



# Dr. N.G.P. ARTS AND SCIENCE COLLEGE

(An Autonomous Institution, Affiliated to Bharathiar University, Coimbatore)  
Approved by Government of Tamil Nadu & Accredited by NAAC with A++ Grade (3<sup>rd</sup> Cycle - 3.64 CGPA)  
Dr. N.G.P. - Kalapatti Road, Coimbatore - 641048, Tamil Nadu, India  
Web: [www.drngpasc.ac.in](http://www.drngpasc.ac.in) | Email: [info@drngpasc.ac.in](mailto:info@drngpasc.ac.in) | Phone: +91-422-2369100

## Regulations 2023 - 24 for Undergraduate Programme

(Outcome Based Education model with Choice Based Credit System)

### M.Sc Microbiology Degree

(For the students admitted during the academic year 2023-24 and onwards)

#### Programme : Microbiology

#### ELIGIBILITY:

A pass in any one of the following Degree Course of B.Sc. Microbiology / Biotechnology / Biology / Botany / Zoology / Plant Science / Animal Sciences / Biochemistry / Bioinformatics / Environmental Science / Food and Nutrition / Clinical Lab Technology of any University in Tamil Nadu or an Examination accepted as equivalent thereto by the Academic Council, Course to such conditions as may be prescribed thereto are permitted to appear and qualify for the **M.Sc., Microbiology Examination** of this College after a course study of two academic years.

#### PROGRAMME OBJECTIVES:

The Curriculum is designed to attain the following learning goals which students shall accomplish by the time of their graduation to:

1. Present intense knowledge in areas of organization and functioning of microorganisms.
2. Familiarize with the operations of bio instruments and related techniques.
3. Enable students to understand the applications of microbiology in healthcare, agriculture, food technology and environmental protection.
4. Provide opportunities to develop skills and participate in Research Projects.



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## Programme Outcomes

On the successful completion of the programme, the following are the expected outcomes.

PO Number	PO Statement
PO1	To impart knowledge of various branches of Microbiology and to understand the role of microorganisms in human welfare and sustainable development.
PO2	To acquire skills in the techniques used to observe and study the nature of microorganisms and the techniques, skills, and modern tools necessary for biological practice.
PO3	To appreciate the complexities of microbiological processes for industrial and other purposes, especially the genetic manipulation of microorganisms for the production of antibiotics, hormones, etc.
PO4	To inculcate broad education necessary to understand the impact of microbiological solutions in a global and societal context; an ability to function in multi-disciplinary teams; To develop the ability to identify, formulate, and solve biological problems and to design and conduct experiments, as well as to analyze and interpret data.
PO5	To create awareness of contemporary issue and to appreciate the applications of Microbiology to become an entrepreneur.






## CURRICULUM

## M.SC MICROBIOLOGY

Course Code	Course Category	Course Name	L	T	P	Exam (h)	Max Marks			Credits
							CIA	ESE	Total	
First Semester										
233MB2A1CA	Core - I	Fundamentals of Microbiology	4	-	-	3	25	75	100	4
233MB2A1CB	Core - II	Microbial Physiology and Bacterial Diversity	4	-	-	3	25	75	100	4
233MB2A1CC	Core - III	Mycology, Phycology and Lichenology	4	-	-	3	25	75	100	4
233MB2A1CD	Core - IV	Comprehensive Biology	3	1	-	3	25	75	100	3
233MB2A1CE	Core - V	Bio Analytical Techniques	3	1	-	3	25	75	100	3
233MB2A1CP	Core Practical - I	Basic Techniques in Microbiology	-	-	6	9	40	60	100	3
233MB2A1DA	DSE - I	Microbial Technology	3	1	-	3	25	75	100	3
233BC2A1DA		Cancer Biology, Diagnosis and Therapy								
233BT2A1DA		Applied Biotechnology								
Total			21	3	6				700	24

*[Signature]*  
 BoS Chairman/HOD  
 Department of Microbiology  
 Dr. N. G. P. Arts and Science College  
 Coimbatore - 641 048

 <b>Dr.N.G.P. Arts and Science College</b>		
<b>APPROVED</b>		
BoS- 15th 10/06/2023	AC - 15th 14/07/2023	GB - 20th 05/08/2023



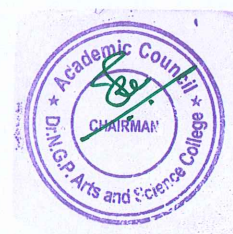
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Course Code	Course Category	Course Name	L	T	P	Exam (h)	Max Marks			Credits
							CIA	ESE	Total	
Second Semester										
233MB2A2CA	Core - VI	Microbial Genetics	4	-	-	3	25	75	100	4
233MB2A2CB	Core - VII	Immunology and Immunotechniques	4	-	-	3	25	75	100	4
233MB2A2CC	Core - VIII	Virology	4	-	-	3	25	75	100	4
233MB2A2CD	Core - IX	Medical Bacteriology	3	1	-	3	25	75	100	3
233MB2A2CE	Core - X	Recombinant DNA Technology	3	1	-	3	25	75	100	3
233MB2A2CP	Core Practical -II	Immunology and Molecular Techniques	-	-	6	9	40	60	100	3
233MB2A2DA	DSE - II	Bionanotechnology	3	1	-	3	25	75	100	3
233BC2A2DA		Biochemistry of Toxicology								
233BT2A2DA		Forensic Biotechnology								
Total			21	3	6	-	-		700	24

*[Signature]*  
**BoS Chairman/HOD**  
**Department of Microbiology**  
**Dr. N. G. P. Arts and Science College,**  
**Coimbatore - 641 048**

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<b>APPROVED</b>		
BoS-16 <sup>th</sup> 18.10.23	AC-16 <sup>th</sup> 13.12.23	GB-21 <sup>st</sup> 05.01.24



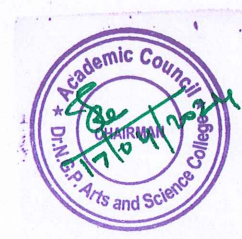
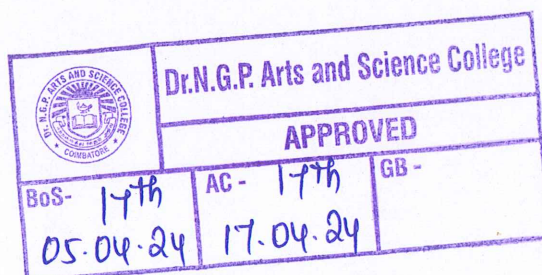
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Course Code	Course Category	Course Name	L	T	P	Exam (h)	Max Marks			Credits
							CIA	ESE	Total	
Third Semester										
233MB2A3CA	Core - XI	Environmental and Agricultural Microbiology	4	-	-	3	25	75	100	4
233MB2A3CB	Core - XII	Medical Mycology and Parasitology	4	-	-	3	25	75	100	4
233MB2A3CC	Core - XIII	Pharmaceutical Microbiology and Quality Assurance	4	-	-	3	25	75	100	4
233MB2A3CD	Core - XIV	Food Microbiology and Food Quality Control	4	-	-	3	25	75	100	4
233MB2A3CE	Core - XV	Research Methodology and Biostatistics	3	1	-	3	25	75	100	3
233MB2A3CP	Core Practical - III	Applied Microbiological Techniques	-	-	6	9	40	60	100	3
233MB2A3CT	IT	Internship	-	-	-	-	40	60	100	2
233MB2A3DA	DSE - III	Medical Laboratory Techniques	3	1	-	3	25	75	100	3
233BC2A3DA		Free Radicals and Antioxidant System								
233BT2A3DA		Molecular Therapeutics								
Total			22	2	6	-	-	-	800	27

*[Signature]*  
17/4/24  
BoS Chairman/HOD  
Department of Microbiology  
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Course Code	Course Category	Course Name	L	T	P	Exam (h)	Max Marks			Credits
							CIA	ESE	Total	
Fourth Semester										
233MB2A4CA	Core - XVI	Fermentation Technology	4	1	-	3	25	75	100	3
233MB2A4CB	Core - XVII	Bioethics, Biosafety and IPR	4	1	-	3	25	75	100	3
233MB2A4CV	Core-XVIII	Project and Viva - voce	-	-	16	-	80	120	200	8
233MB2A4DA	DSE - IV	Molecular Diagnostics and Bioinformatics	3	1		3	25	75	100	3
233BC2A4DA		Neurobiology								
233BT2A4DA		Stem Cell Technology								
Total			11	3	16				500	17
*Grand Total									2700	92

  
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Self study paper offered by the Department of Microbiology

S. No.	Semester	Course Code	Course Title
1.	III	233MB2ASSA	Developmental Biology
2.		233MB2ASSB	Inheritance Biology



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**PG REGULATION (R5)**  
**(2023-24 and onwards)**  
**(OUTCOME BASED EDUCATION WITH CBCS)**

Effective from the academic year 2023-24 and applicable to the students admitted to the Degree of Master of Arts/Commerce/Management/Science.

**1. NOMENCLATURE**

**1.1 Faculty:** Refers to a group of programmes concerned with a major division of knowledge. Eg. Faculty of Computer Science consists of Programmes like Computer Science, Information Technology, Computer Technology, Computer Applications, Cognitive Systems, Artificial Intelligence and Machine Learning and Cyber Security and Data Analytics etc.

**1.2 Programme:** Refers to the Master of Arts/Management/Commerce/Science Stream that a student has chosen for study.

**1.3 Batch:** Refers to the starting and completion year of a programme of study. Eg. Batch of 2023–2025 refers to students belonging to a 2-year Degree programme admitted in 2023 and completing in 2025.

**1.4 Course:** Refers to component of a programme. A course may be designed to involve lectures / tutorials / laboratory work / seminar / project work/ practical training / report writing / Viva voce, etc or a combination of these, to effectively meet the teaching and learning needs and the credits may be assigned suitably.

**a) Core Courses** A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course.

**b) Extra Departmental Course (EDC):** A course chosen generally from a related discipline/subject, with an intention to seek exposure in the discipline relating to the core domain of the student.



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c) **Discipline Specific Elective Course (DSE):** Elective courses are offered under main discipline/ subject of study.

**d) Internship/Industrial Training (IT)**

Students must undertake industrial / institutional training for a minimum of 15 days during the II semester summer vacation. The students will submit the report for evaluation during III semester.

e) **Project Work:** It is considered as a special course involving application of knowledge in problem solving/analyzing/exploring a real-life situation. The Project work will be given in lieu of a Core paper.

f) **Extra credits** Extra credits will be awarded to a student for achievements in co-curricular activities carried out outside the regular class hours. The guidelines for the award of extra credits are given in section two, these credits are not mandatory for completing the programme.

g) **Advanced Learner Course (ALC):** ALC is doing work of a higher standard than usual for students at that stage in their education. Research work / internships carried out in University/ Research Institutions/ Industries of repute in India or abroad for a period of 15 to 30 days.

## 2. STRUCTURE OF PROGRAMME

- Core Course
- Extra Departmental Course (EDC)
- Discipline Specific Elective (DSE)
- Industrial Training (IT)
- Project

## 3. DURATION OF THE PROGRAMME

M.Sc. /M.Com. / M.A. Programme must be completed within 2 Years (4 semesters) and maximum of 4 Years (8 semesters) from the date of acceptance to the programme. If not, the candidate must enroll in the course determined to be an equivalent by BoS in the most recent curriculum recommended for the Programme.



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#### 4. REQUIREMENTS FOR COMPLETION OF A SEMESTER

Every student shall ordinarily be allowed to keep terms for the given semester in a program of his/ her enrolment, only if he/ she fulfills at least seventy five percent (75%) of the attendance taken as an average of the total number of lectures, practicals, tutorials, etc. wherein short and/or long excursions/field visits/study tours organised by the college and supervised by the faculty as envisaged in the syllabus shall be credited to his attendance. Every student shall have a minimum of 75% as an overall attendance.

#### 5. EXAMINATIONS

The end semester examinations shall normally be conducted after completing 90 working days for each semester. The maximum marks for each theory and practical course as follows,

##### Mark distribution for Theory Courses

Continuous Internal Assessment (CIA) :	40 Marks
End Semester Exams (ESE)	: 60 Marks
Total	: 100 Marks

##### i) Distribution of Internal Marks

S.No.	Particulars	Distribution of Marks
1	CIA I (2.5 Units) (On completion of 45 <sup>th</sup> working day)	5
2	Model ( All 5 Units) (On completion of 85 <sup>th</sup> working day)	5
3	Attendance	05
4	Library Usage	05
5	Skill Enhancement *	05
<b>Total</b>		<b>25</b>

##### Breakup for Attendance Marks:

S.No	Attendance Range	Marks Awarded
1	95% and Above	5
2	90% - 94%	4
3	85% - 89%	3
4	80% - 84%	2
5	75% - 79%	1





**Note:**

Special Cases such as NCC, NSS, Sports, Advanced Learner Course, Summer Fellowship and Medical Conditions etc. the attendance exemption may be given by principal and Mark may be awarded.

**Break up for Library Marks:**

S.No	Attendance Range	Marks Awarded
1	10h and above	5
2	9h- less than 10h	4
3	8h - less than 9h	3
4	7h - less than 8h	2
5	6h - less than 7h	1

**Note:**

In exception, the utilization of e-resources of library will be considered.

**\*Components for "Skill Enhancement" may include the following:**

Class Participation, Case Studies Presentation/Term paper, Field Study, Field Survey, Group Discussion, Term Paper, Presentation of Papers in Conferences, Industry Visit, Book Review, Journal Review, e-content Creation, Model Preparation, Seminar and Assignment.

**Components for Skill Enhancement**

Any one of the following should be selected by the course coordinator

S.No.	Skill Enhancement	Description
1	Class Participation	<ul style="list-style-type: none"> <li>• Engagement in class</li> <li>• Listening Skills</li> <li>• Behaviour</li> </ul>
2	Case Study Presentation/ Term Paper	<ul style="list-style-type: none"> <li>• Identification of the problem</li> <li>• Case Analysis</li> <li>• Effective Solution using creativity/imagination</li> </ul>
3	Field Study	<ul style="list-style-type: none"> <li>• Selection of Topic</li> <li>• Demonstration of Topic</li> <li>• Analysis &amp; Conclusion</li> </ul>
4	Field Survey	<ul style="list-style-type: none"> <li>• Chosen Problem</li> <li>• Design and quality of survey</li> <li>• Analysis of survey</li> </ul>



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5	Group Discussion	<ul style="list-style-type: none"> <li>• Communication skills</li> <li>• Subject knowledge</li> <li>• Attitude and way of presentation</li> <li>• Confidence</li> <li>• Listening Skill</li> </ul>
6	Presentation of Papers in Conferences	<ul style="list-style-type: none"> <li>• Sponsored</li> <li>• International/National</li> <li>• Presentation</li> <li>• Report Submission</li> </ul>
7	Industry Visit	<ul style="list-style-type: none"> <li>• Chosen Domain</li> <li>• Quality of the work</li> <li>• Analysis of the Report</li> <li>• Presentation</li> </ul>
8	Book Review	<ul style="list-style-type: none"> <li>• Content</li> <li>• Interpretation and Inferences of the text</li> <li>• Supporting Details</li> <li>• Presentation</li> </ul>
9	Journal Review	<ul style="list-style-type: none"> <li>• Analytical Thinking</li> <li>• Interpretation and Inferences</li> <li>• Exploring the perception if chosen genre</li> <li>• Presentation</li> </ul>
10	e-content Creation	<ul style="list-style-type: none"> <li>• Logo/ Tagline</li> <li>• Purpose</li> <li>• Content (Writing, designing and posting in Social Media)</li> <li>• Presentation</li> </ul>
11	Model Preparation	<ul style="list-style-type: none"> <li>• Theme/ Topic</li> <li>• Depth of background Knowledge</li> <li>• Creativity</li> <li>• Presentation</li> </ul>
12	Seminar	<ul style="list-style-type: none"> <li>• Knowledge and Content</li> <li>• Organization</li> <li>• Understanding</li> <li>• Presentation</li> </ul>
13	Assignment	<ul style="list-style-type: none"> <li>• Content and Style</li> <li>• Spelling and Grammar</li> <li>• References</li> </ul>





## ii) Distribution of External Marks

<b>Total</b>	<b>:</b>	<b>75</b>
<b>Written Exam</b>	<b>:</b>	<b>75</b>

## Marks Distribution for Practical course

<b>Total</b>	<b>:</b>	<b>100</b>
<b>Internal</b>	<b>:</b>	<b>40</b>
<b>External</b>	<b>:</b>	<b>60</b>

### i) Distribution of Internals Marks

S. No.	Particulars	Distribution of Marks
1	Experiments/Exercises	15
2	Test 1	10
3	Test 2	10
4	Observation Notebook	05
<b>Total</b>		<b>40</b>

### ii) Distribution of Externals Marks

S.No.	Particulars	External Marks
1	Practical	40
2	Record	10
3	Viva- voce	10
<b>Total</b>		<b>60</b>

Practical examination shall be evaluated jointly by Internal and External Examiners.

### A) Mark Distribution for Project

<b>Total</b>	<b>:</b>	<b>200</b>
<b>Internal</b>	<b>:</b>	<b>80</b>
<b>External</b>	<b>:</b>	<b>120</b>

### i) Distribution of Internal Marks

S.No.	Particulars	Internal Marks
1	Review I	30
2	Review II	40
3	Attendance	10
<b>Total</b>		<b>80</b>



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## ii) Distribution of External Marks

S.No	Particulars	External Marks
1	Project Work & Presentation	100
2	Viva -voce	20
<b>Total</b>		<b>120</b>

Evaluation of Project Work shall be done jointly by Internal and External Examiners.

## 6 . Credit Transfer

a. Upon successful completion of 1 NPTEL Course (4 Credit Course) recommended by the department, during Semester I to II, a student shall be eligible to get exemption of one **4 credit course** during the 3<sup>rd</sup> semester. The proposed NPTEL course should cover content/syllabus of exempted core paper in 3<sup>rd</sup> semester.

S. No.	Course Code	Course Name	Proposed NPTEL Course	Credit
1			Option - 1 Paper title	4
			Option - 2 Paper title	
			Option - 3 Paper title	

b. Upon successful completion of 2 NPTEL Courses (2 Credit each) recommended by the department, during Semester I to II, a student shall be eligible to get exemption of **one 4 credit course** during the 3<sup>rd</sup> semester. Out of 2 NPTEL proposed courses, **at least 1 course** should cover content/syllabus of exempted core paper in 3<sup>rd</sup> semester.

### Mandatory

The exempted core paper in the 3<sup>rd</sup> semester should be submitted by the students for approval before the end of 2<sup>nd</sup> semester

Credit transfer will be decided by equivalence committee



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S. No.	Course Code	Course Name	Proposed NPTEL Course	Credit
1			Option - 1 Paper title	2
			Option - 2 Paper title	
			Option - 3 Paper title	
2			Option - 1 Paper title	2
			Option - 2 Paper title	
			Option - 3 Paper title	

NPTEL Courses to be carried out during semester I – II.					
S. No.	Student Name	Class	Proposed NPTEL Course		Proposed Course for Exemption
			Course I	Option 1- Paper Title Option 2- Paper Title Option 3- Paper Title	Any one Core Paper in 3 <sup>rd</sup> Semester
			Course II	Option 1- Paper Title Option 2- Paper Title Option 3- Paper Title	
Class Advisor		HoD		Dean	

### 7. Internship/Industrial Training

#### Mark Distribution for Internship/ Industrial Training

Total	:	100
Internal	:	40
External	:	60

#### i) Distribution of Internal Marks

S.No.	Particulars	Internal Marks
1	Review I	15
2	Review II	20
3	Attendance	5
Total		40



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## ii) Distribution of External Marks

S.No	Particulars	External Marks
1	Internship /Industrial training Presentation	40
2	Viva -voce	20
<b>Total</b>		<b>60</b>

Internship/ Industrial training shall be evaluated jointly by Internal and External Examiners.

## 9. Extra Credits: 10

Earning extra credit is not essential for programme completion. Student is entitled to earn extra credit for achievement in Curricular/Co-Curricular/ Extracurricular activities carried out other than the regular class hours.

A student is permitted to earn a maximum of 10 extra Credits during the programme period.  
A maximum of 1 credit under each category is permissible.

Category	Credit
Self study Course	1
CA/ICSI/CMA (Foundations)	1
CA/ICSI/CMA (Inter)	1
Sports and Games	1
Publications / Conference Presentations (Oral/Poster)/ Awards	1
Innovation / Incubation / Patent / Sponsored Projects / Consultancy	1
Representation in State / National level celebrations	1
Awards/Recognitions/Fellowships	1
<b>Advanced Learner Course (ALC)*</b>	<b>2</b>

Credit shall be awarded for achievements of the student during the period of study only.

## GUIDELINES

### Self study Course

A pass in the self study courses offered by the department.

The candidate should register the self study course offered by the department only in the III semester.



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**CA/ICSI/CMA(Foundations)**

Qualifying foundation in CA/ICSI/CMA / etc.

