B.Sc., MICROBIOLOGY

Syllabus

Program Code: UMB

2023 - Onwards

MANNAR THIRUMALAI NAICKER COLLEGE

(AUTONOMOUS)

Re-accredited with "A+" Grade by NAAC

PASUMALAI, MADURAI – 625 004

MANNAR THIRUMALAI NAICKER COLLEGE (AUTONOMOUS), MADURAI – 625 004

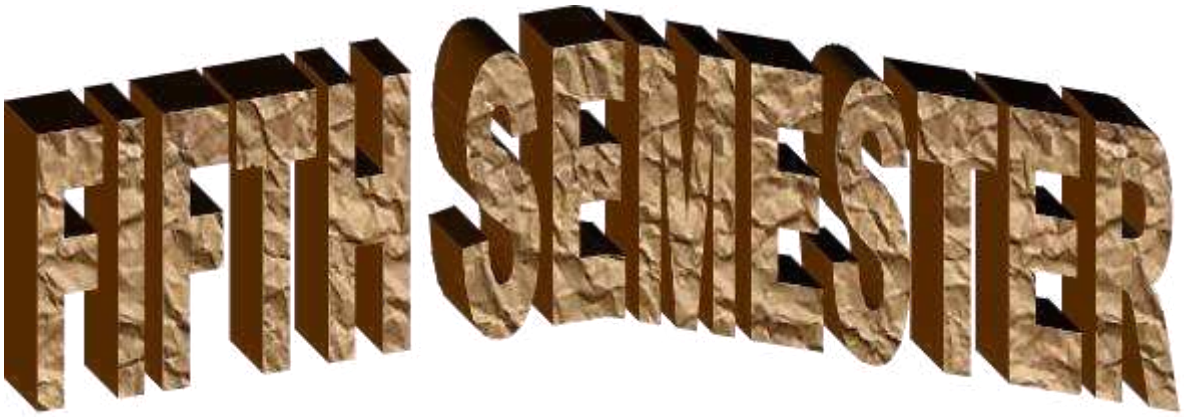
B.SC MICROBIOLOGY CURRICULUM

(For the students admitted from the academic year 2023-2024 onwards)

Course Code	Title of the Course	Hrs	Credits	Maximum Marks		
				Int	Ext	Total
FIRST SEMESTER						
Part – I	**Tamil / Alternative Course**					
23UTAGT11	தமிழ் இலக்கிய வரலாறு - I	6	3	25	75	100
Part – II	**English**					
23UENGE11	General English - I	6	3	25	75	100
Part - III	**Core Courses**					
23UMBCC11	Fundamentals of Microbiology and Microbial Diversity	5	5	25	75	100
23UMBCP11	Fundamentals of Microbiology and Microbial Diversity - Practical	5	5	25	75	100
Part - III	**Elective Course**					
23UMBEC11	Basic and Clinical Biochemistry	4	3	25	75	100
Part IV	**Non Major Elective**					
23UMBNM11	Social and Preventive Medicine	2	2	25	75	100
Part IV	**Foundation Course**					
23UMBFC11	Microbial Taxonomy	2	2	25	75	100
	Total	30	23	175	525	700
SECOND SEMESTER						
Part – I	**Tamil / Alternative Course**					
23UTAGT21	தமிழ் இலக்கிய வரலாறு – II	6	3	25	75	100
Part – II	**English**					
23UENGE21	General English - II	6	3	25	75	100
Part - III	**Core Courses**					
23UMBCC21	Microbial Physiology and Metabolism	5	5	25	75	100
23UMBCP21	Microbial Physiology and Metabolism - Practical	5	5	25	75	100
Part - III	**Elective Course**					
23UMBEC21	Bioinstrumentation	4	3	25	75	100
Part IV	**Non Major Elective**					
23UMBNM21	Nutrition and Health Hygine	2	2	25	75	100
Part IV	**Skill Enhancement course**					
23UMBSC21	Sericulture	2	2	25	75	100
	Total	30	23	175	525	700

Course Code	Title of the Course	Hrs	Credits	Maximum Marks		
				Int	Ext	Total
THIRD SEMESTER						
Part – I	**Tamil / Alternative course**					
23UTAGT31	தமிழக வரலாறும் பண்பாடும்	6	3	25	75	100
Part – II	**English**					
23UENGE31	General English - III	6	3	25	75	100
Part - III	**Core courses**					
23UMBCC31	Molecular Biology and Microbial Genetics	5	5	25	75	100
23UMBCP31	Molecular Biology and Microbial Genetics Practical	4	4	40	60	100
Part - III	**Elective / Allied course**					
23UMBAC31	Clinical Laboratory Technology	4	4	25	75	100
Part - IV	**Skill Based courses**					
23UMBSC31	Organic Farming and Biofertilizer Technology	2	2	25	75	100
23UMBSC32	Aquaculture	2	2	25	75	100
Part - IV	**Mandatory course**					
23UEVSG41	Environmental Studies	1	-	-	-	-
	Total	30	23	190	510	700
FOURTH SEMESTER						
Part – I	**Tamil / Alternative course**					
23UTAGT41	தமிழும் அறிவியலும்	6	3	25	75	100
Part – II	**English**					
23UENGE41	General English - IV	6	3	25	75	100
Part - III	**Core courses**					
23UMBCC41	Immunology and Immunotechnology	5	4	25	75	100
23UMBCP41	Immunology and Immunotechnology Practical	4	4	40	60	100
Part - III	**Elective / Allied course**					
23UMBAC41	Food Processing Technology	4	3	25	75	100
Part - IV	**Skill Based courses**					
23UMBSC41	Vaccine Technology	2	2	25	75	100
23UMBSC42	Apiculture	2	2	25	75	100
Part - IV	**Mandatory course**					
23UEVSG41	Environmental Studies	1	2	25	75	100
	Total	30	23	215	585	800

Course Code	Title of the Course	Hrs	Credits	Maximum Marks		
				Int	Ext	Total
FIFTH SEMESTER						
Part - III	**Core courses**					
23UMBCC51	Bacteriology and Mycology	5	4	25	75	100
23UMBCC52	Virology and Parasitology	5	4	25	75	100
23UMBCP51	Core Practical - V	5	4	40	60	100
Part – III	**Core project**					
23UMBPR51	Project with Viva - Voce	5	4	25	75	100
Part - III	**Elective courses – I**					
23UMBEC51 23UMBEC52 23UMBEC53	**Recombinant DNA Technology** Clinical Biochemistry Marine Microbiology	4	3	25	75	100
Part – III	**Elective courses - II**					
23UMBEC54 23UMBEC55 23UMBEC56	**BioSafety and Bio-Ethics** Nanotechnology Fundamentals of algae, fungi and lichens	4	3	25	75	100
Part - IV	**Mandatory course**					
23UVLEG51	Value Education	2	2	25	75	100
23UMBIN51	Internship Report [Internship / Industrial visit / Field Visit]	-	2	25	75	100
	Total	30	26	215	585	800
SIXTH SEMESTER						
Part - III	**Core courses**					
23UMBCC61	Environmental and Agricultural Microbiology	6	5	25	75	100
23UMBCC62	Food, Dairy and Probiotic Microbiology	6	4	25	75	100
23UMBCP61	Core Practical - VI	6	4	40	60	100
Part - III	**Elective courses - I**					
23UMBEC61 23UMBEC62 23UMBEC63	**Pharmaceutical Microbiology** Plant and animal Biotechnology Diagnostic Microbiology	5	3	25	75	100
Part - III	**Elective courses - II**					
23UMBEC64 23UMBEC65 23UMBEC66	**Entrepreneurship and Bio - Business** Genetics and Biostatistics Fundamentals of Botany and Zoology	5	3	25	75	100
Part - IV	**Skill course**					
23UMBSC61	Microbial Quality Control and Testing	2	2	25	75	100
Part - V	**Extension activities**					
23UNCET61, 23UNSET61, 23UPEET61, 23URRET61, 23UYRET61, 23UHFET61, 23UEOET61 & 23UHRET61	N.C.C, N.S.S, Physical Education, R.R.C, Y.R.C, Health and Fitness Club, ECO Club & Human Rights Club	-	1	25	75	100
	Total	30	22	190	510	700
	Grand total	180	140	1160	3240	4400


FIFTH SEMESTER

Course Name	Bacteriology and Mycology			
Course Code	23UMBCC51	**L**	**P**	**C**
Category	Core	5	-	4

COURSE OBJECTIVES:

- Understand the role of normal flora and pathogenic microbes of various diseases and the clinical microbiological techniques.
- Basic knowledge about Gram positive pathogenic bacteria and their epidemiology.
- Acquire knowledge about Gram negative pathogenic bacteria and nosocomial infections.
- Comprehend knowledge about medically important bacteria and fungi, its classification and significance.
- Gain knowledge about the general characteristics and mode of action of various antibacterial agents.

UNIT - I FUNDAMENTALS OF MEDICAL MICROBIOLOGY 15

History, Classification of Medically Important Microbes, Koch's, and River's postulates-A brief account on the normal microbial flora of the healthy human body – Host-pathogen interactions: Definitions of infection, invasion, primary and opportunistic pathogens, pathogenicity, virulence, toxigenicity, carriers, endemic, epidemic, pandemic diseases and epidemiology – putative virulence factors of human pathogens –infectious disease cycle. Collection and transport of clinical specimens for bacterial and fungal infections.

UNIT - II BACTERIOLOGY – G+ BACTERIA 15

Medically important Gram Positive infections - Causative agent, clinical symptoms, pathogenesis, mode of transmission,lab diagnosis, prevention and treatment of the following bacterial diseases (a) Streptococcal infections (*Streptococcus pyogenes*),(b)Staphylococcalinfections(*Staphylococcusaureus*),(c) Tetanus (*Clostridium tetani*),(d) Diphtheria (*Corynebacteriumdiphtheriae*), (e) Anthrax(*Bacillusanthracis*),(f) Tuberculosis(*Mycobacteriumtuberculosis*),(g)Leprosy(*Mycobacterium leprae*).

UNIT - III BACTERIOLOGY – G- BACTERIA 15

Medically important Gram-Negative infections - Causative agent, clinical symptoms, pathogenesis, mode of transmission, prevention, and treatment of the following bacterial diseases (a) Meningitis(*Streptococcuspneumoniae,Neisseriameningitidis*), (b) typhoid (*Salmonella typhi,*), (c) cholera (*Vibrio cholerae*), (d) bacillary dysentery (*Shigelladysenteriae*); SexuallyTransmitteddiseases (syphilis– *Treponemapallidum,*Nosocomial infections – definition, importance,and their control (*Pseudomonas aeruginosa*).

UNIT - IV MYCOLOGY 15

Medically important Fungi - Classification of medically important fungi; Superficial mycoses – *Pityriasis versicolor*, *Tinea nigra*, Piedra, Cutaneous mycoses: *Microsporum* sp., *Trichophyton* sp. and *Epidermophyton floccosum*; Subcutaneous mycoses: Chromoblastomycosis; Sporotrichosis; Systemic Mycoses -Blastomycosis; Histoplasmosis*;* Opportunistic Infections -Candidiasis; Cryptococcosis; Zygomycosis; Mycotoxins: Aflatoxin.

UNIT - V	ANTIMICROBIAL CHEMOTHERAPY	15
Antimicrobial agents -General characteristics and mode of action of antibacterial agents :Modesofaction with an example for each: Inhibitor of nucleic acid synthesis [Ciprofloxacin]; Inhibitor of cell wall synthesis Penicillin]; Inhibitors of cell membrane function [Amphotericin-B];Inhibitors of protein synthesis [Streptomycin]; Inhibitor of metabolism, Antifungal agents: Mechanism of action of Amphotericin B and Griseofulvin.		
	Total Lecture Hours	**75**

BOOKS FOR STUDY:

- Tom Parker, M. Leslie and H. Collier. (1990). Topley & Wilson's Principles of Bacteriology, Virology and Immunity,8th Edition. London: Edward Arnold.
- Greenwood, D., Slack, R. B and Peutherer, J. F., (2012)Medical Microbiology, 18th Edition. Churchill Livingstone, London.
- Finegold,S.M.(2000)DiagnosticMicrobiology,10th Edition.C.V.Mosby Company, St. Louis.
- Ananthanarayanan, R and Jayaram Panicker C. K. (2020). Textbook of Microbiology. Orient Longman, Hyderabad.
- JagdishChander(2018).TextbookofMedicalMycology,4th edition,Jaypeebrothers medical publishers.
- Gerhardt, P., Murray, R.G.,Wood, W.A and Kreig, N.R. (Editors)(1994), Methods for General and Molecular Bacteriology. ASM Press, Washington, DC.

BOOKS FOR REFERENCES:

- Kevin Kavanagh, (2018). Fungi – Biology and Applications 3rd Edition. Wiley Blackwell publishers.
- C.J. Alexopoulos, C.W. Mims, M. Blackwell, (2007). Introductory Mycology, 4th edition. Wiley publishers.
- A.J.Salle(2007).Fundamentalprinciplesofbacteriology, 4th edition,Tata McGraw-Hill Publications.
- ChristopherC.Kibbler,RichardBarton,NeilA.R.Gow,SusanHowell,DonnaM. MacCallum, Rohini J. Manuel (2017). Oxford Textbook of Medical Mycology.Oxford University Press.

WEB RESOURCES:

- **http://textbookofbacteriology.net/nd**
- **https://microbiologysociety.org/members-outreach-resources/links.html**
- **http://mycology.cornell.edu/fteach.html**
- **https://www.adelaide.edu.au/mycology/**
- **https://www.isham.org/mycology-resources/mycological-links**

Nature of Course	EMPLOYABILITY			SKILL ORIENTED	✓		ENTREPRENEURSHIP				
Curriculum Relevance	LOCAL		REGIONAL		NATIONAL		GLOBAL	✓			
Changes Made in the Course	Percentage of Change			No Changes Made			New Course	✓			

***Treat 20% as each unit (20*5=100%) and calculate the percentage of change for the course.**

COURSE OUTCOMES:		K LEVEL
After studying this course, the students will be able to:		
CO1	Understand the importance of normal flora of human body and acquire knowledge on the process of infectious disease.	K1 to K4
CO2	Explain the various bacterial pathological events during the progression of an infectious disease and apply the underlying mechanisms of spread of disease and its control.	K1 to K4
CO3	Compile a list of disease-causing bacteria and compare their modes of infection, symptoms, diagnosis and treatment.	K1 to K4
CO4	Comprehend human - fungal interaction, which can be applied to obtain in-depth knowledge on fungal diseasesand the mechanism behind the disease process.	K1 to K4
CO5	Explain the types of mycoses caused in humans and categorize the modes of infection, pathogenesis and treatment with introduction to mycotoxins.	K1 to K4

MAPPING WITH PROGRAM OUTCOMES:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S		S		S		S			M
CO2	S		S		S		S			M
CO3	S		S		S		S			M
CO4	S		S		S		S			M
CO5	S		S	M	S	M	S		S	M

S- STRONG M – MEDIUM L - LOW

CO / PO MAPPING:

COS	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	3	2	2	3	3
CO 2	3	2	3	3	3
CO 3	2	3	2	2	3
CO 4	3	2	3	3	3
CO 5	3	2	3	3	3
WEIGHTAGE	14	11	13	14	14
WEIGHTED PERCENTAGE OF COURSE CONTRIBUTION TO POS	93.33	73.33	86.66	93.33	93.33

LESSON PLAN:

UNIT	Bacteriology and Mycology	HRS	PEDAGOGY
I	History, Classification of Medically Important Microbes, Koch's, and River's postulates-A brief account on the normal microbial flora of the healthy human body – Host-pathogen interactions: Definitions of infection, invasion, primary and opportunistic pathogens, pathogenicity, virulence, toxigenicity, carriers, endemic, epidemic, pandemic diseases	15	Chalk & Talk

	and epidemiology – putative virulence factors of human pathogens – infectious disease cycle. Collection and transport of clinical specimens for bacterial and fungal infections.		
II	Medically important Gram Positive infections **-** Causative agent, clinical symptoms, pathogenesis, mode of transmission,prevention and treatment of the following bacterial diseases (a) Streptococcal infections (*Streptococcus pyogenes*, *Streptococcus faecalis*),(b)Staphylococcalinfections(*Staphylococcusaureus*),(c) Tetanus (*Clostridium tetani*)(d) Diphtheria (*Corynebacteriumdiphtheriae*)(e)Anthrax(*Bacillusanthracis*)(f)Tuberculosis(*Mycobacteriumtuberculosis*),(g)Leprosy(*Mycobacterium leprae*).	**15**	**Chalk & Talk**
III	Medically important Gram-Negative infections - Causative agent, clinical symptoms, pathogenesis, mode of transmission, prevention, and treatment of the following bacterial diseases (a) Meningitis (*Streptococcus pneumoniae, Neisseria meningitidis*), (b) typhoid (*Salmonella typhi, Salmonella paratyphi*), (c) cholera (*Vibrio cholerae*), (d) bacillary dysentery (*Shigella dysenteriae*); Sexually Transmitted diseases (syphilis–*Treponema pallidum,* Gonorrhoea- *Neisseria gonorrhoeae*); Nosocomial infections – definition, importance, and their control (*Pseudomonas aeruginosa*).	**15**	**Chalk & Talk**
IV	Medically important Fungi - Classification of medically important fungi; Superficial mycoses: *Pityriasisversicolor*, *Tineanigra*, Piedra; Cutaneousmycoses:*Microsporum* sp., *Trichophyton* sp. and *Epidermophyton floccosum*; Subcutaneous mycoses: Chromoblastomycosis; Sporotrichosis; Systemic Mycoses - Blastomycosis; Histoplasmosis*;* Opportunistic Infections -Candidiasis; Cryptococcosis; Zygomycosis; Mycotoxins: Aflatoxin.	**15**	**Chalk & Talk**
V	Antimicrobial agents -General characteristics and mode of action of Antibacterial agents : Modes of action with an example for each: Inhibitor of nucleic acid synthesis; Inhibitor of cell wall synthesis; Inhibitor of cell membrane function; Inhibitor of protein synthesis; Inhibitor of metabolism, Antifungal agents: Mechanism of action of Amphotericin B and Griseofulvin.	**15**	**Chalk & Talk**

Learning Outcome Based Education & Assessment (LOBE) Formative Examination - Blue Print Articulation Mapping – K Levels with Course Outcomes (COs)						
Internal	**Cos**	**K Level**	**Section A**		**Section B Either or Choice**	**Section C Either or Choice**
			MCQs			
			No. of. Questions	**K - Level**		
CI AI	**CO1**	**K1 – K4**	2	K1, K2	2(K2, K2)	2(K3, K3)
	CO2	**K1 – K4**	2	K1, K2	2(K3, K3)	2(K4, K4)
CI AII	**CO3**	**K1 – K4**	2	K1, K2	2(K2, K2)	2(K3, K3)
	CO4	**K1 – K4**	2	K1, K2	2(K3, K3)	2(K4, K4)
Question Pattern CIA I & II		**No. of Questions to be asked**	4		4	4
		No. of Questions to be answered	4		2	2
		Marks for each question	1		5	8
		Total Marks for each section	4		10	16

Distribution of Marks with K Level CIA I & CIA II							
	K Level	**Section A (Multiple Choice Questions)**	**Section B (Either / Or Choice)**	**Section C (Either / Or Choice)**	**Total Marks**	**% of (Marks without choice)**	**Consolidate of %**
CIA I	**K1**	**2**			**2**	**3.6**	**25**
	K2	**2**	**10**		**12**	**21.4**	
	K3		**10**	**16**	**26**	**46.4**	**46.4**
	K4			**16**	**16**	**28.6**	**28.6**
	Marks	**4**	**20**	**32**	**56**	**100**	**100**
CIA II	**K1**	**2**			**2**	**3.6**	**7.2**
	K2	**2**	**10**		**12**	**3.6**	
	K3		**10**	**16**	**26**	**46.4**	**46.4**
	K4			**16**	**16**	**46.4**	**46.4**
	Marks	**4**	**20**	**32**	**56**	**100**	**100**

K1- Remembering and recalling facts with specific answers

K2- Basic understanding of facts and stating main ideas with general answers

K3- Application oriented- Solving Problems

K4- Examining, analyzing, presentation and make inferences with evidences

CO5 will be allotted for individual Assignment which carries five marks as part of CIA component.

Summative Examination – Blue Print Articulation Mapping – K Level with Course Outcomes (COs)						
S. No	COs	K - Level	Section A (MCQs)		Section B (Either / or Choice) With K - LEVEL	Section C (Either / or Choice) With K - LEVEL
			No. of Questions	K – Level		
1	CO1	K1-K4	2	K1, K2	2(K2, K2)	2(K3, K3)
2	CO2	K1-K4	2	K1, K2	2(K3, K3)	2(K4, K4)
3	CO3	K1-K4	2	K1, K2	2(K2, K2)	2(K3, K3)
4	CO4	K1-K4	2	K1, K2	2(K3, K3)	2(K4, K4)
5	CO5	K1-K4	2	K1, K2	2(K3, K3)	2(K4, K4)
No. of Questions to be Asked			10		10	10
No. of Questions to be answered			10		5	5
Marks for each question			1		5	8
Total Marks for each section			10		25	40
(Figures in parenthesis denotes, questions should be asked with the given K level)						

Distribution of Marks with K Level						
K Level	Section A (Multiple Choice Questions)	Section B (Either or Choice	Section C (Either/ or Choice)	Total Marks	% of (Marks without choice)	Consolidated %
K1	5			5	3.6	4
K2	5	20		25	17.8	18
K3		30	32	62	44.3	44
K4			48	48	34.3	34
Marks	10	50	80	140	100	100
NB: Higher level of performance of the students is to be assessed by attempting higher level of K levels.						

