programme (NILP) મુજબ નો વિષય છે?					Yes/~~No~~
7	Swayam પ્લેટફોર્મપરના MOOC વિષય પર આધારિત આ વિષય છે?					~~Yes~~/No
8	ઇન્ડીયન નોલેજ સીસ્ટમ (IKS) પર આધારિત વિષય છે ?					Yes/~~No~~

Course Outcomes:

On completion of the course, the student shall be able to:

1. Isolate and quantify the nucleic acid material form the bacteria
2. Validate the purity of the genetic material
3. Make the changes in the DNA using physical agents

Major 15 P

MAJOR 15: Molecular Biology Practical

1. Isolation of DNA from bacterial culture
2. Agarose gel Electrophoresis of Isolated DNA

3. Quantification of DNA by – DPA method and Spectroscopic analysis
4. Isolation of RNA from yeast
5. Quantification of RNA by - Orcinol method and Spectroscopic analysis
6. Isolation of plasmid (Only demonstration experiment)

Reference Book:

- Dubey, R.C., Maheshwari, D.K. (2005). Practical Microbiology. New Delhi: S. Chand & Company Limited.
- Sharma, K. (2005). Manual of Microbiology – Tools and Techniques. New Delhi: Ane books.
- Benson, H.J. (2002). Microbiological Applications – Laboratory Manual in General Microbiology – 8th edition: MacGrow Hill Company.

Pedagogic tools:

- Chalk and Board
- PPT and Videos.
- Practical demonstration

Suggested readings / E-resources

- **https://www.youtube.com/watch?v=1PqWnu2uBrY**
- **https://www.youtube.com/watch?v=8jVNcT5Dapk**

Suggested MOOCs

- **https://www.youtube.com/watch?v=slY4qrnZIM8**
- **https://www.youtube.com/watch?v=SR4FX6O2u98**

B.Sc. Honours/ Honours with Research in Microbiology
(NCrF Level- 5.5 - Third Year – B.Sc. in Microbiology)

Semester – VI

Course Category	**Major-16**
Title of the Course	**Microbiology -16: Fundamentals of Genetics**
Course Credit	**03 – Theory + 1 – Practical = Total – 4**
Teaching Hours per Sem.	**45 – Theory + 30 – Practical**
Total Marks	**CCE- 50 + SEE- 50 = Total – 100**

1	Employability/Entrepreneurship/Skill Development પરકેન્દ્રિતથયેલછેકેનહિ ?					Yes/~~No~~
2	Value added Courses Imparting Transferable and Life Skillsનાગુણોધરાવેછે?					Yes/~~No~~
3	Major		Yes/~~No~~	Minor		~~Yes~~/No
	Skill Enhancement Courses		~~Yes~~/No	Ability Enhancement Courses		~~Yes~~/No
	Value Added Courses		~~Yes~~/No	Exit/ Vocational Courses		~~Yes~~/No
4	Holistic Education	Yes/~~No~~	Multidisciplinary	Yes/~~No~~	Interdisciplinary	Yes/~~No~~
5	દિવ્યાંગમાટેવિષયઅંતર્ગતઆનુસાંગિકજોગવાઈકરાયેલછે ?					Yes/~~No~~
6	New India Literacy Programme (NILP) મુજબનોવિષયછે?					Yes/~~No~~
7	Swayam પ્લેટફોર્મપરના MOOC વિષયપરઆધારિતઆવિષયછે ?					Yes/~~No~~
8	ઇન્ડીયનનોલેજસીસ્ટમ (IKS) પરઆધારિતવિષયછે ?					~~Yes~~/No

Course outcomes

By the end of this course, students will be able to:

1. Understand and explain the foundational concepts of classical genetics, including genetic terminology, Mendelian inheritance patterns, and the limitations of Mendel's laws.
2. Describe and compare mechanisms of gene transfer in prokaryotes such as transformation, transduction, and conjugation, and assess their roles in genetic diversity and horizontal gene transfer.
3. Explain the nature, types, and mechanisms of action of transposable genetic elements, and distinguish between different types of genetic recombination including homologous, site-specific, and illegitimate recombination.
4. Analyze different types of DNA mutations, understand the molecular basis of mutagenesis, and evaluate the impact of physical, chemical, and biological mutagens through assays like

the Ames test.