**CA/ICSI/CMA(Inter)**

Qualifying Inter in CA/ICSI/CMA / etc.

**Sports and Games**

The Student can earn extra credit based on their Achievement in sports in University / State / National/ International.

**Publications / Conference Presentations (Oral/Poster)**

Research Publications in Journals

Oral/Poster presentation in Conference

**Innovation / Incubation / Patent / Sponsored Projects / Consultancy**

Development of model/ Products /Prototype /Process/App/Registration of Patents/ Copyrights/Trademarks/Sponsored Projects /Consultancy

**Representation in State/ National level celebrations**

State / National level celebrations such as Independence day, Republic day Parade, National Integration camp etc.

**Awards/Recognitions/Fellowships**

Regional/ State / National level awards/ Recognitions/Fellowships

**\*Advanced Learner Course (ALC):**

ALC is doing work of a higher standard than usual for students at that stage in their education.

Research work/internships carried out in University/ Research Institutions/ Industries of repute in India or abroad for a period of 15 to 30 days will be considered as Advanced Learners Course.



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### QUESTION PAPER PATTERN

#### CIA Test I : [1½ Hours-2.5 Units] - 25 Marks

SECTION	MARKS	DESCRIPTION	TOTAL	Remarks
Section - A	8 x 0.5= 04 Marks	MCQ	25 Marks	Marks secured will be converted To 5 mark
Section - B	3 x 2 = 06 Marks	Answer ALL Questions Either or Type ALL Questions Carry Equal Marks		
Section - C	3 x 05 = 15 Marks			

#### CIA Test II/ Model [3 Hours-5 Units] - 75 Marks

SECTION	MARKS	DESCRIPTION	TOTAL	Remarks
Section - A	10 x 1 = 10 Marks	MCQ		
Section - B	5 x 3 = 15 Marks	Answer ALL Questions (Either or Type Questions) Each Questions Carry Equal Marks	75 Marks	Marks secured will be converted To 5 mark
Section - C	5 x 8 = 40 Marks			
Section - D	1 x 10 = 10 Marks	Compulsory Question		

#### End Semester Examination [3 Hours-5 Units] - 75 Marks

SECTION	MARKS	DESCRIPTION	TOTAL
Section - A	10 x 1 = 10 Marks	MCQ	75 Marks
Section - B	5 x 3 = 15 Marks	Answer ALL Questions (Either or Type Questions) Each Questions Carry Equal Marks	
Section - C	5 x 8 = 40 Marks		
Section - D	1 x 10 = 10 Marks	Compulsory Question	



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Course Code	Course Name	Category	L	T	P	Credit
233MB2A1CA	FUNDAMENTALS OF MICROBIOLOGY	CORE	4	-	-	4

### PREAMBLE

This course has been designed for students to learn and understand

- History of Microorganisms
- Basic techniques in Microbiology
- Characteristics of algae, fungi, protozoa and viruses.

### COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Explain the theories to understand the importance of microorganisms.	K2
CO2	Apply the principles of sterilization and disinfection. Make use of the types of Media.	K3
CO3	Compare and contrast the principles of Microscopy	K2
CO4	Compare and understand the characteristics of algae, fungi and protozoa.	K4
CO5	Compare and understand the characteristics of viruses.	K4

### MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	✓				
CO2	✓	✓	✓	✓	✓
CO3		✓		✓	✓
CO4	✓	✓			
CO5	✓	✓			

<input checked="" type="checkbox"/>	Skill Development	<input type="checkbox"/>	Entrepreneurial Development
<input checked="" type="checkbox"/>	Employability	<input type="checkbox"/>	Innovations
<input type="checkbox"/>	Intellectual Property Rights	<input type="checkbox"/>	Gender Sensitization
<input type="checkbox"/>	Social Awareness/ Environment	<input type="checkbox"/>	Constitutional Rights/ Human Values/ Ethics



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*M.Sc. Microbiology (Students admitted during the AY 2023-24)*



233MB2A1CA	FUNDAMENTALS OF MICROBIOLOGY	SEMESTER I
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Total Credits: 4

Total Instruction Hours: 48 h

### Syllabus

#### Unit I History of Microbiology 10 h

The Historic foundations and development of Microbiology - Spontaneous generation- Germ theory of diseases - Cell theory - Contributions of Antony van Leuwenhoek - Joseph Lister - Robert Koch - Louis Pasteur - Edward Jenner - John Tyndall - Sergei N. Winogradsky - Salmon A. Waksman - Alexander Flemming - Paul Erlich - Fannie Hesse - Elie Metchnikoff, Lederberg and Zinder, Lwoff, Arber and Smith, Temin and Baltimore - Scope of microbiology.

#### Unit II Sterilization and culturing methods 10 h

Sterilization and disinfection - Physical and chemical methods. Culturing of Bacteria - Isolation, purification and Cultivation of different types of Microorganisms -Aerobes and Anaerobes - Culture maintenance and Preservation - Culture Collection centres -ATCC, MTCC and NFMCC.

#### Unit III Microscopy and Staining 10 h

Principles of Microscopy- Light microscope, Inverted microscope, Electron microscope - TEM and SEM, Polarization microscope, Confocal, Perifocal, Atomic force microscope. Stains and staining principles: Simple, Gram, Negative, Capsule, Spore, Flagellar and Acid fast staining.

#### Unit IV Prokaryotes 9 h

Characteristics of Prokaryotic cells - Basic cell types: Prokaryotic cells - Size, shape and Arrangement - Overview of structure - Cell membrane. Internal membrane structure - Cytoplasm- Nucleoid - Inclusions - chlorosomes - carboxysomes - magnetosomes - phycobilisomes -Endospores. External structure - Cell Wall - Flagella and its function - Glycocalyx - Slime layer.

#### Unit V Protozoa, Viruses, Fungi and Algae 9 h

General Characteristics of Protozoa. Structure and Reproduction of Paramecium sp. General Properties of Viruses. Cultivation of Plant and Animal Viruses. Characterization and Enumeration of Viruses-Plant Viruses- CaMV and RNA containing Plant Viruses- TMV. General characteristics of algae- Structure and reproduction of Chlamydomonas sp. General characteristics of fungi- Structure and reproduction of Aspergillus niger



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**Text Books**

- 1 Black J G, 2015, **Microbiology**, 9<sup>th</sup> Edition, John Wiley and Sons, New Jersey, United States
- 2 Joanne Wiley, Linda Sherwood, Christopher J and Woolverton, 2020, **Prescott's Microbiology**, 11<sup>th</sup> Edition, McGraw Hill Company, New York, United States.

**References**

- 1 Micheal T Madigan, 2018, **Brock Biology of Microorganisms**, 14<sup>th</sup> Edition, Pearson Education, New Delhi
- 2 Jeffrey C Pommerville, 2010, **Alcamo's Fundamentals of Microbiology**, 9<sup>th</sup> Edition, Jones and Bartlett Publishers, Massachusetts, United States
- 3 Salle A J, 2014, **Fundamental Principles of Bacteriology**, 7<sup>th</sup> Edition, Tata Mc Hill Publishing Company Ltd., New Delhi
- 4 Michael Pelczar, 2021, **Microbiology**, 5<sup>th</sup> Edition, Tata Mc Hill Publishing Company Ltd., New Delh



Course Code	Course Name	Category	L	T	P	Credit
233MB2A1CB	MICROBIAL PHYSIOLOGY AND BACTERIAL DIVERSITY	CORE	4	-	-	4

### PREAMBLE

This course has been designed for students to learn and understand

- The physiological, biochemical and metabolic properties of Microorganisms.
- The respiratory and nutritional pathways of microorganisms.
- The significance of Bacterial diversity.

### COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	To discuss the nutritional classification of microorganisms based on carbon, energy and electron sources.	K3
CO2	To comprehend nomenclature, classification, kinetics and types of enzymes with an emphasis on nature of enzyme Inhibitions.	K4
CO3	To confer the significance of different pathways of carbohydrate metabolism.	K3
CO4	To acquire the knowledge on the concepts of biosynthesis of amino acids, nucleotides, fatty acids and cell wall of Gram positive and Gram negative bacteria.	K2
CO5	To outline the diversified classes among bacteria.	K5

### MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	✓			✓	✓
CO2	✓	✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓
CO4	✓	✓	✓	✓	✓
CO5	✓	✓	✓	✓	✓

<input checked="" type="checkbox"/> Skill Development	<input type="checkbox"/> Entrepreneurial Development
<input checked="" type="checkbox"/> Employability	<input type="checkbox"/> Innovations
<input type="checkbox"/> Intellectual Property Rights	<input type="checkbox"/> Gender Sensitization
<input type="checkbox"/> Social Awareness/ Environment	<input type="checkbox"/> Constitutional Rights/ Human Values/ Ethics



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M.Sc. Microbiology (Students admitted during the AY 2023-24)



233MB2A1CB	MICROBIAL PHYSIOLOGY AND BACTERIAL DIVERSITY	SEMESTER I
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Total Credits: 4

Total Instruction Hours: 48 h

## Syllabus

## Unit I Nutrition and Growth 10 h

Nutritional types of microorganisms: Phototrophs, Autotrophs, Lithotrophs, Organotrophs. Nutritional requirements -Macro, Micro nutrients and trace elements. Membrane transport - passive, facilitated diffusion, active transport (Proton Motive force, PTS, role of permeases), group translocation and ion uptake. Factors affecting Microbial growth - Temperature, pH, Osmosis, Pressure, Oxygen and Radiation. Physiology of Growth - Growth curve. Growth measurements - batch, continuous and synchronous.

## Unit II Enzymes and co enzymes 9 h

IUBMB classification and nomenclature of enzymes, active site, Lock and key Mechanism and induced fit hypothesis, Enzyme kinetics- negative and positive. Enzyme inhibition: Reversible - Competitive, Noncompetitive, uncompetitive and irreversible inhibition -Feedback inhibition. Regulatory and Allosteric enzymes.

## Unit III Energy Production pathways 10 h

EMP pathway - Substrate level Phosphorylation - HMP Pathway -Entner Doudroff pathway - Glyoxalate pathway - Krebs cycle. Energy production: Electron transport chain and Oxidative phosphorylation, Pasteur Effect, Bioluminescence. Fermentations of Carbohydrates: Acidic: Homolactic, Mixed acid, Butanediol and Propionic acid fermentation. Alcoholic fermentation: Ethanol.  $\beta$  - Oxidation of Fatty acids.

## Unit IV Biosynthesis of Biomolecules 9 h

Biosynthesis of Aspartate, pyruvate, histidine and serine amino acid families - Purine and pyrimidine nucleotides - Denovo and salvage pathway. Biosynthesis of fatty acids and lipids. Biosynthesis of gram positive and gram negative cell wall.

## Unit V Bacterial Diversity 10 h

Introduction to Archaea - Ecology, Cell walls and membranes, Genetics and molecular biology, metabolism. Archaeal taxonomy - Outline characteristics - Crenarchaeota and Euryarchaeota. Methylophs - Methanogens. Eubacteria - Photosynthetic bacteria, Cyanobacteria - Spirochaetes - Bacteroidetes. Characteristics of Proteobacteria: Alpha (Rickettsia), Beta (Neisseria), Gamma (Pseudomonas), Delta (Desulfovibrio) and Epsilon (Helicobacter). Low G+C gram positive (Staphylococcus) and High G+C gram positive (Mycobacterium). Case study on Profiling of Microbial Community from different soil.



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M.Sc. Microbiology (Students admitted during the AY 2023-24)

### Text Books

- 1 David White and George D. Hageman, 2000, **Microbial Physiology and Biochemistry Laboratory**, Oxford University Press, India.
- 2 Joanne Wiley, Linda Sherwood, Christopher J and Woolverton, 2016, **Prescott's Microbiology**, 10<sup>th</sup> Edition, Mc Graw Hill Company.

### References

- 1 Moat. A.G, J.W.Foster, 2002. **Microbial physiology**. 4<sup>th</sup> edition. John Wiley & sons. Australia.
- 2 Demain A.J. and Solomon INA, 1999. 2<sup>nd</sup> edition. **Manual of Industrial Microbiology and Biotechnology**, ASM press.USA.
- 3 Geoffrey Michael Gadd, 2008, **Bacterial Physiology and Metabolism**, Cambridge University Press, UK
- 4 Doelle. H.W, 1960, **Bacterial Metabolism**, 2<sup>nd</sup> edition. Academic, Press. USA.
- 5 Gerhard Gottschalk, 2006, **Bacterial Metabolism**, Springer-Verlag, New York.





Course Code	Course Name	Category	L	T	P	Credit
233MB2A1CC	MYCOLOGY, PHYCOLOGY AND LICHENOLOGY	CORE	4	-	-	4

### PREAMBLE

This course has been designed for students to learn and understand

- To acquire knowledge of the diversity of Fungi, Algae, and Lichens
- To gain knowledge on the structural organization and reproduction
- To obtain knowledge on the importance of Fungi, Algae, and Lichens

### COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	To introduce diversity, classification, and characteristics and acquire knowledge on economic quality of fungi	K4
CO2	To understand the organization and reproduction process of fungi	K3
CO3	To introduce classification, characteristics, and economic quality of algae.	K4
CO4	To understand the organization, reproduction, cultivation and various roles of algae in the environment.	K4
CO5	To grasp the basic characteristics, classification and economic importance of lichens	K4

### MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	✓	✓	✓	✓	✓
CO2		✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓
CO4	✓	✓	✓		
CO5	✓	✓	✓		✓

<input checked="" type="checkbox"/> Skill Development	<input checked="" type="checkbox"/> Entrepreneurial Development
<input checked="" type="checkbox"/> Employability	<input checked="" type="checkbox"/> Innovations
<input checked="" type="checkbox"/> Intellectual Property Rights	<input type="checkbox"/> Gender Sensitization
<input checked="" type="checkbox"/> Social Awareness/ Environment	<input type="checkbox"/> Constitutional Rights/ Human Values/ Ethics



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233MB2A1CC	MYCOLOGY, PHYCOLOGY AND LICHENOLOGY	SEMESTER I
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Total Credits: 4

Total Instruction Hours: 48 h

### Syllabus

#### Unit I Classification and Characteristics of Fungi 10 h

Classification of fungi (Alexopoulos and Mims, 1979). Recent trends in classification of fungi. General characters of major classes: Mastigomycotina, Schizomycotina, Ascomycotina, Basidiomycotina and Deuteromycotina. Phylogeny and interrelationships of major groups of fungi. Economic importance of fungi.

#### Unit II Organization and Reproductions of Fungi 10 h

Thallus organization - reproduction, life cycle types, parasexual cycles, reduction in sexuality in fungi - physiological races in fungi - spore dispersal mechanisms and fungal genetics, study of fossil fungi.

#### Unit III Classification And Characteristics of Algae 8 h

Classification of algae (Fritsch, 1945). Salient features of major classes: Chlorophyta, Cyanophyta, Charophyta, Xanthophyta, Phaeophyta and Rhodophyta. Ultrastructure of prokaryotic and eukaryotic algal cells and their components. Economic importance of algae.

#### Unit IV Ecology, Cultivation and Life Cycle Patterns of Algae 10 h

Ecology of algae - algae as pollution indicators, algal blooms, algicides - culture and cultivation of fresh water and marine algae - Knop's solution and Chu-10 medium (1972). Origin and evolution of sex in algae, phylogeny and interrelationships of algae. Lifecycle patterns in algae. Study of fossil algae.

#### Unit V Classification and characteristics of Lichens 10 h

Classification of Lichens (Hale, 1969). Occurrence and interrelationship of phycobionts and mycobionts, structure and reproduction in Ascolichens, Basidiolichens, and Deuterolichens. Lichens as indicators of pollution. Economic importance of Lichens. Case Study- Algal diversity and algal bloom in water bodies of your native city or state.



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### Text Books

- 1 Michael Madigan, 2015, **Brock Biology of Microorganisms**, 14<sup>th</sup> Edition, Pearson Publishers, New Delhi
- 2 Vashishta BR, Sinha AK, Singh VP, 2010, **Botany for Degree students Algae**, 1<sup>st</sup> Edition, S Chand & Company Ltd. India

### References

- 1 Alexopoulos CJ, Mims CW, Blackwell M, 2002, **Introductory Mycology**, 4<sup>th</sup> Edition, Wiley India Pvt. Ltd, India
- 2 Moore D, Robson GD, Anthony P, Trinci J, 2011, **21st Century Guidebook to Fungi**, Cambridge University Press, United Kingdom
- 3 Thomas H. Nash, 2008, **Lichen Biology**, 2<sup>nd</sup> Edition Cambridge University Press, India
- 4 Ernst Athearn Bessey, 2020, **Morphology and taxonomy of fungi**, 1<sup>st</sup> Edition, Alpha Edition Publishers, India
- 5 <http://archive.bio.ed.ac.uk/jdeacon/microbes/fungalwe.html>
- 6 <https://gclambathach.in/lms/Algae.pdf>
- 7 <http://www.mycolog.com/chapter11.html>



Course Code	Course Name	Category	L	T	P	Credit
233MB2A1CD	CORE IV: COMPREHENSIVE BIOLOGY	CORE	3	1	-	3

### PREAMBLE

This course has been designed for students to learn and understand

- The structure and function of biomolecules
- The basic concepts of developmental biology and cell signaling
- The evolution of living cells.

### COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Understand the importance of biological molecules.	K3
CO2	Cognize the basic concepts of developmental biology.	K3
CO3	Critically understand the idea on how a cell responds to external stimulus.	K3
CO4	Understand the inheritance of chromosomes.	K3
CO5	Cognize the formation and evolution pattern exhibited till date by living organisms over different time frames.	K3

### MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	✓	✓	✓	✓	
CO2	✓	✓	✓	✓	
CO3	✓	✓	✓	✓	
CO4	✓	✓	✓	✓	
CO5	✓	✓	✓	✓	

<input checked="" type="checkbox"/> Skill Development	<input type="checkbox"/> Entrepreneurial Development
<input type="checkbox"/> Employability	<input checked="" type="checkbox"/> Innovations
<input type="checkbox"/> Intellectual Property Rights	<input type="checkbox"/> Gender Sensitization
<input type="checkbox"/> Social Awareness/ Environment	<input type="checkbox"/> Constitutional Rights/ Human Values/ Ethics



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233MB2A1CD	CORE IV: COMPREHENSIVE BIOLOGY	SEMESTER I
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Total Credits: 3

Total Instruction Hours: 48 h

### Syllabus

#### Unit I Structure of atoms, molecules and chemical bonds 10 h

Composition, structure and function of bio-molecules (carbohydrates, lipids, proteins, nucleic acids and vitamins). Interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction etc.). Principles of biophysical chemistry (pH, buffer, thermodynamics, colligative properties). Conformation of proteins (Ramachandran plot, secondary structure, domains, motif and folds).

#### Unit II Basic concepts of developmental biology 10 h

Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; fertilization and early development.

#### Unit III Cell Signaling 10 h

Cell signaling - Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways, bacterial and plant two component systems, light signaling in plants, bacterial chemotaxis and quorum sensing.

#### Unit IV Inheritance biology 9 h

Gene mapping methods: Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids, development of mapping population in plants. Extra chromosomal inheritance: Inheritance of Mitochondrial and chloroplast genes, maternal inheritance. Human genetics: Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders.

#### Unit V Evolution 9 h

Emergence of evolutionary thoughts Lamarck; Darwin-concepts of variation, adaptation, struggle, fitness and natural selection; Origin of cells and unicellular evolution: Origin of basic biological molecules; Abiotic synthesis of organic monomers and polymers; Concept of Oparin and Haldane; Experiment of Miller; The first cell; Evolution of prokaryotes; Origin of eukaryotic cells; Evolution of unicellular eukaryotes; Paleontology and Evolutionary History: The evolutionary time scale; Eras, periods and epoch.

Case Study 1: Is there a scenario, where, within the earth, there are locations mimicking the ancient timelines with regards to temperatures (when the globe was formed from the sun due to explosion). If so, are we still witnessing abiotic synthesis even today?