Summative Examinations - Question Paper – Format

Q. No.	Unit	CO	K-level		
Answer **ALL** the questions				**PART – A**	**(10 x 1 = 10 Marks)**
1.	**Unit - I**	**CO1**	**K1**		
				a)	b)
				c)	d)
2.	**Unit - I**	**CO1**	**K2**		
				a)	b)
				c)	d)
3.	**Unit - II**	**CO2**	**K1**		
				a)	b)
				c)	d)
4.	**Unit - II**	**CO2**	**K2**		
				a)	b)
				c)	d)
5.	**Unit - III**	**CO3**	**K1**		
				a)	b)
				c)	d)
6.	**Unit - III**	**CO3**	**K2**		
				a)	b)
				c)	d)
7.	**Unit - IV**	**CO4**	**K1**		
				a)	b)
				c)	d)
8.	**Unit - IV**	**CO4**	**K2**		
				a)	b)
				c)	d)
9.	**Unit - V**	**CO5**	**K1**		
				a)	b)
				c)	d)
10.	**Unit - V**	**CO5**	**K2**		
				a)	b)
				c)	d)

Answer **ALL** the questions		**PART – B**		**(5 x 5 = 25 Marks)**
11. a)	**Unit - I**	**CO1**	**K2**	
		OR		
11. b)	**Unit - I**	**CO1**	**K2**	
12. a)	**Unit - II**	**CO2**	**K3**	
		OR		
12. b)	**Unit - II**	**CO2**	**K3**	
13. a)	**Unit - III**	**CO3**	**K2**	
		OR		
13. b)	**Unit - III**	**CO3**	**K2**	
14. a)	**Unit - IV**	**CO4**	**K3**	
		OR		
14. b)	**Unit - IV**	**CO4**	**K3**	
15. a)	**Unit - V**	**CO5**	**K3**	
		OR		
15. b)	**Unit - V**	**CO5**	**K3**	

Answer **ALL** the questions		**PART – C**		**(5 x 8 = 40 Marks)**
16. a)	**Unit - I**	**CO1**	**K3**	
		OR		
16. b)	**Unit - I**	**CO1**	**K3**	
17. a)	**Unit - II**	**CO2**	**K4**	
		OR		
17. b)	**Unit - II**	**CO2**	**K4**	
18. a)	**Unit - III**	**CO3**	**K3**	
		OR		
18. b)	**Unit - III**	**CO3**	**K3**	
19. a)	**Unit - IV**	**CO4**	**K4**	
		OR		
19. b)	**Unit - IV**	**CO4**	**K4**	
20. a)	**Unit - V**	**CO5**	**K4**	
		OR		
20. b)	**Unit - V**	**CO5**	**K4**	

Course Name	Virology and Parasitology			
Course Code	23UMBCC52	**L**	**P**	**C**
Category	Core	5	-	4

COURSE OBJECTIVES:

- To gain knowledge on properties and classification of viruses and collection of relevant clinical samples for diagnosing viral infections.
- Tounderstandpathogenicmicroorganismsofvirusesandthemechanismsbywhichthey cause disease in the human body.
- To gain knowledge about reemerging viral infections and develop diagnostic skills, including the use and interpretation of laboratory test in the diagnosis of infectious diseases.
- Understand the types of parasites causing infections in the intestine.
- To develop skills in the diagnosis of parasitic infections**.**

UNIT - I VIRUSES AND ITS CLASSIFICATION **15**

General Properties, replication and Classification of viruses (Baltimore classification), Cultivation of viruses- in animals, embryonated eggs and tissue culture, Virus purification assays - collection and transport of clinical specimens for viral infections.

UNIT - II VIRAL DISEASES **15**

Viral diseases with reference to symptoms, pathogenesis, transmission, prophylaxis and control – Arboviruses (Flavi virus), Picorna viruses (Polio virus and Rhinovirus), Hepatitis viruses(HAV, HBV, HCV), Rabies virus, Orthomyoviruses (Influenza virus) and Paramyxoviruses (Mumps virus), Pox viruses (Variola, Vaccinia), Herpes viruses (Herpes simplex, Varicella zoster), Adeno viruses, Rota viruses and HIV viruses. Oncogenic viruses (Human Papilloma virus), mechanism of viral oncogenesis and clinical manifestations.

UNIT - III EMERGING VIRAL INFECTIONS & ANTIVIRAL AGENTS **15**

Emerging and reemerging viral infections (Swine flu, Ebola, and Corona) – causes, spread and preventive measures. Detection of viruses in clinical specimens – Serological and Molecular diagnosis of virus infections – Antiviral agents, Interferons and Viral Vaccines,Immunization schedules.

UNIT - IV INTRODUCTION TO MEDICAL PARASITOLOGY **15**

General introduction to Medical Parasitology, Classification of medically important parasites. Morphology, life cycle, pathogenesis, clinical features, laboratory diagnosis, prevention and treatment of diseases caused by the following organisms: *Entameobahistolytica*, flagellates (*Giardia lamblia, Leishmaniadonovani*), Sporozoa- *Plasmodium*spps.

UNIT - V INTRODUCTION TO HELMINTHS **15**

Introduction to Helminthes,Platyhelminthes – *Taenia solium – Fasciola hepatica* –. Nemathelminthes – *Ascaris lumbricoidess— Enterobius vermicularis —— Wuchereria bancroftii* –. Collection, transport and examination of sample.LaboratorytechniquesinparasitologyExaminationoffaecesforova.

Total Lecture Hours **75**

BOOKS FOR STUDY:

- S., Rajan(2007). Medical microbiology, MJP publisher.
- JeyaramPaniker, C.K. (2006). Text Book of Parasitology Jay Pee Brothers,NewDelhi.
- AroraD.R.andAroraB.(2002).MedicalParasitology,1stEditionCBSPublishers& Distributors, New Delhi.
- Chatterjee (1986). Medical Parasitology. Tata McGraw Hill, Calcutta.
- ParijaS.C.(1996).TextBookofMedicalParasitology.4thedition,OrientLongman, AllIndia Publishers & Distributors.

BOOKS FOR REFERENCES:

- Jawetz, E., Melnick, J.L. and Adelberg, E.A. (2000).Review of Medical Microbiology, 19thEdition. Lange Medical Publications, U.S.A.
- Ananthanarayan,R.andJeyaramPaniker,C.K.(2009).TextBookofMicrobiology,8thEdition. Orient Longman, Chennai .
- Conrat HF, Kimball PC and Levy JA. (1988). Virology. II edition. Prentice Hall Englewood Cliff, New Jersey.
- Topley&Wilsons's(1990).PrinciplesofBacteriology,VirologyandImmunity,8thEdition, Vol. III Bacterial Diseases, Edward Arnold, London.
- Finegold, S.M. (2000).Diagnostic Microbiology, 10th Edition. C.V. Mosby Company,St.Louis.

WEB RESOURCES:

- **https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4047123/**
- **https://www.ncbi.nlm.nih.gov/pubmed/21722309**
- **https://www.sciencedirect.com/science/article/pii/S2211753919300193**
- **https://cmr.asm.org/content/30/3/811**
- **https://www.nejm.org/doi/full/10.1056/NEJMoa1811400**

Nature of Course	EMPLOYABILITY		SKILL ORIENTED		ENTREPRENEURSHIP	✓			
Curriculum Relevance	LOCAL		REGIONAL		NATIONAL		GLOBAL	✓	
Changes Made in the Course	Percentage of Change		No Changes Made		New Course	✓			

***Treat 20% as each unit (20*5=100%) and calculate the percentage of change for the course.**

COURSE OUTCOMES:		K LEVEL
After studying this course, the students will be able to:		
CO1	Understandthestructureandpropertiesofviruses, cultivation methods and diagnosis of viral diseases.	K1 to K4
CO2	Knowledgeofbasicandgeneralconceptsofcausationofdisease by the pathogenic microorganisms and various parameters ofassessment of their severity and the methods of diagnosis.	K1 to K4
CO3	Insights to treatment options of viral diseases.	K1 to K4
CO4	Knowledge about the importance of protozoans in the intestine.	K1 to K4
CO5	Knowledge of Nematodes as infectious agent.	K1 to K4

MAPPING WITH PROGRAM OUTCOMES:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1					M					M
CO2					M					M
CO3					M					M
CO4					M					M
CO5					M					M

S- STRONG M – MEDIUM L - LOW

CO / PO MAPPING:

COS	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	2	3	2	2	2
CO 2	3	2	2	1	2
CO 3	2	2	1	2	3
CO 4	3	2	2	2	2
CO 5	2	2	2	2	1
WEIGHTAGE	12	11	9	9	10
WEIGHTED PERCENTAGE OF COURSE CONTRIBUTION TO POS	80	73.3	60	60	66.6

LESSON PLAN:

UNIT	Virology and Parasitology	HRS	PEDAGOGY
I	General Properties, replication and Classification of viruses (Baltimore classification), Cultivation of viruses- in animals, embryonated eggs and tissue culture, Virus purification assays - collection and transport of clinical specimens for viral infections.	15	Chalk & Talk, PPT
II	Viral diseases with reference to symptoms, pathogenesis, transmission, prophylaxis and control – Arboviruses (Flavi virus), Picorna viruses	15	Chalk & Talk, PPT

	(Polio virus and Rhinovirus), Hepatitis viruses(HAV, HBV, HCV, HDV, HEV), Rabies virus, Orthomyoviruses (Influenza virus) and Paramyxoviruses (Mumps and Measles virus), Pox viruses (Variola, Vaccinia), Herpes viruses (Herpes simplex, Varicella zoster), Adeno viruses, Rota viruses and HIV viruses. Oncogenic viruses (Human Papilloma virus): Introduction, characteristics of transformed cells, mechanism of viral oncogenesis and clinical manifestations.		
III	Emerging and reemerging viral infections (SARS, Swine flu, Ebola, Dengue, Chikungunya- and Corona) – causes, spread and preventive measures. Detection of viruses in clinical specimens – Serological and Molecular diagnosis of virus infections – Antiviral agents, Interferons and Viral Vaccines,Immunization schedules.	**15**	**Chalk & Talk, PPT**
IV	General introduction to Medical Parasitology, Classification of medically important parasites. Morphology, life cycle, pathogenesis, clinical features, laboratory diagnosis, prevention and treatment of diseases caused by the following organisms: *Entameobahistolytica*, flagellates (*Giardia lamblia, Leishmaniadonovani*), Sporozoa-*Plasmodium*spps.	**15**	**Chalk & Talk, PPT**
V	Introduction to Helminthes,Platyhelminthes – *Taenia* – *Fasciola* – *Paragonimus* – *Schistosoma*spps.. Nemathelminthes – Ascaris– *Ankylostoma* – *Enterobius* – *Trichuris* – *Trichinella* – *Wuchereria* – *Dracanculus.* Collection, transport and examination of specimen LaboratorytechniquesinparasitologyExaminationoffaecesforovaand cyst by direct wet mount and iodine wet mount, Concentration methods(FloatationandSedimentationtechniques),Examinationof blood for parasites. Cultivation of parasites.	**15**	**Chalk & Talk, PPT,Assignment**

Learning Outcome Based Education & Assessment (LOBE)
Formative Examination - Blue Print
Articulation Mapping – K Levels with Course Outcomes (COs)

Internal	Cos	K Level	Section A		Section B Either or Choice	Section C Either or Choice
			MCQs			
			No. of. Questions	K - Level		
CI AI	CO1	K1 – K4	2	K1, K2	2(K2, K2)	2(K3, K3)
	CO2	K1 – K4	2	K1, K2	2(K3, K3)	2(K4, K4)
CI AII	CO3	K1 – K4	2	K1, K2	2(K2, K2)	2(K3, K3)
	CO4	K1 – K4	2	K1, K2	2(K3, K3)	2(K4, K4)
Question Pattern CIA I & II		No. of Questions to be asked	4		4	4
		No. of Questions to be answered	4		2	2
		Marks for each question	1		5	8
		Total Marks for each section	4		10	16

Distribution of Marks with K Level CIA I & CIA II							
	K Level	Section A (Multiple Choice Questions)	Section B (Either / Or Choice)	Section C (Either / Or Choice)	Total Marks	% of (Marks without choice)	Consolidate of %
CIA I	K1	2			2	3.6	25
	K2	2	10		12	21.4	
	K3		10	16	26	46.4	46.4
	K4			16	16	28.6	28.6
	Marks	4	20	32	56	100	100
CIA II	K1	2			2	3.6	7.2
	K2	2	10		12	3.6	
	K3		10	16	26	46.4	46.4
	K4			16	16	46.4	46.4
	Marks	4	20	32	56	100	100

K1- Remembering and recalling facts with specific answers

K2- Basic understanding of facts and stating main ideas with general answers

K3- Application oriented- Solving Problems

K4- Examining, analyzing, presentation and make inferences with evidences

CO5 will be allotted for individual Assignment which carries five marks as part of CIA component.

Summative Examination – Blue Print Articulation Mapping – K Level with Course Outcomes (COs)						
S. No	COs	K - Level	Section A (MCQs)		Section B (Either / or Choice) With K - LEVEL	Section C (Either / or Choice) With K - LEVEL
			No. of Questions	K – Level		
1	CO1	K1-K4	2	K1, K2	2(K2, K2)	2(K3, K3)
2	CO2	K1-K4	2	K1, K2	2(K3, K3)	2(K4, K4)
3	CO3	K1-K4	2	K1, K2	2(K2, K2)	2(K3, K3)
4	CO4	K1-K4	2	K1, K2	2(K3, K3)	2(K4, K4)
5	CO5	K1-K4	2	K1, K2	2(K3, K3)	2(K4, K4)
No. of Questions to be Asked			10		10	10
No. of Questions to be answered			10		5	5
Marks for each question			1		5	8
Total Marks for each section			10		25	40
(Figures in parenthesis denotes, questions should be asked with the given K level)						

Distribution of Marks with K Level						
K Level	**Section A (Multiple Choice Questions)**	**Section B (Either or Choice**	**Section C (Either/ or Choice)**	**Total Marks**	**% of (Marks without choice)**	**Consolidated %**
K1	**5**			**5**	**3.6**	**4**
K2	**5**	**20**		**25**	**17.8**	**18**
K3		**30**	**32**	**62**	**44.3**	**44**
K4			**48**	**48**	**34.3**	**34**
Marks	**10**	**50**	**80**	**140**	**100**	**100**
NB: Higher level of performance of the students is to be assessed by attempting higher level of K levels.						

Summative Examinations - Question Paper – Format

Q. No.	**Unit**	**CO**	**K-level**		
Answer **ALL** the questions				**PART – A**	**(10 x 1 = 10 Marks)**
1.	**Unit - I**	**CO1**	**K1**		
				a)	b)
				c)	d)
2.	**Unit - I**	**CO1**	**K2**		
				a)	b)
				c)	d)
3.	**Unit - II**	**CO2**	**K1**		
				a)	b)
				c)	d)
4.	**Unit - II**	**CO2**	**K2**		
				a)	b)
				c)	d)
5.	**Unit - III**	**CO3**	**K1**		
				a)	b)
				c)	d)
6.	**Unit - III**	**CO3**	**K2**		
				a)	b)
				c)	d)
7.	**Unit - IV**	**CO4**	**K1**		
				a)	b)
				c)	d)
8.	**Unit - IV**	**CO4**	**K2**		
				a)	b)
				c)	d)
9.	**Unit - V**	**CO5**	**K1**		
				a)	b)
				c)	d)
10.	**Unit - V**	**CO5**	**K2**		
				a)	b)
				c)	d)

Answer **ALL** the questions		**PART – B**		**(5 x 5 = 25 Marks)**
11. a)	**Unit - I**	**CO1**	**K2**	
		OR		
11. b)	**Unit - I**	**CO1**	**K2**	
12. a)	**Unit - II**	**CO2**	**K3**	
		OR		
12. b)	**Unit - II**	**CO2**	**K3**	
13. a)	**Unit - III**	**CO3**	**K2**	
		OR		
13. b)	**Unit - III**	**CO3**	**K2**	
14. a)	**Unit - IV**	**CO4**	**K3**	
		OR		
14. b)	**Unit - IV**	**CO4**	**K3**	
15. a)	**Unit - V**	**CO5**	**K3**	
		OR		
15. b)	**Unit - V**	**CO5**	**K3**	

Answer **ALL** the questions		**PART – C**		**(5 x 8 = 40 Marks)**
16. a)	**Unit - I**	**CO1**	**K3**	
		OR		
16. b)	**Unit - I**	**CO1**	**K3**	
17. a)	**Unit - II**	**CO2**	**K4**	
		OR		
17. b)	**Unit - II**	**CO2**	**K4**	
18. a)	**Unit - III**	**CO3**	**K3**	
		OR		
18. b)	**Unit - III**	**CO3**	**K3**	
19. a)	**Unit - IV**	**CO4**	**K4**	
		OR		
19. b)	**Unit - IV**	**CO4**	**K4**	
20. a)	**Unit - V**	**CO5**	**K4**	
		OR		
20. b)	**Unit - V**	**CO5**	**K4**	

Course Name	Core Practical - V			
Course Code	23UMBCP51	**L**	**P**	**C**
Category	Core Practical	-	5	4

COURSE OBJECTIVES:

- To familiarize students with medical microbiology techniques and technical knowledgeon collection and processing of clinical samples.
- To learn the techniques for isolation and identification of bacterial pathogens.
- To gain expertise in various techniques of clinically important viral pathogens and their identification.
- To get acquainted with medically important fungi and their metabolism.
- To categorize parasites and understand their role in infections.

UNIT - I Clinical Sample Processing **15**

Collection and Transport of Clinical specimens. Simple, Differential and Special staining [ZN staining for AFB] of Clinical materials. Culture techniques used to isolate microorganisms.

UNIT - II Bacterial Biochemistry and Antimicrobial Susceptibility **15**

Identification of bacterial pathogens by their biochemical reactions. Antimicrobial susceptibility testing by disc-diffusion technique and determination of Minimum Inhibitory Concentration.

UNIT - III Virus and Phage Isolation and Cultivation **15**

Isolation of Bacteriophages from Sewage and other natural sources. Identification of Viruses in Slides/Smears/Spotters. Demonstration of Negri bodies (Staining). Cultivation of Viruses in Embryonated eggs – Amniotic, Allantoic, Yolk sac routes and Chorio-allantoic membrane.

UNIT - IV Fungal Identification and Analysis **15**

Microscopic identification of medically important Fungi – KOH and Lactophenol cotton Blue staining. Slide culture techniques for fungal Identification, Identification of Dermatophytes, Germ tube test for Yeasts.

UNIT - V Laboratory Diagnosis of Parasitic Infections **15**

Direct Examination of Feces – wet mount and Iodine mount – Demonstration of Protozoan cysts and Helminthes eggs. Concentration techniques of stool specimen – Floatation and Sedimentation methods. Examination of blood for Malarial parasites – thin and thick smear preparations. Identification of Medically important parasites in slides / specimens as spotters.

Total Lecture Hours **75**

BOOKS FOR STUDY:

- Dubey, R.C. and Maheswari, D.K. (2020). S. Chand Publishers. ISBN-13: 9788121921534, ISBN-10: 8121921538.
- K.R. Aneja (2017). Experiments in Microbiology, Plant Pathology, Tissue Culture and Microbial Biotechnology. 5th Edition. New Age International Publishers. ISBN-10: 9386418304, ISBN-13: 978-9386418302.
- Collee, J.G., Fraser, A.G., Marnion, B.P. and Simmons, A. (1996). Mackie & McCartney Practical Medical Microbiology. 14th Edition. Elsevier. ISBN-10: 813120393X, ISBN-13:978-8131203934.
- Prince CP (2009). Practical Manual of Medical Microbiology, Ist edition, Jaypee digital publishing.
- James H. Jorgensen, Karen C. Carroll, Guido Funke, Michael A. Pfaller, Marie Louise Landry, Sandra S. Richter, David W. Warnock (2015). Manual of Clinical Microbiology, 11th Edition, ASM press

BOOKS FOR REFERENCES:

- Patricia M. Tille (2021). Bailey & Scott's Diagnostic Microbiology, 15th Edition. Elsevier. ISBN-10: 0323681050, ISBN-13: 978-0323681056.
- Monica Cheesbrough (2006). District Laboratory Practice in Tropical Countries. Part 1. 2nd Edition. Cambridge University Press. ISBN-10: 0521171571, ISBN-13: 9780521171571.
- Michael A. Pfaller (ed.) (2015). Manual of Clinical Microbiology. Vol. 1 and 2. 11th Edition. ASM Press. ISBN-10: 9781555817374, ISBN-13: 978-1555817374.
- Josephine A. Morello, Paul A. Granato and Helen EckelMizer (2002). Laboratory Manual and Workbook in Microbiology. 7th Edition. The McGraw Hill Company. ISBN: 0-07246354-6.
- Rowland, S.S., Walsh, S.R., Teel, L.D. and Carnahan, A.M. ((1994). Pathogenic and Clinical Microbiology: A Laboratory Manual. Lippincott Williams & Wilkins. ISBN-10: 0316760498, ISBN-13: 9780316760492.