5. Identify various forms and causes of DNA damage, and describe key DNA repair mechanisms including mismatch repair, excision repair, photo-reactivation, recombinational repair, and SOS response.

Course Content	Hours	Marks
Unit 1: Introduction to classical Genetics		
• History of genetics • Basic genetic terminology (gene, alleles, chromosome, plasmid, genome, chromatids, genotype, phenotype, dominant, recessive, homozygous, heterozygous) • Mendelian Genetics (Mendel's laws) Monohybrid and dihybrid crosses • Limitations of Mendelian Laws	**9**	**10**
Unit 2: Gene transfer in prokaryotes		
• Transformation: Natural transformation, competence, DNA uptake, role of natural transformation • Artificial induced competence, electroporation • Transduction: Generalized transduction, Specialized transduction and Abortive transduction • Conjugation: Mechanism of DNA transfer in Gram positive and Gram-negative bacteria	**9**	**10**
Unit 3: Transposons and recombination technology		
• Transposable genetic elements: Definition, types (insertion sequence, composite transposons and retro transposons • Mechanism and effect of transposon • Definition and Types of Recombination: Homologous recombination • Site specific recombination and Illegitimate recombination	**9**	**10**
Unit 4: DNA Mutations	**9**	**10**
• Types of mutation – Spontaneous mutation and Induced mutation • Biochemical bases of mutation and Reversion • Mutagenesis – Physical, Chemical and Biological • Ames test		
Unit 5: DNA Damage and Repair		
• Types and Causes of DNA Damage • Mechanisms of DNA repair – Mismatch and Excision Repair • Photo reactivation and Recombinational • SOS Repair	**9**	**10**

Text books:

1. Twyman R. M., Advanced Molecular Biology – 1st Edition. Taylor & Fransis Group. UK.

2. Gardner, M. J. Simmons, D. P. Snustad, PRINCIPLES OF GENETICS- 8th Edition. John Wiley & Sons.
3. Trevan, M.D., et al., Biotechnology -The Biological Principles . Tata Mcgraw Hill Publishing Co Ltd.

Reference Books:

1. Krebs, J. E.,Goldstein, E. S. et al., Lewin's Genes XII (any recent Edition), Jones and Bartlett Publishers, Inc., USA.
2. Atlas. R.M., Principles of Microbiology- 2nd Edition. Wm. C. Brown Publishers.
3. Lehninger principles of biochemistry by Nelson, D., and Cox, M. 4th - 8th edition. W.H. Freeman and Company, New York.
4. Synder L., Champness, et al. Molecular Genetics of Bacteria –4th Edition. ASM Press, USA.
5. Verma P.S. & Agarwal V.K., Cell Biology, Genetics, Molecular Biology, Evolution & Ecology - Reprint Edn. 2006 edition. S Chand publications
6. Malacinski G. M. & David Freifelder, Essential of Molecular Biology – 3rd Edition. Boston : Jones and Bartlett Publishers, c1998.
7. Prescott, Healey and Klein., Microbiology - 5th - 10th Edition, Tata-McGraw Hill publications, Delhi.
8. Gardner, M. J. Simmons, D. P. Snustad, PRINCIPLES OF GENETICS- 8th Edition. John Wiley & Sons.
9. Trevan, M.D., et al., Biotechnology -The Biological Principles . Tata Mcgraw Hill Publishing Co Ltd.
10. John Cronan, et al., Microbial Genetics - 2nd Edition. Narosa publications.
11. T. A. Brown, Gene Cloning and DNA Analysis: An Introduction -7th Edition. Wiley-Blackwell publications.
12. S. B. Primrose, R.Twyman & B. Old, Principles of Gene Manipulation. 6th Edition. Wiley-Blackwell publications

Pedagogic tools:

- Chalk and Board
- PPT and Videos.
- Practical demonstration

Suggested reading / E-resources

NCBI Bookshelf – Molecular Biology of the Cell (Chapter: DNA Transfer)

NCBI – Molecular Biology of the Gene (Watson, et al.)