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### Text Books

- 1 Dr. A. P. Singh & Kumar Pushkar, 2021, **Upkar CSIR-UGC NET/JRF/SET Life Sciences**, 1<sup>st</sup> Edition, Upkar Prakashan publishers, India.
- 2 Quaisher J. Hossain, Prashant Kumar, Ashish Nagesh, 2018, **UGC CSIR NET / SLET (JRF & LS) Life Sciences**, 4<sup>th</sup> Edition, Arihang Publications

### References

- 1 Pranav Kumar & Usha Mina, 2020, **Pathfinder Academy: CSIR-JRF-NET Life Sciences Book Combo Set with Ecology**, 1<sup>st</sup> Edition, Pathfinder Publication.
- 2 De Robertis, E. D. P, 2017, **Cell and Molecular Biology**, 8<sup>th</sup> Edition, Lea & Febiger, New York.
- 3 Van De Graaff, R. Ward Rhees, Sidney L. Palmer, 2013, **Schaum's Outline of Human Anatomy and Physiology**, 4<sup>th</sup> Edition, Mcgraw-Hill Companies, New York.
- 4 <http://www.easybiologyclass.com/csir-jrf-net-life-sciences-previous-year-question-papers/>





Course Code	Course Name	Category	L	T	P	Credit
233MB2A1CE	BIO ANALYTICAL TECHNIQUES	CORE	3	1	-	3

### PREAMBLE

This course has been designed for students to learn and understand

- To comprehend the principle and instrumentation of diverse instruments for Microbiology
- To procure knowledge on the working methods of different instruments
- To appreciate its application in diverse fields

### COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	To understand the principles, instrumentation with an emphasis on applications of Analytical centrifuge.	K3
CO2	To become equipped with the operational principle and working methods of spectral instruments	K2
CO3	To procure knowledge on the principles and techniques of various types of electrophoresis	K3
CO4	To acquaint the concept of radioactivity and its types of decay	K3
CO5	Application of knowledge for the characterization of Biomolecules	K3

### MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	✓	✓	✓	✓	
CO2		✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓
CO4	✓	✓		✓	
CO5	✓	✓	✓	✓	✓

<input checked="" type="checkbox"/> Skill Development	<input checked="" type="checkbox"/> Entrepreneurial Development
<input checked="" type="checkbox"/> Employability	<input checked="" type="checkbox"/> Innovations
<input type="checkbox"/> Intellectual Property Rights	<input type="checkbox"/> Gender Sensitization
<input type="checkbox"/> Social Awareness/ Environment	<input type="checkbox"/> Constitutional Rights/ Human Values/ Ethics



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233MB2A1CE	BIO ANALYTICAL TECHNIQUES	SEMESTER I
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Total Credits: 3

Total Instruction Hours: 48 h

### Syllabus

#### Unit I Centrifugation and Chromatography 10 h

Centrifugation - Principles and types - Low speed, High speed and Ultra centrifuge. Applications of Analytical Ultra Centrifugation - Determination of Molecular weight and purity of macromolecules. Chromatography: Instrumentation, detection methods and Applications of TLC, Column, Gas, Ion Exchange, HPLC, Gel Filtration, GCMS and LCMS.

#### Unit II Colorimetry and Spectrometry 10 h

Colorimetry: Principles, Instrumentation, Application and Analysis - Qualitative and Quantitative. Spectrophotometry: Principles, Instrumentation and Applications of UV, Visible, IR, NMR, FTIR, Atomic absorption, Mass Spectroscopy and MALDI - TOF, Spectrofluorometry and Flame Photometry

#### Unit III Electrophoresis 8 h

Electrophoresis: Principles and Instrumentation - Separation of Nucleic acids - Agarose Gel Electrophoresis, Electrophoresis of RNA, Capillary Electrophoresis and Microchip Electrophoresis. Separation of Proteins - SDS - PAGE, Native Gel, Gradient Gel, Iso Electric Focusing, 2D Page, Cellulose Acetate Electrophoresis, Western Blotting - Detection, Estimation and Recovery of Proteins in gel.

#### Unit IV Radiometry 10 h

Introduction - Detection and Measurement of Radioactivity - Detection based on gas ionization - Autoradiography and its applications - Scintillation Counting - Safety Aspects - Biosensors and its applications (DNA and Immunosensors).

#### Unit V Quantification Methods for Biomolecules 10 h

Quantitative determination of Macromolecules: Carbohydrates (DNSA and Anthrone method), Lipids (Gravimetric), Protein (Lowry and Bradford method). Determination of Molecular weight of protein (MS and SDS-PAGE) and DNA (Agarose gel). Estimation of Microbial pigments: Chlorophylls and Carotenoids. Case study - Collect the various plant leaves from our college campus and analyze their compounds using chromatography techniques



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**Text Books**

- 1 *L Veerakumari, 2011, Bioinstrumentation, 1<sup>st</sup> Edition, MJB Publishers.*
- 2 *Keith Wilson and John Walker, 2010, Principles and Techniques of. Biochemistry and Molecular Biology, 7<sup>th</sup> edition, Cambridge University Press*

**References**

- 1 *Plummer .T David, 2004, An Introduction to Practical Biochemistry, 3<sup>rd</sup> Edition, TMH Publishers*
- 2 *Terrance G Cooper, 2010, The tools of Biochemistry, 2<sup>nd</sup> Edition, John Wiley and sons.*
- 3 *Rodney Boyer, 2000, Modern Experimental Biochemistry, 3<sup>rd</sup> Edition, Pearson education Publishers*
- 4 *Swahney S K and Singh R, 2014, Introductory Practical Biochemistry, Narosa Publishing House*



233MB2A1CP	CORE PRACTICAL: BASIC TECHNIQUES IN MICROBIOLOGY	SEMESTER I
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Total Credits: 3

Total Instructions Hours: 72 h

S.No	Contents
1	Bacterial Staining techniques - Gram, Acid-fast, Spore, Capsule and Negative Staining.
2	Morphological observation of Fungi -LPCB Mount.
3	Micrometry - Measurement of Microorganisms.
4	Motility determination- Hanging drop and soft agar inoculation.
5	Enumeration of Microorganisms from soil: Bacteria, Fungi and Actinomycetes.
6	Determination of Bacterial generation time - Direct microscopic method and turbidity method
7	Effect of various intrinsic factors on the growth of bacterium - pH, Temperature
8	IMViC test, Hydrogen sulphide test, Oxidase test, Calalase test, Urease test
9	Preferential utilization of sugar - Carbohydrate fermentation & TSI; Polymer degradation - Starch, Casein
10	Quantitative determination of Sugar by DNSA method and Protein by Lowry et al method
11	Separation techniques: Chromatography- TLC and Column.
12	Microscopic observation of Algae and Lichen thallus

Note: Out of 12-10 Mandatory



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## References

- 1 James Cappuccino, Natalie Sherman, 2013, **Microbiology: A Laboratory Manual**, 10<sup>th</sup> Edition, Pearson Publishers
- 2 Aneja. K.R, 2012. **Experiments in Microbiology, Plant Pathology and Biotechnology**, 2<sup>nd</sup> edition. New age publisher
- 3 Rajan S. Selvi Christy.R, *Experimental Procedures in Lifesciences*, CBS Publishers & Distributors Pvt Ltd
- 4 Kannan, N, 1997, **Laboratory Manual of General Microbiology**, 1<sup>st</sup> Edition, Panima Publishing house



Course Code	Course Name	Category	L	T	P	Credit
233MB2A1DA	MICROBIAL TECHNOLOGY	DSE	3	1	-	3

### PREAMBLE

This course has been designed for students to learn and understand

- The production of Sustainable products using Microorganisms.
- The importance of Microorganisms in Pharmaceutical sector.
- How to explore the ideas in commercial level

### COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Inculcate about microbial products and its scale up production through establishing a small scale industry	K2
CO2	Exemplify the ideas about the production and uses of Biofuel and Biofertilizer.	K3
CO3	Demonstrate the commercial production of Biopolymers using Microorganisms.	K4
CO4	Understand the way of cells and enzymes were immobilized for industrial uses.	K3
CO5	Explore the pharmaceutical products and possibilities of converting it to a commercial product.	K4

### MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	✓		✓	✓	✓
CO2	✓	✓		✓	✓
CO3	✓		✓	✓	✓
CO4	✓		✓		✓
CO5	✓	✓		✓	✓

<input checked="" type="checkbox"/> Skill Development	<input checked="" type="checkbox"/> Entrepreneurial Development
<input checked="" type="checkbox"/> Employability	<input checked="" type="checkbox"/> Innovations
<input checked="" type="checkbox"/> Intellectual Property Rights	<input type="checkbox"/> Gender Sensitization
<input type="checkbox"/> Social Awareness/ Environment	<input type="checkbox"/> Constitutional Rights/ Human Values/ Ethics



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233MB2A1DA	MICROBIAL TECHNOLOGY	SEMESTER I
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Total Credits: 3

Total Instruction Hours: 48 h

## Syllabus

**Unit I** Microbial products 10 h

Single Cell Protein and its Economic Aspects: Bacterial, Yeast, Fungal and Algal Proteins - Brewer's and Baker's yeast - Food and Fodder yeast - Mushroom (Agaricus, Oyster) and Products from Higher fungi (Ganoderma lucidum).

**Unit II** Production of Biofuel & Biofertilizer 10 h

Production, Methods and Uses of Bioethanol (*S cerevisiae*) - Biodiesel (*Chlorella*) - Biohydrogen (*Chlamydomonas*) - Biogas (*Methanobacteria*). Biofertilizer - N<sub>2</sub> fixing, Phosphate Solubilizing, Phosphate Mobilizing, Plant Growth Promoting Rhizobacteria - Mass production and Applications.

**Unit III** Biopolymer production 8 h

Production and Uses of Polyhydroxybutyrate (PHB) - Xanthan - Alginate - Cellulose - Cyanophycin - Levan - Melanin - Welan - Succinoglucon- Curdlan- Chitosan - Polyhydroxyalkanoates - Hyaluronic acid.

**Unit IV** Immobilization of Cells & Enzymes 10 h

Cells - Surface attachment of cells - Entrapment - Hydrogel method, Preformed support materials - Containment behind a barrier: Microencapsulation, Immobilization using membranes - Self aggregation of cells - Methods for Enzyme immobilization - Carrier binding method, Intermolecular cross linking - Applications of Immobilized cells and Enzymes

**Unit V** Microbial products with pharmaceutical importance 10 h

Vaccines - Steps of Manufacturing - Growing the microbes and separation - Preparation of Live and killed vaccine - Preparation of Toxoid and uses - BCG Vaccine - Cholera vaccine - Rabies vaccine - Diphtheria toxoid. Pharmaceutical industry - certification & accreditation required. Bioentrepreneurship opportunities and Funding sources - Government funds, Venture capital, NGOs, Crowd funding and Incubation centers. Antimicrobial compounds from soil microbes - Case study



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### Text Books

- 1 Patel A H, 2012, **Industrial Microbiology**, 2<sup>nd</sup> Edition, Trinity Press, New Delhi
- 2 El-Mansi E M T, Bryce C F A, Dahhou B, Sanchez S, Demain A L and Allman A R, 2012, **Fermentation Microbiology and Biotechnology**, 3<sup>rd</sup> Edition, CRC Press, USA

### References

- 1 Bernard R Glick, Jack J Pasternek and Cheryl L Patten, 2010, **Molecular Biotechnology - Principles and Applications of Recombinant DNA**, 4<sup>th</sup> Edition, ASM Publishers, USA]
- 2 Nidhi Goel, 2013, **Pharmaceutical Microbiology**, 1<sup>st</sup> Edition, Narosa Publishing House, New Delhi
- 3 Puvanakrishnan R, Sivasubramanian S and Hemalatha T, 2012, **Microbial Technology - Concepts and Applications**, 1<sup>st</sup> Edition, MJP Publishers, New Delhi
- 4 [https://agritech.tnau.ac.in/org\\_farm/orgfarm\\_biofertilizertechnology.html](https://agritech.tnau.ac.in/org_farm/orgfarm_biofertilizertechnology.html)





Course Code	Course Name	Category	L	T	P	Credit
233BC2A1DA	CANCER BIOLOGY,DIAGNOSIS AND THERAPY	DSE	3	1	-	3

### PREAMBLE

This course has been designed for students to learn and understand

- Molecular basis of cancer, mutations causing cancer, and repair mechanisms.
- The basic principles of cancer development and available therapeutic options
- The different diagnostic and treatment methods for cancer.

### COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Compare and contrast benign and malignant tumors and the morphological characteristics of cancer cells.	K4
CO2	Justify the molecular basis of cancer. Distinguish interdisciplinary areas in cancer biology.	K5
CO3	Evaluate the molecular mechanism of oncogenesis, tumor biology and the role of cell cycle in cancer.	K5
CO4	Validate the role of tumor suppressor genes and apoptosis. Explain about epigenetics.	K5
CO5	Summarize on the choice of diagnosis and therapy available for cancer patients.	K6

### MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓
CO4	✓	✓	✓	✓	✓
CO5	✓	✓	✓	✓	✓

<input checked="" type="checkbox"/>	Skill Development	<input type="checkbox"/>	Entrepreneurial Development
<input checked="" type="checkbox"/>	Employability	<input type="checkbox"/>	Innovations
<input type="checkbox"/>	Intellectual Property Rights	<input type="checkbox"/>	Gender Sensitization
<input type="checkbox"/>	Social Awareness/ Environment	<input type="checkbox"/>	Constitutional Rights/ Human Values/ Ethics



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COIMBATORE | INDIA

*M.Sc. Microbiology (Students admitted during the AY 2023-24)*



233BC2A1DA	CANCER BIOLOGY, DIAGNOSIS AND THERAPY	SEMESTER I
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Total Credits: 3

Total Instruction Hours: 48 h

## Syllabus

## Unit I Introduction 9 h

Introduction: Cancer cell-morphology and growth characteristics. Metastasis and cytoskeleton. Types of growth- hyperplasia, dysplasia, anaplasia and neoplasia. Types and prevalence of cancer. Nomenclature of neoplasms, classification based on origin/organ. Differences between benign and malignant tumors.

## Unit II Carcinogenesis 9 h

Cancer epidemiology and endocrinology. Cancer causing agents-radiation, viruses, chemicals. Multistep carcinogenesis: Initiation, Promotion, Progression. Para-neoplastic syndromes. Mutation-definition, significance, rates and frequency. Mutagenic agents. Molecular basis of mutagenesis: induced and spontaneous mutations, crossing over and segregation. Mutation Types-addition, deletion, inversion, reciprocal, translocation, insertional translocation and frame-shift mutations. Chemical carcinogenesis- genetic and epigenetic carcinogens, pro- carcinogens and co-carcinogens, promoters and initiators, testing for carcinogenicity, Ames test. Aberrant metabolism during cancer development.

## Unit III Tumor Markers and Signal Transduction 10 h

Oncogenes - RNA and DNA tumor viruses, retroviruses and viral oncogenes and abrupt activation. Src and Ras gene, mechanism and characteristic of cell transformation. Molecular mechanism of oncogenesis- protooncogenesis, oncoproteins, tumor suppressor genes involved in cancer. Radiation- effect of ionizing radiations on DNA, chromosomal aberrations. Cancer Markers: Genetic basis of cancer, use of tumor markers in detection and monitoring of cancer. Signal transduction in cancer: cell-cell interactions, cell adhesion, invasion and metastasis, VEGF signaling and angiogenesis; role of transcription factors. Growth factors-EGF, TNF- $\alpha$  and TGF- $\beta$  and growth factor receptors. Free radicals and antioxidants in cancer. Diet and cancer.

## Unit IV Cell Cycle, Cell Death and Cancer 10 h

Cell Cycle Regulation cancer: control of the cell cycle - cyclins and CDKs, and tumor suppressor genes p53, p21Rb, BRAC1 and BRAC2. Telomeres, and Immortality; Epigenetics- role of DNA methylation in gene silencing- epigenetic silencing of tumor - suppressor genes. Death - signaling pathways - mitochondrial and death receptor pathways, (Intrinsic- extrinsic pathways). Mechanism and Impact of apoptosis.

## Unit V Cancer Diagnosis and Cancer Therapy, Stem Cells and Cancer 10 h

Principles and methods of cancer diagnosis - biochemical, genetic, cytotoxic, cell growth and viability tests. Diagnosis of cancer by histopathology, MRI scans, PET scan, cytogenetics test, karyotype, FISH. Strategies of anticancer drug therapy-chemotherapy, gene therapy, immuno therapy, radiotherapy and surgical therapy. Principles of cancer biomarkers and their applications.



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**Text Books**

- 1 Mc Kinnell R.G et al, 2012, "The Biological Basis of Cancer", 2nd edition, Cambridge University Press, London.
- 2 Weinberg R.A, 2014, "The Biology of Cancer", 2nd edition, Garland Science, New York & London.

**References**

- 1 Vincent T. De Vita M. D et al, 2020, "Principles and Practice of Oncology: Primer of Molecular Biology in Cancer", 3rd edition, Lippincott Williams and Wilkins, Philadelphia.
- 2 Pelengaris S and Khan M, 2010, "The Molecular Biology of Cancer - A bridge from bench to bed side", 2nd edition; Wiley Black well, London.
- 3 Hesketh R, 2013, "Introduction to Cancer Biology", 1st edition, Cambridge University Press, London.
- 4 Pezzella F et al, 2019, "Oxford textbook of Cancer Biology", 1st edition, Oxford University Press, London



Course Code	Course Name	Category	L	T	P	Credit
233BT2A1DA	APPLIED BIOTECHNOLOGY	DSE	3	1	-	3

### PREAMBLE

This course has been designed for students to learn and understand

- the applications of biotechnology in plant , animal and Environmental field
- the applications of biotechnology in health care sector
- the products obtained from fermentation and its applications.

### COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Understand the fundamental applications of Biotechnology	K1
CO2	Know the basics and fundamentals of biotechnology applications in environment.	K2
CO3	Discuss about the disease and disease prevention.	K3
CO4	Discuss the applications of Enzymes in various fields.	K4
CO5	Discuss the production and application of products obtained from fermentation technology.	K1

### MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	✓	✓		✓	
CO2	✓		✓	✓	✓
CO3			✓	✓	✓
CO4	✓	✓	✓	✓	✓
CO5	✓	✓	✓	✓	✓

<input type="checkbox"/> Skill Development	<input checked="" type="checkbox"/> Entrepreneurial Development
<input checked="" type="checkbox"/> Employability	<input type="checkbox"/> Innovations
<input type="checkbox"/> Intellectual Property Rights	<input type="checkbox"/> Gender Sensitization
<input type="checkbox"/> Social Awareness/ Environment	<input type="checkbox"/> Constitutional Rights/ Human Values/ Ethics



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COIMBATORE | INDIA

*M.Sc. Microbiology (Students admitted during the AY 2023-24)*



233BT2A1DA	APPLIED BIOTECHNOLOGY	SEMESTER I
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Total Credits: 3

Total Instruction Hours: 48 h

## Syllabus

**Unit I**      Agricultural, Plant Biotechnology and Animal Biotechnology      10 h

Applications of transgenic crop technology: Herbicide resistance (Glyphosate Resistance plants), Pest resistance (Bt Cotton) and Virus Resistance. Enhancement of micro-nutrients (Vitamin A & Vitamin E). Delayed Fruit Ripening. Molecular pharming in plants. Transgenic animals (Transgenic mice and Transgenic cattle). Production and recovery of products from animal tissue cultures (Blood clotting factors, Growth hormones, insulin).

**Unit II**      Environmental Biotechnology      08 h

Bioremediation- (Bioaugmentation and Biostimulation). Biodegradation of Xenobiotic compounds . Bioleaching. Microbially Enhanced Oil Recovery. Biotechnological methods for hazardous waste management. Bioindicators –Biomarkers –Biosensors –Management for effluent toxicity, heavy metal pollution, thermal and radioactive pollution

**Unit III**      Health Care Biotechnology      10 h

Disease prevention – vaccines: conventional vaccines, purified antigen vaccines, recombinant vaccines. DNA vaccines, synthetic vaccines. Disease Diagnosis – Probes, monoclonal antibodies and detection of genetic diseases. Disease treatment – interferons, monoclonal antibodies. gene therapy, enzyme therapy and replacement. Forensic medicine.

**Unit IV**      Enzyme Biotechnology      10 h

Enzyme used for Diagnostic purpose- (acid phosphatase, alanine aminotransferase and alkaline phosphatase). Cardiac Biomarkers. Enzymes used for screening liver and kidney diseases. Enzymes used in food Industry, leather industry, wool industries, dairy industry and Textile industry.

**Unit V**      Fermentation Biotechnology      10 h

Production, harvest, recovery and uses – enzymes, Antibiotics (Tetracycline), vitamins (B2), Aminoacids (glutamic acid), Organic solvents (ethanol); Organic acids (lactic acid). Single Cell Protein (algae), beverages (Wine). Formulation of Biofertilizer (Rhizobium), Biopesticides.



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## Text Books

- 1 Bernard R Glick and Jack J Pasternak, 2010, **Molecular Biotechnology: Principles and Applications of recombinant DNA**, 4<sup>th</sup> Edition. ASM Press
- 2 Slater, Scott, and Fowler, 2008, **Plant Biotechnology: The genetic manipulation of plants**. 2<sup>nd</sup> Edition. Oxford University Press, UK

## References

- 1 S. S. Marwaha & K. Arora, 2000, **Food processing Biotechnological application**, Asiatech Publishers INC, New Delhi
- 2 T. Palmer, Bonner PLR, 2014, **Enzymes: Biochemistry, Biotechnology and Clinical Chemistry**, 2<sup>nd</sup> Edition. Woodhead Publishing Limited, Oxford.
- 3 P.F. Stanbury and A. Whitaker, 2005, **Principles of Fermentation technology**, 2<sup>nd</sup> Edition. Pergamon press.
- 4 El-Mansi, C.F.A. Bryce, A.L. Demain, A.R. Allman, 2007, **Fermentation microbiology and Biotechnology**, 2<sup>nd</sup> edition, Taylor and Francis.