WEB RESOURCES:

- **https://www.microcarelab.in/media/microcarelab.in/files/Sample-Collection-Manual.pdf**
- **http://ssu.ac.ir/cms/fileadmin/user_upload/Daneshkadaha/pezeshki/microb/file_amuzeshi/Lab_QA_Microbiology_QA.pdf**
- **https://www.academia.edu/11977315/Basic_Laboratory_Procedures_in_Clinical_Bacteriology**
- **https://cmr.asm.org/content/31/3/e00062-17.full.pdf**
- **https://microbiologyinfo.com/techniques-of-virus-cultivation/**

Nature of Course	EMPLOYABILITY		SKILL ORIENTED	✓	ENTREPRENEURSHIP			
Curriculum Relevance	LOCAL		REGIONAL		NATIONAL		GLOBAL	✓
Changes Made in the Course	Percentage of Change		No Changes Made		New Course	✓		

***Treat 20% as each unit (20*5=100%) and calculate the percentage of change for the course.**

COURSE OUTCOMES:		K LEVEL
After studying this course, the students will be able to:		
CO1	Demonstrate methods to observe and measure microorganisms by standard microbiological techniques.	K1 to K4
CO2	Identify pathogenic microorganisms in the laboratory set-up and interpret their sensitivity towards commonly administered antibiotics.	K1 to K4
CO3	Understand experimental tools used to cultivate and characterize clinically important viruses and bacteriophages	K1 to K4
CO4	Elucidate clinically important fungi.	K1 to K4
CO5	Investigate Parasites of medical importance and identify them from clinical specimens.	K1 to K4

MAPPING WITH PROGRAM OUTCOMES:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1				S	M		S			
CO2				S	S		S	L		
CO3				S	S		S	L		
CO4				S	S		S	L		
CO5				S	S		S	L		

S- STRONG M – MEDIUM L - LOW

CO / PO MAPPING:

COS	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	3	2	3	3	3
CO 2	2	3	2	2	3
CO 3	3	2	2	2	3
CO 4	2	2	2	2	2
CO 5	2	2	2	2	2
WEIGHTAGE	12	11	11	11	13
WEIGHTED PERCENTAGE OF COURSE CONTRIBUTION TO POS	80	73.33	73.33	73.33	86.66

LESSON PLAN:

UNIT	Core Practical - V	HRS	PEDAGOGY
I	Collection and Transport of Clinical specimens. Simple, Differential and Special staining of Clinical materials. Culture techniques used to isolate microorganisms.	15	Chalk & Talk, PPT, Demostration
II	Identification of bacterial pathogens by their biochemical reactions. Antimicrobial susceptibility testing by disc-diffusion technique and	15	Chalk & Talk, PPT,

	determination of Minimum Inhibitory Concentration.		**Demostration**
III	Isolation of Bacteriophages from Sewage and other natural sources. Identification of Viruses in Slides/Smears/Spotters. Demonstration of Negri bodies (Staining). Cultivation of Viruses in Embryonated eggs – Amniotic, Allantoic, Yolk sac routes and Chorio-allantoic membrane.	**15**	**Chalk & Talk, PPT, Demostration**
IV	Microscopic identification of medically important Fungi – KOH and Lactophenol cotton Blue staining. Slide culture techniques for fungal Identification, Identification of Dermatophytes. Germ tube test, Carbohydrate fermentation and assimilation tests for Yeasts.	**15**	**Chalk & Talk, PPT, Demostration**
V	Direct Examination of Feces – wet mount and Iodine mount – Demonstration of Protozoan cysts and Helminthes eggs. Concentration techniques of stool specimen – Floatation and Sedimentation methods. Examination of blood for Malarial parasites – thin and thick smear preparations. Identification of Medically important parasites in slides / specimens as spotters.	**15**	**Chalk & Talk, PPT, Demostration**

Learning Outcome Based Education & Assessment(LOBE) Formative Examination - Blue Print Articulation Mapping K – Levels with Course Outcomes (COs)

INTERNAL	**COs**	**K LEVEL**	**MAJOR**	**MINOR**	**SPOTTERS**	**RECORD**	**VIVA**
CIAI	**CO1**	**K1**					**5**
	CO2	**K2**				**5**	
	CO3	**K3**			**5**		
	CO4	**K4**		**5**			
	CO5	**K4**	**5**				
Question Pattern		No. of Questions to be asked	**2 (A-Written B-Practical Demo)**	**2 (A-Written B-Practical Demo)**	**2**	**1**	**5**
		No. of Questions to be answered	**2**	**2**	**2**	**1**	**5**
		Marks for each question	**A-10 B-5**	**A-5 B-5**	**2.5**	**10**	**1**
		Total Marks for Each section	**15**	**10**	**5**	**5**	**5**

Distribution of Marks with K Level									
	K Level	**Major**	**Minor**	**Spotters**	**Record**	**Viva**	**Total Marks**	**% of Marks without choice**	**Consolidated %**
CIA	**K1**	**-**	**-**	**-**	**-**	**5**	**5**	**12.5**	**12.5**
	K2	**-**	**-**	**-**	**5**	**-**	**5**	**12.5**	**12.5**
	K3	**-**	**-**	**5**	**-**	**-**	**5**	**12.5**	**12.5**
	K4	**-**	**10**	**-**	**-**	**-**	**10**	**25**	**25**
	K4	**15**					**15**	**37.5**	**37.5**
	Marks	**15**	**10**	**5**	**5**	**5**	**40**	**100**	**100**

K1- Remembering and recalling facts with specific answers

K2- Basic understanding of facts and stating main ideas with general answers

K3- Application oriented- Solving Problems

K4- Examining, analyzing, presentation and make inferences with evidences

Summative Examination – Blue Print Articulation Mapping K – Levels with Course Outcomes (COs)							
EXTERNAL	**COs**	**K LEVEL**	**MAJOR**	**MINOR**	**SPOTTERS**	**RECORD**	**VIVA**
CIAI	**CO1**	**K1**					**5**
	CO2	**K2**				**10**	
	CO3	**K3**			**20**		
	CO4	**K4**		**20**			
	CO5	**K4**	**25**				
Question Pattern		No.ofQuestions to be asked	**2 (A-Written B-Practical Demo)**	**2 (A-Written B-Practical Demo)**	**2**	**1**	**5**
		No. of Questions to be answered	**2**	**2**	**2**	**1**	**5**
		Marksforeach question	**A-15 B-5**	**A-10 B-5**	**5**	**10**	**1**
		TotalMarksfor Eachsection	**20**	**15**	**10**	**10**	**5**

Distribution of Marks with K Level CIA									
	K Level	Major	Minor	Spotters	Record	Viva	Total Marks	% of Marks without choice	Consolidated %
CIA	K1					5	5	8.33	8.33
	K2				10		10	16.66	16.66
	K3			10			10	16.66	16.66
	K4		15				15	25	25
	K4	20					20	33.33	33.33
	Marks	20	15	10	10	5	60	100	100

Course Name	Project with Viva - Voce			
Course Code	23UMBPR51	**L**	**P**	**C**
Category	Project	-	5	4

COURSE OBJECTIVES:

- To get accustomed to solve a problem.
- To work in harmony with fellow microbiologists.
- To appreciate the outcome of experiments.
- To arrive at a conclusion for the selected issue**.**

Course Content:

Group Project	–	Maximum 4 Students in a group [extended up to 5 with the consent of HOD]
Record submission	–	A hard bound report to be submitted to the Department.
Evaluation	–	Project (oral) presentation followed by a brief Viva
Internal	–	40 Marks (Course Teacher)
External	–	60 Marks (Course teacher & External Examiner)

Course Description

The Project is conducted by the following Course Pattern.

Internal

Presentation Submission	**25**

External

Project Report Viva Voce	**75**
Total	**100**

Group projects enable students to get hands-on training in microbiological techniques needed forresearch. Thus the students can share diverse perspectives resulting in pooling of knowledge and skills. Group work may approach tasks and solve problems in novel, interesting ways, there by converting established theoretical concepts to practical skills. If structured properly, it will promote team work and collaboration. Group projects also will help students to choose are search design, solve real life problems and benefit the society at large. Thus group project facilitates the students to convert ideas to practice thereby creating a research culture among students.

Guidelines for group project:

- A research problem need to be selected based on creative ability and scientific thought.
- A brief description of the problem needs to be given.
- Hypothesis statement should be framed.
- Objectives by which the project work is to be carried out should be clearly stated.
- Methodology has to be designed to test the hypothesis.
- Results obtained need to be replicable.
- Documented report has to be submitted on completion of the project.

Nature of Course	EMPLOYABILITY		SKILL ORIENTED	✓	ENTREPRENEURSHIP			
Curriculum Relevance	LOCAL		REGIONAL		NATIONAL		GLOBAL	✓
Changes Made in the Course	Percentage of Change		No Changes Made	✓	New Course			
***Treat 20% as each unit (20*5=100%) and calculate the percentage of change for the course.**								

COURSE OUTCOMES:		**K LEVEL**
After studying this course, the students will be able to:		
CO1	To get accustomed to research.	**K1 to K4**
CO2	To get trained in microbiological techniques.	**K1 to K4**
CO3	To be aware of common problems encountered during research activities,	**K1 to K4**
CO4	To develop interest in result – oriented works.	**K1 to K4**
CO5	To develop leadership skills by active participation in the group	**K1 to K4**

MAPPING WITH PROGRAM OUTCOMES:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	S	M	S	M					
CO2	S	M	M	M	L					
CO3	M	M	M	M	S					
CO4	M	S	M	S	M					
CO5	M	M	S	S	L					

S- STRONG		M – MEDIUM			L - LOW
CO / PO MAPPING:					
COS	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO 1	**2**	**3**	**2**	**3**	**2**
CO 2	**3**	**2**	**2**	**2**	**1**
CO 3	**2**	**2**	**2**	**2**	**3**
CO 4	**2**	**3**	**2**	**3**	**2**
CO 5	**2**	**2**	**3**	**3**	**1**
WEIGHTAGE	**11**	**12**	**11**	**13**	**9**
WEIGHTED PERCENTAGE OF COURSE CONTRIBUTION TO POS	**73.33**	**80**	**73.33**	**86.66**	**60**

Course Name	Recombinant DNA Technology			
Course Code	23UMBEC51	**L**	**P**	**C**
Category	Elective	4	-	3

COURSE OBJECTIVES:

- Understand the principles of rDNA technology.
- Illustrate the molecular tools employed in gene cloning.
- Discuss the importance of various molecular techniques and their importance in Biotechnology.
- Acquire knowledge about the concepts of tissue culture methods and transgenic organisms.
- Examine recent trends in genetic engineering and its application in human welfare.

UNIT - I **"Recombinant DNA Technology: Milestones, Tools, and Processes"** **12**

Milestones in rDNA Technology-Gene Manipulation-Steps involved in Gene Cloning. Isolation of Chromosomal and Plasmid DNA. Restriction enzymes with types - Discovery, Types, Mode of action-Application of Ligase, DNA Polymerase, DNA Modifying enzymes and Topoisomerases. Use of Linkers and Adapters.

UNIT - II **"Gene Transfer, Vectors, and Genomic Libraries in Genetic Engineering"** **12**

Artificial Gene Transfer methods- Calcium Chloride Induction, Electroporation, Microinjection, Biolistic method, Liposome and Viral-mediated delivery. Cloning vectors –Properties and Applications – Plasmid Based Vectors- Natural VectorspSC101 and pMB1, Ti Plasmid.Artificial Vectors- pBR322 and pUC. Phage BasedVectors- Lambda phage. Hybrid Vectors, Phagemid, Cosmid, BAC and YAC. Screening of Recombinants. Genomic DNA and cDNAlibrary-Construction and Screening.

UNIT - III **"Molecular Tools in Genetic Engineering"** **12**

Molecular Tools- PCR- Types. Gel Electrophoresis- AGE and PAGE Blotting Techniques-Southern, Western & Northern. DNA sequencing methods-Sanger's and Automated method. Gene Targeting-Knock-in & Knock-outs,Recent Trends in Genetic Engineering- Targeted Genome Editing- ZFNs, TALENs, CRISPRs.. DNA Finger Printing.

UNIT - IV **"Advances in Plant and Animal Biotechnology"** **12**

Plant Biotechnology – Media, Growth Regulators and Equipment for Plant Tissue Culture- Explant - Micropropagation- Callus and Protoplast Culture Production of Bio-Active Secondary Metabolites by Plant Tissue Culture -Crown Gall Tumors - and-AnimalBiotechnology-PrinciplesofAnimalCellCulture,MediaandEquipment for Animal Cell Culture – Primary and Secondary Cultures- Cell Lines- Types, Establishment and Maintenance of Cell Lines.

UNIT - V	"Genetic Engineering Applications: Transgenics and Therapeutics"	12
Applications of Genetic Engineering - Transgenic Animals – Mice and Sheep-Recombinant Cytokines and their use in the Treatment of Animal infections- Monoclonal Antibodies in Therapy- Vaccines and their Applications in Animal Infections - Human Gene Therapy-Germ line and Somatic Cell Therapy -Ex-vivo Gene Therapy-SCID (Severe Combined Immuno Deficiency) – In-vivo Gene Therapy- CFTR (Cystic Fibrosis Transmembrane Regulator)–Vectors inGeneTherapy-ViralandNon-ViralVectors.TransgenicPlantsBtCotton,BtCorn, Round Ready soybean, FlavrSavr Tomato and Golden Rice.		
	Total Lecture Hours	**60**

BOOKS FOR STUDY:

- Brown T.A.(2016). Gene Cloning and DNA Analysis. 7thEdition . John Wiley and Jones, Ltd.
- Dale J. W., Schantz M.V. and Plant N. (2012). From Gene to Genomes – Concepts and Applications of DNA Technology. 3rd Edition. John Wileys and Sons Ltd.
- Keya Chaudhuri (2013). Recombinant DNA technology. The Energy and Resources Institute.
- Siddra Ijaz, Imran UlHaq (2019). Recombinant DNA Technology. Cambridge Scholars Publishing.
- Monika Jain (2012). Recombinant DNA Techniques: A Textbook, I Edition,Alpha Science International Ltd

BOOKS FOR REFERENCES:

- Maloy S. R., Cronan J.E. Jr. and FreifelderD.(2011). Microbial Genetics. 2nd Edition. Narosa Publishing Home Pvt Ltd.
- Glick B. R. and Patten C.L.(2018). Molecular Biotechnology – Principles and Applications of Recombinant DNA. 5th Edition. ASM Press.
- Russell P.J. (2010). iGenetics - A Molecular Approach, 3rd Edition. Pearson New International Edition.
- Synder L., Peters J. E., Henkin T.M. and Champness W. (2013). Molecular Genetics of Bacteria,4th Edition. ASM Press Washington-D.C. ASM Press.
- James D.Watson, Michael Gilman, Jan Witkowski, Mark Zoller (1992). Recombinant DNA. Scientific American Books

WEB RESOURCES:

- **https://www.britannica.com/recombinant-DNA-technology**
- **https://www.byjus.com/recombinant-dna-technology**
- **https://www..rpi.edu**
- **https://www..ncbi.nlm.nih.gov**
- **https://www.le.ac.uk/recombinant-dna-and-genetic-techniques**

Nature of Course	EMPLOYABILITY			SKILL ORIENTED	✓		ENTREPRENEURSHIP					
Curriculum Relevance	LOCAL		REGIONAL		NATIONAL			GLOBAL	✓			
Changes Made in the Course	Percentage of Change			No Changes Made			New Course	✓				

***Treat 20% as each unit (20*5=100%) and calculate the percentage of change for the course.**

COURSE OUTCOMES:		K LEVEL
After studying this course, the students will be able to:		
CO1	Illustrate the steps involved in introduction and expression of foreign DNA into bacteria, animal and plants cells and their screening.	K1 to K4
CO2	Discuss the various cloning vectors and their applications.	K1 to K4
CO3	Assess the usage and advantages of molecular tools.	K1 to K4
CO4	Explain plant and animal tissue culture protocols and gene transfer mechanism.	K1 to K4
CO5	Elucidate and understand the application of genetic engineering and gene therapy.	K1 to K4

MAPPING WITH PROGRAM OUTCOMES:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	S	S	S					M
CO2	M	M	M	M	S		S			S
CO3	S	M	M	S	M		S	S		S
CO4	M	M	S	M	S			M		
CO5	S	S	M	S	S			S		

S- STRONG M – MEDIUM L - LOW

CO / PO MAPPING:

COS	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	3	2	3	3	3
CO 2	2	2	2	2	3
CO 3	3	2	2	3	2
CO 4	2	2	3	2	3
CO 5	3	3	2	3	3
WEIGHTAGE	13	11	12	13	14
WEIGHTED PERCENTAGE OF COURSE CONTRIBUTION TO POS	86.66	73.33	80	86.66	93.33

LESSON PLAN:

UNIT	Recombinant DNA Technology	HRS	PEDAGOGY
I	Milestones in rDNA Technology-Gene Manipulation Steps involved in Gene Cloning. Isolation of Chromosomal and Plasmid DNA. Restriction endonuclease - Discovery, Types, Mode of action-Application of Ligase, DNA Polymerase ,DNA Modifying enzymes and Topoisomerases. Use of Linkers and Adapters.	12	Chalk & Talk, PPT
II	Artificial Gene Transfer methods- Calcium Chloride Induction, Electroporation, Microinjection, Biolistic method, Liposome and Viral-mediated delivery. Cloning vectors –Properties and Applications –	12	Chalk & Talk, PPT

	Plasmid Based Vectors- Natural VectorspSC101 and pMB1.Artificial Vectors- pBR322 and pUC. Phage Based Vectors- Lambda phage. Hybrid Vectors, Phagemid, Cosmid, BAC and YAC. Screening of Recombinants. Genomic DNA and cDNA library-Construction and Screening.		
III	Molecular Tools- PCR- Types. Gel Electrophoresis- AGE and PAGE Blotting Techniques-Southern, Western &Northern.DNA sequencing methods-Sanger's and Automated method. Recent Trends in Genetic Engineering- Targeted Genome Editing- ZFNs, TALENs, CRISPRs. Gene Targeting-Knock-in & Knock-outs.DNA Finger Printing,	**12**	**Chalk & Talk, PPT**
IV	Plant Biotechnology – Media, Growth Regulators and Equipment for Plant Tissue Culture-Explant Culture- Micropropagation- Callus and Protoplast Culture Production of Bio-Active Secondary Metabolites by Plant Tissue Culture -Agrobacterium and Crown Gall Tumors, Ti-Plasmid and Ri-Plasmid-Animal Biotechnology-Principles of Animal Cell Culture, Media and Equipment for Animal Cell Culture – Primary and Secondary Cultures- Cell Lines- Types, Establishment and Maintenance of Cell Lines.	**12**	**Chalk & Talk, PPT**
V	Applications of Genetic Engineering - Transgenic Animals – Mice and Sheep-Recombinant Cytokines and their use in the Treatment of Animal infections- Monoclonal Antibodies in Therapy- Vaccines and their Applications in Animal Infections - Human Gene Therapy-Germline and Somatic Cell Therapy -Ex-vivo Gene Therapy-SCID (Severe Combined Immuno Deficiency) – In-vivo Gene Therapy- CFTR (Cystic Fibrosis Transmembrane Regulator) –Vectors in Gene Therapy-Viral and Non-Viral Vectors. Transgenic Plants Bt Cotton, Bt Corn, Round Ready soybean, FlavrSavr Tomato and Golden Rice.	**12**	**Chalk & Talk, PPT**

Learning Outcome Based Education & Assessment (LOBE)
Formative Examination - Blue Print
Articulation Mapping – K Levels with Course Outcomes (COs)

Internal	Cos	K Level	Section A MCQs		Section B Either or Choice	Section C Either or Choice
			No. of. Questions	K - Level		
CI	**CO1**	**K1 – K4**	2	K1, K2	2(K2, K2)	2(K3, K3)
AI	**CO2**	**K1 – K4**	2	K1, K2	2(K3, K3)	2(K4, K4)
CI	**CO3**	**K1 – K4**	2	K1, K2	2(K2, K2)	2(K3, K3)
AII	**CO4**	**K1 – K4**	2	K1, K2	2(K3, K3)	2(K4, K4)
Question Pattern CIA I & II		**No. of Questions to be asked**	4		4	4
		No. of Questions to be answered	4		2	2
		Marks for each question	1		5	8
		Total Marks for each section	4		10	16

Distribution of Marks with K Level CIA I & CIA II							
	K Level	Section A (Multiple Choice Questions)	Section B (Either / Or Choice)	Section C (Either / Or Choice)	Total Marks	% of (Marks without choice)	Consolidate of %
CIA I	K1	2			2	3.6	25
	K2	2	10		12	21.4	
	K3		10	16	26	46.4	46.4
	K4			16	16	28.6	28.6
	Marks	4	20	32	56	100	100
CIA II	K1	2			2	3.6	7.2
	K2	2	10		12	3.6	
	K3		10	16	26	46.4	46.4
	K4			16	16	46.4	46.4
	Marks	4	20	32	56	100	100

K1- Remembering and recalling facts with specific answers

K2- Basic understanding of facts and stating main ideas with general answers

K3- Application oriented- Solving Problems

K4- Examining, analyzing, presentation and make inferences with evidences

CO5 will be allotted for individual Assignment which carries five marks as part of CIA component.

Summative Examination – Blue Print Articulation Mapping – K Level with Course Outcomes (COs)						
S. No	COs	K - Level	Section A (MCQs)		Section B (Either / or Choice) With K - LEVEL	Section C (Either / or Choice) With K - LEVEL
			No. of Questions	K – Level		
1	CO1	K1-K4	2	K1, K2	2(K2, K2)	2(K3, K3)
2	CO2	K1-K4	2	K1, K2	2(K3, K3)	2(K4, K4)
3	CO3	K1-K4	2	K1, K2	2(K2, K2)	2(K3, K3)
4	CO4	K1-K4	2	K1, K2	2(K3, K3)	2(K4, K4)
5	CO5	K1-K4	2	K1, K2	2(K3, K3)	2(K4, K4)
No. of Questions to be Asked			10		10	10
No. of Questions to be answered			10		5	5
Marks for each question			1		5	8
Total Marks for each section			10		25	40
(Figures in parenthesis denotes, questions should be asked with the given K level)						

Distribution of Marks with K Level						
K Level	**Section A (Multiple Choice Questions)**	**Section B (Either or Choice**	**Section C (Either/ or Choice)**	**Total Marks**	**% of (Marks without choice)**	**Consolidated %**
K1	**5**			**5**	**3.6**	**4**
K2	**5**	**20**		**25**	**17.8**	**18**
K3		**30**	**32**	**62**	**44.3**	**44**
K4			**48**	**48**	**34.3**	**34**
Marks	**10**	**50**	**80**	**140**	**100**	**100**
NB: Higher level of performance of the students is to be assessed by attempting higher level of K levels.						

Summative Examinations - Question Paper – Format

Q. No.	**Unit**	**CO**	**K-level**		
Answer **ALL** the questions				**PART – A**	**(10 x 1 = 10 Marks)**
1.	**Unit - I**	**CO1**	**K1**		
				a)	b)
				c)	d)
2.	**Unit - I**	**CO1**	**K2**		
				a)	b)
				c)	d)
3.	**Unit - II**	**CO2**	**K1**		
				a)	b)
				c)	d)
4.	**Unit - II**	**CO2**	**K2**		
				a)	b)
				c)	d)
5.	**Unit - III**	**CO3**	**K1**		
				a)	b)
				c)	d)
6.	**Unit - III**	**CO3**	**K2**		
				a)	b)
				c)	d)
7.	**Unit - IV**	**CO4**	**K1**		
				a)	b)
				c)	d)
8.	**Unit - IV**	**CO4**	**K2**		
				a)	b)
				c)	d)
9.	**Unit - V**	**CO5**	**K1**		
				a)	b)
				c)	d)
10.	**Unit - V**	**CO5**	**K2**		
				a)	b)
				c)	d)

Answer **ALL** the questions		**PART – B**		**(5 x 5 = 25 Marks)**
11. a)	**Unit - I**	**CO1**	**K2**	
		OR		
11. b)	**Unit - I**	**CO1**	**K2**	
12. a)	**Unit - II**	**CO2**	**K3**	
		OR		
12. b)	**Unit - II**	**CO2**	**K3**	
13. a)	**Unit - III**	**CO3**	**K2**	
		OR		
13. b)	**Unit - III**	**CO3**	**K2**	
14. a)	**Unit - IV**	**CO4**	**K3**	
		OR		
14. b)	**Unit - IV**	**CO4**	**K3**	
15. a)	**Unit - V**	**CO5**	**K3**	
		OR		
15. b)	**Unit - V**	**CO5**	**K3**	

Answer **ALL** the questions		**PART – C**		**(5 x 8 = 40 Marks)**
16. a)	**Unit - I**	**CO1**	**K3**	
		OR		
16. b)	**Unit - I**	**CO1**	**K3**	
17. a)	**Unit - II**	**CO2**	**K4**	
		OR		
17. b)	**Unit - II**	**CO2**	**K4**	
18. a)	**Unit - III**	**CO3**	**K3**	
		OR		
18. b)	**Unit - III**	**CO3**	**K3**	
19. a)	**Unit - IV**	**CO4**	**K4**	
		OR		
19. b)	**Unit - IV**	**CO4**	**K4**	
20. a)	**Unit - V**	**CO5**	**K4**	
		OR		
20. b)	**Unit - V**	**CO5**	**K4**	

Course Name	Clinical Biochemistry			
Course Code	23UMBEC52	**L**	**P**	**C**
Category	Elective	4	-	3

COURSE OBJECTIVES:

- The main objective of this paper is to skill the students in procedures followed in biochemistry Laboratory.
- To acquire knowledge in the field of biochemistry.
- To get familiarize with the test protocols followed in Hospital Laboratory.
- To understand the principle and clinical significance behind various diseases.
- To learn and understand the methods of body fluid collection

UNIT - I	**Biochemical specimen collection**	**12**

Biochemical specimen to perform qualitative& Quantitative analysis–Body fluids-Blood,Urine,faces, Cerebraspinal fluid, Gastric juices, amniotic fluid &other materials- Collection, Transport & Analysis. Laboratory safety & hygienic practices.