Suggested MOOCs

SWAYAM/NPTEL: Microbiology (Prof. T. Satyanarayana, DU)

Coursera: Genomic Data Science Specialization (Johns Hopkins)

NPTEL: Genetic Engineering Theory and Application (IIT Kharagpur)

B.Sc. Honours/ Honours with Research in Microbiology
(NCrF Level- 5.5 - Third Year – B.Sc. in Microbiology)

Semester – VI

Course Category	**Major Practical -16**
Title of the Course	**Microbiology -16P: Fundamentals of Genetics**
Course Credit	**01**
Teaching Hours per Sem.	**30**
Total Marks	**CCE – 25**

1	Employability/Entrepreneurship/Skill Development પર કેન્દ્રિત થયેલ છે કે નહિ?					Yes/~~No~~
2	Value added Courses Imparting Transferable and Life Skills નાગુણોધરાવેછે?					Yes/~~No~~
3	Major		Yes/~~No~~	Minor		~~Yes~~/No
	Skill Enhancement Courses		Yes/~~No~~	Ability Enhancement Courses		Yes/~~No~~
	Value Added Courses		~~Yes~~/No	Exit/ Vocational Courses		~~Yes~~/No
4	Holistic Education	Yes/~~No~~	Multidisciplinary	~~Yes~~/No	Interdisciplinary	~~Yes~~/No
5	દિવ્યાંગમાટેવિષયઅંતર્ગતઆનુસાંગિકજોગવાઈકરાયેલછે ?					Yes/~~No~~
6	New India Literacy Programme (NILP) મુજબ નો વિષય છે?					Yes/~~No~~
7	Swayam પ્લેટફોર્મપરના MOOC વિષય પર આધારિત આ વિષય છે?					~~Yes~~/No
8	ઇન્ડીયન નોલેજ સીસ્ટમ (IKS) પર આધારિત વિષય છે ?					Yes/~~No~~

Course Outcomes:

On completion of the course, the student shall be able to:

1. Understand and analyze classical inheritance patterns through monohybrid and dihybrid crosses, reinforcing Mendelian genetics.
2. Demonstrate genetic manipulation techniques in bacteria, such as transformation and conjugation, to study gene transfer mechanisms.
3. Induce and isolate bacterial mutants using physical and chemical methods, and assess traits such as lactose fermentation and antibiotic resistance.
4. Apply microbiological methods to screen and select mutants, including gradient-plate and replica plating techniques.
5. Interpret the Ames test as a tool for evaluating the mutagenic potential of chemicals and its relevance in genetic toxicology (demonstration-based).

Major Practical: Microbiology -16P: Fundamentals of Genetics – Practical
1. Observation of phenotypes and inheritance patterns by use of Mono hybrid Cross and Dihybrid Cross 2. Transformation of plasmid in bacteria 3. Conjugation in E. coli by plate method 4. Isolation of lactose non-fermenter mutant of E. coli by physical mutagenesis 5. Isolation of antibiotic-resistant bacteria by gradient-plate method. 6. Isolation of streptomycin resistant mutants by Replica plating technique. 7. The Ames test – For detecting potential carcinogens (Demonstration)

Reference Book:

- Dubey, R.C., Maheshwari, D.K. (2005). Practical Microbiology. New Delhi: S. Chand & Company Limited.
- Sharma, K. (2005). Manual of Microbiology – Tools and Techniques. New Delhi: Ane books.
- Benson, H.J. (2002). Microbiological Applications – Laboratory Manual in General Microbiology – 8th edition: MacGrow Hill Company.

Pedagogic tools:

- Chalk and Board
- PPT and Videos.
- Practical demonstration

Suggested readings / E-resources

- **https://www.youtube.com/watch?v=1PqWnu2uBrY**
- **https://www.youtube.com/watch?v=8jVNcT5Dapk**

Suggested MOOCs

- **https://www.youtube.com/watch?v=slY4qrnZIM8**
- **https://www.youtube.com/watch?v=SR4FX6O2u98**

B.Sc. Honours/ Honours with Research in Microbiology
(NCrF Level- 5.5 Third Year – B.Sc. in Microbiology)

Semester VI

Course Category	**Minor-6**
Title of the Course	**Overview of IPR**
Course Credit	**02 Theory + 02 Practical = Total 4 credit**
Teaching Hours per Sem.	**30 (T) + 60 (P)**
Total Marks	**CCE- 50 + SEE- 50 = 100 Marks**