*[Signature]* 10/06/2023  
 BoS Chairman/HOD  
 Department of Microbiology  
 Dr. N. G. P. Arts and Science College  
 Coimbatore - 641 048

 Dr. N. G. P. Arts and Science College		
<b>APPROVED</b>		
BoS - 15 <sup>th</sup> 10/06/2023	AC - 15 <sup>th</sup> 14/07/2023	GB - 20 <sup>th</sup> 05/08/2023



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COIMBATORE | INDIA

M.Sc. Microbiology (Students admitted during the AY 2023-24)



Course Code	Course Name	Category	L	T	P	Credit
233MB2A2CA	MICROBIAL GENETICS	CORE	4	-	-	4

#### PREAMBLE

This course has been designed for students to learn and understand

- The fundamentals behind classical genetics
- Mechanisms of gene replication and expression
- The knowledge of Genetic material exchange and mutations

#### COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Understand the biological process by a historical approach to study classical systems of gene regulation in bacteria.	K2
CO2	Understand the topology of DNA and RNA, and evaluate the molecular mechanisms of DNA replication.	K4
CO3	Apply the principles of transcription and translation in gene expression	K3
CO4	Compare the mutational types, DNA repair mechanisms, and apply the molecular markers to study the microbial diversity	K4
CO5	Apply the horizontal gene transfer concepts in mapping of genes.	K4

#### MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	✓	✓	✓		✓
CO2		✓	✓	✓	✓
CO3	✓	✓		✓	✓
CO4	✓	✓			
CO5	✓	✓			✓

#### COURSE FOCUSES ON

<input checked="" type="checkbox"/> Skill Development	Entrepreneurial Development
Employability	<input checked="" type="checkbox"/> Innovations
<input checked="" type="checkbox"/> Intellectual Property Rights	Gender Sensitization
<input checked="" type="checkbox"/> Social Awareness/ Environment	Constitutional Rights/ Human Values/ Ethics





233MB2A2CA	MICROBIAL GENETICS	SEMESTER II
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Total Credits: 4

Total Instruction Hours: 48 h

## Syllabus

- Unit I**      Classical Genetics      9 h  
Mendel's Laws: Monohybrid - Dihybrid - Test cross, concept of dominance, segregation, independent assortment; Chromosome theory of inheritance. Chromosomes & crossing over. Sex-influenced and limited inheritance. Chromatin structure and organization.
- Unit II**      DNA and RNA      10 h  
DNA and RNA as genetic material. Nucleic Acid chemical composition, C value paradox, Physical structures of DNA, Circular and Superhelical DNA. RNA Structure and types. DNA Replication - Basic rule for replication of all nucleic acids - Geometry of DNA replication - Enzymology.
- Unit III**      Gene Expression      10 h  
Transcription: Transcription in prokaryotes and eukaryotes - structures of rRNA, tRNA and mRNA. Inhibitors of transcription. Reverse Transcription. Antisense RNA and its significant. Genetic code. Translation - Transfer of RNA and aminoacyl synthetases - codon, anticodon interactions - Wobble hypothesis. Post-transcriptional and translational modification.
- Unit IV**      Mutation and Molecular Markers      9 h  
Mutation - types of Mutation -Spontaneous and induced mutation. Mutagenesis-Physical and Chemical. DNA repair mechanisms: Photo reactivation - Excision repair - Recombination repair - SOS repair. Molecular Markers, RFLP, RAPD, AFLP and Isozyme Loci. CRISPR gene editing.
- Unit V**      Gene transfer      10 h  
Mechanisms of Gene transfer in bacteria - Transformation - Transduction and Conjugation. Phage genetics, Phage T mutants, Genetic recombination, Genetic mapping of T4 Phage. Regulation of gene activity - Operon model- positive and negative operon: (Lac, Trp), Autoregulation - translational regulation.

## Case study

Consider that you have isolated a rod shaped bacterium from a sewage sample that has the potential of adapting to different environments. You have to analyze the up-regulation and down-regulation of different genes for different growth conditions through restrictive digestion.





## Text Books

- 1 Freidfelder, D 1995, **Microbial genetics**. 1<sup>st</sup> Edition. New Delhi: Narosa Publishing House.
- 2 Gardner, E. J, Simmons, M J & D P Snustard, 2006, **Principles of Genetics**, 8<sup>th</sup> Edition, John Wiley & Sons, New York.

## References

- 1 Klug .W.S. and Cummings, M.R., 2016, **Essentials of Genetics**, 9<sup>th</sup> Edition, New Delhi: Pearson Publishers.
- 2 Larry Snyder, Joseph E. Peters, Tina M. Henkin, 2013, **Molecular Genetics of Bacteria**, 4<sup>th</sup> Edition, Wendy Champness, ASM Press.
- 3 David Freifelder, 2000, **Microbial Genetics**, 7<sup>th</sup> Edition Narosa Publishing House, New Delhi.
- 4 Jocelyn E. Krebs, Elliott S. Goldstein. Stephen T. Kilpatrick, 2014, **Lewin's Genes – X**, 11<sup>th</sup> Edition, Jones & Bartlett Learning.
- 5 Freifelder, D 2004, **Molecular Biology**. 1<sup>st</sup> Edition, New Delhi: Narosa Publishing House



Course Code	Course Name	Category	L	T	P	Credit
233MB2A2CB	IMMUNOLOGY AND IMMUNOTECHNIQUES	CORE	4	-	-	4

#### PREAMBLE

This course has been designed for students to learn and understand

- The structural features of the components of the immune system
- The functions of Immune system.
- The mechanisms involved in Immune system development and responsiveness

#### COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Apply the knowledge of immune cells and organs in immune profiling through CBC	K3
CO2	Understand the basis of immune response and properties of antigen and antibodies	K4
CO3	Develop and Evaluate the Immuno-diagnostic methods for effective diagnosis	K4
CO4	Assess the level of immune-regulation during microbial infection	K4
CO5	Conclude the efficient HLA matching of donor and recipient in transplantation.	K4

#### MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	✓	✓	✓		✓
CO2	✓	✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓
CO4	✓	✓		✓	✓
CO5	✓		✓		✓

#### COURSE FOCUSES ON

<input checked="" type="checkbox"/> Skill Development	<input checked="" type="checkbox"/> Entrepreneurial Development
<input checked="" type="checkbox"/> Employability	<input checked="" type="checkbox"/> Innovations
Intellectual Property Rights	Gender Sensitization
Social Awareness/ Environment	Constitutional Rights/ Human Values/ Ethics





233MB2A2CB	IMMUNOLOGY AND IMMUNOTECHNIQUES	SEMESTER II
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Total Credits: 4

Total Instruction Hours: 48 h

### Syllabus

#### Unit I History and Scope of Immunology 10 h

Historical background and scope of Immunology, Defence mechanisms of human body - First line defence - Anatomical and Physiological barriers - Second line defence - Fever, inflammation and Phagocytosis - Third line defence - Cells and organs of immune system.

#### Unit II Immunity & Types 10 h

Immunity - types of immunity - Natural, acquired, specific and non specific, cell mediated and humoral, active and passive immunity. Antigens - properties, Epitopes, haptens, adjuvant, cross reactivity. Antibodies - properties, structure (primary & secondary) and isotypes. Diversity and specificity. Anti antibodies. Complement pathway.

#### Unit III Antigen-Antibody reactions 10 h

Serology - Antigens and antibody reactions - Introduction and classification of antigens and antibody reactions - Agglutination and precipitation reaction. Strength of antigen and antibody binding - affinity & avidity. Therapeutic applications of monoclonal antibodies and Complement fixation reaction. Immunofluorescence, RIA, RAST, ELISA and Flow cytometry - RT-PCR.

#### Unit IV Lymphocyte Response 9 h

Response of B-cell and T-cell to antigens. B-cell and T-cell products. Hyper sensitivity - Type I, II, III and IV - MHC antigens - types and functions. Immunity to infectious diseases - Viral, bacterial and protozoan.

#### Unit V Transplantation Immunology 9 h

Transplantation immunology - Tissue transplantation and grafting - Mechanism of graft acceptance and rejection - HLA typing - Tumor immunology - Immunodeficiency disorders - Primary (SCID) and Secondary (AIDS) and auto immunity. Vaccines - Types and vaccination methods. Case Study on vaccines for Covid'19.



### Text Books

- 1 Roitt IM, 2017, **Essential Immunology**, 13th Edition, Wiley-Blackwell Publishers, United States.
- 2 Kuby, 2018, **Immunology**, 8th edition, W.H. Freeman Publishers, New York.

### References

- 1 Lauren M. Sompayrac, 2019, **How Immune System Works**, 6th Edition, Wiley-Blackwell, United States..
- 2 Raif S. Geha and Luigi D. Notarangelo, 2016, **Case Studies in Immunology : A Clinical Companion**, 7th Edition, Garland Science Publishers, United States
- 3 Tizard I R, 1995, **Immunology an Introduction**, 4th Edition, Saunders College Pub, United States
- 4 <https://microbenotes.com/category/immunology/>





Course Code	Course Name	Category	L	T	P	Credit
233MB2A2CC	VIROLOGY	CORE	4	-	-	4

#### PREAMBLE

This course has been designed for students to learn and understand

- To get the basic knowledge on general properties of viruses
- To impart knowledge on bacterial, plant and animal viruses and their diagnosis.
- The role and production of conventional and modern viral vaccines and their mode of action

#### COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Classify viruses systematically.	K3
CO2	Analyse and interpret the properties of plant viruses bacteriophages.	K4
CO3	Evaluate and distinguish animal viruses	K4
CO4	Criticize the Routine and Molecular Diagnosis with special reference to Virology.	K4
CO5	Design attenuate and recombinant viral vaccines.	K4

#### MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	✓	✓	✓		✓
CO2	✓	✓		✓	✓
CO3	✓	✓	✓	✓	✓
CO4	✓	✓	✓		✓
CO5	✓		✓	✓	

#### COURSE FOCUSES ON

<input checked="" type="checkbox"/> Skill Development	<input checked="" type="checkbox"/> Entrepreneurial Development
<input checked="" type="checkbox"/> Employability	<input checked="" type="checkbox"/> Innovations
<input checked="" type="checkbox"/> Intellectual Property Rights	Gender Sensitization
<input checked="" type="checkbox"/> Social Awareness/ Environment	Constitutional Rights/ Human Values/ Ethics





233MB2A2CC	VIROLOGY	SEMESTER II
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Total Credits: 4

Total Instruction Hours: 48 h

### Syllabus

#### Unit I Introduction to viruses 9 h

General properties and Baltimore system of Virus classification. Cultivation and purification of viruses - Principles of bio-safety, containment facilities, maintenance and handling of laboratory animals and requirements of virology laboratory. Basic immune response to viral infection. Infective amino acids: Virions and Prions.

#### Unit II Bacteriophages and Plant Viruses 9 h

Structure, genome replication, Lytic and lysogenic cycle of bacteriophages, protein synthesis and assembly of DNA containing bacteriophages - T4, lambda, Mu, ΦX174 & M13 phages - RNA containing bacteriophages - MS2 and Φ6 group. Plant viruses - CaMV and Gemini Virus - RNA containing plant viruses - TMV, Cowpea mosaic viruses, Bromo mosaic viruses and Satellite viruses.

#### Unit III Animal Viruses 10 h

Mechanism of viral entry, multiplication and release from host cell. Pathogenicity of DNA containing animal viruses - Adeno viruses, Herpes viruses, Pox viruses, RNA containing animal viruses - Rhabdo virus, Hepatitis viruses, Orthomyxo virus, H1N1, Paramyxovirus, HIV and Rubella virus. Emerging foodborne viruses a case study- Noro virus and Hepatitis a virus (HAV).

#### Unit IV Diagnostic Methods 10 h

Immunodiagnosis - Staining and microscopy for viral inclusion bodies analysis by Electron microscopy, Haemagglutination, Complement fixation, Neutralization, Western blot, RIPA, Flowcytometry and Immunohistochemistry. Nucleic acid based diagnosis - Nucleic acid hybridization, Polymerase chain reaction, Microarray to detect protein and nucleotides.

#### Unit V Prophylaxis 10 h

Viral Vaccines - Conventional vaccines and recombinant vaccines immunomodulators (cytokines). Antivirals - Interferon: Definition and its types, Mass production of Interferon, anti retrovirals - mechanism of action and drug resistance. Modern approaches of virus control - Anti-sense RNA, siRNA.





### Text Books

- 1 *Dimmock N J, Easton A J, and Leppard K N, 2016, **Introduction to Modern Virology**, 7<sup>th</sup> Edition, Blackwell publishing, New Jersey.*
- 2 *Stainier R V, Ingraham J L, Wheelis M L and Painter P R, 1992, **The General Microbiology**, 5<sup>th</sup> Edition, Macmillan, Hampshire & London..*

### References

- 1 *Ananthanarayanan R and CK Jayaram Panicker, 2017, **Introduction to Medical Microbiology**, 10<sup>th</sup> Edition, The Orient Longman, New Delhi..*
- 2 *Black J G and Black LJ, 2017, **Microbiology – Principles and Explorations**, 10<sup>th</sup> Edition, John Wiley & Sons Inc. New York..*
- 3 *Rogger Hull, 2001, **Mathews Plant Virology**, 4<sup>th</sup> Edition, Academic Press, New Delhi..*
- 4 *[https://bio.libretexts.org/Bookshelves/Microbiology/Book%3A\\_Microbiology\\_\(Boundless\)/7%3A\\_Microbial\\_Genetics](https://bio.libretexts.org/Bookshelves/Microbiology/Book%3A_Microbiology_(Boundless)/7%3A_Microbial_Genetics).*



Course Code	Course Name	Category	L	T	P	Credit
233MB2A2CD	MEDICAL BACTERIOLOGY	CORE	3	1	-	3

#### PREAMBLE

This course has been designed for students to learn and understand

- The indigenous microbial flora
- The principle of Gram positive and Gram negative organisms
- The importance of zoonotic diseases

#### COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Apply the epidemiological concepts in identifying the etiology of disease outbreak	K3
CO2	Analyze and identify the gram positive bacterial pathogens from clinical samples	K4
CO3	Analyze and identify the gram negative bacterial pathogens from clinical samples	K4
CO4	Analyze and identify the other significant bacterial pathogens from clinical samples	K4
CO5	Develop infection control policy, antimicrobial sensitivity and resistance pattern of pathogenic bacteria and waste disposal management system	K4

#### MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	✓	✓	✓	✓	✓
CO2		✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓
CO4	✓	✓	✓		
CO5	✓	✓	✓		✓

#### COURSE FOCUSES ON

<input checked="" type="checkbox"/> Skill Development	Entrepreneurial Development
<input checked="" type="checkbox"/> Employability	Innovations
Intellectual Property Rights	Gender Sensitization
<input checked="" type="checkbox"/> Social Awareness/ Environment	Constitutional Rights/ Human Values/ Ethics





233MB2A2CD	MEDICAL BACTERIOLOGY	SEMESTER II
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Total Credits: 3

Total Instruction Hours: 48 h

### Syllabus

#### Unit I Indigenous normal microbial flora 10 h

Indigenous normal microbial flora of human body. General attributes and virulence factors of bacteria causing infections. Epidemiology of infections. Host Parasite relationships – Nonspecific host immune mechanisms. Ground rules for collection and dispatch of clinical specimens for microbiological diagnosis.

#### Unit II Gram positive organisms 8 h

Gram positive organisms - Morphology, cultural characteristics, pathogenicity and laboratory diagnosis of *Staphylococcus aureus*, *Streptococcus pyogenes*, *Pneumococcus*, *Bacillus anthracis*, *Corynebacterium diphtheriae*, *Mycobacterium tuberculosis*, *Mycobacterium leprae*. Role of cell signaling and quorum sensing in microbial diseases

#### Unit III Gram negative organisms 10 h

Gram negative organisms - Morphology, cultural characteristics, pathogenicity and laboratory diagnosis of *E. coli*, *Klebsiella pneumoniae*, *Salmonella typhi*, *Shigella dysenteriae*, *Pseudomonas aeruginosa*, *Vibrio cholerae*, *Bordetella pertussis*, *Neisseria gonorrhoeae*, and *Neisseria meningitidis*, *Brucella abortus*.

#### Unit IV Miscellaneous bacteria 10 h

A detailed account of cultural and morphological characteristics, pathogenicity, clinical manifestations and laboratory diagnosis of Actinomycetes (*Actinomyces* and *Nocardia*) and Spirochaetes (*Treponema*, *Borrelia*, *Leptospira*), *Brucellae*, *Listeria*, *Monocytogenes*, *Mycoplasma*, *Rickettsia*, *Chlamydiae*, *Campylobacter* and *Helicobacter pylori*.

#### Unit V Zoonotic diseases 10 h

Zoonotic diseases and their control – Hospital acquired infections – Hospital Infection control committee – functions. Hospital waste disposal – Plastic, Gloves and Paper. Ethical committee – functions. Antimicrobial resistance and Multi drug resistance.



### Case Study

A 35 year old man presented with abdominal pain and bloody diarrhea. He experienced fever, chills, nausea and vomiting. A stool culture was sent to the microbiology laboratory. Identify the organism and its importance in causing infection.

### Text Books

- 1 *Ananthanarayan R and Paniker C. K. J, 2020, Textbook of Microbiology, 11<sup>th</sup> Edition, Universities press Pvt. Ltd*
- 2 *Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. 2013, Jawetz, Melnick and Adelberg's Medical Microbiology, 26<sup>th</sup> edition. McGraw Hill Publication*

### References

- 1 *Goering R., Dockrell H., Zuckerman M. and Wakelin D, 2007, Mims' Medical Microbiology, 4<sup>th</sup> Edition. Elsevier*
- 2 *Willey JM, Sherwood LM, and Woolverton CJ, 2013, Prescott, Harley and Klein's Microbiology, 9<sup>th</sup> Edition. McGraw Hill Higher Education*
- 3 *Madigan MT, Martinko JM, Dunlap PV and Clark DP, 2014, Brock Biology of Microorganisms, 14<sup>th</sup> Edition. Pearson International Edition*
- 4 *www.sciencedirect.com > medical-bacteriology*





Course Code	Course Name	Category	L	T	P	Credit
233MB2A2CE	RECOMBINANT DNA TECHNOLOGY	CORE	3	1	-	3

#### PREAMBLE

This course has been designed for students to learn and understand

- The utilization of different DNA manipulating enzymes and its exploitation for beneficial applications
- The development of clones and transform them into organisms, making them to produce new products
- On how to utilize the microbial system in developing products of commercial importance

#### COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Apply the ideas of restriction modification system, towards evolution of recombinant DNA technology	K3
CO2	Reframe different vectors in the development of new recombinants	K4
CO3	Employ transport vectors for producing recombinant cells	K4
CO4	Measure and screen the recombinants	K4
CO5	Synthesize commercially important products of microbial origin by rDNA techniques	K4

#### MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓
CO4	✓	✓	✓	✓	✓
CO5	✓	✓	✓	✓	✓

#### COURSE FOCUSES ON

<input checked="" type="checkbox"/> Skill Development	<input checked="" type="checkbox"/> Entrepreneurial Development
<input checked="" type="checkbox"/> Employability	<input checked="" type="checkbox"/> Innovations
Intellectual Property Rights	Gender Sensitization
Social Awareness/ Environment	Constitutional Rights/ Human Values/ Ethics





233MB2A2CE	RECOMBINANT DNA TECHNOLOGY	SEMESTER II
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Total Credits: 3

Total Instruction Hours: 48 h

### Syllabus

#### Unit I Enzymology of rDNA Technology 10 h

History and Scope of rDNA technology - Restriction modification system. Enzymes involved in rDNA techniques, its classification, cofactor involved and mode of action - Restriction endonuclease, Restriction Exonuclease, Polymerases, Klenow, DNA dependent RNA polymerase, Ligase, Reverse Transcriptase, Terminal Transferase, polynucleotide Kinase, alkaline phosphatase.

#### Unit II Vectors 10 h

Introduction to vectors and types - Host cells and vectors - Host cell types (prokaryotic and eukaryotic) - plasmid vectors (host range and incompatibility) pBR322, pUC18/19; Phage based vectors - M13 & Lambda; cosmids; phagemids; fosmid; Artificial chromosomes - BACs; - Eukaryotic vectors - YAC; Shuttle vectors; plant vectors; (Ti plasmid based vectors and caulimoviral vector) - Expression vectors for prokaryotes and eukaryotes; Vectors with tags - Histidine tags.

#### Unit III Cloning and Transformation 10 h

Cloning strategies - DNA cloning a) Sticky ends b) Blunt ends c) Homopolymeric tailing d) Use of adapters & linkers; Construction of genomic DNA libraries (shotgun cloning) and cDNA libraries; Gene transfer techniques in plants, animals and microbes - Transformation, electroporation, microprojectile system, liposome mediated transfer, genegun etc.