UNIT - II	**Hematology**	**12**

Hematology–Introduction & Definition. Types and Functions of Blood. Blood collection& handling.BloodTest-CBC,ESR,GTTClotting&BleedingTime.Bloodglucosetest –hBA1C- Principle & Clinical significance. TSH & hCG

UNIT - III	**Lipid Profile**	**12**

DeterminationofLipidprofile,procedure&clinicalsignificances-Totalcholesterol,TriglycerideTG, Lipoprotein analysis

UNIT - IV	**Kidney Function Test**	**12**

KidneyFunctionTest: Procedure,Principle&Clinicalsignificance-(BUN)Bloodurea,Serum-Creatinine, Uric Acid.

UNIT - V	**Liver Function Test**	**12**

Principle & procedure-Liver Test–cell damage &Dysfunction test. GOT–Clinical Significance– CRP Heart, Liver & Muscular Diseases. Measurement of serum bilirubin, Albumin & Globulin– Method

Total Lecture Hours	**60**

BOOKS FOR STUDY:

- R.Sood,(2018)Tesxtbookofbiochemistry,CBSPublisher&Distributors.
- Teiz,FundamentalsofClinicalBiochemistry,W.B-SaundersCompany

BOOKS FOR REFERENCES:

- Harold Varley, Pratical Clinical biochemistry,4th Edition. CBC Publisher &Distributor
- Practical Clinical Biochemistry, volumeI and II, 5th edition – Varleyet.al.,CBS Publishers,
- AllanGaw,MichealMurphy,RobertCowan,DenisOReilly,Micheal Stewart andJamesShepherd.Churchill Livingtons,ClinicalBiochemistry:An illustrated color text 3rd Edition.
- Zubay,Biochemistry4thEdition(WMCBrownPublishers)

WEB RESOURCES:

- **https://www.medicalnewstoday.com/articles/265443**
- **https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3894536/#:~:text=The%20levels%20of%20aspartate%20aminotransferase,liver%20are%20injured%20or%20not.**
- **https://ors.od.nih.gov/sr/dohs/safety/laboratory/Pages/student_goodlab.aspx**
- **https://my.clevelandclinic.org/health/diagnostics/17684-blood-urea-nitrogen-bun-test**

Nature of Course	EMPLOYABILITY			SKILL ORIENTED			ENTREPRENEURSHIP	✓				
Curriculum Relevance	LOCAL		REGIONAL		NATIONAL		GLOBAL	✓				
Changes Made in the Course	Percentage of Change			No Changes Made	✓		New Course					

***Treat 20% as each unit (20*5=100%) and calculate the percentage of change for the course.**

COURSE OUTCOMES:		**K LEVEL**
After studying this course, the students will be able to:		
CO1	Classify the methods and transport of Body Fluids	**K1 to K4**
CO2	Utilize the various methods of disease diagnosis in blood.	**K1 to K4**
CO3	Illustrate the procedure, procedure &Clinical significance of diseases.	**K1 to K4**
CO4	Classify the Non protein Nitrogenous compounds.	**K1 to K4**
CO5	Identify and learn the methods of body fluids testing and disease diagnosis.	**K1 to K4**

MAPPING WITH PROGRAM OUTCOMES:										
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S				M			M
CO2	S		S	S						
CO3	S					S				
CO4			S	S						
CO5	S						M			S
S- STRONG				M – MEDIUM					L - LOW	

CO / PO MAPPING:					
COS	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	2	3	1	2	2
CO 2	1	2	3	2	3
CO 3	2	1	2	2	3
CO 4	3	3	2	1	2
CO 5	3	2	2	3	1
WEIGHTAGE	11	11	10	10	11
WEIGHTED PERCENTAGE OF COURSE CONTRIBUTION TO POS	73.3	73.3	66.6	66.6	73.3

LESSON PLAN:

UNIT	Clinical Biochemistry	HRS	PEDAGOGY
I	Biochemicalspecimentoperformqualitative&Quantitativeanalysis– Bodyfluids-Blood,Urine,faces, Cerebraspinal fluid, Gastric juices, amniotic fluid &other materials- Collection, Transport & Analysis. Laboratory safety & hygienic practices.	12	Chalk & Talk, PPT
II	Hematology–Introduction & Definition. Types and Functions of Blood. Blood collection& handling.BloodTest-CBC,ESR,GTTClotting&BleedingTime.Bloodglucosetest –hBA1C-Principle & Clinical significance. TSH & hCG	12	Chalk & Talk, PPT
III	DeterminationofLipidprofile,procedure&clinicalsignificances-Totalcholesterol,TriglycerideTG, Lipoprotein analysis	12	Chalk & Talk, PPT
IV	KidneyFunctionTest: Procedure,Principle&Clinicalsignificance-(BUN)Bloodurea,Serum-Creatinine, Uric Acid.	12	Chalk & Talk, PPT
V	Principle & procedure-Liver Test–cell damage &Dysfunction test. GOT–Clinical Significance– CRP Heart, Liver & Muscular Diseases. Measurement of serum bilirubin, Albumin & Globulin– Method	12	Chalk & Talk, PPT, Assignment

Learning Outcome Based Education & Assessment (LOBE) Formative Examination - Blue Print Articulation Mapping – K Levels with Course Outcomes (COs)						
Internal	**Cos**	**K Level**	**Section A**		**Section B Either or Choice**	**Section C Either or Choice**
			MCQs			
			No. of. Questions	**K - Level**		
CI AI	**CO1**	**K1 – K4**	2	K1, K2	2(K2, K2)	2(K3, K3)
	CO2	**K1 – K4**	2	K1, K2	2(K3, K3)	2(K4, K4)
CI AII	**CO3**	**K1 – K4**	2	K1, K2	2(K2, K2)	2(K3, K3)
	CO4	**K1 – K4**	2	K1, K2	2(K3, K3)	2(K4, K4)
Question Pattern CIA I & II		**No. of Questions to be asked**	4		4	4
		No. of Questions to be answered	4		2	2
		Marks for each question	1		5	8
		Total Marks for each section	4		10	16

Distribution of Marks with K Level CIA I & CIA II							
	K Level	**Section A (Multiple Choice Questions)**	**Section B (Either / Or Choice)**	**Section C (Either / Or Choice)**	**Total Marks**	**% of (Marks without choice)**	**Consolidate of %**
CIA I	**K1**	**2**			**2**	**3.6**	**25**
	K2	**2**	**10**		**12**	**21.4**	
	K3		**10**	**16**	**26**	**46.4**	**46.4**
	K4			**16**	**16**	**28.6**	**28.6**
	Marks	**4**	**20**	**32**	**56**	**100**	**100**
CIA II	**K1**	**2**			**2**	**3.6**	**7.2**
	K2	**2**	**10**		**12**	**3.6**	
	K3		**10**	**16**	**26**	**46.4**	**46.4**
	K4			**16**	**16**	**46.4**	**46.4**
	Marks	**4**	**20**	**32**	**56**	**100**	**100**

K1- Remembering and recalling facts with specific answers

K2- Basic understanding of facts and stating main ideas with general answers

K3- Application oriented- Solving Problems

K4- Examining, analyzing, presentation and make inferences with evidences

CO5 will be allotted for individual Assignment which carries five marks as part of CIA component.

Summative Examination – Blue Print Articulation Mapping – K Level with Course Outcomes (COs)						
S. No	COs	K - Level	Section A (MCQs)		Section B (Either / or Choice) With K - LEVEL	Section C (Either / or Choice) With K - LEVEL
			No. of Questions	K – Level		
1	CO1	K1-K4	2	K1, K2	2(K2, K2)	2(K3, K3)
2	CO2	K1-K4	2	K1, K2	2(K3, K3)	2(K4, K4)
3	CO3	K1-K4	2	K1, K2	2(K2, K2)	2(K3, K3)
4	CO4	K1-K4	2	K1, K2	2(K3, K3)	2(K4, K4)
5	CO5	K1-K4	2	K1, K2	2(K3, K3)	2(K4, K4)
No. of Questions to be Asked			10		10	10
No. of Questions to be answered			10		5	5
Marks for each question			1		5	8
Total Marks for each section			10		25	40
(Figures in parenthesis denotes, questions should be asked with the given K level)						

Distribution of Marks with K Level						
K Level	Section A (Multiple Choice Questions)	Section B (Either or Choice	Section C (Either/ or Choice)	Total Marks	% of (Marks without choice)	Consolidated %
K1	5			5	3.6	4
K2	5	20		25	17.8	18
K3		30	32	62	44.3	44
K4			48	48	34.3	34
Marks	10	50	80	140	100	100
NB: Higher level of performance of the students is to be assessed by attempting higher level of K levels.						

Summative Examinations - Question Paper – Format

Q. No.	Unit	CO	K-level		
Answer **ALL** the questions				**PART – A**	**(10 x 1 = 10 Marks)**
1.	**Unit - I**	**CO1**	**K1**		
				a)	b)
				c)	d)
2.	**Unit - I**	**CO1**	**K2**		
				a)	b)
				c)	d)
3.	**Unit - II**	**CO2**	**K1**		
				a)	b)
				c)	d)
4.	**Unit - II**	**CO2**	**K2**		
				a)	b)
				c)	d)
5.	**Unit - III**	**CO3**	**K1**		
				a)	b)
				c)	d)
6.	**Unit - III**	**CO3**	**K2**		
				a)	b)
				c)	d)
7.	**Unit - IV**	**CO4**	**K1**		
				a)	b)
				c)	d)
8.	**Unit - IV**	**CO4**	**K2**		
				a)	b)
				c)	d)
9.	**Unit - V**	**CO5**	**K1**		
				a)	b)
				c)	d)
10.	**Unit - V**	**CO5**	**K2**		
				a)	b)
				c)	d)

Answer **ALL** the questions		**PART – B**		**(5 x 5 = 25 Marks)**
11. a)	**Unit - I**	**CO1**	**K2**	
		OR		
11. b)	**Unit - I**	**CO1**	**K2**	
12. a)	**Unit - II**	**CO2**	**K3**	
		OR		
12. b)	**Unit - II**	**CO2**	**K3**	
13. a)	**Unit - III**	**CO3**	**K2**	
		OR		
13. b)	**Unit - III**	**CO3**	**K2**	
14. a)	**Unit - IV**	**CO4**	**K3**	
		OR		
14. b)	**Unit - IV**	**CO4**	**K3**	
15. a)	**Unit - V**	**CO5**	**K3**	
		OR		
15. b)	**Unit - V**	**CO5**	**K3**	

Answer **ALL** the questions		**PART – C**		**(5 x 8 = 40 Marks)**
16. a)	**Unit - I**	**CO1**	**K3**	
		OR		
16. b)	**Unit - I**	**CO1**	**K3**	
17. a)	**Unit - II**	**CO2**	**K4**	
		OR		
17. b)	**Unit - II**	**CO2**	**K4**	
18. a)	**Unit - III**	**CO3**	**K3**	
		OR		
18. b)	**Unit - III**	**CO3**	**K3**	
19. a)	**Unit - IV**	**CO4**	**K4**	
		OR		
19. b)	**Unit - IV**	**CO4**	**K4**	
20. a)	**Unit - V**	**CO5**	**K4**	
		OR		
20. b)	**Unit - V**	**CO5**	**K4**	

Course Name	Marine Microbiology			
Course Code	23UMBEC53	**L**	**P**	**C**
Category	Elective	4	-	3

COURSE OBJECTIVES:

- To describe the diversity of marine microorganism.
- To describe basic concepts of marine microbiology and provide a foundation for later studies. The main objective of this course is to give students an insight into the dynamics of marine microbes.
- To become familiar with concepts of microbes of extreme environments.
- To know various marine pollutants.
- To demonstrate and understand seafood microbiology.

UNIT – I	**Introduction to Microbial Oceanography**	**12**

Marine ecosystem: benthic & littoral zone, saltpan, mangroves and estuarine microbes, microbial loop. Diversity of microorganism - planktons, bacteria, algae and fungi.

UNIT - II	**Microbes of extreme environments**	**12**

Mechanism of extremophiles – halophiles – deep sea microbes. Microbes of hydrothermal vents - thermophilic, alkalophilic, osmophilic and barophilic, psychrophilic microorganisms – hyperthermophiles and halophiles.

UNIT - III	**Dynamics of Marine Microbes**	**12**

Carbon cycle: Phototrophic microbes, the oceanic carbonate system and global warming. Nitrogen cycle: Nitrogen fixers – Iron limitation – ocean fertilization. Decomposition of organic matter. Bioleaching and biodeterioration of natural and synthetic materials.

UNIT - IV	**Marine pollution**	**12**

Microorganisms responsible for bioluminescence in marine environment. Uses of bioluminescence. Microbial indicators of marine pollution and control, biofouling, biofilms, biodegradation and bioremediation of marine pollutants. Use of genetically engineered microorganisms in biodegradation.

UNIT - V	**Sea food microbiology**	**12**

Normal genera associated with fish – fish spoilage – Human pathogens and contaminants. Zoonotic – Brief account on aquaculture pathogens - Vibriosis – shrimp diseases – White Spot Syndrome of Viral infection.

Total Lecture Hours	**60**

BOOKS FOR STUDY:

- Colin Munn. 2009, Marine Microbiology: Ecology & Applications 2nd Edition. Garland Science, Taylor & Francis.
- David L. Kirchman. 2008, Microbial Ecology of the Oceans, 2nd Edition, John Wiley & Sons

BOOKS FOR REFERENCES:

- Madigan, M.T. and Martinko, J.M. 2006, Biology of Microorganisms, 11th Edition, Pearson Prentice Hall, USA. Volume VI – Science Syllabus / 2023 - 2024 Academic Council Meeting Held On 20.04.2023 Page 182 2.
- Steffi. P. F. and Rajeswari Anburaj. R. 2020, A Text book on Marine Microbiology, Ryan Publishers.
- Gasol, J.M. and Kirchman, D.L, 2018. Microbial ecology of the oceans. 3rd edition, John Wiley & Sons.

WEB RESOURCES:

- **https://academic.oup.com/fems-journals/pages/marinemicrobiology**
- **https://microbenotes.com/marine-microorganisms/**
- **https://www.sciencedirect.com/topics/earth-and-planetary-sciences/marine-microorganism**
- **https://link.springer.com/book/10.1007/978-3-319-33000-6**
- **https://www.mdpi.com/2077-1312/8/2/78?trk=organization_guest_main-feed-card-text**
- **https://lnu.se/en/research/research-groups/marin-microbiology/**

Nature of Course	EMPLOYABILITY		SKILL ORIENTED	✓	ENTREPRENEURSHIP			
Curriculum Relevance	LOCAL		REGIONAL		NATIONAL		GLOBAL	✓
Changes Made in the Course	Percentage of Change		No Changes Made	✓	New Course			

***Treat 20% as each unit (20*5=100%) and calculate the percentage of change for the course.**

COURSE OUTCOMES:		**K LEVEL**
After studying this course, the students will be able to:		
CO1	Explain marine ecosystem, deep sea microbes and marine pollution	**K1 to K4**
CO2	Outline the diversity of microorganism, mechanism of extremophiles, carbon cycle, nitrogen cycle and aquaculture pathogens.	**K1 to K4**
CO3	Categorise deep sea microbes, bioleaching and biodeterioration.	**K1 to K4**
CO4	Compare hydrothermal vents microbes, hyperthermophiles and halophiles.	**K1 to K4**
CO5	Illustrate decomposition, biodegradation, biofilms and bioremediation of marine pollutants	**K1 to K4**

MAPPING WITH PROGRAM OUTCOMES:										
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S				M			M
CO2	S		S	S						
CO3	S					S				
CO4			S	S						
CO5	S						M			S
S- STRONG				M – MEDIUM					L - LOW	

CO / PO MAPPING:					
COS	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	2	3	1	2	2
CO 2	1	2	3	2	3
CO 3	2	1	2	2	3
CO 4	3	3	2	1	2
CO 5	3	2	2	3	1
WEIGHTAGE	11	11	10	10	11
WEIGHTED PERCENTAGE OF COURSE CONTRIBUTION TO POS	73.3	73.3	66.6	66.6	73.3

LESSON PLAN:

UNIT	Marine Microbiology	HRS	PEDAGOGY
I	Introduction to Microbial Oceanography - Marine ecosystem: benthic & littoral zone, saltpan, mangroves and estuarine microbes, microbial loop. Diversity of microorganism - planktons, bacteria, algae and fungi.	12	Chalk & Talk, PPT
II	Microbes of extreme environments - Mechanism of extremophiles – halophiles – deep sea microbes. Microbes of hydrothermal vents - thermophilic, alkalophilic, osmophilic and barophilic, psychrophilic microorganisms – hyperthermophiles and halophiles.	12	Chalk & Talk, PPT
III	Dynamics of Marine Microbes - Carbon cycle: Phototrophic microbes, the oceanic carbonate system and global warming. Nitrogen cycle: Nitrogen fixers – Iron limitation – ocean fertilization. Decomposition of organic matter. Bioleaching and biodeterioration of natural and synthetic materials.	12	Chalk & Talk, PPT
IV	Marine pollution - Microorganisms responsible for bioluminescence in marine environment. Uses of bioluminescence. Microbial indicators of marine pollution and control, biofouling, biofilms, biodegradation and bioremediation of marine pollutants. Use of genetically engineered microorganisms in biodegradation.	12	Chalk & Talk, PPT

V	Sea food microbiology - Normal genera associated with fish – fish spoilage – Human pathogens and contaminants. Zoonotic – Brief account on aquaculture pathogens - Vibriosis – shrimp diseases – White Spot Syndrome of Viral infection.	**12**	**Chalk & Talk, PPT, Assignment**

Learning Outcome Based Education & Assessment (LOBE) Formative Examination - Blue Print Articulation Mapping – K Levels with Course Outcomes (COs)						
Internal	**Cos**	**K Level**	**Section A**		**Section B Either or Choice**	**Section C Either or Choice**
			MCQs			
			No. of. Questions	**K - Level**		
CI AI	**CO1**	**K1 – K4**	2	K1, K2	2(K2, K2)	2(K3, K3)
	CO2	**K1 – K4**	2	K1, K2	2(K3, K3)	2(K4, K4)
CI AII	**CO3**	**K1 – K4**	2	K1, K2	2(K2, K2)	2(K3, K3)
	CO4	**K1 – K4**	2	K1, K2	2(K3, K3)	2(K4, K4)
Question Pattern CIA I & II		**No. of Questions to be asked**	4		4	4
		No. of Questions to be answered	4		2	2
		Marks for each question	1		5	8
		Total Marks for each section	4		10	16

Distribution of Marks with K Level CIA I & CIA II							
	K Level	**Section A (Multiple Choice Questions)**	**Section B (Either / Or Choice)**	**Section C (Either / Or Choice)**	**Total Marks**	**% of (Marks without choice)**	**Consolidate of %**
CIA I	**K1**	**2**			**2**	**3.6**	**25**
	K2	**2**	**10**		**12**	**21.4**	
	K3		**10**	**16**	**26**	**46.4**	**46.4**
	K4			**16**	**16**	**28.6**	**28.6**
	Marks	**4**	**20**	**32**	**56**	**100**	**100**
CIA II	**K1**	**2**			**2**	**3.6**	**7.2**
	K2	**2**	**10**		**12**	**3.6**	
	K3		**10**	**16**	**26**	**46.4**	**46.4**
	K4			**16**	**16**	**46.4**	**46.4**
	Marks	**4**	**20**	**32**	**56**	**100**	**100**

K1- Remembering and recalling facts with specific answers

K2- Basic understanding of facts and stating main ideas with general answers

K3- Application oriented- Solving Problems

K4- Examining, analyzing, presentation and make inferences with evidences

CO5 will be allotted for individual Assignment which carries five marks as part of CIA component.

Summative Examination – Blue Print Articulation Mapping – K Level with Course Outcomes (COs)						
S. No	COs	K - Level	Section A (MCQs)		Section B (Either / or Choice) With K - LEVEL	Section C (Either / or Choice) With K - LEVEL
			No. of Questions	K – Level		
1	CO1	K1-K4	2	K1, K2	2(K2, K2)	2(K3, K3)
2	CO2	K1-K4	2	K1, K2	2(K3, K3)	2(K4, K4)
3	CO3	K1-K4	2	K1, K2	2(K2, K2)	2(K3, K3)
4	CO4	K1-K4	2	K1, K2	2(K3, K3)	2(K4, K4)
5	CO5	K1-K4	2	K1, K2	2(K3, K3)	2(K4, K4)
No. of Questions to be Asked			10		10	10
No. of Questions to be answered			10		5	5
Marks for each question			1		5	8
Total Marks for each section			10		25	40
(Figures in parenthesis denotes, questions should be asked with the given K level)						

Distribution of Marks with K Level						
K Level	Section A (Multiple Choice Questions)	Section B (Either or Choice	Section C (Either/ or Choice)	Total Marks	% of (Marks without choice)	Consolidated %
K1	5			5	3.6	4
K2	5	20		25	17.8	18
K3		30	32	62	44.3	44
K4			48	48	34.3	34
Marks	10	50	80	140	100	100
NB: Higher level of performance of the students is to be assessed by attempting higher level of K levels.						