1	Employability/Entrepreneurship/Skill Development પરકેન્દ્રિતથયેલછેકેનહિ ?					Yes/~~No~~
2	Value added Courses Imparting Transferable and Life Skillsનાગુણોધરાવેછે?					Yes/~~No~~
3	Major		~~Yes~~/No	Minor		Yes/~~No~~
	Skill Enhancement Courses		~~Yes~~/No	Ability Enhancement Courses		~~Yes~~/No
	Value Added Courses		~~Yes~~/No	Exit/ Vocational Courses		~~Yes~~/No
4	Holistic Education	Yes/~~No~~	Multidisciplinary	Yes/~~No~~	Interdisciplinary	Yes/~~No~~
5	દિવ્યાંગમાટેવિષયઅંતર્ગતઆનુસાંગિકજોગવાઈકરાયેલછે ?					Yes/~~No~~
6	New India Literacy Programme (NILP) મુજબનોવિષયછે?					Yes/~~No~~
7	Swayam પ્લેટફોર્મપરના MOOC વિષયપરઆધારિતઆવિષયછે ?					Yes/~~No~~
8	ઇન્ડીયનનોલેજસીસ્ટમ (IKS) પરઆધારિતવિષયછે ?					Yes/~~No~~

Course Outcomes

By the end of the course, students will be able to:

1. Understand the basic concepts and significance of Intellectual Property Rights (IPR).
2. Identify and differentiate between various types of IPR – Patent, Copyright, Trademark, GI, and Industrial Design.
3. Describe the role of international IPR organizations such as WTO, WIPO, TRIPS, and GATT.
4. Evaluate the need for protecting traditional knowledge and biological resources through legal frameworks like the Biodiversity Act.

Course Content	Hours	Marks
Unit 1: Introduction to Intellectual Property (IP)	**10**	**17**
• What is IPR? Basic Concept of Intellectual Property • Kinds of Intellectual Property – Patent, Copyright & Trademark, and trade secrets, Industrial Design, GI • Economic Importance of Intellectual Property • Overview of Global Institutions dealing with IPR (TRIPS, WTO, WIPO, GATT)		
Unit 2: Patent, Industrial Design and Trademark	**10**	**17**
• Patent: Subject matter, criteria, Filing Process and Infringement and Enforcement overview (Case study: Basmati Rice, Wireless Communication System-ISRO) • Industrial Design: Meaning, Registration and Infringement (Apple iPhone, Charkha Redesign – National Innovation Foundation (Ahmedabad)) • Trademark: Definition, Types, Registration Process • Trade mark Case study: google-Wordsmark, Amul: Word and character		
Unit 3: Copyright, Related rights, GI and Protection for biological materials	**10**	**16**
• Copyright: Definition, scope, subject matter, procedure (Case study: KBC Theme Music, Windows Operating System) • Geographical Indications (GI): Concept, legal protection, Indian examples (Case study: Gir Kesar Mango, Darjeeling Tea) • Protection for Biological Materials (plant variety protection (PPV), Biodiversity Act) • Case study of PPV (Pusa Basmati-1121 Rice-IARI, COVID-19 mRNA Vaccine Technology)		

Reference Books:

1. P Narayan, Intellectual Property Law, Eastern Law House
2. Intellectual Property Handbook, WIPO Publications
3. Intellectual Property Law Bare Act, LexisNexis, New Delhi
4. V. K. Ahuja, Intellectual Property Rights, LexisNexis, New Delhi
5. Looking Good, WIPO Publications
6. IPRs: NPTEL resource

E-resources:

1. Subramanian, N., & Sundararaman, M. (2018). Intellectual Property Rights – An Overview. Retrieved from (http://www.bdu.ac.in/cells/ipr/docs/ipr-eng-ebook.pdf)
2. World Intellectual Property Organisation. (2004). WIPO Intellectual property Handbook. Retrieved from https://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo_pub489.pdf)

B.Sc. Honours/ Honours with Research in Microbiology
(NCrF Level- 5.5 third Year – B.Sc. in Microbiology)

Semester VI

Course Category	**Minor Practical -6**
Title of the Course	**Minor -6P: Overview of IPR**
Course Credit	**02**
Teaching Hours per Sem.	**60**
Total Marks	**CCE- 50 marks**