#### Unit IV Screening and characterization of cloned DNA 10 h

Screening: Direct: Antibiotic resistance, lacZ complementation (Blue-white selection), plaque phenotype; Indirect: Immunochemical detection - Nucleic acid hybridization, Blotting - Dot and Colony Blotting; Chromosome walking. Chromosome jumping. Characterization of clones - Restriction mapping - restriction fragment length polymorphism (RFLP) - Polymerase chain reaction (PCR) - Types of PCR and their applications. DNA sequencing: Primer walking, Maxim and Gilbert method, dideoxy method and micro array.

#### Unit V Applications 8 h





Gene silencing techniques: Introduction to siRNA and siRNA technology, micro RNA, construction of siRNA vectors, principle and application of gene silencing. CRISPR, CRISPR/Cas9 technology. Gene knockouts and Gene Therapy: Creation of knockout mice, suicide gene therapy, gene replacement, gene targeting. Other applications: Transgenic, Genome projects and their implications, application in global gene expression analysis. Applications of recombinant DNA technology in medicine, agriculture, veterinary sciences and protein engineering.

### Case Study

In 2020 there was a viral pandemic disease that shook the entire world. Design a recombinant product that could have tackled the virus by developing immunity in individuals, in the form of an active or passive vaccine.

### Text Books

- 1 *Brown, T.A. 2020, Gene Cloning and DNA Analysis: An Introduction, Wiley-Blackwell. 8<sup>th</sup> Edition. New Jersey. United States.*
- 2 *Thieman, W.J. and Palladino, M.A. 2019, Introduction to Biotechnology, Books a la Carte. 4<sup>th</sup> Edition, Pearson Education, Noida.*

### References

- 1 *Krebs, J.E., Goldstein E.S. and Kilpatrick S.T. 2018, Lewin's Gene XII, Jones & Bartlett Publishers, Boston. United States.*
- 2 *Primrose, S.B. and Twyman, R.M. 2016, Principles of Gene manipulation and Genomics, 8<sup>th</sup> Edition, John Wiley and Sons Ltd, Wiley-Blackwell. United Kingdom.*
- 3 *Bernard R. Glick, Jack J. Pasternak, Cheryl L. Patten. 2010, Molecular Biotechnology. Principles and Applications of Recombinant DNA, 4<sup>th</sup> Edition. ASM Press. University of Michigan. United States.*
- 4 *Susan, R.B. 2008, Biotechnology, Cengage Learning Pvt. Ltd., New Delhi.*
- 5 <https://archive.nptel.ac.in/courses/102/103/102103013/#downloads>



233MB2A2CP	CORE PRACTICAL II : IMMUNOLOGY AND MOLECULAR TECHNIQUES	SEMESTER II
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Total Credits: 3

Total Instructions Hours: 72 h

S.No	Contents
1	Serological test for HBsAg and HBcAg
2	Antigen, Antibody detection by Dot ELISA
3	Immunodiffusion – Ouchterlony method
4	Isolation & Identification of bacteria from clinical samples - Urine, Pus, Sputum, Stool
5	Bacterial Transformation, Conjugation
6	Restriction Digestion of chromosomal DNA
7	Detection of Protein by Western Blotting
8	Isolation and separation of chromosomal DNA from bacteria
9	Isolation and titration of coli phages from sewage sample
10	Determination of Minimal Inhibitory Concentration – Broth dilution method
11	Cultivation of animal virus by Egg inoculation – Yolk sac, Amniotic cavity Demonstration
12	Production of Chick Antibodies (IgY) – Demonstration

**Note:** End Semester Practical Examination requires completion of 10 experiments out of 12.





## References

- 1 *James Cappuccino, Natalie Sherman, 2013, Microbiology: A Laboratory Manual, 10<sup>th</sup> Edition, Pearson Publishers*
- 2 *Aneja. K.R, 2012, Experiments in Microbiology, Plant Pathology and Biotechnology, 2<sup>nd</sup> Edition. New age publisher*
- 3 *Rajan S. Selvi Christy.R, 2019, Experimental Procedures in Lifesciences, CBS Publishers & Distributors Pvt Ltd*
- 4 *Kannan, N, 1997, Laboratory Manual of General Microbiology, 1<sup>st</sup> Edition, Panima Publishing house*



Course Code	Course Name	Category	L	T	P	Credit
233MB2A2DA	BIONANOTECHNOLOGY	DSE	3	1	-	3

#### PREAMBLE

This course has been designed for students to learn and understand

- The role of microbes and other eukaryotes in the synthesis of nanoparticles
- Advanced methods of characterization of nano particles
- Educate the potential applications of nano particles/ materials in a variety of areas.

#### COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Explore the basics of Nanosciences and its applications	K3
CO2	Synthesize nanoparticles at the laboratory scale	K4
CO3	Analyze the nanoparticles by spectral and electron microscopic techniques	K4
CO4	Apply bionanomaterials in drug development and delivery	K4
CO5	Criticize the merits and demerits of nanomaterial applications	K4

#### MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	✓		✓	✓	✓
CO2	✓	✓	✓	✓	
CO3	✓	✓	✓	✓	✓
CO4	✓	✓	✓		✓
CO5	✓	✓		✓	✓

#### COURSE FOCUSES ON

<input checked="" type="checkbox"/> Skill Development	<input checked="" type="checkbox"/> Entrepreneurial Development
<input checked="" type="checkbox"/> Employability	<input checked="" type="checkbox"/> Innovations
<input checked="" type="checkbox"/> Intellectual Property Rights	Gender Sensitization
Social Awareness/ Environment	Constitutional Rights/ Human Values/ Ethics





233MB2A2DA	BIONANOTECHNOLOGY	SEMESTER II
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Total Credits: 3

Total Instruction Hours: 48 h

### Syllabus

#### Unit I Introduction to bionanotechnology 9 h

History – concept and future prospects – application in Life Sciences. Terminologies – nanotechnology, bionanotechnology, nanobiomaterials, biocompatibility, nanomedicine, nano tube, nanowires, quantum Dots, nanocomposite, nanoparticles, nanosensors, Nanofiber, Dendrimeter. Emergence of Bionanotechnology.

#### Unit II Synthesis of nanoparticles 10 h

Synthesis - Top-down approach & bottom-up approach - Types of nanoparticles production - principle and mechanism of synthesis – physical - Sonicator, Ball mill, ablation, evaporation-condensation; chemical - reducing method - chemical reduction, irradiation, electrochemical, photoreduction; biological - microbes, plants. Green synthesis

#### Unit III Characterization of Nanoparticles 10 h

Physical and chemical properties of nanoparticles. Characterization- UV-Vis spectroscopy, particle size analyzer, Electron Microscopy – HRTEM, SEM, AFM, EDS, XRD. Other tools and techniques required for bionanotechnology: X- Ray crystallography, FTIR, NMR.

#### Unit IV Applications of bionanotechnology 10 h

Targeted drug delivery, biosensors and biomarkers, food and agriculture, DNA nanotech, nanoviricides, tissue engineering, gene delivery. Antibacterial activities of nanoparticles. Toxicology in nanoparticles – Dosimetry. Molecular nanotechnology – nanomachines – collagen.

#### Unit V Merits and demerits of nanoparticles 9 h

Health and safety implications from nanoparticles: Health issues – Environmental issues – Need for regulation – Societal implications – Possible military applications- Potential benefits and risks for developing countries – Intellectual property issues. Bioinformatic tools in nanotechnology: molecular modeling, docking, computer assisted molecular design.

Case study- merits and demerits of nanoparticles in health and environment safety



### Text Books

- 1 Parthasarathy BK. 2007, **Introduction to Nanotechnology**, Isha Publication.
- 2 Elisabeth Papazoglou and Aravind Parthasarathy. 2007, **Bionanotechnology**, Morgan and Claypool Publishers, New Delhi.

### References

- 1 Bernd Rehm, 2006, **Microbial Bionanotechnology: Biological Self-assembly Systems and Biopolymer-based Nanostructures**. Horizon Scientific Press.
- 2 David E Reisner and Joseph D Bronzino, 2008, **Bionanotechnology: Global Prospects**. CRC Press, New Delhi.
- 3 Ehud Gazit, 2006, **Plenty of Room for Biology at the Bottom: An Introduction to Bionanotechnology**. Imperial College Press.
- 4 Kamali Kannangara, 2005, **Nanotechnology: Basic science and Emerging technologies**- Mick Wilson, Overseas Press.





Course Code	Course Name	Category	L	T	P	Credit
233BC2A2DA	BIOCHEMISTRY OF TOXICOLOGY	DSE	3	1	-	3

### PREAMBLE

This course has been designed for students to learn and understand

- The biochemical basis of toxicology.
- The effects & metabolism of toxins
- General toxicology, methods of toxicity testing, toxins from microbes, carcinogenic & teratogenic toxins, pesticide, metal and chemical toxicology.

### COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Conclude the importance of toxicology.	K5
CO2	Distinguish and evaluate the biochemical effects of toxic agents on cellular macromolecules and tissues.	K5
CO3	Compare and perceive different genetic methods used for testing toxicity.	K5
CO4	Assess the effects and metabolism of various microbial Toxins, teratogens and carcinogens.	K5
CO5	Justify the mode of action of toxic pesticides, heavy metals, chemicals and air pollutants.	K5

### MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓
CO4	✓	✓	✓	✓	✓
CO5	✓	✓	✓	✓	✓

### COURSE FOCUSES ON

<input checked="" type="checkbox"/> Skill Development	<input checked="" type="checkbox"/> Entrepreneurial Development
<input checked="" type="checkbox"/> Employability	<input checked="" type="checkbox"/> Innovations
<input checked="" type="checkbox"/> Intellectual Property Rights	Gender Sensitization
<input checked="" type="checkbox"/> Social Awareness/ Environment	Constitutional Rights/ Human Values/ Ethics



233BC2A2DA	BIOCHEMISTRY OF TOXICOLOGY	SEMESTER II
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Total Credits: 3

Total Instruction Hours: 48 h

### Syllabus

#### Unit I Introduction to Toxicology 9 h

Definition and scope of toxicology, Classification of toxic agents. Dose-response relationship: Synergism and Antagonism, Determination of ED50 and LD50. Acute and chronic exposures, Factors influencing toxicity - Abiotic and Biotic factors, Chemical interactions - Bioaccumulation and Bio-magnification.

#### Unit II Biochemical basis of Toxicology 9 h

Toxicokinetics-ADME (Absorption, Distribution, Metabolism and Excretion) and Toxicodynamics. Mechanisms of Toxicity, Interaction of toxicant with target molecules -Disturbance of excitable membrane function. Altered calcium homeostasis. Covalent binding to cellular macromolecules. Organ toxicology, Genetic and reproductive toxicology, Toxicogenomics.

#### Unit III Principles and procedures of testing for acute toxic effects 10 h

Toxicity testing - Genetic toxicity testing and mutagenesis assays - In-vitro test systems - Bacterial mutation tests: Reversion test, Fluctuation tests, Ames test, Eukaryotic mutation test. In-vivo mammalian mutation tests - Host mediated assay and Dominant lethal test. Use of drosophila in toxicity testing. DNA Repair assays, Chromosome damage test. Toxicity testing in animals. Toxicological evaluation of Recombinant DNA - derived proteins.

#### Unit IV Effects and Metabolism of toxins 10 h

Fungal toxins, Mycotoxins - Aflatoxins, Bacterial toxins - Exotoxins and Endotoxins, Viral toxins, Algal toxins, Teratogens, Carcinogens, Mutagens, Snake venom toxin, Spider, Scorpion and Jellyfish toxins, Antivenom. Xenobiotic metabolism: Phase I- III reactions, Cytochrome-P450. Free radical theory of oxygen toxicity.

#### Unit V Pesticide toxicology, Metal toxicology, Chemical toxicology, Air and water pollutants 10 h

Mechanism and site of action of Chlorinated organics (DDT, BHC), organophosphates and carbamates. Fungicides, Herbicides. Environmental consequences of pesticide toxicity. Biopesticides, Mode of action of toxic heavy





metals - arsenic, mercury, cadmium and lead. Biochemical effects of ozone, peroxyacetyl nitrate (PAN) carbon monoxide, nitrogen oxides, sulphur dioxide and cyanide. Drug induced toxicity -example- Paracetamol. Common air pollutants, water pollutants and their sources, air pollution due to methyl - isocyanate (MIC) and asbestos. Toxicology of food additives, case studies

### Text Books

- 1 *Klaassen Curtis D, 2019, Casarett and Doull's Toxicology - The basic Science of Poisons, 9<sup>th</sup> Edition, McGraw Hill Education, London.*
- 2 *Cockerham L.G and Shane B.S, 2019, Basic Environmental Toxicology, 1<sup>st</sup> Edition, CRC Press, New York.*

### References

- 1 *Robert S.M and James R.C, 2015, Principles of Toxicology: Environmental and Industrial Applications, 3<sup>rd</sup> Edition, John Wiley and Sons, New York.*
- 2 *De A.K, 2017, Environmental Chemistry, 8<sup>th</sup> Edition, Newage International Publishers, NewDelhi.*
- 3 *Gupta P.K, 2016, Fundamentals of Toxicology - Essential concepts and Applications, 1<sup>st</sup> Edition, Academic Press, Cambridge, USA.*
- 4 *Gupta R, 2019, Biomarkers in Toxicology, 2<sup>nd</sup> Edition, Academic Press, Cambridge, USA.*



Course Code	Course Name	Category	L	T	P	Credit
233BT2A2DA	FORENSIC BIOTECHNOLOGY	DSE	3	1	-	3

#### PREAMBLE

This course has been designed for students to learn and understand

- Basics and fundamentals of the sample collection and examination in forensic aspects
- Different types of DNA profiling and DNA databases used in Forensic analysis
- Applications of Forensic Biotechnology in various fields

#### COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Describe the sample collection for forensic examinations.	K2
CO2	Know the methods to characterize the different samples on forensic prospective.	K3
CO3	Interpret and examine forensic evidence by DNA profiling methods	K3
CO4	Analyze and interpret the forensic DNA Statistics and Database	K4
CO5	Conclude the significance and applications of Forensic Biotechnology	K4

#### MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	✓	✓	✓		✓
CO2		✓	✓	✓	✓
CO3	✓	✓		✓	✓
CO4	✓	✓			
CO5	✓	✓			✓

#### COURSE FOCUSES ON

<input checked="" type="checkbox"/>	Skill Development	<input type="checkbox"/>	Entrepreneurial Development
<input checked="" type="checkbox"/>	Employability	<input type="checkbox"/>	Innovations
<input type="checkbox"/>	Intellectual Property Rights	<input type="checkbox"/>	Gender Sensitization
<input checked="" type="checkbox"/>	Social Awareness/ Environment	<input type="checkbox"/>	Constitutional Rights/ Human Values/ Ethics





233BT2A2DA	FORENSIC BIOTECHNOLOGY	SEMESTER II
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Total Credits: 3

Total Instruction Hours: 48 h

### Syllabus

#### Unit I Introduction and Forensic Sample Collection 08 h

Forensic science - History, scope, branches and functions. Forensic science in international perspectives, including set up of INTERPOL and FBI. Duties of forensic scientists. Forensic laboratories in India-Central Forensic Science Laboratory. Collection and Preservation of Blood, Semen, Saliva, Urine, Faeces and Milk samples for forensic examinations.

#### Unit II Forensic Sample Examination 10 h

Forensic characterization: Hair- morphology and types, their importance, nature, location, collection, evaluation and tests for their identification. Blood- Properties and blood grouping, presumptive and confirmatory tests. Sperm-composition, morphology of spermatozoa, presumptive and confirmatory tests (including Azoospermic semen stains), seminal fluid isozymes typing, forensic significance of sperm, collection and analysis of evidences in rape cases.

#### Unit III Forensic Sample DNA Profiling 10 h

DNA Profiling: Introduction, history of DNA typing, molecular biology of DNA, variations, polymorphism, DNA extraction-organic and inorganic extraction. Comparison of extraction methods and commercial kits. DNA typing systems-RFLP, PCR amplifications and Sequence polymorphism. Analysis of SNP, YSTR and mitochondrial DNA. Ancient DNA typing and evaluation of DNA typing results.

#### Unit IV Statistics and DNA databank 10 h

DNA Statistics: frequency estimate calculations, interpretations, allele frequency determination, Paternity/Maternity index, Sibling index, Probability of match. Human Genome Project: introduction, history, goals, benefits, social, ethical and legal issues. DNA forensic databases, ethical, legal, and social issues associated with DNA Data banking, potential benefits of DNA Data banking, quality control, certification and accreditation.





**Unit V Applications of Forensic Biotechnology**

10 h

Forensic significance of DNA profiling: Applications in disputed paternity cases, child swapping, missing person's identity- civil immigration, veterinary, wildlife and agriculture cases. Legal perspectives- legal standards for admissibility of DNA profiling, procedural and ethical concerns, status of development of DNA profiling in India and abroad. New and future technologies: SNPs, DNA chips, DNA Barcoding and limitations of DNA profiling.

**Text Books**

- 1 Richard Saferstein E, 2020, "Forensic Science Handbook", 2<sup>nd</sup> Edition, Prentice Hall, New Delhi.
- 2 Allan Jamieson and Scott Bader, 2016, "A Guide to Forensic DNA Profiling", 10<sup>th</sup> Edition, John Wiley & Sons, UK.

**References**

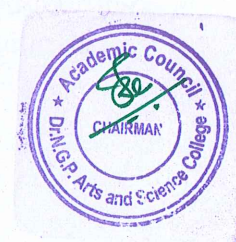
- 1 John Butler M, 2005, "Forensic DNA Typing - Biology, Technology, and Genetics of STR Markers", 2<sup>nd</sup> Edition, Academic Press, United States.
- 2 John Butler M, 2009, "Fundamentals of Forensic DNA Typing", 1<sup>st</sup> Edition, Academic Press, United States
- 3 Stuart James H and William Eckert G, 1993, "Interpretation of blood stain evidence at Crime scenes", 2<sup>nd</sup> Edition, CRC Press, US.
- 4 William Tilstone J, Kathleen Savage A and Leigh Clark A, 2006, "Forensic Science: An Encyclopedia of History, Methods and Techniques", 1<sup>st</sup> Edition, ABC - CLINO Inc, California.

*[Signature]*  
 BoS Chairman/HOD  
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APPROVED		
BoS- 16 <sup>th</sup> 18.10.23	AC- 16 <sup>th</sup> 13.12.23	GB- 21 <sup>st</sup> 05.01.24



*M.Sc. Microbiology (Students admitted during the AY 2023-24)*



Course Code	Course Name	Category	L	T	P	Credit
233MB2A3CA	ENVIRONMENTAL AND AGRICULTURAL MICROBIOLOGY	CORE	4	-	-	4

#### PREAMBLE

This course has been designed for students to learn and understand

- The diversity of microorganisms in different milieu.
- The beneficial role of microbes in the process of recycling different molecules with the aid of biogeochemical cycles.
- Explore the positive utilities of microorganisms in agriculture.

#### COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Validate the microorganisms of air	K3
CO2	Comprehend the different biogeochemical cycles	K3
CO3	Utilize microorganisms in agriculture	K3
CO4	Analyze the quality of water sample	K3
CO5	Utilize microorganisms efficiently in removing wastes	K3

#### MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	✓		✓	✓	
CO2	✓		✓	✓	
CO3	✓	✓	✓	✓	✓
CO4	✓		✓		
CO5	✓	✓	✓	✓	✓

Course Focuses on

<input checked="" type="checkbox"/> Skill Development	<input checked="" type="checkbox"/> Entrepreneurial Development
<input checked="" type="checkbox"/> Employability	<input type="checkbox"/> Innovations
<input type="checkbox"/> Intellectual Property Rights	<input type="checkbox"/> Gender Sensitization
<input checked="" type="checkbox"/> Social Awareness/ Environment	<input type="checkbox"/> Constitutional Rights/ Human Values/ Ethics



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COIMBATORE | INDIA

M.Sc. Microbiology (Students admitted during the AY 2023-24)



233MB2A3CA	ENVIRONMENTAL AND AGRICULTURAL MICROBIOLOGY	SEMESTER III
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**Total Credits: 4**

**Total Instruction Hours: 48 h**

### Syllabus

#### **Unit I** Aerobiology 9 h

Microbial flora of air - Biological indicators of air pollution. Enumeration of microorganisms from air - Air sampling devices. Significance of air Micro flora, Airborne diseases - Bacterial, Fungal and Viral. Effect of Air pollution on plants and Humans. Air sanitation - Dilution, UV light, HEPA filters, fumigation, desiccant rotor.

#### **Unit II** Soil Microbiology 9 h

Structure, Types, Physical and Chemical properties - Soil microbes - Isolation, types of organisms and its enumeration - Weathering and Humus formation - Soil pollution - Sources. Biogeochemical cycling - Nitrogen, Carbon, Phosphorous, Sulphur and Iron cycles its significance.

#### **Unit III** Microbes in Agriculture 10 h

Nitrogen Fixing Microorganisms - Symbiotic and free - living nitrogen fixers - Rhizobium, Azotobacter, Azospirillum, Frankia, BGA and Azolla - Phosphate solubilizers - Phosphobacterium and Aspergillus. Phytopathogens - Bacterial, Fungal and Viral diseases - Wilt, Blight, Canker, Mosaic, Wildfire, Crown gall, Soft rot - Control measures.