Summative Examinations - Question Paper – Format

Q. No.	Unit	CO	K-level		
Answer **ALL** the questions				**PART – A**	**(10 x 1 = 10 Marks)**
1.	**Unit - I**	**CO1**	**K1**		
				a)	b)
				c)	d)
2.	**Unit - I**	**CO1**	**K2**		
				a)	b)
				c)	d)
3.	**Unit - II**	**CO2**	**K1**		
				a)	b)
				c)	d)
4.	**Unit - II**	**CO2**	**K2**		
				a)	b)
				c)	d)
5.	**Unit - III**	**CO3**	**K1**		
				a)	b)
				c)	d)
6.	**Unit - III**	**CO3**	**K2**		
				a)	b)
				c)	d)
7.	**Unit - IV**	**CO4**	**K1**		
				a)	b)
				c)	d)
8.	**Unit - IV**	**CO4**	**K2**		
				a)	b)
				c)	d)
9.	**Unit - V**	**CO5**	**K1**		
				a)	b)
				c)	d)
10.	**Unit - V**	**CO5**	**K2**		
				a)	b)
				c)	d)

Answer **ALL** the questions		**PART – B**		**(5 x 5 = 25 Marks)**
11. a)	**Unit - I**	**CO1**	**K2**	
		OR		
11. b)	**Unit - I**	**CO1**	**K2**	
12. a)	**Unit - II**	**CO2**	**K3**	
		OR		
12. b)	**Unit - II**	**CO2**	**K3**	
13. a)	**Unit - III**	**CO3**	**K2**	
		OR		
13. b)	**Unit - III**	**CO3**	**K2**	
14. a)	**Unit - IV**	**CO4**	**K3**	
		OR		
14. b)	**Unit - IV**	**CO4**	**K3**	
15. a)	**Unit - V**	**CO5**	**K3**	
		OR		
15. b)	**Unit - V**	**CO5**	**K3**	

Answer **ALL** the questions		**PART – C**		**(5 x 8 = 40 Marks)**
16. a)	**Unit - I**	**CO1**	**K3**	
		OR		
16. b)	**Unit - I**	**CO1**	**K3**	
17. a)	**Unit - II**	**CO2**	**K4**	
		OR		
17. b)	**Unit - II**	**CO2**	**K4**	
18. a)	**Unit - III**	**CO3**	**K3**	
		OR		
18. b)	**Unit - III**	**CO3**	**K3**	
19. a)	**Unit - IV**	**CO4**	**K4**	
		OR		
19. b)	**Unit - IV**	**CO4**	**K4**	
20. a)	**Unit - V**	**CO5**	**K4**	
		OR		
20. b)	**Unit - V**	**CO5**	**K4**	

Course Name	Biosafety and Bio - Ethics			
Course Code	23UMBEC54	**L**	**P**	**C**
Category	Elective	4	-	3

COURSE OBJECTIVES:

- To create a research environment-encourage investigation, analysis and studying the bioethicalprinciples,values, concepts, andsocialandjuridicalimplicationscontainedintheUniversal Declaration on Bioethics and Human.
- Rightsinordertoassisttheirapplicationandpromotioninthe areasofscience, biotechnology and medicine.
- To discuss about various aspects of biosafety regulations, IPR and bioethics concerns arising from the commercialization of biotech products.
- TointroducefundamentalaspectsofIntellectualpropertyRightstostudentswhoaregoing to play a major role in development and management of innovative projects in industries.
- To understand the importance of IPR, Patents and Patent laws.

UNIT - I INTRODUCTION TO BIO SAFETY **12**

Basics of Bio safety - Laboratory Hazards and Hazard symbols. Definitions on Biohazard, Bio safety and Bio security- Biohazard- LAI, BP. Biohazard Classification. Biological Risk Groups. Need and application of bio safety. Good Laboratory Practices (GLP), Good Manufacturing Practices (GMP).

UNIT - II INTRODUCTION TO HAZARDOUS MATERIAL **12**

Hazardous materials in Biology - Categories of Waste in the Biotechnology Laboratories, Bio hazardous waste and their disposal and treatments- issues in use of GMO's, risk for animal/human/ agriculture and environment owing to GMO. Hazardous materials, Emergency response/ first aids in Laboratories.

UNIT - III BIO SAFETY RULES IN INDIA **12**

Biological Safety Containment in Laboratory - Primary and secondary containments - Physical and biological containment. Types of bio safety containments (level I,II,III),PPE, Bio safety guidelines in India-Roles of Institutional Bio safety Committee, RCGM, GEAC.

UNIT - IV INTRODUCTION TO BIOETHICS **12**

Introduction and need of Bioethics-its relationship with other branches, Ethical implications of biotechnological products and techniques. Ethical Issues involving human cloning, human genome project, prenatal diagnosis, agriculture and animal rights, Social and ethical implications of biological weapons.

UNIT - V INTRODUCTION TO IPR AND PATENT **12**

IPR, Patents and Patent laws - Intellectual property rights-TRIP- GATT International conventions patents, Methods of application of patents, Legal implications. Biodiversity and farmer rights, Objectives of the patent system, Basic principles and general requirements of patent law, Biotechnological inventions, and patent law. Legal development-Patentable subjects and protection in biotechnology. The patenting of living organisms**.**

Total Lecture Hours **60**

BOOKS FOR STUDY:

- Usharani .B, S Anbazhagi, C K Vidya, (2019). Biosafety in Microbiological Laboratories- 1stEdition, Notion Press, ISBN-10f1645878856.
- Satheesh.M.K.,(2009).BioethicsandBiosafety 1stEdition,J.KInternationalPublishing House Pvt. Ltd: Delhi, ISBN :9788190675703.
- DeepaGoel and ShominiParashar, (2013). IPR, Biosaftey and Bioethics- 1stEdition, Pearson education: Chennai, ISBN-13: 978-8131774700.
- Rajmohan Joshi (2006). Biosafety and Bioethics. Gyan Books publisher.
- Sateesh. M.K. (2013). Bioethics and Biosafety. i.K. International pvt,Ltd.

BOOKS FOR REFERENCES:

- Nithyananda, KV.(2019).Intellectual Property Rights: Protection and Management, India, Learning India Private Limited, ISBN-10:9f386668572.
- Neeraj, P.,&Khusdeep,D.(2014).IntellectualPropertyRights,India,IN:PHIlearning Private Limited, ISBN : 9788120349896.
- Ahuja,VK.(2017).LawrelatingtoIntellectualPropertyRights,India,IN:LexisNexis,ISBN-10: 8131251659.
- Edited by Sylvia Uzochukwu, Nwadiuto (Diuto) Esiobu, Arinze Stanley Okoli, Emeka Godfrey Nwoba, EzebuiroNwagboChristpeace, Charles OluwaseunAdetunji, AbdulrazakIbrahim,BenjaminEwaUbi(2022).BiosafetyandBioethicsinBiotechnology-Policy,Advocacy, and Capacity Building,1st edition. CRC Press.
- SreeKrishna.V(2007).BioethicsandBiosafetyinBiotechnology.Newageinternational publishers.

WEB RESOURCES:

- **Subramanian, N., &Sundararaman, M. (2018). Intellectual Property Rights – An Overview.Retrieved from http://www.bdu.ac.in/cells/ipr/docs/ipr-eng-ebook.pdf.**
- **World Intellectual Property Organisation. (2004). WIPO Intellectual propertyHandbook. Retrievedfromhttps://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo_pub_489.pdf.**
- **https://www..niehs.nih.gov/bioethics**
- **https://www.sist.sathyabama.ac.in**
- **https://www.longdom.org/bioethics-and-biosafety**

Nature of Course	EMPLOYABILITY		SKILL ORIENTED	✓	ENTREPRENEURSHIP			
Curriculum Relevance	LOCAL		REGIONAL		NATIONAL		GLOBAL	✓
Changes Made in the Course	Percentage of Change		No Changes Made		New Course	✓		

***Treat 20% as each unit (20*5=100%) and calculate the percentage of change for the course.**

COURSE OUTCOMES:		K LEVEL
After studying this course, the students will be able to:		
CO1	Understand the control measures of laboratory hazards (chemical, biological and physical)and topractice safety strategies and personal protective equipment.	K1 to K4
CO2	Develop stratagems for the use of genetically modified organisms and Hazardous materials.	K1 to K4
CO3	Develop skills of critical ethical analysis of contemporary moral problems in medicine and health care.	K1 to K4
CO4	Analyze and respondtothecommentsofotherstudentsregarding philosophical issues.	K1 to K4
CO5	PavethewayforthestudentstocatchupIntellectualProperty(IP)as a career option a. R&D IP Counsel b. Government Jobs – PatentExaminerc.PrivateJobsd.PatentagentandTrademarkagente.Entrepreneur.	K1 to K4

MAPPING WITH PROGRAM OUTCOMES:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S				M			M
CO2	S		S	S						
CO3	S					S				
CO4			S	S						
CO5	S						M			S

S- STRONG M – MEDIUM L - LOW

CO / PO MAPPING:

COS	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	2	3	1	2	2
CO 2	1	2	3	2	3
CO 3	2	1	2	2	3
CO 4	3	3	2	1	2
CO 5	3	2	2	3	1
WEIGHTAGE	11	11	10	10	11
WEIGHTED PERCENTAGE OF COURSE CONTRIBUTION TO POS	73.3	73.3	66.6	66.6	73.3

LESSON PLAN:

UNIT	Biosafety and Bio - Ethics	HRS	PEDAGOGY
I	Basics of Biosafety - Laboratory Hazards and Hazard symbols. Definitions on Biohazard, Biosafety and Biosecurity- Biohazard- LAI, BP. Biohazard Classification. BiologicalRiskGroups. Need and application of biosafety. Good Laboratory Practices (GLP), Good Manufacturing Practices (GMP).	12	Chalk & Talk, PPT

II	Hazardous materials in Biotechnology **-** Categories of Waste in the Biotechnology Laboratories, Biohazardous waste and their disposal and treatments- issues in use of GMO's, risk for animal/human/ agriculture and environment owing to GMO. Hazardous materials, Emergency response/ first aids in Laboratories.	**12**	**Chalk & Talk, PPT**
III	Biological Safety Containment in Laboratory **-** Primary and secondary containments - Physical and biological containment. Typesofbiosafetycontainments(levelI,II,III),PPE,Biosafety guidelinesinIndia-RolesofInstitutionalBiosafetyCommittee, RCGM, GEAC.	**12**	**Chalk & Talk, PPT**
IV	IntroductionandneedofBioethics-itsrelationshipwithotherbranches, Ethical implications of biotechnological products and techniques.Ethical Issues involving human cloning, human genome project, prenatal diagnosis, agriculture and animal rights, Social and ethical implications of biological weapons.	**12**	**Chalk & Talk, PPT**
V	IPR, Patents and Patent laws **-** Intellectual property rights-TRIP- GATT International conventions patents, Methods of application of patents, Legal implications. Biodiversity and farmer rights, Objectives of the patent system, Basic principles and general requirements of patent law, Biotechnological inventions, and patent law. Legal development-Patentable subjects and protection in biotechnology. The patenting of living organisms.	**12**	**Chalk & Talk, PPT, Assignment**

Learning Outcome Based Education & Assessment (LOBE)
Formative Examination - Blue Print
Articulation Mapping – K Levels with Course Outcomes (COs)

Internal	Cos	K Level	Section A		Section B Either or Choice	Section C Either or Choice
			MCQs			
			No. of. Questions	K - Level		
CI AI	CO1	K1 – K4	2	K1, K2	2(K2, K2)	2(K3, K3)
	CO2	K1 – K4	2	K1, K2	2(K3, K3)	2(K4, K4)
CI AII	CO3	K1 – K4	2	K1, K2	2(K2, K2)	2(K3, K3)
	CO4	K1 – K4	2	K1, K2	2(K3, K3)	2(K4, K4)
Question Pattern CIA I & II		No. of Questions to be asked	4		4	4
		No. of Questions to be answered	4		2	2
		Marks for each question	1		5	8
		Total Marks for each section	4		10	16

Distribution of Marks with K Level CIA I & CIA II							
	K Level	Section A (Multiple Choice Questions)	Section B (Either / Or Choice)	Section C (Either / Or Choice)	Total Marks	% of (Marks without choice)	Consolidate of %
CIA I	K1	2			2	3.6	25
	K2	2	10		12	21.4	
	K3		10	16	26	46.4	46.4
	K4			16	16	28.6	28.6
	Marks	4	20	32	56	100	100
CIA II	K1	2			2	3.6	7.2
	K2	2	10		12	3.6	
	K3		10	16	26	46.4	46.4
	K4			16	16	46.4	46.4
	Marks	4	20	32	56	100	100

K1- Remembering and recalling facts with specific answers

K2- Basic understanding of facts and stating main ideas with general answers

K3- Application oriented- Solving Problems

K4- Examining, analyzing, presentation and make inferences with evidences

CO5 will be allotted for individual Assignment which carries five marks as part of CIA component.

Summative Examination – Blue Print Articulation Mapping – K Level with Course Outcomes (COs)						
S. No	COs	K - Level	Section A (MCQs)		Section B (Either / or Choice) With K - LEVEL	Section C (Either / or Choice) With K - LEVEL
			No. of Questions	K – Level		
1	CO1	K1-K4	2	K1, K2	2(K2, K2)	2(K3, K3)
2	CO2	K1-K4	2	K1, K2	2(K3, K3)	2(K4, K4)
3	CO3	K1-K4	2	K1, K2	2(K2, K2)	2(K3, K3)
4	CO4	K1-K4	2	K1, K2	2(K3, K3)	2(K4, K4)
5	CO5	K1-K4	2	K1, K2	2(K3, K3)	2(K4, K4)
No. of Questions to be Asked			10		10	10
No. of Questions to be answered			10		5	5
Marks for each question			1		5	8
Total Marks for each section			10		25	40
(Figures in parenthesis denotes, questions should be asked with the given K level)						

Distribution of Marks with K Level						
K Level	**Section A (Multiple Choice Questions)**	**Section B (Either or Choice**	**Section C (Either/ or Choice)**	**Total Marks**	**% of (Marks without choice)**	**Consolidated %**
K1	**5**			**5**	**3.6**	**4**
K2	**5**	**20**		**25**	**17.8**	**18**
K3		**30**	**32**	**62**	**44.3**	**44**
K4			**48**	**48**	**34.3**	**34**
Marks	**10**	**50**	**80**	**140**	**100**	**100**
NB: Higher level of performance of the students is to be assessed by attempting higher level of K levels.						

Summative Examinations - Question Paper – Format

Q. No.	**Unit**	**CO**	**K-level**		
Answer **ALL** the questions				**PART – A**	**(10 x 1 = 10 Marks)**
1.	**Unit - I**	**CO1**	**K1**		
				a)	b)
				c)	d)
2.	**Unit - I**	**CO1**	**K2**		
				a)	b)
				c)	d)
3.	**Unit - II**	**CO2**	**K1**		
				a)	b)
				c)	d)
4.	**Unit - II**	**CO2**	**K2**		
				a)	b)
				c)	d)
5.	**Unit - III**	**CO3**	**K1**		
				a)	b)
				c)	d)
6.	**Unit - III**	**CO3**	**K2**		
				a)	b)
				c)	d)
7.	**Unit - IV**	**CO4**	**K1**		
				a)	b)
				c)	d)
8.	**Unit - IV**	**CO4**	**K2**		
				a)	b)
				c)	d)
9.	**Unit - V**	**CO5**	**K1**		
				a)	b)
				c)	d)
10.	**Unit - V**	**CO5**	**K2**		
				a)	b)
				c)	d)

Answer **ALL** the questions		**PART – B**		**(5 x 5 = 25 Marks)**
11. a)	**Unit - I**	**CO1**	**K2**	
		OR		
11. b)	**Unit - I**	**CO1**	**K2**	
12. a)	**Unit - II**	**CO2**	**K3**	
		OR		
12. b)	**Unit - II**	**CO2**	**K3**	
13. a)	**Unit - III**	**CO3**	**K2**	
		OR		
13. b)	**Unit - III**	**CO3**	**K2**	
14. a)	**Unit - IV**	**CO4**	**K3**	
		OR		
14. b)	**Unit - IV**	**CO4**	**K3**	
15. a)	**Unit - V**	**CO5**	**K3**	
		OR		
15. b)	**Unit - V**	**CO5**	**K3**	

Answer **ALL** the questions		**PART – C**		**(5 x 8 = 40 Marks)**
16. a)	**Unit - I**	**CO1**	**K3**	
		OR		
16. b)	**Unit - I**	**CO1**	**K3**	
17. a)	**Unit - II**	**CO2**	**K4**	
		OR		
17. b)	**Unit - II**	**CO2**	**K4**	
18. a)	**Unit - III**	**CO3**	**K3**	
		OR		
18. b)	**Unit - III**	**CO3**	**K3**	
19. a)	**Unit - IV**	**CO4**	**K4**	
		OR		
19. b)	**Unit - IV**	**CO4**	**K4**	
20. a)	**Unit - V**	**CO5**	**K4**	
		OR		
20. b)	**Unit - V**	**CO5**	**K4**	

Course Name	Nanotechnology			
Course Code	23UMBEC55	**L**	**P**	**C**
Category	Elective	4	-	3

COURSE OBJECTIVES:

- To understand the basics and need for Biosafety procedures.
- To get accustomed to the Governing bodies of Biosafety guidelines
- To become aware of and manage biological risks.
- To acquire the knowledge about Intellectual property and its legal protection.
- To understanding the types of patents and patent filing procedures.

UNIT - I ELEMENTS OF NANOTECHNOLOGY **12**

Introduction to Nanotechnology and Nanoscience, characteristics of nano materials, classification of nanomaterials based on dimensionality, nanostructured materials and applications of nanotechnology.

UNIT - II NANOSTRUCTURE CHARACTERIZATION **12**

Nanostructure and nanomaterial characterization methods – Electron microscopy and other electron-based methods, Spectroscopic techniques, Scanning probe microscopy, Magnetic Resonance Techniques and ion-based techniques – RBS, PIXE, ERDA, SIMS & NRA.

UNIT - III APPLICATION OF NANOMATERIALS **12**

Carbon Nanostructures – Fullerenes and Nanotubes, Porous nanomaterials – Porous silicon and other porous nanomaterials, Sculptured Thinfilms, Aerogels, Quantum Dots, Langmuir-Blodgett Films, Nanowires, Nanorods, Nanopillars and Polymer Nanocomposites.

UNIT - IV NANOMEDICINE **12**

Proteins from non-natural aminoacids, Peptide nucleic acids, Personalized medicine, Immunotoxins as targeted cell killers – Liposome-mediated Drug delivery, Artificial blood, Cyclic peptides from nanotubes, Artificial Life and Biosensors.

UNIT - V NANOMATERIAL SYNTHESIS **12**

Methods of Nanomaterial synthesis – Chemical – chemical precipitation and co-precipitation, metal nanocrystals by reduction, sol-gel synthesis, reverse micelles and micelle formation – Self-assembly and catalysis – process o self-assembly, semiconductor island, monolayers, biometrics and colloids – Fabrication of nanomaterials by physical methods – Inert gas condensation, Molecular Beam Epitaxy and Deep-UV Lithography.

Total Lecture Hours **60**

BOOKS FOR STUDY:

- Raul J. Martin-Palma and Akhlesh Lakhtakia, 2010, Nanotechnology – A Crash Course, Library of Congress Cataloging-in-Publication Data.
- David S. Goodsell, 2004, Bionanotechnology – Lessons from Nature, John Wiley & Sons Inc.Publications.
- Jeremy Ramsden, 2009, Essentials of Nanotechnology, Jeremy Ramsden and Ventus PublishingApS.
- Shah M. A and Shah K. A., 2019, Nanotechnology – The Science of Small, 2nd Ed., Wiley Publications.
- Shanmugam S., 2011, Nanotechnology, MJP Publishers.

BOOKS FOR REFERENCES:

- Guozhong Cao, 2004, Nanostructures and Nanomaterials – Syntheis, Properties and Applications, Imperial College Press.
- Thomas Varghese and Balakkrishna K. M., 2023, Nanotechnology – An introduction to Synthesis, Properties and Applications of Nanomaterials, Atlantic Publishers and Distributors Pvt. Ltd.
- Panda H, 2010, Nanoscience and Nanotechnology Handbook, Asia Pacific Business Press Inc.,

WEB RESOURCES:

- **https://www.nanowerk.com/what-are-nanomaterials.php**
- **https://www.understandingnano.com/medicine.html**
- **https://ccsuniversity.ac.in/bridge-library/pdf/L3%20Synthesis%20of%20Nanostructured%20Materials%20Prof%20BPS.pdf**
- **https://nanografi.com/blog/artificial-intelligence-integration-with-nanotechnology/**
- **https://ieeexplore.ieee.org/document/9934704**

Nature of Course	EMPLOYABILITY			SKILL ORIENTED			ENTREPRENEURSHIP		✓			
Curriculum Relevance	LOCAL		REGIONAL		NATIONAL		GLOBAL	✓				
Changes Made in the Course	Percentage of Change			No Changes Made	✓		New Course					

***Treat 20% as each unit (20*5=100%) and calculate the percentage of change for the course.**

COURSE OUTCOMES:		**K LEVEL**
After studying this course, the students will be able to:		
CO1	Acquire knowledge in basic nanotechnology.	**K1 to K4**
CO2	Get accustomed to identification method of nanostructures.	**K1 to K4**
CO3	Understand the types of nanomaterials and their applications.	**K1 to K4**
CO4	Appreciate the applications of Nanotechnology in Medicine.	**K1 to K4**
CO5	Understand the various methods of producing Nanomaterials.	**K1 to K4**

MAPPING WITH PROGRAM OUTCOMES:										
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S				M			M
CO2	S		S	S						
CO3	S					S				
CO4			S	S						
CO5	S						M			S
S- STRONG				M – MEDIUM					L - LOW	

CO / PO MAPPING:					
COS	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	2	3	1	2	2
CO 2	1	2	3	2	3
CO 3	2	1	2	2	3
CO 4	3	3	2	1	2
CO 5	3	2	2	3	1
WEIGHTAGE	11	11	10	10	11
WEIGHTED PERCENTAGE OF COURSE CONTRIBUTION TO POS	73.3	73.3	66.6	66.6	73.3

LESSON PLAN:

UNIT	Nanotechnology	HRS	PEDAGOGY
I	**ELEMENTS OF NANOTECHNOLOGY -** Introduction to Nanotechnology and Nanoscience, characteristics of nano materials, classification of nanomaterials based on dimensionality, nanostructured materials and applications of nanotechnology.	12	Chalk & Talk, PPT
II	**NANOSTRUCTURE CHARACTERIZATION -** Nanostructure and nanomaterial characterization methods – Electron microscopy and other electron-based methods, Spectroscopic techniques, Scanning probe microscopy, Magnetic Resonance Techniques and ion-based techniques – RBS, PIXE, ERDA, SIMS & NRA.	12	Chalk & Talk, PPT
III	**APPLICATION OF NANOMATERIALS-** Carbon Nanostructures – Fullerenes and Nanotubes, Porous nanomaterials – Porous silicon and other porous nanomaterials, Sculptured Thinfilms, Aerogels, Quantum Dots, Langmuir-Blodgett Films, Nanowires, Nanorods, Nanopillars and Polymer Nanocomposites.	12	Chalk & Talk, PPT
IV	**NANOMEDICINE -** Proteins from non-natural aminoacids, Peptide nucleic acids, Personalized medicine, Immunotoxins as targeted cell killers – Liposome-mediated Drug delivery, Artificial blood, Cyclic peptides from nanotubes, Artificial Life and Biosensors.	12	Chalk & Talk, PPT

V	**NANOMATERIAL SYNTHESIS -** Methods of Nanomaterial synthesis – Chemical – chmical precipitation and co-precipitation, metal nanocrystals by reduction, sol-gel synthesis, reverse micelles and myle formation – Self-assembly and catalysis – process o selfassembly, semiconductor island, monolayers, biometrics and colloids– Fabrication of nanomaterials by physical methods – Inert gas condensation, Molecular Beam Epitaxy and Deep-UV Lithography.	**12**	**Chalk & Talk, PPT, Assignment**

Learning Outcome Based Education & Assessment (LOBE) Formative Examination - Blue Print Articulation Mapping – K Levels with Course Outcomes (COs)						
Internal	**Cos**	**K Level**	**Section A MCQs**		**Section B Either or Choice**	**Section C Either or Choice**
			No. of. Questions	**K - Level**		
CI AI	**CO1**	**K1 – K4**	2	K1, K2	2(K2, K2)	2(K3, K3)
	CO2	**K1 – K4**	2	K1, K2	2(K3, K3)	2(K4, K4)
CI AII	**CO3**	**K1 – K4**	2	K1, K2	2(K2, K2)	2(K3, K3)
	CO4	**K1 – K4**	2	K1, K2	2(K3, K3)	2(K4, K4)
Question Pattern CIA I & II		**No. of Questions to be asked**	4		4	4
		No. of Questions to be answered	4		2	2
		Marks for each question	1		5	8
		Total Marks for each section	4		10	16

Distribution of Marks with K Level CIA I & CIA II							
	K Level	**Section A (Multiple Choice Questions)**	**Section B (Either / Or Choice)**	**Section C (Either / Or Choice)**	**Total Marks**	**% of (Marks without choice)**	**Consolidate of %**
CIA I	**K1**	**2**			**2**	**3.6**	**25**
	K2	**2**	**10**		**12**	**21.4**	
	K3		**10**	**16**	**26**	**46.4**	**46.4**
	K4			**16**	**16**	**28.6**	**28.6**
	Marks	**4**	**20**	**32**	**56**	**100**	**100**
CIA II	**K1**	**2**			**2**	**3.6**	**7.2**
	K2	**2**	**10**		**12**	**3.6**	
	K3		**10**	**16**	**26**	**46.4**	**46.4**
	K4			**16**	**16**	**46.4**	**46.4**
	Marks	**4**	**20**	**32**	**56**	**100**	**100**

K1- Remembering and recalling facts with specific answers

K2- Basic understanding of facts and stating main ideas with general answers

K3- Application oriented- Solving Problems

K4- Examining, analyzing, presentation and make inferences with evidences

CO5 will be allotted for individual Assignment which carries five marks as part of CIA component.