1	Employability/Entrepreneurship/Skill Development પર કેન્દ્રિત થયેલ છે કે નહિ?					Yes/~~No~~
2	Value added Courses Imparting Transferable and Life Skills નાગુણોધરાવેછે?					Yes/~~No~~
3	Major		Yes/~~No~~	Minor		~~Yes~~/No
	Skill Enhancement Courses		Yes/~~No~~	Ability Enhancement Courses		Yes/~~No~~
	Value Added Courses		~~Yes~~/No	Exit/ Vocational Courses		~~Yes~~/No
4	Holistic Education	Yes/~~No~~	Multidisciplinary	~~Yes~~/No	Interdisciplinary	~~Yes~~/No
5	દિવ્યાંગમાટેવિષયઅંતર્ગતઆનુસાંગિકજોગવાઈકરાયેલછે ?					Yes/~~No~~
6	New India Literacy Programme (NILP) મુજબ નો વિષય છે?					Yes/~~No~~
7	Swayam પ્લેટફોર્મપરના MOOC વિષય પર આધારિત આ વિષય છે?					~~Yes~~/No
8	ઇન્ડીયન નોલેજ સીસ્ટમ (IKS) પર આધારિત વિષય છે ?					Yes/~~No~~

Course Outcomes:

At the end of the course, the student shall be able to:

1. Apply for patent and other IPR.
2. Differentiate among procedure to apply for different IPR and can comprehend the consequences of infringement

Minor Practical- 5:
Minor -5P: Overview of IPR – Practical

1. To understand the concept of IPR and classify various forms of IP
2. To gain hands-on experience in patent search
3. To analyze a granted patent and its significance (Case Review)
4. Geographical Indication (GI) Case Study
5. Case Study on Trademark and Brand Protection
6. To study and understand the concept of Geographical Indication (GI) through a case study of an Indian GI product

Reference Books:

1. P Narayan, Intellectual Property Law, Eastern Law House
2. Intellectual Property Handbook, WIPO Publications
3. Intellectual Property Law Bare Act, LexisNexis, New Delhi
4. V. K. Ahuja, Intellectual Property Rights, LexisNexis, New Delhi
5. Looking Good, WIPO Publications
6. IPRs: NPTEL resource

E-resources:

1. Subramanian, N., & Sundararaman, M. (2018). Intellectual Property Rights – An Overview. Retrieved from (http://www.bdu.ac.in/cells/ipr/docs/ipr-eng-ebook.pdf)
2. World Intellectual Property Organisation. (2004). WIPO Intellectual property Handbook. Retrieved from https://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo_pub489.pdf)

Annexure to B.Sc. Honours/ Honours with Research in Microbiology
(NCrF Level- 5.5 Third Year – B.Sc. Degree in Microbiology)

Semester VI

MAJOR COURSE – INTERNSHIP – 4 Credit CONCEPT NOTE

Concept note for **'Internship'** a 4-credit course offered in 3rd year exit semester-6 at NCrF 5.5 level to earn B.Sc. degree; in context to GoG & SU- SOP in light of NEP 2020.

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1. Background & Rationale

In line with the National Education Policy (NEP) 2020, which emphasizes work-integrated, experiential, and learner-centric education, the proposed "Internship" course is designed to bridge the gap between theoretical knowledge and practical application. This course is aimed at final-year (3rd year exit semester-6) students pursuing a B.Sc. degree. It will equip students with hands-on experience, enhance their professional skills, and improve their employability in a rapidly evolving job market.

2. Course Overview

- **Title:** Internship
- **Credit Value:** 4 Credits
- **Eligibility:** Final year (3rd year exit semester-6) students enrolled in B.Sc. programs

Mode: On-site industry placement, research project, or institution-based internship

- **Duration:** Typically 4-6 weeks-120 Hrs. during the final semester (flexibility as per internship partner requirements)

3. Objectives

- **Integrate Theory with Practice:** Enable students to apply classroom knowledge to real-world problems.
- **Develop Professional Competencies:** Foster soft skills (communication, teamwork, problem-solving) and technical competencies.
- **Industry Exposure:** Provide direct exposure to industry practices, research environments, or applied settings.
- **Enhance Employability:** Prepare students for the job market by building relevant work experience and professional networks.
- **Promote Lifelong Learning:** Encourage self-directed learning and adaptability through practical challenges.