#### **Unit IV** Aquatic Microbiology 10 h

Microbiology of water - Fresh water and Marine - Water Pollution and Waterborne Pathogens - Assessment of water quality - Chemical and Microbial - Bacteriological examination of water - MPN, Coliform count - Indicator organisms - Microbiology of Sewage - Waste water treatment - primary, secondary and tertiary - Biological oxygen demand (BOD) and Chemical oxygen demand (COD).

#### **Unit V** Waste Management 10 h

Recycling of Solid wastes - landfills, vermicomposting - Value added products from wastes - Biogas, Mushroom and SCP production. Biodegradation of Complex Polymers - Cellulose, Hemicellulose, Lignin, Chitin and Pectin, Bioremediation - In- situ, Ex -situ, Intrinsic and Engineered, Bioleaching - Copper and Uranium.





Case Study: Case Study: Consider that due to induced mutation most of the bacteria present on the surface of our earth are killed. Which biogeochemical cycle is this condition capable of altering tremendously and why? What could be the after effect of such a condition?

### Text Books

- 1 Atlas R. M and Bartha, (2005). Marketing Management. (5th Edn.) Delhi:Prentice Hall.
- 2 Black J. G. (2013). Microbiology. (8 Edn.) New Delhi:John Wiley and Sons.

### References

- 1 Michael Madigan, (2015). Brock Biology of Microorganisms. (15 Edn.) New Delhi:Pearson publishers.
- 2 Maier RM, Pepper IL and Gerba CP,. (2009). Environmental Microbiology. (2 Edn.) New Delhi:Academic Press.
- 3 Joseph C Daniel, (1999). Environmental Aspects of Microbiology. (1Edn.) Chennai: Bright Sun publishers.
- 4 Alexander,M. (1977). Introduction to soil microbiology. (2 Edn.) John Wiley & Sons, Inc.,. New York.
- 5 Madigan, M., Bender K. S., Buckley D.H., Sattley W. M., and Stahl D.A. Brock. (2017) . Biology of Microorganisms. (15th ed) Pearson Publishers, New York.
- 6 NPTEL Course - Applied Environmental Microbiology:  
<https://nptel.ac.in/courses/105107173>



Course Code	Course Name	Category	L	T	P	Credit
233MB2A3CB	MEDICAL MYCOLOGY AND PARASITOLOGY	CORE	4	-	-	4

### PREAMBLE

This course has been designed for students to learn and understand

- The concept of infectious disease process, transport, processing and examination of medically important fungi
- The concept of infectious disease process, transport, processing and examination of medically important parasite
- Helminthic infections and emerging parasitic infections

CO Number	CO Statement	Knowledge Level
CO1	Recognize the importance of infectious disease and processing of clinical samples.	K3
CO2	Classify the morphology, cultural characteristics and pathogenesis of fungal infections.	K3
CO3	Illustrate the morphology, cultural characteristics and pathogenesis of subcutaneous mycosis. (Rewrite)	K3
CO4	Adapt suitable technique to identify the blood borne parasitic infections.	K3
CO5	Apply the techniques for identification of helminthic parasitic infections.	K3

### MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	✓	✓	✓	✓	✓
CO2		✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓
CO4	✓	✓	✓		
CO5	✓	✓	✓		✓

Course Focuses on

<input checked="" type="checkbox"/>	Skill Development	<input checked="" type="checkbox"/>	Entrepreneurial Development
<input checked="" type="checkbox"/>	Employability	<input type="checkbox"/>	Innovations
<input type="checkbox"/>	Intellectual Property Rights	<input type="checkbox"/>	Gender Sensitization
<input type="checkbox"/>	Social Awareness/ Environment	<input type="checkbox"/>	Constitutional Rights/ Human Values/ Ethics



Dr. NGPASC

COIMBATORE | INDIA

*M.Sc. Microbiology (Students admitted during the AY 2023-24))*



233MB2A3CB	MEDICAL MYCOLOGY AND PARASITOLOGY	SEMESTER III
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**Total Credits: 4**

**Total Instruction Hours: 48 h**

### Syllabus

#### **Unit I** Overview of Fungal Infections 10 h

Morphology, Taxonomy, classification of fungi, detection and recovery of fungi from clinical specimens. Classification of medically important Fungi (Morphology, Infection & Reproduction), Immunity to Fungal Infections. Culture Media and Stains in Mycology, Normal fungal flora of human beings, Specimen collection, preservation, Transportation & Identification of Mycological Agent.

#### **Unit II** Dermatophytes 10 h

Dermatophytes and agents of superficial mycoses - *Trichophyton*, *Epidermophyton* and *Microsporum*. Yeasts of medical importance - *Candida*, *Cryptococcus*. *Pityriasis versicolor*, *White piedra*, *Black piedra*, *Tinea nigra* and Mycotoxins. Allergic Fungal diseases - Mycetismus.

#### **Unit III** Subcutaneous and other Mycosis 10 h

Subcutaneous Mycosis - Mycetoma, Sporotrichosis, Chromoblastomycosis, Systemic Mycosis- Histoplasmosis, Blastomycosis, Coccidioidomycosis, Black fungus. Opportunistic Mycosis - Candidiasis, Aspergillosis, Miscellaneous Mycosis- Otomycosis. Fungal infections in eyes.

#### **Unit IV** Introduction and classification of parasites 9 h

Introduction and classification of parasites - Pathogenesis, life cycle, lab diagnosis and prognosis of blood parasites - Malaria, and Filariasis - Intestinal amoebae. Examination of faeces, Direct and concentration methods.

#### **Unit V** Helminthic Infections 9 h

Helminthic Infections - *Taenia solium*, *T. Saginata*, *Echinococcus granulosus*, *Fasciola hepatica*, *Paragonimus westermani* and *Schistosomes*, *Ascaris lumbricoids*, *Ancylostoma duodenale*, *Trichuris trichiura* and *Enterobius vermicularis*. Blood smear examination - Serology and Molecular Diagnosis- Emerging parasitic infections.





Case study: A 60 year old male admitted to the hospital complaining of shortness of breath, fever, chest pain and cough with blood. His medical history indicates he has smoked one pack of cigarette per day for past 40 years. Recently, he has been on immunosuppressive therapy for severe arthritis. A biopsy specimen of lung is obtained, a black colony growth observed on agar plate. Could you find the causative agent with further diagnosis? And suggest some drugs.

### Text Books

- 1 Chander J. 2017, "Text Book of Medical Mycology", 4th Edition. Jaypee Brothers Medical Pub. New Delhi.
- 2 Errol Reiss, H. Jean Shadomy, G. Marshall Lyon, 2016, "Fundamental Medical Mycology", Wiley-Blackwell. Unites States.

### References

- 1 Reiss E. Shadomy H.J. and Lyon G.M, 2011, "Fundamental Medical Mycology", Wiley-Blackwell. Unites States.
- 2 Brooks G., Carrol K.C., Butel J. and Morse S, 2012, "Jawetz Melnick and Adelberg Medical Microbiology", 26th Edition. Lange Medical Publications USA.
- 3 Chatterjee K.D, 2019, "Parasitology: Protozoology and Helminthology", 13th Edition. CBS Publishers & Distributors Pvt. Limited. New Delhi.
- 4 Arora DR, 2020, "Medical Parasitology",. 5th Edition. CBS Publishers & Distributors Pvt. Limited. New Delhi.





Course Code	Course Name	Category	L	T	P	Credit
233MB2A3CC	PHARMACEUTICAL MICROBIOLOGY AND QUALITY ASSURANCE	CORE	4		-	4

### PREAMBLE

This course has been designed for students to learn and understand

- The Quality and Sterility methods in pharmaceutical products
- Role of a microbiologist in Pharma Industry
- Standardization of protocols in quality assurance of pharmaceutical products

### COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Understand the sampling guidelines for quality control.	K3
CO2	Apply GMP in pharmaceutical industry.	K3
CO3	Interpret the test in accordance with pharmacopoeia compendia standards.	K3
CO4	Analyze the significance of quality assurance in a pharmaceutical industrial process.	K3
CO5	Adopt the regulatory compliance in pharma industry	K3

### MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	✓	✓	✓	✓	✓
CO2		✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓
CO4	✓	✓	✓		
CO5	✓	✓	✓		✓

### Course Focuses on

<input checked="" type="checkbox"/> Skill Development	<input checked="" type="checkbox"/> Entrepreneurial Development
<input checked="" type="checkbox"/> Employability	<input type="checkbox"/> Innovations
<input type="checkbox"/> Intellectual Property Rights	<input type="checkbox"/> Gender Sensitization
<input type="checkbox"/> Social Awareness/ Environment	<input type="checkbox"/> Constitutional Rights/ Human Values/ Ethics



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233MB2A3CC	PHARMACEUTICAL MICROBIOLOGY AND QUALITY ASSURANCE	SEMESTER III
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**Total Credits: 4**

**Total Instruction Hours: 48 h**

### Syllabus

#### **Unit I** Overview on practices and sampling 9 h

WHO good manufacturing practices: Quality management in the drug industry: Heating, Ventilation and air conditioning systems of sterile and non-sterile pharmaceutical firms -Quality assurance - sampling and it types -raw materials, water, containers, condensates, polythene bags and air.

#### **Unit II** Spoilage and Quality analysis 9 h

Types of spoilage- Physical, chemical and biological - Factors affecting spoilage - assessment of microbial spoilage - Selection and use of cleaning and disinfection agents in pharmaceutical manufacturing - Environmental monitoring methods in sterile and non sterile area -Sterilization control - sterilization monitors and Quality assurance of products.

#### **Unit III** Testing methods and Regulations 10 h

Sterile and non sterile pharmaceutical products and their testing protocols: Sterility test - Microbial Limit Test - Bacterial endotoxin test (LAL test). Microbiological quality and regulatory requirements for WHO and FDA - Containment system integrity - Veterinary antimicrobial products - Bio therapeutics and manufactured products.

#### **Unit IV** Quality assurance in pharmaceutical industry 10 h

The role of the qualified person in microbiological quality assurance - Safety in microbiology - Rapid enumeration and identification methods - Measurement of biocide effectiveness - International disinfectant testing protocols. Clean-in-Place, Sterilization in- place, clean room design, operation and regulatory standards.

#### **Unit V** Validation in quality assurance 10 h

Microbiological quality assurance - Validation and types. Validation of aseptic processing and media fill piggy back analysis- Internal and Regulatory Auditing of the pharmaceutical microbiology department. Report writing and Documentation in microbiology lab.





Case study: Examine the changes in the environmental parameters in around the pharmaceutical industry such as N<sub>2</sub>, CO<sub>2</sub>, SO<sub>2</sub> and microbial flora

### Text Books

- 1 Philip Kotler, R (2014). Quality assurance of pharmaceuticals A compendium of guidelines and related materials Volume 2. (2 updated Edn.) Delhi: Prentice Hall
- 2 W.B.Hugo&A.D.Russel (2007). Pharmaceutical Microbiology. (4Edn.) New Delhi: Blackwell Scientific Publications

### References

- 1 Dr Norman Hodges and Professor Geoff Hanlon (2012).Essential Microbiology for Pharmacy and Pharmaceutical Science. (1 Edn.) Wiley Blackwell
- 2 Geoff Hanlon and Tim Sandle, (2015). Industrial Pharmaceutical Microbiology - Vol&VolIII: standards & Controls.(5Edn.):Euromed Communications..
- 3 Madigan ,M. (2006). Brock Biology of Microorganisms. (11 Edn.) USA: Pearson-Prentice Hall.
- 4 [www.pdfdrive.net.in](http://www.pdfdrive.net.in)



Course Code	Course Name	Category	L	T	P	Credit
233MB2A3CD	FOOD MICROBIOLOGY AND FOOD QUALITY CONTROL	CORE	4	-	-	4

### PREAMBLE

This course has been designed for students to learn and understand

- The relation between food and microbes.
- The significance of fermented foods, food borne diseases and food quality control
- The importance of food laws and regulations

### COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Understand the physiological conditions of microbes in food.	K3
CO2	Summarize the importance of food borne diseases.	K3
CO3	Apply suitable microbiological techniques for identification of food borne microorganisms.	K3
CO4	Adopt various quality assurance methods in food industry.	K3
CO5	Understand the food laws and regulations.	K3

### MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	✓	✓			
CO2		✓		✓	✓
CO3	✓		✓		
CO4	✓	✓		✓	✓
CO5	✓	✓	✓		✓

Course Focuses on

<input checked="" type="checkbox"/>	Skill Development	<input checked="" type="checkbox"/>	Entrepreneurial Development
<input checked="" type="checkbox"/>	Employability	<input type="checkbox"/>	Innovations
<input type="checkbox"/>	Intellectual Property Rights	<input type="checkbox"/>	Gender Sensitization
<input checked="" type="checkbox"/>	Social Awareness/ Environment	<input type="checkbox"/>	Constitutional Rights/ Human Values/ Ethics



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233MB2A3CD	<b>FOOD MICROBIOLOGY AND FOOD QUALITY CONTROL</b>	<b>SEMESTER III</b>
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**Total Credits: 4**

**Total Instruction Hours: 48 h**

### Syllabus

#### **Unit I** Food as a substrate 12 h

Incidence and types of microorganisms in food – Contamination and Spoilage of Meat, Poultry, Sea foods, Vegetables, Fruits. Principles of food preservations: Asepsis, Preservation by use of High temperature, Low temperature, Canning, Drying, Radiation and Food additives.

#### **Unit II** Fermented foods and food borne diseases 9 h

Fermented foods - pickles - sauerkraut - Meat and fishery products – Country cured hams, Dry sausages, Katsuobushi. Fermented milk products –, Yoghurt and Cheese. Food poisoning – Food borne diseases- Bacterial and Non- Bacterial.

#### **Unit III** Microbial analysis of food 10 h

Indicator organisms – Direct examination – culture techniques – enumeration methods – plate – Viable & Total Count; Alternative methods – Dye reduction tests , electrical methods , ATP determination: Rapid methods, immunological methods – DNA / RNA methodology – Laboratory accreditation.

#### **Unit IV** Quality assurance in food industry 8 h

In house Committee for quality assurance, Persons involved, Internal Microbial Quality control Policy, Quality Check at every step from collection of raw materials till it reaches the customer, GMP, SSOP, HACCP- Principles & Applications.

#### **Unit V** Food laws and regulations 9 h

National – PFA Essential Commodities Act (FPO, MPO etc.). International – Codex Alimentarius, ISO – 9000 series, ISO 22000 & BS 5750. Regulatory Agencies – WTO, FSSAI. Hygiene and sanitation in food sector General Principles of Food Hygiene, GHP for commodities, equipment, work area and personnel, cleaning and disinfection (Methods and agents commonly used in the hospitality industry), Safety aspects of processing water (uses & standards) and Waste Water & Waste disposal.



Case study: A patient comes with a doctor's prescription with the symptoms of diarrhea and vomiting, typically lasting 1 to 7 days and also with abdominal cramps, nausea, fever, back aches, and fatigue. Analyse the causative agent of the infection relevant to the symptoms.

### Text Books

- 1 Frazier. W.C and D.C Westhoff, (2008). Food Microbiology. (5th Edn.) Delhi: McGraw Hill publishing Co.,. .
- 2 Jay,J. M. (2007). Modern Food Microbiology. (7Edn.) New York: Van.

### References

- 1 Adams. M. R and M. D Moss,. (2008). Food Microbiology. (3 Edn.) New Delhi: Panama Publishers...
- 2 D Kumar Bhatt, Priyanka Tomar,. (2010). An Introduction to Food Science Technology and Quality Management. (Edn.) New Delhi: Kalyani Publishers..





Course Code	Course Name	Category	L	T	P	Credit
233MB2A3CE	RESEARCH METHODOLOGY AND BIOSTATISTICS	CORE	3	1	-	3

### PREAMBLE

This course has been designed for students to learn and understand

- The range of research methods
- The basis of statistical methods and their usage
- The importance of statistical methods in biological sciences

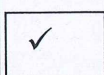
### COURSE OUTCOMES

On the successful completion of the course, students will be able to

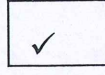
CO Number	CO Statement	Knowledge Level
CO1	Categorize and design a research study and recognize the process and analysis of research data.	K3
CO2	Interpret the reports for statistical and qualitative data. Demonstrate competence in open defense presentation.	K4
CO3	Write the research article and extramural proposals	K3
CO4	Acquire the knowledge on basic concepts of biostatistics	K4
CO5	Understand and compute the basic descriptive statistical measures.	K4

### MAPPING WITH PROGRAMME OUTCOMES

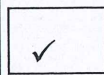
COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	✓		✓	✓	✓
CO2	✓	✓	✓	✓	
CO3	✓	✓		✓	✓
CO4	✓	✓	✓	✓	
CO5		✓	✓	✓	✓



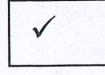
Skill Development



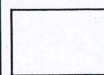
Entrepreneurial Development



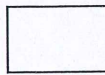
Employability



Innovations



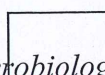
Intellectual Property Rights



Gender Sensitization



Dr. NGRASCO Awareness/ Environment



Constitutional Rights/ Human Values/ Ethics

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233MB2A3CE	RESEARCH METHODOLOGY AND BIOSTATISTICS	SEMESTER III
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**Total Credits: 3**

**Total Instruction Hours: 48 h**

### Syllabus

#### **Unit I**      Research Methodology: An Introduction      9 h

Research Methodology - Definition, objectives and types of research. Research approaches - Processing and analysis of research data - Identification of research gap - Research design. Sampling - types and design.

#### **Unit II**      Thesis Preparation and presentation      9 h

Components of thesis - Title - Acknowledgements - Abstract - Keywords - Introduction - Materials and Methods - Results - Discussion - Summary - Bibliography and its types. Preparation for Open Defense Presentation.

#### **Unit III**      Article and Research proposal preparation      10 h

Article Writing: Article collection - Mendeley reference manager tool - Components of Research article, Review article. Book and book chapters - Research proposal writing - Developing an outline Preamble - specific aim - background structure - budget proposal and justification. Plagiarism. Funding agencies in India and their operations - GOs and NGOs.

#### **Unit IV**      Introduction to Biostatistics      10 h

Definition - Scope of Biostatistics. Applications of biostatistics. Specific aspects of statistical data - Collection and Classification of data. Methods of representation of statistical data - Graphical, Pictorial and tabular - essential features, types, significance and limitations

#### **Unit V**      Descriptive statistics      10 h

Measures of central tendency - Arithmetic mean, Median, Mode. Calculation of Mean, median, Mode in series of individual observations, discrete series, continuous. Measures of dispersion - standard deviation. Correlation - Karl pearsons coefficient of correlation - Analysis in SPSS software.

Case Study: Point out the difference between one tailed and two tailed tests and how can you test the significance between two mean under large sample?





## Text Books

- 1 Gupta, S. P., (2009). Specifications of Statistical methods, 28th Edition. Sultan Chand & sons. .
- 2 Kothari, C. R., (2004). Research Methodology: Methods and Techniques, New Age International, New Delhi.