Summative Examination – Blue Print Articulation Mapping – K Level with Course Outcomes (COs)						
S. No	COs	K - Level	Section A (MCQs)		Section B (Either / or Choice) With K - LEVEL	Section C (Either / or Choice) With K - LEVEL
			No. of Questions	K – Level		
1	CO1	K1-K4	2	K1, K2	2(K2, K2)	2(K3, K3)
2	CO2	K1-K4	2	K1, K2	2(K3, K3)	2(K4, K4)
3	CO3	K1-K4	2	K1, K2	2(K2, K2)	2(K3, K3)
4	CO4	K1-K4	2	K1, K2	2(K3, K3)	2(K4, K4)
5	CO5	K1-K4	2	K1, K2	2(K3, K3)	2(K4, K4)
No. of Questions to be Asked			10		10	10
No. of Questions to be answered			10		5	5
Marks for each question			1		5	8
Total Marks for each section			10		25	40
(Figures in parenthesis denotes, questions should be asked with the given K level)						

Distribution of Marks with K Level						
K Level	Section A (Multiple Choice Questions)	Section B (Either or Choice	Section C (Either/ or Choice)	Total Marks	% of (Marks without choice)	Consolidated %
K1	5			5	3.6	4
K2	5	20		25	17.8	18
K3		30	32	62	44.3	44
K4			48	48	34.3	34
Marks	10	50	80	140	100	100
NB: Higher level of performance of the students is to be assessed by attempting higher level of K levels.						

Summative Examinations - Question Paper – Format

Q. No.	Unit	CO	K-level		
Answer **ALL** the questions				**PART – A**	**(10 x 1 = 10 Marks)**
1.	**Unit - I**	**CO1**	**K1**		
				a)	b)
				c)	d)
2.	**Unit - I**	**CO1**	**K2**		
				a)	b)
				c)	d)
3.	**Unit - II**	**CO2**	**K1**		
				a)	b)
				c)	d)
4.	**Unit - II**	**CO2**	**K2**		
				a)	b)
				c)	d)
5.	**Unit - III**	**CO3**	**K1**		
				a)	b)
				c)	d)
6.	**Unit - III**	**CO3**	**K2**		
				a)	b)
				c)	d)
7.	**Unit - IV**	**CO4**	**K1**		
				a)	b)
				c)	d)
8.	**Unit - IV**	**CO4**	**K2**		
				a)	b)
				c)	d)
9.	**Unit - V**	**CO5**	**K1**		
				a)	b)
				c)	d)
10.	**Unit - V**	**CO5**	**K2**		
				a)	b)
				c)	d)

Answer **ALL** the questions		**PART – B**		**(5 x 5 = 25 Marks)**
11. a)	**Unit - I**	**CO1**	**K2**	
		OR		
11. b)	**Unit - I**	**CO1**	**K2**	
12. a)	**Unit - II**	**CO2**	**K3**	
		OR		
12. b)	**Unit - II**	**CO2**	**K3**	
13. a)	**Unit - III**	**CO3**	**K2**	
		OR		
13. b)	**Unit - III**	**CO3**	**K2**	
14. a)	**Unit - IV**	**CO4**	**K3**	
		OR		
14. b)	**Unit - IV**	**CO4**	**K3**	
15. a)	**Unit - V**	**CO5**	**K3**	
		OR		
15. b)	**Unit - V**	**CO5**	**K3**	

Answer **ALL** the questions		**PART – C**		**(5 x 8 = 40 Marks)**
16. a)	**Unit - I**	**CO1**	**K3**	
		OR		
16. b)	**Unit - I**	**CO1**	**K3**	
17. a)	**Unit - II**	**CO2**	**K4**	
		OR		
17. b)	**Unit - II**	**CO2**	**K4**	
18. a)	**Unit - III**	**CO3**	**K3**	
		OR		
18. b)	**Unit - III**	**CO3**	**K3**	
19. a)	**Unit - IV**	**CO4**	**K4**	
		OR		
19. b)	**Unit - IV**	**CO4**	**K4**	
20. a)	**Unit - V**	**CO5**	**K4**	
		OR		
20. b)	**Unit - V**	**CO5**	**K4**	

Course Name	Fundamentals of Algae, Fungi and Lichens			
Course Code	23UMBEC56	**L**	**P**	**C**
Category	Elective	4	-	3

COURSE OBJECTIVES:

- Describe general characters, habitat, structure and reproduction of algae, fungi and Lichens
- Classify the life cycle of algae, fungi and Lichens
- Discuss the properties of algae, fungi and Lichens (K2).
- Demonstrate biological importance of algae, fungi and Lichens (K3).
- Contrast economic importance of algae, fungi and Lichens (K4).

UNIT - I	**Algae: Classification, Structure, Reproduction & Uses**	**12**

General characteristics of algae. Classification (F.E.Fritsch and Smith), diverse habitat, Range of thallus structure, Photosynthetic pigments and food reserves. Reproduction (vegetative, asexual and sexual), Economic importance (algae as food and fodder, algae in agriculture, pharmaceuticals and industries).

UNIT - II	**Algae: Habitat, Structure, and Life Cycles**	**12**

Habitat, structure, reproduction and life cycle of algae: Chlorophyceae – Volvox, Coleochaete, Xanthophyceae – Vaucheria Phaeophyceae – Ectocarpus Rhodophyceae – Polysiphonia.

UNIT - III	**Fungi: Characteristics, Classification, Reproduction & Importance**	**12**

General characteristics of fungi: Definition, Classification of fungi. (Saccardo and Ainsworth's), occurrence, thallus organization, asexual and sexual reproduction, biological and economic importance of fungi.

UNIT - IV	**Fungal Diversity: Habitat, Structure, Reproduction & Life Cycle**	**12**

Habitat, structure, reproduction and life cycle of fungi: Yeast, Rhizopus, Aspergillus, Peziza, Agaricus.

UNIT - V	**Lichens: Characteristics, Structure, Reproduction & Ecological Importance**	**12**

Lichens: General characters, habitat, structure, reproduction and economic importance of lichens, importance of lichens as colonizers and indicators of environment.

Total Lecture Hours	**60**

BOOKS FOR STUDY:

- Sambamurty A.V.S.S, 2013. A Text book of Algae, I.K International publications
- Sharma O.P, 1989. A Text book of Fungi, Tata McGraw - Hill Education.

BOOKS FOR REFERENCES:

- Prescott, Harley and Klein, 2006. Microbiology, 6th Ed., Tata McGraw Hills.
- Alexopoulos C. J and Mims C. W, 2000. Introductory Mycology, 3rd Ed., Wiley Eastern Publications.
- Geeta Sumbali, B. M. Johri, 2005. The Fungi, Alpha Science International Publications.

WEB RESOURCES:

- https://nph.onlinelibrary.wiley.com/doi/10.1111/nph.18048
- https://www.mdpi.com/2223-7747/12/17/3172
- https://www.biologydiscussion.com/notes/lichens/study-notes-on-lichens-biology/34202
- https://openstax.org/books/microbiology/pages/5-5-lichens

Nature of Course	EMPLOYABILITY		SKILL ORIENTED	✓	ENTREPRENEURSHIP			
Curriculum Relevance	LOCAL		REGIONAL		NATIONAL		GLOBAL	✓
Changes Made in the Course	Percentage of Change		No Changes Made	✓	New Course			

***Treat 20% as each unit (20*5=100%) and calculate the percentage of change for the course.**

COURSE OUTCOMES:		**K LEVEL**
After studying this course, the students will be able to:		
CO1	Understand the characteristics, classification, reproduction, and economic importance of algae.	**K1 to K4**
CO2	Describe the habitat, structure, reproduction, and life cycle of key algal groups.	**K1 to K4**
CO3	Explain fungal classification, structure, reproduction, and economic significance.	**K1 to K4**
CO4	Analyse the habitat, structure, and life cycles of representative fungal species	**K1 to K4**
CO5	Understand the structure, reproduction, and ecological role of lichens.	**K1 to K4**

MAPPING WITH PROGRAM OUTCOMES:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S				M			M
CO2	S		S	S						
CO3	S					S				
CO4			S	S						
CO5	S						M			S

S- STRONG **M – MEDIUM** **L - LOW**

CO / PO MAPPING:					
COS	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO 1	**2**	**3**	**1**	**2**	**2**
CO 2	**1**	**2**	**3**	**2**	**3**
CO 3	**2**	**1**	**2**	**2**	**3**
CO 4	**3**	**3**	**2**	**1**	**2**
CO 5	**3**	**2**	**2**	**3**	**1**
WEIGHTAGE	**11**	**11**	**10**	**10**	**11**
WEIGHTED PERCENTAGE OF COURSE CONTRIBUTION TO POS	**73.3**	**73.3**	**66.6**	**66.6**	**73.3**

LESSON PLAN:

UNIT	Fundamentals of Algae, Fungi and Lichens	HRS	PEDAGOGY
I	General characteristics of algae. Classification, diverse habitat, Range of thallus structure, Photosynthetic pigments and food reserves. Reproduction Economic importance.	**12**	**Chalk & Talk, PPT**
II	Habitat, structure, reproduction and life cycle of algae: Chlorophyceae – Volvox, Coleochaete, Xanthophyceae – Vaucheria Phaeophyceae – Ectocarpus Rhodophyceae – Polysiphonia.	**12**	**Chalk & Talk, PPT**
III	General characteristics of fungi: Definition, Classification of fungi. occurrence, thallus organization, asexual and sexual reproduction, biological and economic importance of fungi.	**12**	**Chalk & Talk, PPT**
IV	Habitat, structure, reproduction and life cycle of fungi: Yeast, Rhizopus, Aspergillus, Peziza, Agaricus.	**12**	**Chalk & Talk, PPT**
V	Lichens: General characters, habitat, structure, reproduction and economic importance of lichens, importance of lichens as colonizers and indicators of environment.	**12**	**Chalk & Talk, PPT, Assignment**

Learning Outcome Based Education & Assessment (LOBE) Formative Examination - Blue Print Articulation Mapping – K Levels with Course Outcomes (COs)						
Internal	**Cos**	**K Level**	**Section A**		**Section B Either or Choice**	**Section C Either or Choice**
			MCQs			
			No. of. Questions	**K - Level**		
CI AI	**CO1**	**K1 – K4**	2	K1, K2	2(K2, K2)	2(K3, K3)
	CO2	**K1 – K4**	2	K1, K2	2(K3, K3)	2(K4, K4)
CI AII	**CO3**	**K1 – K4**	2	K1, K2	2(K2, K2)	2(K3, K3)
	CO4	**K1 – K4**	2	K1, K2	2(K3, K3)	2(K4, K4)
Question Pattern CIA I & II		**No. of Questions to be asked**	4		4	4
		No. of Questions to be answered	4		2	2
		Marks for each question	1		5	8
		Total Marks for each section	4		10	16

Distribution of Marks with K Level CIA I & CIA II							
	K Level	**Section A (Multiple Choice Questions)**	**Section B (Either / Or Choice)**	**Section C (Either / Or Choice)**	**Total Marks**	**% of (Marks without choice)**	**Consolidate of %**
CIA I	**K1**	**2**			**2**	**3.6**	**25**
	K2	**2**	**10**		**12**	**21.4**	
	K3		**10**	**16**	**26**	**46.4**	**46.4**
	K4			**16**	**16**	**28.6**	**28.6**
	Marks	**4**	**20**	**32**	**56**	**100**	**100**
CIA II	**K1**	**2**			**2**	**3.6**	**7.2**
	K2	**2**	**10**		**12**	**3.6**	
	K3		**10**	**16**	**26**	**46.4**	**46.4**
	K4			**16**	**16**	**46.4**	**46.4**
	Marks	**4**	**20**	**32**	**56**	**100**	**100**

K1- Remembering and recalling facts with specific answers

K2- Basic understanding of facts and stating main ideas with general answers

K3- Application oriented- Solving Problems

K4- Examining, analyzing, presentation and make inferences with evidences

CO5 will be allotted for individual Assignment which carries five marks as part of CIA component.

Summative Examination – Blue Print Articulation Mapping – K Level with Course Outcomes (COs)						
S. No	COs	K - Level	Section A (MCQs)		Section B (Either / or Choice) With K - LEVEL	Section C (Either / or Choice) With K - LEVEL
			No. of Questions	K – Level		
1	CO1	K1-K4	2	K1, K2	2(K2, K2)	2(K3, K3)
2	CO2	K1-K4	2	K1, K2	2(K3, K3)	2(K4, K4)
3	CO3	K1-K4	2	K1, K2	2(K2, K2)	2(K3, K3)
4	CO4	K1-K4	2	K1, K2	2(K3, K3)	2(K4, K4)
5	CO5	K1-K4	2	K1, K2	2(K3, K3)	2(K4, K4)
No. of Questions to be Asked			10		10	10
No. of Questions to be answered			10		5	5
Marks for each question			1		5	8
Total Marks for each section			10		25	40
(Figures in parenthesis denotes, questions should be asked with the given K level)						

Distribution of Marks with K Level						
K Level	Section A (Multiple Choice Questions)	Section B (Either or Choice	Section C (Either/ or Choice)	Total Marks	% of (Marks without choice)	Consolidated %
K1	5			5	3.6	4
K2	5	20		25	17.8	18
K3		30	32	62	44.3	44
K4			48	48	34.3	34
Marks	10	50	80	140	100	100
NB: Higher level of performance of the students is to be assessed by attempting higher level of K levels.						

Summative Examinations - Question Paper – Format

Q. No.	Unit	CO	K-level		
Answer **ALL** the questions				**PART – A**	**(10 x 1 = 10 Marks)**
1.	**Unit - I**	**CO1**	**K1**		
				a)	b)
				c)	d)
2.	**Unit - I**	**CO1**	**K2**		
				a)	b)
				c)	d)
3.	**Unit - II**	**CO2**	**K1**		
				a)	b)
				c)	d)
4.	**Unit - II**	**CO2**	**K2**		
				a)	b)
				c)	d)
5.	**Unit - III**	**CO3**	**K1**		
				a)	b)
				c)	d)
6.	**Unit - III**	**CO3**	**K2**		
				a)	b)
				c)	d)
7.	**Unit - IV**	**CO4**	**K1**		
				a)	b)
				c)	d)
8.	**Unit - IV**	**CO4**	**K2**		
				a)	b)
				c)	d)
9.	**Unit - V**	**CO5**	**K1**		
				a)	b)
				c)	d)
10.	**Unit - V**	**CO5**	**K2**		
				a)	b)
				c)	d)

Answer **ALL** the questions		**PART – B**		**(5 x 5 = 25 Marks)**
11. a)	**Unit - I**	**CO1**	**K2**	
		OR		
11. b)	**Unit - I**	**CO1**	**K2**	
12. a)	**Unit - II**	**CO2**	**K3**	
		OR		
12. b)	**Unit - II**	**CO2**	**K3**	
13. a)	**Unit - III**	**CO3**	**K2**	
		OR		
13. b)	**Unit - III**	**CO3**	**K2**	
14. a)	**Unit - IV**	**CO4**	**K3**	
		OR		
14. b)	**Unit - IV**	**CO4**	**K3**	
15. a)	**Unit - V**	**CO5**	**K3**	
		OR		
15. b)	**Unit - V**	**CO5**	**K3**	

Answer **ALL** the questions		**PART – C**		**(5 x 8 = 40 Marks)**
16. a)	**Unit - I**	**CO1**	**K3**	
		OR		
16. b)	**Unit - I**	**CO1**	**K3**	
17. a)	**Unit - II**	**CO2**	**K4**	
		OR		
17. b)	**Unit - II**	**CO2**	**K4**	
18. a)	**Unit - III**	**CO3**	**K3**	
		OR		
18. b)	**Unit - III**	**CO3**	**K3**	
19. a)	**Unit - IV**	**CO4**	**K4**	
		OR		
19. b)	**Unit - IV**	**CO4**	**K4**	
20. a)	**Unit - V**	**CO5**	**K4**	
		OR		
20. b)	**Unit - V**	**CO5**	**K4**	

Course Name	Internship Report [Internship / Industrial Visit / Field Visit]			
Course Code	23UMBIN51	**L**	**P**	**C**
Category	Summer Internship	-	-	2

Course Content:

EachGroup – 5 Students

Area of learning – Qualitychecking,productionofbeneficialmicrobesand entrepreneurship skills.

Record submission– AhardboundreporttobesubmittedtotheDepartment. Evaluation – Project (oral) presentation followed by a brief Viva

Course Description

TheIn-PlanttrainingisconductedbythefollowingCourse Pattern.

Internal

Presentation

Submission **25**

External

In-planttrainingReport

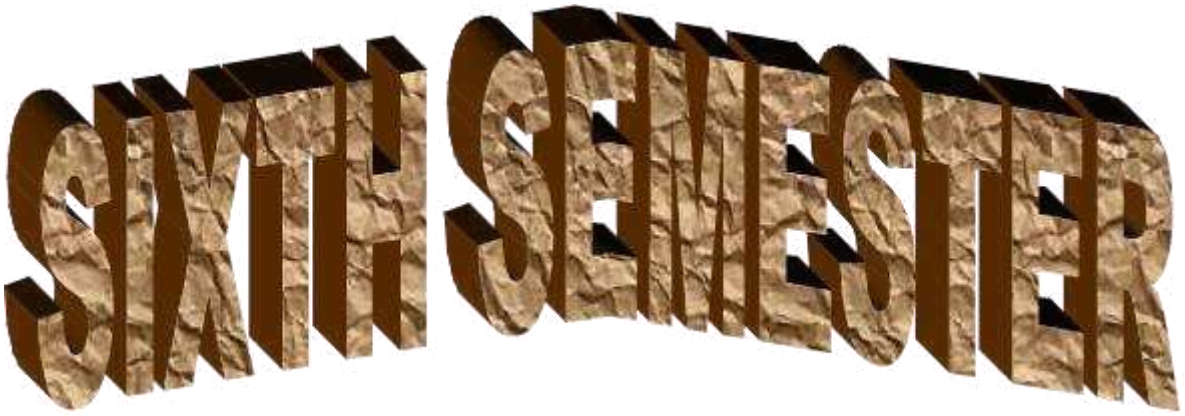
Viva Voce **75**

Total **100**

COURSE OUTCOMES:		K LEVEL
After studying this course, the students will be able to:		
CO1	Acquireskillsin differenttechniquesin Microbiology.	K1 to K4
CO2	Explorevarious job opportunities in thefield	K1 to K4
CO3	Getaccustomedtoupdatedlaboratoryinstruments.	K1 to K4
CO4	Applythelearntheoryskillsinpractice.	K1 to K4
CO5	LearntheSOPsfollowed inMicrobiology-relatedlabs.	K1 to K4

CO / PO MAPPING:					
COS	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	2	3	1	2	2
CO 2	1	2	3	2	3
CO 3	2	1	2	2	3
CO 4	3	3	2	1	2
CO 5	3	2	2	3	1
WEIGHTAGE	11	11	10	10	11
WEIGHTED PERCENTAGE OF COURSE CONTRIBUTIO N TO POS	73.3	73.3	66.6	66.6	73.3

CO / PO MAPPING:					
COS	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	2	1	2	2	1
CO 2	2	2	2	1	1
CO 3	1	1	1	1	2
CO 4	2	2	2	2	1
CO 5	1	1	1	1	2


SIXTH SEMESTER

MANNAR THIRUMALAI NAICKER COLLEGE (AUTONOMOUS)

DEPARTMENT OF MICROBIOLOGY

FOR THOSE WHO JOINED IN 2023-2024 AND AFTER

Course Name	Environmental and Agricultural Microbiology			
Course Code	23UMBCC61	**L**	**P**	**C**
Category	Core	6	-	5

COURSE OBJECTIVES:

- To discussthedistributionandassociationofmicroorganisminvariousecosystemsandto know about the role of microorganism in water pollution and water quality.
- To acquire knowledge about the role of microorganism in water pollution and water quality
- Gain knowledge about microbes as biofertilizers and the aspects of application.
- To learn about the process of solid waste management and sewage water treatment
- Gain knowledge on various plant diseases and pathogens

UNIT - I Soil Microflora **18**

Microorganisms and their Habitats. Terrestrial Environment: Soil profile and soil micro flora. Role of microorganisms in elemental cycles in nature: Carbon, Nitrogen. Aquatic Environment: Micro flora of fresh water and marine habitats. Atmosphere: Aero micro flora. Assessment of air quality, Air sanitation. ExtremeHabitats: Extremophiles: Microbes thriving at high & low temperatures, pH, high hydrostatic & osmotic pressures, salinity, &low nutrient levels.. Environmental Protection Agency (EPA)-role in environmental protection.