4. Expected Outcomes

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

- Demonstrate the application of theoretical concepts to practical scenarios.
- Analyze and solve real-world problems in their respective fields.
- Communicate effectively with industry professionals and peers.
- Develop and present a comprehensive project report reflecting their internship experience.
- Exhibit improved professional and interpersonal skills essential for future employment.

5. Alignment with NEP 2020

The course supports NEP 2020's focus on:

- **Experiential Learning:** By integrating internships into the curriculum, students gain firsthand experience in their fields.
- **Industry-Academia Collaboration:** The course fosters partnerships with industry and research organizations, creating a two-way learning environment.
- **Holistic Education:** Emphasizing practical skills alongside theoretical knowledge prepares students for diverse professional challenges.

Implementation Guidelines for the "Internship" Course

A. Internship Placement & Partnerships

1. **Establish Collaborations:**
   - Forge MOUs with relevant industries, research institutes, and laboratories in the respective fields.
   - Leverage existing industry networks and alumni connections.
2. **Internship Cell:**
   - Create a dedicated internship cell within the placement/industry relations office to coordinate opportunities and monitor progress.

B. Student Selection & Matching Eligibility & Application:

- As per the provision made in GoG- SOP pg.71 – Table- 9.2

C. Internship Duration & Scheduling

1. **Timeline:**
   - The internship should be completed over 4-6 weeks-120 hrs. during the final semester.
   - Flexibility can be provided based on the nature and requirements of the placement.
2. **Scheduling:**
   - Coordinate with academic departments to ensure minimal disruption to ongoing academic requirements.

D. Supervision & Mentorship

1. **Dual Mentorship:**
   - Assign an on-site industry/research mentor and an internal faculty mentor for

each student.
    - Conduct regular check-ins and progress reviews.
2. **Documentation:**
    - Maintain a logbook or journal where students record daily activities, challenges, and learning outcomes.

E. Assessment & Evaluation

1. **Components of Assessment:**
    - **Project Report:** Detailed documentation of tasks, learning experiences, and outcomes.
    - **Presentation:** A formal presentation summarizing the internship experience and project outcomes.
    - **Mentor Feedback:** Evaluation from both the industry and academic mentors.

2. **Grading Criteria:**
    - Define clear rubrics covering technical competence, application of knowledge, problem-solving skills, and communication.

F. Documentation & Certification

1. **Submission Guidelines:**
    - Establish standardized formats for the internship report and presentation.
    - Set submission deadlines and provide templates as needed.
2. **Certification:**
    - Issue an internship certificate upon successful completion, signed by the industry mentor and the academic coordinator.

G. Monitoring & Continuous Improvement

1. **Feedback Mechanism:**
    - Collect feedback from students, mentors, and industry partners post-internship.
    - Use insights to refine future internship placements and course structure.

2. **Periodic Review:**
    - Conduct annual reviews of the internship program to ensure alignment with academic goals and industry trends.

ASSESSMENT & EVALUATION

Below is a detailed framework for evaluating the Internship course that incorporates both continuous internal evaluation and a robust semester-end evaluation, along with a structured progress diary for ongoing monitoring.

1. <u>Continuous Internal Evaluation Components</u>

A. Daily/Weekly Progress Logs

- **Task Documentation:**
  • Students maintain a log of daily tasks, assignments, and activities performed

at the internship site.

• Logs should capture key actions, technical skills practiced, and challenges encountered.

- **Reflective Journal/ Diary/Report:**
  • A weekly reflective entry where students discuss learning experiences, personal growth, and adjustments made in response to challenges.

  • Encourages self-assessment and critical reflection on the work process.

B. Mentor and Faculty Check-ins

- **On-Site Mentor Feedback:**
  • Weekly feedback forms filled by the on-site industry/research mentor.

  • Evaluates aspects like punctuality, work quality, initiative, teamwork, and problem- solving ability.
- **Academic Supervisor Interaction:**
  • Bi-weekly virtual or in-person meetings between the student and a designated faculty mentor.