## References

- 1 Zar, J.H. (2006). Biostatistical analysis, 4th Edn. Pearson education Inc. New Jersey.
- 2 Sundar Rao, P.S.S. and Richard, J. (2006). Introduction to Biostatistics & Research methods. Prentice -Hall of India (P) Ltd, New Delhi.
- 3 R S N Pillai and Bhagavathi, S. (2003). Practical Statistics. 4th Edn. Chand Publisher
- 4 D. N. Elhance, Veena Elhance and B. M. Aggarwa. (2010). Fundamentals of Statistics First Edition, Kitab Mahal Publisher
- 5 [https://onlinecourses.nptel.ac.in/noc20\\_bt28/preview](https://onlinecourses.nptel.ac.in/noc20_bt28/preview)
- 6 [https://onlinecourses.swayam2.ac.in/cec20\\_mg13/preview](https://onlinecourses.swayam2.ac.in/cec20_mg13/preview)
- 7 [https://onlinecourses.swayam2.ac.in/cec20\\_bt23/preview](https://onlinecourses.swayam2.ac.in/cec20_bt23/preview)



233MB2A3CP	CORE PRACTICAL: MICROBIOLOGICAL TECHNIQUES	APPLIED	SEMESTER III
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Total Credits: 3

Total Instructions Hours: 72 h

S.No	Contents
1	Isolation of air borne microorganisms - Settling plate method
2	Microbial dye decolorization - Methylene blue/ Crystal violet
3	Isolation of symbiotic nitrogen fixers - Rhizobium
4	Isolation of Microbes (bacteria and fungi) from spoiled fruits and vegetables
5	Quality analysis of non-sterile therapeutic products - Microbial Limit test
6	Enumeration of microorganisms from water using membrane filtration method
7	Extraction and estimation of pigments from Algae/ Bacteria
8	Alcohol fermentation from fruits - wine
9	Isolation and identification of clinically important fungi - <i>Candida albicans</i> , <i>Aspergillus</i> sp.,
10	Quality analysis of milk sample - Resazurin test
11	Cultivation of Oyster Mushroom
12	Real Time PCR - Demonstration

**Note:** Out of 12-10 Mandatory



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## References

- 1 Aneja K R, 2012, "Experiments in Microbiology, plant pathology and biotechnology", 4th Edition. New age publishers, Kolkata
- 2 James C Cappuccino, 2013, "Microbiology A laboratory manual", 1st edition, Pearson education publishers, Bangaluru
- 3 Rajan S and Selvi Christy, 2018, "Experimental Procedures in Life Sciences", ISBN 13: 9789386478252, CBS Publishers, India
- 4 Kannan N, 1997, Laboratory Manual of General Microbiology, 1st edition, Panima Publishing House, New Delhi





Course Code	Course Name	Category	L	T	P	Credit
233MB2A3DA	MEDICAL LABORATORY TECHNIQUES	DSE	3	1	-	3

### PREAMBLE

This course has been designed for students to learn and understand

- The organization of clinical laboratory
- The processing of clinical samples
- The importance of SOP in laboratory testing

### COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Understand the organization of clinical laboratory	K1
CO2	Apply suitable antiseptics and disinfectants in laboratory conditions	K1
CO3	Analyze various clinical samples.	K2
CO4	Calibrate the instruments for quality assurance.	K2
CO5	Formulate SOP in clinical laboratory	K3

### MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	✓	✓	✓		✓
CO2		✓	✓	✓	✓
CO3	✓	✓		✓	✓
CO4	✓	✓			
CO5	✓	✓			✓

Course Focuses on

<input checked="" type="checkbox"/> Skill Development	<input checked="" type="checkbox"/> Entrepreneurial Development
<input checked="" type="checkbox"/> Employability	<input type="checkbox"/> Innovations
<input type="checkbox"/> Intellectual Property Rights	<input type="checkbox"/> Gender Sensitization
<input type="checkbox"/> Social Awareness/ Environment	<input type="checkbox"/> Constitutional Rights/ Human Values/ Ethics



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233MB2A3DA	MEDICAL LABORATORY TECHNIQUES	SEMESTER III
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Total Credits: 3

Total Instruction Hours: 48 h

### Syllabus

#### Unit I Introduction to Clinical laboratory 9 h

Basic laboratory principles - Organization of clinical laboratory - Biosafety in containment laboratory - National and International GLP (Good laboratory Practices) - Role of medical laboratory technician - personnel hygiene and safety measures.

#### Unit II Antiseptics & Disinfectants 9 h

Definition -Types - Mode of Action - Uses. Antimicrobial agents and Antibiotics: Introduction, mechanism of action, classification and uses, Antibiotic susceptibility testing - Stokes, Kirby-Bauer method, Minimal Inhibitory Concentration and Minimal Bactericidal Concentration.

#### Unit III Collection and processing of blood 10 h

Collection and processing of blood sample- separation of serum and plasma - Sampling errors - Preservation of samples. Determination of Total Count, Differential Count, Erythrocyte Sedimentation Rate, Hemoglobin concentration (Hb), Bleeding Time & Clotting Time. ABO Blood group system. Detection of blood glucose, Urea, Cholesterol and Bilirubin. Profiling - Liver function test, Renal function tests. Hormones - T3, T4, TSH, FSH, LH, Prolactin, Insulin.

#### Unit IV Processing of Urine, Stool and Sputum sample 10 h

Collection, transport and Storage of Urine, Stool and Sputum sample. Macroscopic and Microscopic examination - Urine: sugar, albumin, bile salts, bile pigments and ketone bodies - Pregnancy Test. Stool - Cyst, Ova, Mucus, Pus, RBC, Reduced sugar, Occult blood. Sputum -Petroff's method, AFB staining.

#### Unit V Maintenance of Laboratory 10 h

Maintenance of Laboratory Equipment's - Centrifuge, calorimeter, microscope, incubator, autoclave. Laboratory Certification process - National Accreditation Board for Laboratories, Indian Standard Organization - Standard Operating Procedure - Clinical Laboratory records. Biomedical waste management - Bureau of Indian Standards- danger signs and Symbols.





Case study: A patient comes to you with a doctor's prescription asking you to analyze the thyroid profiling of the patient. The patient has memory issues, drying of skin, hair fall, weight gain etc. What are the tests that you would perform under thyroid profiling? What could probably be the ailment surrounding the patient with your limited knowledge on the patient and his history. Based on your report, what could probably the doctor prescribe the patient?

### Text Books

- 1 Ananthanarayanan R and CK Jayaram Panicker, (2020). Textbook of Microbiology. (11Edn.) Delhi: Orient Longman..
- 2 Monica Cheesbrough, (2018). District Laboratory Practice in Tropical Countries. (2Edn.) USA: Cambridge University Press..

### References

- 1 Bailey and Scotts,. (1994). Diagnostic Microbiology. (9 Edn.) New Delhi: Baron and FinegoldCVMosby Publications.
- 2 Jawetz E Melnic JL and Adel berg EA,. (1998). Review of Medical Microbiology. (10 Edn.) USA: Lange Medical Publications.
- 3 Mackie and McCatney,. (1994). Medical Microbiology. (14 Edn.) New Delhi: Church will Livingston.
- 4 Patrick.K.Murray,I.N. (2012). Medical Microbiology. (4 Edn.) USA: Mosboy Publishers.





Course Code	Course Name	Category	L	T	P	Credit
233BC2A3DA	FREE RADICALS AND ANTIOXIDANT SYSTEM	DSE	3	1		3

### PREAMBLE

This course has been designed for students to learn and understand

- the concepts of free radicals, ROS & RNS, and their chemical characteristics.
- the importance of enzymic antioxidants in preventing oxidative damage
- the role of antioxidants as immunomodulators and their impacts on body.

### COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Demonstrate the formation of free radicals, ROS, and RNS in biological systems and their sources	K3
CO2	Examine the effects of free radicals in various disease conditions and effect of exercise on antioxidants	K4
CO3	Analyze the chemistry, mechanism and effect of enzymic and synthetic antioxidants	K4
CO4	Evaluate the chemistry, mechanism and functions of different non-enzymic antioxidants	K5
CO5	Assess the role of antioxidant in therapeutics and gain insights into future perspectives and challenges in the field	K5

### MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓
CO4	✓	✓	✓	✓	✓
CO5	✓	✓	✓	✓	✓

<input checked="" type="checkbox"/>	Skill Development	<input type="checkbox"/>	Entrepreneurial Development
<input checked="" type="checkbox"/>	Employability	<input type="checkbox"/>	Innovations
<input type="checkbox"/>	Intellectual Property Rights	<input type="checkbox"/>	Gender Sensitization
<input checked="" type="checkbox"/>	Social Awareness/ Environment	<input type="checkbox"/>	Constitutional Rights/ Human Values/ Ethics





233BC2A3DA	<b>FREE RADICALS AND ANTIOXIDANT SYSTEM</b>	<b>SEMESTER III</b>
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**Total Credits: 3**

**Total Instruction Hours: 48 h**

### **Syllabus**

#### **Unit I Introduction to Free Radicals and Oxidative Stress 10 h**

Definition of free radicals, Reactive Oxygen Species (ROS) and Reactive Nitrogen Species (RNS). Formation and physiological roles of free radicals. Mechanism of oxidative damage to biomolecules (DNA, proteins, lipids). Techniques for measuring ROS/RNS levels.

#### **Unit II Reactive Oxygen Species and Disease 10 h**

Oxidative stress in atherosclerosis, obesity and metabolic syndrome, hypertension, Alzheimer's, Parkinson's, Mitochondrial dysfunction, skin aging processes, Air pollution and respiratory diseases. Exercise-induced ROS production, Redox balance and muscle recovery. Effects of exercise on antioxidant defense systems.

#### **Unit III Enzymic Antioxidants and synthetic Antioxidants 8 h**

Enzymic antioxidants- Chemistry, mechanism, antioxidant effect of superoxide dismutase (SOD), Catalase, Glutathione Peroxidase and the glutathione system

Synthetic antioxidants: BHA (butylated hydroxyanisole), BHT (butylated hydroxytoluene), TBHQ (tert-butylhydroquinone), and their chemical properties.

#### **Unit IV Non Enzymic Antioxidants 10 h**

Non Enzymic antioxidants- source, chemistry, toxicity, biochemical functions, bioavailability, bioassays, Antioxidant effects of Vit A, Vit C (ascorbic acid), Vit E (tocopherols and tocotrienols), glutathione and selenium.

#### **Unit V Emerging Topics in Free Radicals and Antioxidant system 10 h**

Mitochondrial-targeted therapeutics .Antioxidants as immunomodulators. Antioxidant strategies for stem cell therapy. Redox modulators in cancer therapy- Redox-active compounds in drug discovery. Clinical trials and future perspectives.

Antioxidant supplementation and disease prevention. - Personalized nutrition and antioxidant requirements





## Text Books

- 1 Steven I Baskin, Harry Salem, 2020 "Oxidants, Antioxidants, and free Radicals", 1st Edition, CRC Press, Florida
- 2 Donald Armstrong, 1994, "Free Radicals in Diagnostic Medicine: A systems approach to Laboratory Technology, Clinical Correlations and Antioxidant Therapy; v. 366", 4th edition, Springer Science, LLC.

## References

- 1 Barry Halliwell and John M.C. Gutteridge, 1998, "Free Radicals in Biology and Medicine", 3rd Edition, Oxford University Press, United Kingdom
- 2 Vibila Rani, 2015, "Free Radicals in Human health and Disease", 5th edition, Springer, New York, USA
- 3 Helmut Sies, 1991, "Oxidative Stress: Oxidants and Antioxidants", 2nd edition, Academic Press, London, United Kingdom
- 4 Dietmar Spengler, 2015, "The Redox Theory of Aging: Physiological Roles and Mechanisms of Aging", 3rd edition, Springer, New York, USA



Course Code	Course Name	Category	L	T	P	Credit
233BT2A3DA	MOLECULAR THERAPEUTICS	DSE	3	1	-	3

### PREAMBLE

This course has been designed for students to learn and understand

- The types of gene therapy and drug delivery.
- The importance of cell therapy and recombinant therapy.
- The basis of microbial pathogenesis and various immunological approaches.

### COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Sketch the process of drug targeting and gene therapy	K3
CO2	Evaluate the use of stem cells and tissue engineering in therapy	K4
CO3	Summarize recombinant gene therapy	K5
CO4	Integrate pathogenic diseases and metabolic disorders	K5
CO5	Design the concept of immunotherapy and its applications	K5

### MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓
CO4	✓	✓		✓	✓
CO5	✓	✓			✓

<input checked="" type="checkbox"/> Skill Development	<input type="checkbox"/> Entrepreneurial Development
<input checked="" type="checkbox"/> Employability	<input type="checkbox"/> Innovations
<input type="checkbox"/> Intellectual Property Rights	<input type="checkbox"/> Gender Sensitization
<input type="checkbox"/> Social Awareness/ Environment	<input checked="" type="checkbox"/> Constitutional Rights/ Human Values/ Ethics





233BT2A3DA	MOLECULAR THERAPEUTICS	SEMESTER III
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**Total Credits: 3**

**Total Instruction Hours: 48 h**

### Syllabus

#### **Unit I Concepts of Gene Therapy and Drug Delivery 09 h**

Introduction to Gene Therapy, Drug targeting and drug delivery system. Intracellular barriers of gene delivery, gene therapy for inherited and acquired diseases, virus mediated gene transfer. Liposome and Nanoparticles mediated gene delivery.

#### **Unit II Stem cells and Tissue Engineering 10 h**

Introduction to Cellular therapy. Stem cells: definition, properties and potency of stem cells; Sources: embryonic and adult stem cells, Role of adult and embryonic stem cells in therapy. Concept of tissue engineering; Role of scaffolds; Role of growth factors in tissue engineering. Clinical applications and Ethical issues.

#### **Unit III Recombinant Gene therapy 10 h**

Introduction to Recombinant therapy, Clinical application of recombinant technology, Erythropoietin, insulin analogs and its role in diabetes, Recombinant human growth hormone, streptokinase and urokinase in thrombosis. Recombinant coagulation factors.

#### **Unit IV Microbial Pathogenicity 10 h**

General concept of infectious disease, types of infectious diseases. Progression of Infection and Disease -Entrance (Portal of entry), Colonization (Adherence; Adhesion; Attachment), Prevention of Host Defenses, Antigenic Variation, Penetration into Host Cytoskeleton, Damage to Host Cells, Production of Toxins.

#### **Unit V Immunotherapy 09 h**

Introduction to Immunotherapy, Monoclonal antibodies and their role in cancer treatment, role of recombinant interferons, Immunostimulant and Immunosuppressors in organ transplants, role of cytokine therapy in cancer. MAMP, RAMP and DAMP triggered immunity. Vaccines: types, recombinant vaccines and their clinical applications.





## Text Books

- 1 Palsson, B. and Bhatia, S. N, 2004, "Tissue Engineering", 2<sup>nd</sup> Edition, Prentice Hall, USA.
- 2 Greenwell, P. and McCulley, M, 2008, "Molecular Therapeutics: 21st century Medicine", 1<sup>st</sup> Edition, Wiley-Blackwell, USA.

## References

- 1 Coleman, W.B. and Tsongalis, G.J, 2006, "Molecular Diagnostics for the Clinical Laboratory", 2<sup>nd</sup> Edition, Humana Press, USA.
- 2 Leonard, DGB, 2016, "Molecular Pathology in Clinical Practice", 2<sup>nd</sup> Edition, Springer International Publishers, USA.
- 3 Whitehouse, D. and Rapley, R, 2012, "Molecular and Cellular Therapeutics", 1<sup>st</sup> Edition, Wiley – Blackwell Publications, USA.
- 4 Quesenberry, P.J. and Stein, G.S, 1998, "Stem Cell Biology and Gene Therapy", 1<sup>st</sup> Edition, John Wiley and Sons Publications, USA





233MB2ASSA	GOOD MANUFACTURING PRACTICES	SEMESTER III
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Total Credits: 2

## Syllabus

### Unit I Principles and Importance of GMP

Principles and Importance of GMP – Definition of GMP, Quality management, Personnel, Risk management, Quality control, Documentation, Inspections

### Unit II Chemical Labelling & Safety

Chemical Labelling & Safety - Safe handling of chemicals and equipment in the laboratory. Handling and disposal of infected, dangerous materials, accidents, safety measures, fire safety, emergency treatment.

### Unit III Sanitation

Sanitation - Cleaning and sanitation compounds and their uses – for process equipments - for environmental cleaning (drains, coolers, etc.) - influence of water quality. Environment sanitation and monitoring - environmental monitoring / pathogen testing - pest control programs.

### Unit IV Equipments and SOPs

Emergency Equipment & Standard Operating Procedures – Maintenance of emergency equipment in a laboratory setting - evaluating Standard Operating Procedures (SOPs) and safety plans

### Unit V Regulatory Agencies

International and federal regulatory agencies that impact the work of Microbiology - WHO, FDA, CDC, EPA, FSSAI



## Text Books

- 1 Mark Gregory Slomiany, 2009, "The indispensable guide to Good laboratory practices", Second edition, Create Space Independent Publishing Platform, Scott Valley...

## References

- 1 A WHO guide to good manufacturing practice (GMP) requirements: Volume 1,2,3,4,5. Part 2-Validation, by Gillian Chaloner-Larsson, Ph.D, GCL Bioconsult, Ottawa
- 2 Good Manufacturing Practices for Pharmaceuticals, Sixth Edition by: Graham Bunn Publisher: Informa Healthcare; 6 edition | 424 pages (2007) [http://ebookey.org/GoodManufacturing-Practices-for-Pharmaceuticals-SixthEdition\\_859976.html#uPYoXd8huFeqqXB9.99](http://ebookey.org/GoodManufacturing-Practices-for-Pharmaceuticals-SixthEdition_859976.html#uPYoXd8huFeqqXB9.99).
- 3 Sandy Weinberg, 2007, "Good Laboratory Practice Regulations", Fourth Edition. CRC Press, US.





233MB2ASSB	Introduction to Human Anatomy	SEMESTER III
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Total Credits: 1

### Syllabus

#### Unit I Parts of the body

Parts of the body-body cavity, trunk, upper limb, lower limb- membranes-mucos, serus, synovial-basic tissues-epithelial, connective tissue, neuron

#### Unit II Skeletal and Muscular system

Skeletal system: Classification and functions of skeletal system – structure of bone-joints-clinical aspects. Muscular system: classification and functions-chief muscles of the body.

#### Unit III Respiratory and cardiovascular system

Respiratory system: Organs of respiration – Nose, Nasopharynx, larynx, trachea, bronchi, lungs – clinical aspects. Cardiovascular system: Heart, circulation of blood, pulse, blood pressure-lymph node, thymus

#### Unit IV Digestive and Urinary system

Digestive system: Organs of digestive-mouth, tongue, esophagus, stomach-intestine-small intestine, large intestine. Urinary system: components of urinary system-kidney, nephron, ureters, urinary bladder –functions of kidney.

#### Unit V Reproductive and Nervus system

[Reproductive system: Female reproductive system-internal genital organ-external genital organ-male reproductive system – internal and external genital organs. Nervus system: nervus system-neuron, cerebral cortex, cerebellum, cerebrospinal fluid, spinal cord.



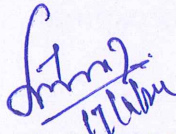



## Text Books

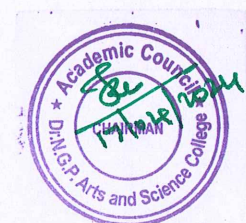
- 1 Krishna Garg and Medha Joshi. 2017. "Anatomy and Physiology for Nurses", First Edition, CBS Publishers Pvt Ltd.
- 2 Anne Waugh and Allison Grant. 2006. "Anatomy and Physiology in Health and Illness", Tenth Edition, Churchill Livingstone, Elsevier.

## References

- 1 Gary A. Thibodeau, Kevin T. Patton. 2013. Structure & Function of the Body", 14<sup>th</sup> Edition, Elsevier
- 2 Ranganathan TS. 2000. A Textbook of Human Anatomy, 1st edition. S Chand Publishing
- 3 <https://nptel.ac.in/courses/102104058>
- 4 <https://microbenotes.com/heart-anatomy-functions/>

  
 BoS Chairman/HOD  
 Department of Microbiology  
 Dr. N. G. P. Arts and Science College  
 Coimbatore - 641 048

			Dr.N.G.P. Arts and Science College		
APPROVED					
BoS-	17th	AC -	17th	GB -	
	05-04-24		17-04-24		



Dr. NGPASC

COIMBATORE | INDIA

*M.Sc. Microbiology (Students admitted during the AY 2023-24))*



Course Code	Course Name	Category	L	T	P	Credit
233MB2A4CA	FERMENTATION TECHNOLOGY	CORE	4	1	-	3

### PREAMBLE

This course has been designed for students to learn and understand

- The concept of fermentation and fermentor types.
- The flow of Upstream and Downstream processing.
- The application of economical microorganisms for the industrial production of bioactive compounds.

### COURSE OUTCOMES

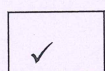
On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Introduce the concept of fermentation and its types.	K2
CO2	Describe the characteristics and applications of industrially important microorganisms.	K3
CO3	Comprehend the methods of inoculum development, Formulation and Sterilization of fermentation media for Upstream processing.	K3
CO4	Categorize the different methods of product recovery in Downstream processing.	K4
CO5	Confer the mechanism of industrial production of commercially important molecules from microorganisms	K4

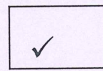
### MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	✓	✓	✓	✓	✓
CO2		✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓
CO4	✓	✓	✓	✓	✓
CO5	✓	✓	✓	✓	✓

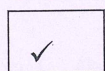
### COURSE FOCUS ON:



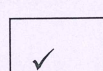
Skill Development



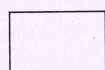
Entrepreneurial Development



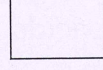
Employability



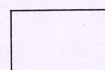
Innovations



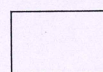
Intellectual Property Rights



Gender Sensitization



Social Awareness/ Environment



Constitutional Rights/ Human Values/ Ethics



Dr.NGPASC

COIMBATORE | INDIA

*M. Sc., Microbiology (Students admitted for the Academic Year 2023-24)*



233MB2A4CA	FERMENTATION TECHNOLOGY	SEMESTER IV
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Total Credits: 3

Total Instruction Hours: 60 h

### Syllabus

#### Unit I Introduction to Fermentation Process 12 h

An introduction to fermentation process - The range of fermentation process - Microbial biomass, Enzymes, Metabolites, Recombinant products, Transformation processes - Component parts of Fermentation process - Fermentor types - Bioreactors for Aerobic fermentation - Stirred Bioreactors - Reactors for immobilized cells - Heat exchange, Stirring and Mixing, Gas exchange and Mass transfer.