UNIT - II Water Potability **18**

Water portability: Sources and types of water surface, ground, stored, distilled, mineral and de-mineralized water and their pollution, biological indicators of water Pollution, Eutrophication. Conventional, MPN index, coliform test, Membrane filtration. BOD, COD. Advanced molecular methods for water analysis. Water borne diseases – Typhoid and cholera. Central Pollution Control Board (CPCB) standards.

UNIT - III Microbial Interactions **18**

Microbial Interactions: Rhizosphere microflora. Concepts of Nitrogen fixation – Symbiotic and asymbiotic nitrogen fixers. Brief account of microbial interactions: Symbiosis, neutralism, commensalism, competition, Ammensalism, Synergism, parasitism, and predation. General account and Significance of Biofertilizers and biocontrol agents–Bacterial [*Bacillus thuringiensis*],cyanobacterial [*Anabaena*],fungal – VAM, viral - NPV.Massproductionof Rhizobialbiofertilizer. Biocontrol agents – Bacterial, viral, fungal.

UNIT - IV Waste treatment and bioremediation **18**

Waste treatment and bioremediation: Solid waste management: Sources and types of solid waste, composting, vermi composting, production of biogas. Liquid waste management: Primary, secondary, and tertiary sewage treatment. Bioremediation and waste management: Need and scope of bioremediation .Degradation of hydrocarbons, oil spills, heavy metals – Chromium, lead, and xenobiotics – PCB.

UNIT - V Plant pathology **18**

Plant pathology: Mode of entry of pathogens, Microbial enzymes, toxins, growth regulators and suppressor of plant defense in plant diseases. Plant defense mechanisms. Bacterialdiseases– Citruscanker, Blight of paddy. Viral disease – TMV, CMV. Fungal disease- red rot ofsugarcane, Tikka disease. Plant disease management.

Total Lecture Hours **90**

BOOKS FOR STUDY:

- JosephC.Daniel.(2006).EnvironmentalaspectsofMicrobiology2ndEdition.BrightSun Publications.
- Pradipta. K.M. (2008). Textbook of Environmental Microbiology.I.K.Publishing. House
- Ramanathan ,and Muthukaruppan SM.(2005).Environmental Microbiology. OmSakthi Pathipagam, Annamalai Nagar.
- K. Vijaya Ramesh.(2004).Environmental Microbiology. 1stEdition. MJP Publishers
- SubbaRao.N.S.(2017). Soil Microbiology.4thEdition.Oxford and IBH Publishing Pvt.Ltd

BOOKS FOR REFERENCES:

- New York, Hong Kong.
- EcEldowneyS,HardmanD.J.,WaiteD.J.,WaiteS.(1993).Pollution:Ecologyand Biotreatment – Longman Scientific Technical.
- Mitchel, R.(1992). Environmental Microbiology. Wiley –John Wiley and Sons. Inc. Publications, New York
- Clescri, L.S., Greenberg, A.E. and Eaton, A.D.(1998). Standard Methods for Examination of Water and Wastewater, 20thEdition. American Public Health Association.
- Atlas,R.M.andBartha,R.(1992).MicrobialEcology:FundamentalsandApplications,2ndEdition. The Benjamin / Cummings Publishing Co.,Redwood City, CA.

WEB RESOURCES:

- **https://nptel.ac.in/courses/126105016**
- **https://www.classcentral.com/course/swayam-plant-pathology-and-soil-health-14236**
- **https://www.wasteonline.org.uk/resources/InformationSheets/WasteDisposal.htm**
- **https://plantpath.cornell.edu/labs/enelson/PDFs/Hill_et_al_2000.pdf**
- **https://onlinelibrary.wiley.com/doi/full/10.1111/j.1365-2389.2005.00781.x**

Nature of Course	EMPLOYABILITY		SKILL ORIENTED	✓	ENTREPRENEURSHIP			
Curriculum Relevance	LOCAL		REGIONAL		NATIONAL		GLOBAL	✓
Changes Made in the Course	Percentage of Change	**15%**	No Changes Made		New Course			

***Treat 20% as each unit (20*5=100%) and calculate the percentage of change for the course.**

COURSE OUTCOMES:		K LEVEL
After studying this course, the students will be able to:		
CO1	Describe about the structure and function of ecosystems and understand the role of microbes in various environments	K1 to K4
CO2	Identify the cause of water pollution, and perform methods to assess the quality of water.	K1 to K4
CO3	Explain the production of biofertilizers and biopesticides.	K1 to K4
CO4	Explainabout waste treatment process and microbial decomposition and bio-remediation process.	K1 to K4
CO5	Describe about plant diseases causedbymicrobesandacquireaclear idea on plant pathogenic interaction	K1 to K4

MAPPING WITH PROGRAM OUTCOMES:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	S	M	M	M	M		
CO2	S	M	S	S	M	M	M	M		
CO3	S	M	M	M	S	S	S	M		
CO4	M	M	S	S	S	S	M	S		
CO5	S	L	M	M	M	S	M	S		

S- STRONG M – MEDIUM L - LOW

CO / PO MAPPING:

COS	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	3	3	3	2	2
3CO 2	3	2	3	3	2
CO 3	3	2	2	2	3
CO 4	2	2	3	3	3
CO 5	3	1	2	1	2
WEIGHTAGE	14	10	13	11	12
WEIGHTED PERCENTAGE OF COURSE CONTRIBUTION TO POS	93.33	66.66	86.66	73.33	80

LESSON PLAN:

UNIT	Environmental and Agricultural Microbiology	HRS	PEDAGOGY
I	Microorganisms and their Habitats. Terrestrial Environment: Soil profile and soil micro flora. Role of microorganisms in elemental cycles in nature: Carbon, Nitrogen. Aquatic Environment: Micro flora of fresh water and marine habitats. Atmosphere: Aero micro flora. Assessment of air quality, , Air sanitation. Extreme Habitats: Extremophiles: Microbes thriving at high & low temperatures, pH, high hydrostatic & osmotic pressures, salinity, &low nutrient levels. Predisposing factors for Environmental diseases–infectious (water and air borne),control of these diseases. Environmental Protection Agency (EPA)-role in environmental protection.	18	Chalk & Talk, PPT

II	Water potability: Sources and types of water surface, ground, stored, distilled, mineral and de-mineralized water and their pollution, biological indicators of water Pollution, Eutrophication. Conventional Bacteriological standards of Water Quality, MPN index, coliform test, Membrane filtration. BOD, COD. Advanced molecular methods for wateranalysis.Waterbornediseases.CentralPollutionControlBoard(CPCB) standards.	**18**	**Chalk & Talk, PPT, Assignment**
III	Microbial Interactions: Rhizosphere microflora. Concepts of Nitrogen fixation – Symbiotic and asymbiotic nitrogen fixers.Brief account of microbial interactions: Symbiosis, neutralism, commensalism, competition, Ammensalism, Synergism, parasitism, and predation. General account and Significance of Biofertilizers and biocontrol agents–Bacterial,cyanobacterial,VAM.Massproductionof Rhizobialbiofertilizer. Biocontrol agents – Bacterial, viral, fungal	**18**	**Chalk & Talk, PPT**
IV	Waste treatment and bioremediation: Solid waste management: Sources and types of solid waste, composting, vermin composting, production of biogas. Liquid waste management: Primary, secondary, and tertiary sewage treatment. Bioremediation and waste management: Need and scope of bioremediation .Degradation of hydrocarbons, oil spills, heavy metals – Chromium, lead, and xenobiotics – PCB.	**18**	**Chalk & Talk, PPT**
V	Plant pathology: Mode of entry of pathogens, Microbial enzymes, toxins, growth regulators and suppressor of plant defense in plant diseases. Plant defense mechanisms. Bacterialdiseases– Citruscanker, Blight of paddy. Viral disease – TMV, CMV. Fungal disease- red rot ofsugarcane, Tikka disease. Plant disease management**.**	**18**	**Chalk & Talk, PPT Seminar**

Learning Outcome Based Education & Assessment (LOBE)
Formative Examination - Blue Print
Articulation Mapping – K Levels with Course Outcomes (COs)

Internal	Cos	K Level	Section A		Section B Either or Choice	Section C Either or Choice
			MCQs			
			No. of. Questions	K - Level		
CI AI	CO1	K1 – K4	2	K1, K2	2(K2, K2)	2(K3, K3)
	CO2	K1 – K4	2	K1, K2	2(K3, K3)	2(K4, K4)
CI AII	CO3	K1 – K4	2	K1, K2	2(K2, K2)	2(K3, K3)
	CO4	K1 – K4	2	K1, K2	2(K3, K3)	2(K4, K4)
Question Pattern CIA I & II		No. of Questions to be asked	4		4	4
		No. of Questions to be answered	4		2	2
		Marks for each question	1		5	8
		Total Marks for each section	4		10	16

Distribution of Marks with K Level CIA I & CIA II							
	K Level	Section A (Multiple Choice Questions)	Section B (Either / Or Choice)	Section C (Either / Or Choice)	Total Marks	% of (Marks without choice)	Consolidate of %
CIA I	K1	2			2	3.6	25
	K2	2	10		12	21.4	
	K3		10	16	26	46.4	46.4
	K4			16	16	28.6	28.6
	Marks	4	20	32	56	100	100
CIA II	K1	2			2	3.6	7.2
	K2	2	10		12	3.6	
	K3		10	16	26	46.4	46.4
	K4			16	16	46.4	46.4
	Marks	4	20	32	56	100	100

K1- Remembering and recalling facts with specific answers

K2- Basic understanding of facts and stating main ideas with general answers

K3- Application oriented- Solving Problems

K4- Examining, analyzing, presentation and make inferences with evidences

CO5 will be allotted for individual Assignment which carries five marks as part of CIA component.

Summative Examination – Blue Print Articulation Mapping – K Level with Course Outcomes (COs)						
S. No	COs	K - Level	Section A (MCQs)		Section B (Either / or Choice) With K - LEVEL	Section C (Either / or Choice) With K - LEVEL
			No. of Questions	K – Level		
1	CO1	K1-K4	2	K1, K2	2(K2, K2)	2(K3, K3)
2	CO2	K1-K4	2	K1, K2	2(K3, K3)	2(K4, K4)
3	CO3	K1-K4	2	K1, K2	2(K2, K2)	2(K3, K3)
4	CO4	K1-K4	2	K1, K2	2(K3, K3)	2(K4, K4)
5	CO5	K1-K4	2	K1, K2	2(K3, K3)	2(K4, K4)
No. of Questions to be Asked			10		10	10
No. of Questions to be answered			10		5	5
Marks for each question			1		5	8
Total Marks for each section			10		25	40
(Figures in parenthesis denotes, questions should be asked with the given K level)						

Distribution of Marks with K Level						
K Level	**Section A (Multiple Choice Questions)**	**Section B (Either or Choice**	**Section C (Either/ or Choice)**	**Total Marks**	**% of (Marks without choice)**	**Consolidated %**
K1	**5**			**5**	**3.6**	**4**
K2	**5**	**20**		**25**	**17.8**	**18**
K3		**30**	**32**	**62**	**44.3**	**44**
K4			**48**	**48**	**34.3**	**34**
Marks	**10**	**50**	**80**	**140**	**100**	**100**
NB: Higher level of performance of the students is to be assessed by attempting higher level of K levels.						

Summative Examinations - Question Paper – Format

Q. No.	**Unit**	**CO**	**K-level**		
Answer **ALL** the questions				**PART – A**	**(10 x 1 = 10 Marks)**
1.	**Unit - I**	**CO1**	**K1**		
				a)	b)
				c)	d)
2.	**Unit - I**	**CO1**	**K2**		
				a)	b)
				c)	d)
3.	**Unit - II**	**CO2**	**K1**		
				a)	b)
				c)	d)
4.	**Unit - II**	**CO2**	**K2**		
				a)	b)
				c)	d)
5.	**Unit - III**	**CO3**	**K1**		
				a)	b)
				c)	d)
6.	**Unit - III**	**CO3**	**K2**		
				a)	b)
				c)	d)
7.	**Unit - IV**	**CO4**	**K1**		
				a)	b)
				c)	d)
8.	**Unit - IV**	**CO4**	**K2**		
				a)	b)
				c)	d)
9.	**Unit - V**	**CO5**	**K1**		
				a)	b)
				c)	d)
10.	**Unit - V**	**CO5**	**K2**		
				a)	b)
				c)	d)

Answer **ALL** the questions		**PART – B**		**(5 x 5 = 25 Marks)**
11. a)	**Unit - I**	**CO1**	**K2**	
		OR		
11. b)	**Unit - I**	**CO1**	**K2**	
12. a)	**Unit - II**	**CO2**	**K3**	
		OR		
12. b)	**Unit - II**	**CO2**	**K3**	
13. a)	**Unit - III**	**CO3**	**K2**	
		OR		
13. b)	**Unit - III**	**CO3**	**K2**	
14. a)	**Unit - IV**	**CO4**	**K3**	
		OR		
14. b)	**Unit - IV**	**CO4**	**K3**	
15. a)	**Unit - V**	**CO5**	**K3**	
		OR		
15. b)	**Unit - V**	**CO5**	**K3**	

Answer **ALL** the questions		**PART – C**		**(5 x 8 = 40 Marks)**
16. a)	**Unit - I**	**CO1**	**K3**	
		OR		
16. b)	**Unit - I**	**CO1**	**K3**	
17. a)	**Unit - II**	**CO2**	**K4**	
		OR		
17. b)	**Unit - II**	**CO2**	**K4**	
18. a)	**Unit - III**	**CO3**	**K3**	
		OR		
18. b)	**Unit - III**	**CO3**	**K3**	
19. a)	**Unit - IV**	**CO4**	**K4**	
		OR		
19. b)	**Unit - IV**	**CO4**	**K4**	
20. a)	**Unit - V**	**CO5**	**K4**	
		OR		
20. b)	**Unit - V**	**CO5**	**K4**	

Course Name	Food, Dairy Probiotic Microbiology			
Course Code	23UMBCC62	**L**	**P**	**C**
Category	Core	6	-	4

COURSE OBJECTIVES:

- To impart current knowledge of basic and applied microbiological aspects of fluid milks and dairy products for improved quality and food safety.
- Gives an insight into various types of food borne diseases and their prevention
- To gain information aboutmicroflora of milk
- To study about the production offermented dairy products
- Toimpartcurrentknowledgeofprobiotics,prebioticsandfunctionaldairyfoodsforthe health benefits
- To create a sustainable environmentally and technologically advanced dairy farm

UNIT – I Food Preservation 18

Food as a substrate for micro organisms-.Micro organisms important in food microbiology; Molds, yeasts and bacteria -General Characteristics - Classification and importance.Principles of food preservation - Asepsis - Removal of micro organisms, - High temperature-Lowtemperature-Drying-Foodadditives.Nanoscience in food preservation; microencapsulation.

UNIT – II Food Spoilage 18

Contamination and spoilage of food products -Food borne infections (Bacilluscereus,,Salmonellosis,Shigellosis,,and *Campylobacter jejuni*) and intoxications – (*Staphylococcus aureus*,*Clostridiumbotulinum*,and mycotoxins) Food borne disease outbreaks. Conventional and Novel technology in control of food borne pathogens and preventive measures - Food sanitation - plant sanitation-Employees'healthstandards.RegulatoryAgencies&criteria for food safety.

UNIT - III Food Contamination 18

Micro flora of raw milk - sources of contamination. Spoilage and preservationofmilkandmilkproducts.-antimicrobialsystemsinraw milk.Importance of biofilms,theirroleintransmissionofpathogensin dairy products and preventive strategies.

UNIT - IV Food Fermentation 18

Food fermentations: Indian Pickles Bread,vinegar, fermented vegetables (sauerkraut), fermented dairy products (yoghurt, cheese, AcidophilusMilk,Kefir,Koumiss). Oriental fermented foods-Miso – TempehOntjom .Natto,Idli Spoilage and defects of fermented dairyproducts-.Functionalfermentedfoodsandnutraceuticals,bioactive proteins and bioactive peptides, genetically modified foods.

UNIT - V Probiotic Microorganisms 18

Probiotic microorganisms, concept, definitionsafety of probiotic microorganisms, legal status of probiotics Characteristics of Probiotics for selection: stability maintenance of probiotic microorganisms.Roleofprobioticsinhealthanddisease:Mechanism of probiotics. Application of bacteriocins in foods.Biopreservation. Prebiotics: concept, definition, criteria, types and sources of prebiotics, prebiotics and gut microflora - Prebiotics and health benefits: mineral absorption, immune response, cancer prevention, elderly health and infant health, prebiotics in foods.

Total Lecture Hours 90

BOOKS FOR STUDY:

- FrazierWCandWestoffDC.(2017).Foodmicrobiology.5thEditionTATAMcGraw Hill Publishing Company Ltd. New Delhi.
- Adams, M.R., Moss, M.O.(2018). Food Microbiology 1stedition. New Age Publishers by New Age International (P) Ltd., Publishers.
- R.C. Dubey. (2014). Advanced Biotechnology. S. Chand publishers.
- Banwart GJ. (1989). Basic food microbiology, Chapman & Hall, New York
- Sugumar D. (1997). Outlines of dairy technology, Oxford University press. 1997.

BOOKS FOR REFERENCES:

- Jay JM, Loessner MJ and Golden DA.(2005). Modern Food Microbiology. 7thEdition CBS Publishers and Distributors, Delhi, India.
- Prescott,HarleyandKleinWim.(2008).Microbiology,7thEdition McGrawHill Publications.
- Robinson,R.K.(2002).DairyMicrobiologyHandbook-TheMicrobiologyofMilkand Milk Products (Third Edition), A John Wiley & Sons, Inc., New York.
- Yuankunlee,Sepposalminen.(2008).HandbookofprobioticsandprebioticsSecond Edition. A John Wiley & Sons publication Inc.
- DharumauraiDhansekaran,AlwarappanSankaranarayanan.(2021).AdvancesinProbiotics
- Microorganisms in Food and Health 1stEdition. eBook ISBN:9780128230916.

WEB RESOURCES:

- **https://www.researchgate.net/publication/15326559_A_Dynamic_Approach_to_Predicting_BacterialGrowth_in_Food/link/5a1d2e02aca2726120b28eba/download**
- **https://www.fda.gov/food/laboratory-methods-food/bam-foodsamplingpreparation-sample-homogenate**
- **https://www.researchgate.net/publication/243462186_Foodborne_diseases_in_India_-A_review**
- **https://www.researchgate.net/publication/228662659_Fermented_Dairy_Products_Starter_Cultures_and_Potential_Nutritional_Benefits/link/000084160cf23f86393d5764/ download**
- **https://www.fda.gov/food**

Nature of Course	EMPLOYABILITY			SKILL ORIENTED			ENTREPRENEURSHIP		✓	
Curriculum Relevance	LOCAL		REGIONAL		NATIONAL		GLOBAL		✓	
Changes Made in the Course	Percentage of Change			No Changes Made			New Course		✓	

***Treat 20% as each unit (20*5=100%) and calculate the percentage of change for the course.**

COURSE OUTCOMES:		K LEVEL
After studying this course, the students will be able to:		
CO1	Gain knowledge about food as a substrate for various microbes, Understand about the principles and application of different types of food spoilage and preservation technique	K1 to K4
CO2	Acquire a thorough understanding of food borne diseases, testing methods, and preventive technique	K1 to K4
CO3	Gaininformationaboutspoilageofmilkanditsproductsanditsantimicrobial properties	K1 to K4
CO4	Learn about the various fermented product and its various stage of spoilage	K1 to K4
CO5	Impart current knowledge of probiotics, prebiotics and functional dairy foods for the health benefits	K1 to K4

MAPPING WITH PROGRAM OUTCOMES:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	S	S	M	S	M	S	M
CO2	S	M	S	M	S	M	S	M	S	S
CO3	M	S	M	M	S	M	S	M	S	S
CO4	S	S	S	S	M	M	S	S	S	S
CO5	S	S	S	S	M	S	M	S	M	M

S- STRONG M – MEDIUM L - LOW

CO / PO MAPPING:

COS	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	2	3	3	3	2
CO 2	1	2	3	3	2
CO 3	3	2	2	3	3
CO 4	2	2	3	3	3
CO 5	3	1	2	2	2
WEIGHTAGE	11	10	13	14	12
WEIGHTED PERCENTAGE OF COURSE CONTRIBUTION TO POS					

LESSON PLAN:

UNIT	Food & Dairy Probiotic Microbiology	HRS	PEDAGOGY
I	Food as a substrate for microorganisms- Microorganisms important in food microbiology; Molds, yeasts and bacteria -General Characteristics - Classification and importance. Principles of food preservation - Asepsis - Removal of microorganisms, - High temperature - Low temperature- Drying – Food additives. Nanoscience in food	18	Chalk & Talk, PPT

	preservation; microencapsulation.		
II	Contamination and spoilage of food products -Food borne infections (Bacillus cereus, Salmonellosis, Shigellosis, *Listeria monocytogenes* and *Campylobacter jejuni*) and intoxications – (*Staphylococcus aureus*, *Clostridium botulinum*, *Clostridium perfringens* and mycotoxins) Food borne disease outbreaks - newly emerging pathogens. Conventional and Novel technology in control of food borne pathogens and preventive measures - Food sanitation - plant sanitation-Employees' health standards. Regulatory Agencies &criteria for food safety.	**18**	**Chalk & Talk, PPT**
III	Microflora of raw milk - sources of contamination. Spoilage and preservation of milk and milk products, antimicrobial systems in raw milk. Importance of biofilms, their role in transmission of pathogens in dairy products and preventive strategies.	**18**	**Chalk & Talk, PPT**
IV	Food fermentations: Indian Pickles Bread, vinegar, fermented vegetables (sauerkraut), fermented dairy products (yoghurt, cheese, Acidophilus Milk, Kefir, Koumiss). Oriental fermented foods-Miso – Tempeh Ontjom. Natto, Idli Spoilage and defects of fermented dairy products - Functional fermented food sand nutraceuticals, bioactive proteins and bioactive peptides, genetically modified foods.	**18**	**Chalk & Talk, PPT**
V	Probiotic microorganisms, concept, definition safety of probiotic microorganisms, legal status of probiotics Characteristics of Probiotics for selection: stability maintenance of probiotic microorganisms. Role of probiotics in health and disease: Mechanism of probiotics. Application of bacteriocins in foods. Bio-preservation. Prebiotics: concept, definition, criteria, types and sources of prebiotics, prebiotics and gut microflora - Prebiotics and health benefits: mineral absorption, immune response, cancer prevention, elderly health and infant health, prebiotics in foods.	**18**	**Chalk & Talk, PPT & Seminar**

Learning Outcome Based Education & Assessment (LOBE) Formative Examination - Blue Print Articulation Mapping – K Levels with Course Outcomes (COs)						
Internal	**Cos**	**K Level**	**Section A**		**Section B Either or Choice**	**Section C Either or Choice**
			MCQs			
			No. of. Questions	**K - Level**		
CI AI	**CO1**	**K1 – K4**	2	K1, K2	2(K2, K2)	2(K3, K3)
	CO2	**K1 – K4**	2	K1, K2	2(K3, K3)	2(K4, K4)
CI AII	**CO3**	**K1 – K4**	2	K1, K2	2(K2, K2)	2(K3, K3)
	CO4	**K1 – K4**	2	K1, K2	2(K3, K3)	2(K4, K4)
Question Pattern CIA I & II		**No. of Questions to be asked**	4		4	4
		No. of Questions to be answered	4		2	2
		Marks for each question	1		5	8
		Total Marks for each section	4		10	16

Distribution of Marks with K Level CIA I & CIA II							
	K Level	**Section A (Multiple Choice Questions)**	**Section B (Either / Or Choice)**	**Section C (Either / Or Choice)**	**Total Marks**	**% of (Marks without choice)**	**Consolidate of %**
CIA I	**K1**	**2**			**2**	**3.6**	**25**
	K2	**2**	**10**		**12**	**21.4**	
	K3		**10**	**16**	**26**	**46.4**	**46.4**
	K4			**16**	**16**	**28.6**	**28.6**
	Marks	**4**	**20**	**32**	**56**	**100**	**100**
CIA II	**K1**	**2**			**2**	**3.6**	**7.2**
	K2	**2**	**10**		**12**	**3.6**	
	K3		**10**	**16**	**26**	**46.4**	**46.4**
	K4			**16**	**16**	**46.4**	**46.4**
	Marks	**4**	**20**	**32**	**56**	**100**	**100**

K1- Remembering and recalling facts with specific answers

K2- Basic understanding of facts and stating main ideas with general answers

K3- Application oriented- Solving Problems

K4- Examining, analyzing, presentation and make inferences with evidences

CO5 will be allotted for individual Assignment which carries five marks as part of CIA component.