  • Focus on aligning internship outcomes with academic objectives and ensuring compliance with learning goals.

C. Mid-Internship Review

- **Progress Presentation:**
  • At the mid-point, students present a brief progress report (using a poster or slide deck) to both on-site and academic mentors.

  • This review is used to identify any gaps and suggest corrective measures.
- **Structured Evaluation Form:**
  • An evaluation form that captures key performance indicators (KPIs) like application of theoretical concepts, problem-solving skills, communication, and professional behavior. • The evaluation should be documented and submitted to the academic office.

D. Weightage:

- Continuous evaluation (including daily/weekly logs, mid-term review, and mentor check- ins) can account for **50%** of the overall internship grade.

2. Semester End Evaluation Components

A. Final Project Report

- **Detailed Documentation:**
  • A comprehensive report that covers objectives, methodologies, challenges faced, and outcomes.

  • Inclusion of data, analysis, reflections, and recommendations for future work.

- **Quality and Depth:**
  • Emphasis on clarity, analytical depth, and integration of theoretical and practical knowledge.

B. Final Presentation and Viva-Voce

- **Formal Presentation:**
  • A structured presentation (15–20 minutes) summarizing the internship experience and key learning outcomes.

  • Use of visual aids (slides, posters) to demonstrate the project work.

- **Oral Examination:**
  • A viva-voce session conducted by both academic and industry evaluators to probe deeper into the student's understanding and contributions.

C. Mentor Evaluations

- **Comprehensive Feedback:**
  • Final feedback forms from both the on-site mentor and academic supervisor covering overall performance, growth, and readiness for professional challenges.

D. Weightage:

- The semester-end evaluation (project report, final presentation, and mentor feedback) can account for **50%** of the total grade.

3. Progress Diary for Monitoring

A structured progress diary should be maintained by each student. Below is a sample template:

Date	Tasks Undertaken	Learning Outcomes	Challenges/Issues	Actions Taken/Planned	Mentor Feedback (if any)
DD/MM/YYYY	- Task details- Tools used	- Skills learned- Knowledge applied	- Specific challenge- Resource gaps	- Immediate actions- Future strategy	- Comments- Suggestions

Date	Tasks Undertaken	Learning Outcomes	Challenges/Issues	Actions Taken/Planned	Mentor Feedback (if any)
DD/MM/YYYY	…	…	…	…	…

Key Features of the Diary:

- **Frequency:** Entries should be made daily or weekly, depending on the internship's intensity.
- **Reflection:** Encourage students to note personal reflections on their growth and areas for improvement.
- **Review:** The diary is reviewed during mentor check-ins and the mid-internship review to monitor progress and to provide targeted support.
- **Submission:** A compiled version of the progress diary is submitted along with the final project report as evidence of continuous learning and engagement.

Comprehensive framework that includes detailed rubrics for both overall internship evaluation and mapping of Course Outcomes (COs) to Program Outcomes (POs):

Evaluation Rubrics for the Internship Course

A. Overall Internship Evaluation Criteria

Criterion	Excellent (4)	Good (3)	Satisfactory (2)	Needs Improvement (1)	Weightage
Work Quality & Technical Skills	Work is innovative, highly accurate, and demonstrates exceptional application of theoretical concepts.	Work is well executed with minor errors; sound technical application is evident.	Meets basic requirements but shows noticeable errors or limited technical depth.	Work is below expectations; errors and gaps in applying theoretical knowledge are evident.	20%

Reflective Diary & Learning Log	Daily/weekly entries are thorough, insightful, and show deep reflection on challenges, learning outcomes, and actions.	Entries are regular and reflective, demonstrating clear learning and some critical analysis.	Entries are inconsistent with limited reflections or superficial documentation.	Few or no entries; minimal reflection and lack of documented learning are evident.	10%