#### Unit II Industrially important Microorganisms 12 h

Industrially important Microorganisms - Isolation (Primary and Secondary screening), Preservation and Strain improvement (Mutation, Recombination, Regulation, Gene technology and Use of Genetic methods).

#### Unit III Upstream processing 12 h

Upstream processing - Development of Inoculum for Fermentation process - Media for Industrial Fermentation - Formulation, Optimization and Sterilization, Various stages in Upstream (Inoculum preservation, Growth of the inoculum, Fermenter preculture and Production fermentation).

#### Unit IV Fermentation Types and Cultures 12 h

Fermentation Types and Cultures -Batch, Continuous, Fed-batch - Basic Growth Kinetics - Submerged and Solid state Fermentation - Downstream Processing - Recovery and Purification of Intracellular and Extracellular Products (Flocculation, Flotation, Filter systems, Centrifugation, Disintegration, Chromatography, Extraction, Crystallization, Precipitation and Drying).

#### Unit V Microbial production of Commercial Products 12 h

Microbial production of Organic acids (Citric acid and Acetic acid), Enzymes (Amylase and Protease), Aminoacids (Lysine and Glutamic acid), Antibiotics (Penicillin, Streptomycin and Griseofulvin), Vitamins (Riboflavin, Cyanocobalamine and Ascorbic acid) - Biosynthesis of Ergot alkaloids - Microbial transformation - Steroids and Sterols, Non-steroid compounds, Antibiotics and Pesticides.





Case Study: The product named “Dizicum – ready mix syrubb for oral use (Alpha amylase and pepsin syrubb for digestive purpose” manufactured by TAJ Pharma. Find the bioprocesses techniques involved in the production.

### Text Books

- 1 Peter F. Stanbury, Allan Whitaker and Stephen J. Hall, 2017, **Principles of fermentation technology**, 3<sup>rd</sup> edition, Elsevier publications.
- 2 DG. Rao, 2010, **Bioprocess engineering**, 2<sup>nd</sup> edition, , Tata McGraw Hill Publishing Co. Ltd., New Delhi.
- 3 Stanbury P T and Whitaker 1984. **Principles of Fermentation Technology**, 1<sup>st</sup> Edition. Adithya Books pvt ltd. New Delhi.
- 4 Crueger W and Crueger A. 1991. **Biotechnology. A textbook of Industrial Microbiology**. Sinauer Associates Inc.,U.S

### References

- 1 Mansi El-Mansi and Charlie Bryce, **Fermentation Microbiology and Biotechnology**, CRC press, 4<sup>th</sup> edition, 2018
- 2 Michael L. Schuler, Fikret Kargi, Matthew Delisa, 2017, **Bioprocess Engineering: Basic concepts**, 3<sup>rd</sup> edition, Pearson publishers, 2017
- 3 Peppler. H.J. 1997. 2<sup>nd</sup> edition. **Microbial Technology. Microbial Processes**. Vol I & II. Academic Press. Cambridge.
- 4 Demain A.J. and Solomon INA, 1999. 2<sup>nd</sup> edition. **Manual of Industrial Microbiology and Biotechnology**. ASM press.USA.





Course Code	Course Name	Category	L	T	P	Credit
233MB2A4CB	BIOETHICS, BIOSAFETY AND IPR	CORE	4	1	-	3

**PREAMBLE**

This course has been designed for students to learn and understand

- To understand the commercial aspects of biological products developed and its intellectual protection
- To introduce the concepts of Biosafety regulations and incept its importance in the biological research field.
- To enable the understanding of ethical concepts surrounding life science research.

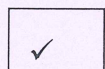
**COURSE OUTCOMES**

On the successful completion of the course, students will be able to

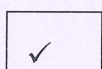
CO Number	CO Statement	Knowledge Level
CO1	To gain awareness about IPR and to take measures for protecting their ideas	K3
CO2	To emphasize on IPR issues and need for knowledge in patent	K2
CO3	To introduce basic concepts of bio safety and to study its impact on the quality of human life.	K3
CO4	To recognise the importance of bio safety practices and guidelines in research.	K2
CO5	To make students learn about the legal safety and public policy issues raised due to the rapid progress in microbiology and development of new products.	K2

**MAPPING WITH PROGRAMME OUTCOMES**

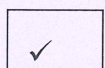
COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	M	M	M	M
CO2	S	S	S	M	S
CO3	S	S	S	S	S
CO4	S	S	S	S	M
CO5	S	M	M	M	M

**COURSE FOCUS ON:**

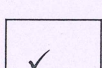
Skill Development



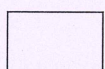
Entrepreneurial Development



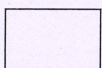
Employability



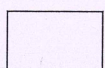
Innovations



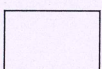
Intellectual Property Rights



Gender Sensitization



Social Awareness/ Environment



Constitutional Rights/ Human Values/ Ethics



Dr.NGPASC

COIMBATORE | INDIA

M. Sc., Microbiology (Students admitted for the Academic Year 2023-24)



233MB2A4CB	BIOETHICS, BIOSAFETY AND IPR	SEMESTER IV
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Total Credits: 3

Total Instruction Hours: 60 h

### Syllabus

#### Unit I Introduction to Intellectual Property Rights 12 h

Concepts of IPR - Designs - Trademarks - Trade secrets - Domain name - Geographical indications - Copy Rights - Evolution of patent law - History of Indian patent system - International conventions and treaties.

#### Unit II Patents 12 h

Classification of patents by WIPO - Classification of patents in India - Categories of patent - Special patent - Patenting of biological products - Patentable and non-patentable inventions in India and abroad - Rights of patent holder and co-owner - Infringement of patent rights and offenses - Patenting life forms - Biodiversity and IPR - Bioinformatics patenting - Gene Patenting. Case study on Patenting Process Overview.

#### Unit III Introduction to Biosafety 12 h

Risk assessment - Cartagena protocol on biosafety - Capacity building - Biosafety guidelines in India evolved by DBT - Rules for the storage and manufacture of hazardous microorganisms and GMO - Bio safety management.

#### Unit IV Biological Agents 12 h

Classification of biological agents - Categories of bio hazardous waste - Labelling and disposal. General safety - Permit for the movement and import of GMOs - Biosafety issues of products developed by rDNA technology - Ecological safety assessment of recombinant organisms - Web based information on biosafety of GMOs.

#### Unit V Bioethics 12 h

Bioethics in research - cloning and stem cell research, Human and animal experimentation, animal rights/welfare, Agricultural biotechnology - Genetically engineered food, environmental risk, labeling and public opinion. Sharing benefits and protecting future generations - Protection of environment and biodiversity - Biopiracy.





### Text Books

- 1 Sateesh M K, 2020, **Bioethics and Biosafety**, Wiley India, New Delhi.
- 2 Deepa goel and Shomini Prasas, 2013, **IPR, Biosafety and Bioethics**, 1<sup>st</sup> Ed., Pearson Education, New Delhi, India.

### References

- 1 Ben Mephram, 2008, **Bioethics - an introduction for the biosciences**, 2<sup>nd</sup> Ed., Oxford University Press, UK.
- 2 Website - <http://www.wipo.int/portal/index.html.en>
- 3 <https://iprlawindia.org>
- 4 <https://bch.cbd.int/protocol>





Course Code	Course Name	Category	L	T	P	Credit
233MB2A4DA	MOLECULAR DIAGNOSTICS AND BIOINFORMATICS	DSE	3	1	-	3

**PREAMBLE**

This course has been designed for students to learn

- Microbes and its involvement in causing life threatening diseases
- The identification and characterization of microbes using different molecular techniques
- The basics of bioinformatics and its tools.

**COURSE OUTCOMES**

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Recognize the concept of molecular diagnosis of Infectious diseases and apply the immunoglobulins for molecular diagnosis.	K3
CO2	Identify the disease by using Nucleotides and Sequencing	K3
CO3	Experiment the nucleic acid amplification by PCR and Analyze the molecules by hybridization process	K3
CO4	Able to explore the biological data to solve several issues in healthcare Domains.	K4
CO5	Apply the knowledge of computational tools to address the clinical problems	K3

**MAPPING WITH PROGRAMME OUTCOMES**

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	✓	✓	✓		✓
CO2	✓	✓	✓	✓	✓
CO3		✓	✓	✓	✓
CO4	✓	✓	✓	✓	
CO5	✓	✓		✓	✓

**COURSE FOCUS ON:**

<input checked="" type="checkbox"/> Skill Development	<input type="checkbox"/> Entrepreneurial Development
<input checked="" type="checkbox"/> Employability	<input type="checkbox"/> Gender Sensitization
<input type="checkbox"/> Intellectual Property Rights (IPR)	<input type="checkbox"/> Social Awareness / Environment
<input type="checkbox"/> Innovations	<input type="checkbox"/> Constitutional Rights / Human Values / Ethics





233MB2A4DA	MOLECULAR DIAGNOSTICS AND BIOINFORMATICS	SEMESTER IV
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Total Credits: 3

Total Instruction Hours: 48 h

## Syllabus

Unit I Introduction to Molecular diagnosis and Immunoglobulin's in diagnosis 12 h

History and Transcending of diagnostics over time - Traditional and molecular diagnostics - Significance of molecular diagnostics - Scope for Molecular diagnostics - Rise of diagnostic industry in Indian and global scenario. Monoclonal and polyclonal antibodies. Agglutination - RIA, ELISA's, chemiluminescence, immunofluorescence, Western blots.

Unit II Molecular Diagnosis using Nucleotides 9 h

Automated DNA sequencing- Principles, Methods and Instrumentation Advances in DNA sequencing - Whole Genome Sequencing, Target Sequencing, New Generation sequencing Methods, Pyrosequencing, Microarrays, Metagenomics.

Unit III PCR and Hybridization 12 h

Nucleic acid amplification methods and types of PCR: Reverse Transcriptase-PCR, Real-Time PCR, Inverse PCR, Ligase Chain Reaction. RACE, RNA fingerprinting. Nucleic acid and Protein extraction and analysis (AGE & PAGE); Western Blot, Southern, northern, dot/slot blot; electrophoresis, nucleic acid probe preparation

Unit IV Introduction to bioinformatics 8 h

Definition, Basics of Bioinformatics, Scope and Applications. Introduction and types: Biological data bases, Importance of databases, DNA sequence databases (NCBI, EMBL, DDBJ, Genbank)- Protein databases (UniProt, Swissprot, PROSITE) and Structural databases (PDB, CATH).

Unit V Bioinformatics tools 7 h

Drug designing Softwares (AutoDock, Schrodinger, ChemSketch) - DNA and Protein similarity searching: BLAST and FASTA, Multiple sequence alignment (ClustalW). Phylogenetic tree types and construction (MEGA).





### Text Books

- 1 William B Coleman, Gregory J Tsongalis, 2005, Molecular Diagnostics: For the Clinical Laboratorian, 2nd Edition, Hanuma Publishers, New Delhi.
- 2 Thomas J Kindt, Barbara A Goldsby, Richard Osborne 2018, Kuby's, Immunology, 8th Edition, W. H. Freeman Publishers, New York.

### References

- 1 George P. Patrinos (Editor), Wilhelm Ansorge (Editor), Phillip B. Danielson Dr. (Editor),. 2016, Molecular Diagnostics, 3rd Edition, Academic press, USA.
- 2 Lele Buckingham and Maribeth L. Flaws, 2019, Molecular Diagnostics: 2 Fundamentals, Methods & Clinical applications, 3rd Edition, F. A. Davis Company, Philadelphia.
- 3 Keith Willson and John Walker, 2010, Principles and Techniques of 3 Biochemistry and Molecular Biology, 7th Edition, Cambridge University Press, US.
- 4 TK Attwood and DJ Parry-Smith, 2003. Introduction to Bioinformatics Pearson PLC Publisher, UK.
- 5 S.C. Rastogi, 2008, Bioinformatics Concepts Skills and Application, PHI Learning, New Delhi.
- 6 Jenny Gu, Philip E. Bourne, 2011, Structural Bioinformatics, 2nd edition, Wiley-Blackwell, Publishers, US.
- 7 <https://microbenotes.com/bioinformatics-databases-software-tools/>
- 8 [https://www.lkouniv.ac.in/site/writereaddata/siteContent/202003291612341467kuaum\\_yadav\\_Bioinformatics.pdf](https://www.lkouniv.ac.in/site/writereaddata/siteContent/202003291612341467kuaum_yadav_Bioinformatics.pdf)





Course Code	Course Name	Category	L	T	P	Credit
233BC2A4DA	NEUROBIOLOGY	DSE	3	1	-	3

#### PREAMBLE

This course has been designed for students to learn and understand

- Overview of nervous system organization and function.
- Neuronal transmission in the body.
- Pathways and mechanisms of neuronal disorders.

#### COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Analyze the morphogenesis of the central nervous system and histology of the nervous system.	K4
CO2	Examine the functioning of the components of the nervous system	K4
CO3	Elaborate the role of different neurotransmitters in nerve impulse conduction	K5
CO4	Evaluate the process of vision, olfaction and taste sensation in detailed pathways	K5
CO5	Explain the neurologic process behind the different neurological diseases	K5

#### MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	✓	✓	✓	✓	✓
CO2	✓	✓	✓		✓
CO3	✓	✓	✓	✓	✓
CO4	✓		✓	✓	✓
CO5	✓	✓	✓	✓	

#### Course Focus on

<input checked="" type="checkbox"/> Skill Development	<input type="checkbox"/> Entrepreneurial Development
<input checked="" type="checkbox"/> Employability	<input type="checkbox"/> Innovations
<input type="checkbox"/> Intellectual Property Rights	<input type="checkbox"/> Gender Sensitization
<input type="checkbox"/> Social Awareness/ Environment	<input type="checkbox"/> Constitutional Rights/ Human Values/ Ethics



Dr. NGPASC

COIMBATORE | INDIA

M. Sc., Microbiology (Students admitted for the Academic Year 2023-24)



233BC2A4DA	NEUROBIOLOGY	SEMESTER IV
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Total Credits: 3

Total Instruction Hours: 48 h

### Syllabus

Unit I      Morphogenesis of central nervous system and Histology of the Nervous System      10 h

Morphogenesis of central nervous system: Early aspects of development, The spinal cord, The brain(Myelencephalon, Metencephalon, Mesencephalon, Prosencephalon, Diencephalon, Telencephalon, Basal Ganglia, Commissures).

Histology of the Nervous System: The neuron: nerve cell body, nucleus, cytoplasm, dendrites, axon. Axonal Transport: fast anterograde, slow anterograde and fast retrograde transport. Types of neurons: multipolar, bipolar, pseudo-unipolar, and unipolar. Neuroglia: astrocytes, oligodendrocytes, microglia, and ependymal cells. Myelinated axons.

Unit II      Design and functioning of the Nervous System      11 h

Neuron, Sensory Receptors, Effectors, information processing, memory. Major Levels of Central Nervous System Function: spinal cord level, lower brain level and higher brain level. Structure and permeability of neuronal membrane: membrane transport proteins, mode of transport, synapse: types (chemical and electrical), Physiologic Anatomy of the Synapse: Presynaptic Terminals, Action Potential and propagation, equilibrium membrane potential, resting membrane potential, Receptor Proteins, Ion Channels (properties and classification), Second Messenger system, Excitation/inhibition in post synaptic membrane.

Unit III      Neurotransmitters      10 h

Neurotransmitters: definition, properties, classes, mechanism of neurotransmitter release. Synthesis, release, physiological and clinical considerations of acetyl choline, GABA, dopamine, norepinephrine, epinephrine, serotonin, histamine, nitric oxide and other novel neurotransmitters. Receptors: nicotinic acetyl choline, NMDA and opioid receptors. Mechanisms of Regulation of Receptors: Desensitization and Down- Regulation

Unit IV      Visual, Olfaction and Taste system      8 h

Visual system: components of eye, different layers of retina, photoreceptors, phototransduction, processing of signals by retinal cells, color vision, visual and





retinal fields, visual pathways, visual reflex Olfaction and Taste: organisation, receptors, sensory transduction, central pathways for olfaction and taste.

Unit V      Neurological diseases      9 h

Description, neurochemistry, pathology, clinical intervention, and biochemical principles of management of neurological diseases: Parkinson's disease, schizophrenia, Huntington's disease, Alzheimer's disease, epilepsy and depression disorder.

### Text Books

- 1 Allan Siegel, Hreday N. Sapru, 2018, "Essential Neuroscience", 4th Edition, Lippincott Williams & Wilkins, a Wolters Kluwer business, United States.
- 2 John E. Hall, Arthur C. Guyton, 2021, "Guyton and Hall Textbook of Medical Physiology", 14th edition, Saunders, an imprint of Elsevier Inc., United States.

### References

- 1 Alan Longstaff, 2011, "Instant notes. Neuroscience", 3rd edition, Taylor & Francis Group, United Kingdom.
- 2 Dale Purves, George J. Augustine, David Fitzpatrick, William C. Hall Anthony-Samuel Iamantia, James O. McNamara, S. Mark Williams, 2017, "Neuroscience", 6th edition, Sinauer Associates, Inc. USA
- 3 Kim E. Barrett, Susan M. Barman, Scott Boitano, William F. Ganong Heddwen L. Brooks, 2019, "Ganong's Review of Medical Physiology", 26th edition, McGraw Hill Education, United States
- 4 Harald Sontheimer, 2015, "Diseases of the Nervous System", 1st Edition, Academic Press, United States.





Course Code	Course Name	Category	L	T	P	Credit
233BT2A4DA	STEM CELL TECHNOLOGY	DSE	3	1	-	3

#### PREAMBLE

This course has been designed for students to learn and understand

- The types of Stem cells
- Characteristics of different stem cells in animals and plants
- Applications of stem cells in various dimensions.

#### COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Know the process of stem cell and storage	K3
CO2	Understand the stem cell importance in plants	K4
CO3	Gain knowledge on the stem cells in animals	K5
CO4	Interpret the role of haemopoietic stem cell	K5
CO5	Analyze the stem cell therapies and its application	K5

#### MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓
CO4	✓	✓	✓	✓	
CO5	✓	✓	✓	✓	✓

#### COURSE FOCUSES ON

<input checked="" type="checkbox"/> Skill Development	<input checked="" type="checkbox"/> Entrepreneurial Development
<input checked="" type="checkbox"/> Employability	<input type="checkbox"/> Innovations
<input type="checkbox"/> Intellectual Property Rights	<input type="checkbox"/> Gender Sensitization
<input checked="" type="checkbox"/> Social Awareness/ Environment	<input checked="" type="checkbox"/> Constitutional Rights/ Human Values/ Ethics





233BT2A4DA	STEM CELL TECHNOLOGY	SEMESTER IV
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Total Credits: 3

Total Instruction Hours: 48 h

### Syllabus

Unit I Stem Cells and Cellular Pedigrees 11 h

Scope of stem cells – definition of stem cells – concepts of stem cells – differentiation, maturation, proliferation, pluripotency, self maintenance and self renewal – problems in measuring stem cells – preservation protocols.

Unit II Stem Cell Concept in Plants 9 h

Stem cell and founder zones in plants – particularly their roots – stem cells of shoot meristems of higher plants. Isolation and harvesting of plant stem cells and their limitations.

Unit III Stem Cell Concept in Animals 10 h

Skeletal muscle stem cell – Mammary stem cells – intestinal stem cells – keratinocyte stem cells of cornea – skin and hair follicles – Tumour stem cells, Embryonic stem cell biology – factors influencing proliferation and differentiation of stem cells – hormone role in differentiation.

Unit IV Haemopoietic Stem Cell 9 h

Biology – growth factors and the regulation of haemopoietic stem cells. Haematopoietic Stem Cells harvesting and limitations, Applications of haematopoietic Stem cells.

Unit V Potential Uses of Stem Cells 9 h

Cellular therapies – vaccines – gene therapy – immunotherapy – tissue engineering – blood and bone marrow – Fc cells.

### Text Books


- 1 Potten CS, 1997, "Stem cells", Elsevier, USA.
- 2 Robert Paul Lanza, 2006, "Essentials of stem cell biology", 2<sup>nd</sup> edition, Academic Press, USA.






## References

- 1 Song Li, Nicolas L'Heureux, Jennifer Elisseeff, 2011, "Stem Cell and Tissue Engineering", 1<sup>st</sup> Edition, World Scientific Publishers, Singapore.
- 2 Robert Lanza, John Gearhart, Brigid Hogan, 2006, "Essentials of Stem Cell Biology", 2<sup>nd</sup> Edition, Macmillan Publishing Solutions, USA.
- 3 Low WC and Verfaillie CM, 2007, "Stem Cell and Regenerative Medicine", 1<sup>st</sup> Edition, World Scientific Publishers, Singapore.
- 4 Lanza R and Atala A, 2007, "Essential of Stem Cell Biology", 3<sup>rd</sup> Edition, Academic Press, USA.

  
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<b>APPROVED</b>		
BoS- 18th 08/11/2024	AC - 18th 26/11/2024	GB -



Dr. NGPASC

COIMBATORE | INDIA

*M. Sc., Microbiology (Students admitted for the Academic Year 2023-24)*