Criterion	Excellent (4)	Good (3)	Satisfactory (2)	Needs Improvement (1)	Weightage
Mentor & Faculty Feedback	Consistently proactive, highly engaged with mentors; excellent teamwork, communication, and initiative are shown.	Generally meets expectations; good communication and collaboration with both mentors and faculty.	Partially meets expectations; occasional delays or gaps in communication are observed.	Rarely engages or communicates effectively; feedback consistently indicates significant issues.	10%
Project Report Quality	Report is comprehensive, analytically rigorous, well-organized, and clearly integrates theory with practice.	Report is structured and detailed with adequate analysis and clear connections between theory and practice.	Report meets minimum requirements but lacks depth, clarity, or comprehensive analysis.	Report is poorly structured, with insufficient analysis and lack of clarity in integrating theory.	30%
Final Presentation & Viva-Voce	Presentation is clear, confident, engaging, and supported by effective visual aids; excellent responses during Q&A.	Presentation is organized and clear with good use of visuals; responses are adequate.	Presentation meets basic requirements but may lack depth or clarity; Q&A responses are limited.	Presentation is unclear and poorly organized; responses during Q&A are unsatisfactory.	30%

Important: The overall grade for the internship will be a weighted sum of these components, with continuous internal evaluation contributing 50% and semester-end evaluation contributing 50%.

B. Attainment Levels for Each CO

For each CO, the following attainment levels can be used:

- **Level 4 (Excellent):**
  - **Indicators:** Student consistently demonstrates exceptional understanding and application; evidence of innovative and analytical thinking is abundant; all documentation is thorough and reflective.
- **Level 3 (Good):**
  - **Indicators:** Student demonstrates solid understanding and application with minor areas for improvement; documentation is clear and reflective; innovative elements are present but could be expanded.
- **Level 2 (Satisfactory):**
  - **Indicators:** Student meets minimum expectations; application and reflection are evident but lack depth or consistency; some areas require further development.
- **Level 1 (Needs Improvement):**
  - **Indicators:** Student shows significant gaps in understanding or application; documentation is minimal or superficial; there is limited evidence of reflective learning or innovation.

ASSESSMENT & EVALUATION

Total Engagement: For a 4-credit internship course at the NCrF 5.5 level, the total engagement is designed to be both intensive and flexible, balancing real-world exposure with academic oversight.

- **Total Engagement:** Approximately minimum 120 hours over the internship period.
- **Duration:** Typically 4-6 weeks.
- **Suggested Daily Breakdown Options:**
  - **Option 1:** 4 hours per day for 5 days a week
  - **Option 2:** 5 hours per day for 4 days a week
- **Suggested Additional Academic Activities:**

In addition to the on-site internship hours, students should allocate about 1 or 2 hours per week for:

- Meeting with academic and industry mentors
- Maintaining and reviewing progress diaries
- Working on the final project report and preparing for presentations

Assessment Weightage: CCE- 50%: SEE-50%

Total Credits: 04 **Total Marks: 100**

1. Continuous Internal Evaluation (50 Marks Total)

- **Daily/Weekly Progress Log & Reflective Diary:** 15 Marks

Consistent, insightful entries demonstrating daily activities, reflections, and learning outcomes.

- **Mentor & Faculty Check-ins:** 10 Marks

Regular, constructive feedback from on-site and academic mentors; demonstration of proactive engagement.

- **Mid-Internship Review (Presentation & Structured Evaluation):** 15 Marks

Quality of interim progress presentation and performance during mid-term review.

- **Ongoing Project Updates & Feedback Implementation:** 10 Marks

Evidence of integrating feedback and continuous improvement throughout the internship.

2. Semester-End Evaluation (50 Marks Total)

- **Final Project Report:** 20 Marks

Comprehensive documentation covering objectives, methodology, challenges, analysis, and reflective conclusions.

- **Final Presentation & Viva-Voce:** 20 Marks

Clarity, organization, use of visual aids, and effectiveness in communicating results during the presentation and Q&A.

- **Overall Mentor Evaluations (Industry & Academic):** 10 Marks

Final assessment by mentors on professional conduct, technical competence, and integration of theoretical knowledge.

SN	Criteria	Max. Marks	Marks Obtained
CCE Components			
1.	Daily/ Weekly progress report	15	
2.	Mid Internship Review (after 60 hrs.)	15	
3.	Project Update & Academic Mentor feedback	10	
4.	Project Update & Internship Mentor feedback	10	
	Total CCE Marks	**50**	
SEE Components			
1	Documentation and find report	20	
2	Presentation & Viva voce	20	
3	Over all Academic & Industry Mentor Evaluation	10	
	Total SEE marks	**50**	
	Total Marks	**100**	