Summative Examination – Blue Print Articulation Mapping – K Level with Course Outcomes (COs)						
S. No	COs	K - Level	Section A (MCQs)		Section B (Either / or Choice) With K - LEVEL	Section C (Either / or Choice) With K - LEVEL
			No. of Questions	K – Level		
1	CO1	K1-K4	2	K1, K2	2(K2, K2)	2(K3, K3)
2	CO2	K1-K4	2	K1, K2	2(K3, K3)	2(K4, K4)
3	CO3	K1-K4	2	K1, K2	2(K2, K2)	2(K3, K3)
4	CO4	K1-K4	2	K1, K2	2(K3, K3)	2(K4, K4)
5	CO5	K1-K4	2	K1, K2	2(K3, K3)	2(K4, K4)
No. of Questions to be Asked			10		10	10
No. of Questions to be answered			10		5	5
Marks for each question			1		5	8
Total Marks for each section			10		25	40
(Figures in parenthesis denotes, questions should be asked with the given K level)						

Distribution of Marks with K Level						
K Level	Section A (Multiple Choice Questions)	Section B (Either or Choice	Section C (Either/ or Choice)	Total Marks	% of (Marks without choice)	Consolidated %
K1	5			5	3.6	4
K2	5	20		25	17.8	18
K3		30	32	62	44.3	44
K4			48	48	34.3	34
Marks	10	50	80	140	100	100
NB: Higher level of performance of the students is to be assessed by attempting higher level of K levels.						

Summative Examinations - Question Paper – Format

Q. No.	Unit	CO	K-level		
Answer **ALL** the questions				**PART – A**	**(10 x 1 = 10 Marks)**
1.	**Unit - I**	**CO1**	**K1**		
				a)	b)
				c)	d)
2.	**Unit - I**	**CO1**	**K2**		
				a)	b)
				c)	d)
3.	**Unit - II**	**CO2**	**K1**		
				a)	b)
				c)	d)
4.	**Unit - II**	**CO2**	**K2**		
				a)	b)
				c)	d)
5.	**Unit - III**	**CO3**	**K1**		
				a)	b)
				c)	d)
6.	**Unit - III**	**CO3**	**K2**		
				a)	b)
				c)	d)
7.	**Unit - IV**	**CO4**	**K1**		
				a)	b)
				c)	d)
8.	**Unit - IV**	**CO4**	**K2**		
				a)	b)
				c)	d)
9.	**Unit - V**	**CO5**	**K1**		
				a)	b)
				c)	d)
10.	**Unit - V**	**CO5**	**K2**		
				a)	b)
				c)	d)

Answer **ALL** the questions		**PART – B**		**(5 x 5 = 25 Marks)**
11. a)	**Unit - I**	**CO1**	**K2**	
		OR		
11. b)	**Unit - I**	**CO1**	**K2**	
12. a)	**Unit - II**	**CO2**	**K3**	
		OR		
12. b)	**Unit - II**	**CO2**	**K3**	
13. a)	**Unit - III**	**CO3**	**K2**	
		OR		
13. b)	**Unit - III**	**CO3**	**K2**	
14. a)	**Unit - IV**	**CO4**	**K3**	
		OR		
14. b)	**Unit - IV**	**CO4**	**K3**	
15. a)	**Unit - V**	**CO5**	**K3**	
		OR		
15. b)	**Unit - V**	**CO5**	**K3**	

Answer **ALL** the questions		**PART – C**		**(5 x 8 = 40 Marks)**
16. a)	**Unit - I**	**CO1**	**K3**	
		OR		
16. b)	**Unit - I**	**CO1**	**K3**	
17. a)	**Unit - II**	**CO2**	**K4**	
		OR		
17. b)	**Unit - II**	**CO2**	**K4**	
18. a)	**Unit - III**	**CO3**	**K3**	
		OR		
18. b)	**Unit - III**	**CO3**	**K3**	
19. a)	**Unit - IV**	**CO4**	**K4**	
		OR		
19. b)	**Unit - IV**	**CO4**	**K4**	
20. a)	**Unit - V**	**CO5**	**K4**	
		OR		
20. b)	**Unit - V**	**CO5**	**K4**	

Course Name	Core Practical - VI			
Course Code	23UMBCP61	**L**	**P**	**C**
Category	Core Practical	-	6	4

COURSE OBJECTIVES:

- To assess the water quality and potability
- To acquire knowledge on enumeration of bacteria from milk and milk quality analysis
- To investigatevariousextracellularenzymeproducersinsoilandtogainknowledgeon preparation of biofertilizers
- Improve knowledge on plant pathogens
- To acquire knowledge on preparation of probiotics and prebiotics

UNIT - I	**Microbial Analysis of Water**	**18**

Physical, chemical, and microbiological assessment of water and potability test for water.
Physical a – Color, pH,
Chemical - alkalinity, acidity, DO, BOD, COD
Microbiological–MPN index (Presumptive, Completed and Confirmatory test)
Study of air microflora by settle plate method.

UNIT - II	**Microbial Analysis of Milk**	**18**

Direct microscopic count of milk.
Methylene blue reductase test and Resazurin test
Microbiological examination of milk by SPC**.**

UNIT - III	**Soil Microbiology**	**18**

Isolation of extracellular enzyme producers–Amylase, protease, lipase
Microbiological assay of antibiotics by cup plate method and other methods
Isolation of *Rhizobium* / phosphate solubilizing organisms
Preparation of biofertilizers – Demonstration

UNIT - IV	**Study of plant Pathogen**	**18**

Study of plant pathogens-Tikka Disease, Red rot of sugarcane.
Study of fungi - *Mucor, ,Aspergillus*

UNIT - V	**Fermented Milk**	**18**

Isolation of constituent flora of fermented milk.
Growth of probiotic LAB in broth, milk and whey.
Preparation of probiotic fermented milks like dahi, yoghurt, lassi and whey drink.

Total Lecture Hours	**90**

BOOKS FOR STUDY:

- CappucinoJandShermanN.(2010).Microbiology:ALaboratoryManual.9thEdition. Pearson Education Limited.
- Kannan. N. (1996). Laboratory manual in General Microbiology. Palani Publications.
- R C Dubey and D K Maheswari.(2002). Practical Microbiology. S. Chand Publishing
- NeelimaGarg,K.L.Garg,K.G.Mukerji(2010).LaboratoryManualofFoodMicrobiology, Wiley publication
- Aneja,KR.(2010).ExperimentsinMicrobiology,PlantpathologyandBiotechnology. New Age International (P) Limited.

BOOKS FOR REFERENCES:

- ChristonJ.HurstEditorinChief,RonaldL.Crawford,JayL.Garland,DavidA.Lipson, AaronL.Mills,LindaD.Stetzenbach(2007).ManualofEnvironmentalMicrobiology, Third Edition,Wiley publication
- James G Cappucino and Natalie Sherman.(2016).Microbiology–A laboratory manual. 4thEdition. The Benjamin publishing company, New York.
- Marylynn V. Yates, Cindy H. Nakatsu, Robert V. Miller, Suresh D. Pillai 2016). Manual of Environmental Microbiology, 4thEdition,ASM press.
- Burns,RichardG(2005).EnvironmentalMicrobiologyALaboratoryManual,2ndEdition
- .Lippincott Williams & Wilkins, Inc.
- IanPepper,CharlesGerba,JeffreyBrendecke(2004).EnvironmentalMicrobiology-Alaboratory manual, Elsevier.

WEB RESOURCES:

- **https://micobenotes.com/fields-of-microbiology/**
- **https://bio.libretexts.org**
- **https://www.google.com**
- **https://www.sfamjournals.onlinelibrary.wiley.com**
- **https://www.degruyter.com**

Nature of Course	EMPLOYABILITY		SKILL ORIENTED	✓	ENTREPRENEURSHIP			
Curriculum Relevance	LOCAL		REGIONAL		NATIONAL		GLOBAL	✓
Changes Made in the Course	Percentage of Change		No Changes Made	✓	New Course			

***Treat 20% as each unit (20*5=100%) and calculate the percentage of change for the course.**

COURSE OUTCOMES:		K LEVEL
After studying this course, the students will be able to:		
CO1	Assess the microbial quality of water and relate the experimental results to the prescribed standards by the statutory bodies	K1 to K4
CO2	Evaluate the quality of milk and enumerate bacteria in milk by standard plate count method	K1 to K4
CO3	Identify extracellular enzyme producing and nitrogen fixing microorganism form soil and to prepare a biofertilizer.	K1 to K4
CO4	Identify various plant pathogenic bacteria	K1 to K4
CO5	Synthesize probiotic fermented milks using microorganisms	K1 to K4

MAPPING WITH PROGRAM OUTCOMES:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	S	S	S	S		
CO2	M	M	S	M	M	M	M	M		
CO3	M	M	M	M	S	M	M	S		
CO4	M	M	M	M	M	S	M	S		
CO5	M	M	M	M	M	S	S	S		

S- STRONG M – MEDIUM L - LOW

CO / PO MAPPING:

COS	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	3	3	3	3	3
CO 2	2	2	3	2	2
CO 3	2	2	2	2	3
CO 4	2	2	2	2	2
CO 5	2	2	2	2	2
WEIGHTAGE	11	11	12	11	12
WEIGHTED PERCENTAGE OF COURSE CONTRIBUTION TO POS	73.33	73.33	80	73.33	80

LESSON PLAN:

UNIT	Core Practical - VI	HRS	PEDAGOGY
I	Physical, chemical, and microbiological assessment of water and potability test for water. Physical a – Color, pH, Chemical - alkalinity, acidity, DO, BOD, COD Microbiological–MPN index (Presumptive, Completed and Confirmatory test) Study of air microflora by settle plate method.	18	Chalk & Talk, Demostration

II	Direct microscopic count of milk. Methylene blue reductase test and Resazurin test Microbiological examination of milk by SPC	**18**	**Chalk & Talk, Demostration**
III	Isolation of extracellular enzyme producers–Amylase, protease, lipase Microbiological assay of antibiotics by cup plate method and other methods Isolation of *Rhizobium* / phosphate solubilizing organisms Preparation of biofertilizers – Demonstration	**18**	**Chalk & Talk, PPT, Demostration**
IV	Study of plant pathogens-Tikka Disease, Red rot of sugarcane. Study of fungi - *Mucor, , Rhizopus*	**18**	**Chalk & Talk, PPT,Demostration**
V	Isolation of constituent flora of fermented milk. Growth of probiotic LAB in broth, milk and whey. Preparation of probiotic fermented milks like dahi, yoghurt, lassi and whey drink.	**18**	**Chalk & Talk, PPT,Demostration**

Learning Outcome Based Education& Assessment(LOBE) Formative Examination - Blue Print Articulation Mapping –K Levels with Course Outcomes(COs)							
INTERNAL	**COs**	**K LEVEL**	**MAJOR**	**MINOR**	**SPOTTERS**	**RECORD**	**VIVA**
CI AI	**CO1**	**K1**					**5**
	CO2	**K2**				**5**	
	CO3	**K3**			**5**		
	CO4	**K4**		**5**			
	CO5	**K4**	**5**				
Question Pattern		No. of Questions to be asked	**2 (A-Written B-Practical Demo)**	**2 (A-Written B-Practical Demo)**	**2**	**1**	**5**
		No. of Questions to be answered	**2**	**2**	**2**	**1**	**5**
		Marks for each question	**A-10 B-5**	**A-5 B-5**	**2.5**	**10**	**1**
		Total Marks for Each section	**15**	**10**	**5**	**5**	**5**

Distribution of Marks with K Level									
	K Level	**Major**	**Minor**	**Spotters**	**Record**	**Viva**	**Total Marks**	**% of Marks without choice**	**Consolidated %**
CIA	**K1**	-	-	-	-	5	5	12.5	12.5
	K2	-	-	-	5	-	5	12.5	12.5
	K3	-	-	5	-	-	5	12.5	12.5
	K4	-	10	-	-	-	10	25	25
	K4	15					15	37.5	37.5
	Marks	15	10	5	5	5	40	100	100

Summative Examination – Blue Print Articulation Mapping – K Level with Course Outcomes (COs)							
EXTERNAL	**COs**	**K LEVEL**	**MAJOR**	**MINOR**	**SPOTTERS**	**RECORD**	**VIVA**
CI A I	**CO1**	K1					5
	CO2	K2				10	
	CO3	K3			20		
	CO4	K4		20			
	CO5	K4	25				
Q Question Pattern		o. of Questions to be asked	2 (A-Written B-Practical Demo)	2 (A-Written B-Practical Demo)	2	1	5
		No. of Questions to be answered	2	2	2	1	5
		Marks for each question	A-15 B-5	A-10 B-5	5	10	1
		Total Marks for Each section	20	15	10	10	5

Distribution of Marks with K Level CIA									
	K Level	**Major**	**Minor**	**Spotters**	**Record**	**Viva**	**Total Marks**	**% of Marks without choice**	**Consolidated %**
CIA	**K1**					5	5	8.33	8.33
	K2				10		10	16.66	16.66
	K3			10			10	16.66	16.66
	K4		15				15	25	25
	K4	20					20	33.33	33.33
	Marks	20	15	10	10	5	60	100	100

Course Name	Pharmaceutical Microbiology			
Course Code	23UMBEC61	**L**	**P**	**C**
Category	Elective	5	-	3

COURSE OBJECTIVES:

- To provide the knowledge on basics of chemotherapy
- To learn the assays and testing methods of antibiotics.
- To gain information about spoilage of pharmaceutical products
- To provide the knowledge on drug discovery and clinical trials
- To learn about regulations in pharmaceutical industry

UNIT – I Introduction to Pharmaceutical **15**

Introduction to Pharmaceutical microbiology: Ecology of microorganisms in pharmaceutical industry: Atmosphere, water, skin and respiratory flora of workers, raw materials, packaging, building and equipments and their control measures; Design and layout of sterile manufacturing.

UNIT - II Microbial contamination **15**

Microbial contamination and spoilage of pharmaceutical products: Microbial aspects of pharmaceutical products; Sterilization of pharmaceutical products: Heat, gaseous, radiation and filtration; Contamination and Spoilage of Pharmaceutical products: sterile in getable and non- in getable, ophthalmologic preparation, implants.

UNIT - III Production of antibiotics **15**

Production of antibiotics: Production of antibacterial – Penicillin, Tetracycline; antifungal – Griseofulvin, Amphotericin; anti parasitic agents – Artemes in, Metronidazole; Semi-synthetic antibiotics and anticancerous agents; Additional application of microorganisms in pharmaceutical sciences: Enzymes-Streptokinase, Streptodornase, L- asperginase and clinical dextrin; Immobilization procedures for pharmaceutical applications (liposomes) ; Biosensors in pharmaceuticals.

UNIT - IV Production of immunological **15**

Production of immunological products and their quality control: Vaccines - DNA vaccines, synthetic peptide vaccines, multivalent vaccines; Vaccine clinical trials; Immunodiagnostics - immuno sera and immunoglobulin; Quality control in Pharmaceutical: In – Process and Final Product Control; Sterility tests..

UNIT – V Quality Assurance **15**

Quality Assurance and Validation: Good Manufacturing Practices (GMP) and Good Laboratory Practices (GLP) in pharmaceutical industry; Regulatory as pects of quality control ;Quality assurance and quality management in pharmaceuticals–BIS(IS),ISI,ISO,WHO and US certification.

Total Lecture Hours **75**

BOOKS FOR STUDY:

- Chand Pasha Kedernath.(2021).Textbook of Pharmaceutical Microbiology. Ramnath Publisher.
- HugoWBandRussellAD.(2004).PharmaceuticalMicrobiologyVIIedition.Blackwell Scientific Publication, Oxford.
- Franklin, D J. and Snow, GA. (2013). Biochemistry of antimicrobial action. Chapman & Hall.
- Kuntal Das (2019). Pharmaceutical Microbiology, second edition, Nirali Prakashan.
- PriyatamaPowar,ShitalNimbargi,VaijayantiSapre(2020).Pharmaceutical Microbiology edition, Technical publications.

BOOKS FOR REFERENCES:

- Kokate,C.K.,Durohit,A.P.andGokhale,S.R.,(2002).Pharmacognosy.12thedition NiraliPrakasham Publishers, Pune.
- S.P.Vyas&V.K.Dixit.(2003).PharmaceuticalBiotechnology.CBSPublishers& Distributors, New Delhi.
- Wallis,T.E.(2005).TextbookofPharmacognosy.5thedition.CBSpublishersand distributors, New Delhi.
- Garrod,L.P.,Lambert,HP.AndC'Grady,F.(1973).AntibioticsandChemotherapy.(eds). Churchill Livingstone.

WEB RESOURCES:

- **https://www.pharmapproach.com/introduction-to-pharmaceutical-microbiology/**
- **https://www.pharmanotes.org/2021/11/pharmaceutical-microbiology-b-pharma.html**
- **https://www.iptsalipur.org/wp-content/uploads/2020/08/BP303T_PMB_UNIT_I.pdf**
- **https://snscourseware.org/snscphs/notes.php?cw=CW_604b15c6313c5**
- **https://www.thermofisher.com**

Nature of Course	EMPLOYABILITY			SKILL ORIENTED			ENTREPRENEURSHIP	✓			
Curriculum Relevance	LOCAL		REGIONAL		NATIONAL		GLOBAL	✓			
Changes Made in the Course	Percentage of Change			No Changes Made			New Course	✓			
***Treat 20% as each unit (20*5=100%) and calculate the percentage of change for the course.**											

COURSE OUTCOMES:		**K LEVEL**
After studying this course, the students will be able to:		
CO1	Learn the basics of chemotherapy and action of antibiotics	**K1 to K4**
CO2	Carry out the microbiological assay of antibiotics	**K1 to K4**
CO3	Analyse Microbiological standardization of Pharmaceuticals ,sterility testing of pharmaceutical products Apply sterilization in pharmaceutical industry	**K1 to K4**
CO4	Evaluate the process and develop new strategies for rational drug design	**K1 to K4**
CO5	Learn the Regulatory guidelines in pharmaceuticals product.	**K1 to K4**

MAPPING WITH PROGRAM OUTCOMES:										
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	S	S	M	M	S	M	M	S
CO2	S	M	M	S	S	S	M	S	S	M
CO3	S	M	M	M	S	S	M	S	S	S
CO4	S	M	M	S	M	M	S	M	S	S
CO5	M	S	S	M	M	M	M	S	M	S
S- STRONG				M – MEDIUM					L - LOW	

CO / PO MAPPING:					
COS	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	2	2	1	2	3
CO 2	1	3	3	2	2
CO 3	2	3	2	2	1
CO 4	3	2	2	1	3
CO 5	3	1	2	3	2
WEIGHTAGE	11	11	10	10	11
WEIGHTED PERCENTAGE OF COURSE CONTRIBUTION TO POS	73.3	73.3	66.6	66.6	73.3

LESSON PLAN:

UNIT	Pharmaceutical Microbiology	HRS	PEDAGOGY
I	Introduction to Pharmaceutical microbiology: Ecology of microorganisms in pharmaceutical industry: Atmosphere, water, skin and respiratory flora of workers, raw materials, packaging, building and equipments and their control measures; Design and layout of sterile manufacturing.	15	Chalk & Talk, PPT
II	Microbial contamination and spoilage of pharmaceutical products: Microbial aspects of pharmaceutical products; Sterilization of pharmaceutical products: Heat, gaseous, radiation and filtration; Contamination and Spoilage of Pharmaceutical products: sterile injectable and non-injectable, ophthalmologic preparation, implants.	15	Chalk & Talk, PPT
III	Production of antibiotics: Production of antibacterial – Penicillin, Tetracycline; antifungal – Griseofulvin, Amphotericin; antiparasitic agents – Artemesin, Metronidazole; Semi-synthetic antibiotics and anticancerous agents; Additional application of microorganisms in pharmaceutical sciences: Enzymes- Streptokinase, Streptodornase, L-asperginase and clinical dextrin; Immobilization procedures for pharmaceutical applications (liposomes); Biosensors in pharmaceuticals.	15	Chalk & Talk, PPT

IV	Production of immunological products and their quality control: Vaccines - DNA vaccines, synthetic peptide vaccines, multivalent vaccines; Vaccine clinical trials; Immunodiagnostics - immuno sera and immunoglobulin; Quality control in Pharmaceutical: In – Process and Final Product Control; Sterility tests..	**15**	**Chalk & Talk, PPT**
V	Quality Assurance and Validation: Good Manufacturing Practices (GMP) and Good Laboratory Practices (GLP) in pharmaceutical industry; Regulator aspects of quality control; Quality assurance and quality management in pharmaceuticals–BIS(IS),ISI,ISO,WHO and US certification.	**15**	**Chalk & Talk, PPT**

arning Outcome Based Education & Assessment (LOBE)Formative Examination - Blue Print Articulation Mapping – K Levels with Course Outcomes (COs)						
Internal	**Cos**	**K Level**	**Section A MCQs**		**Section BEither orChoice**	**Section C Either or Choice**
			No. of. Questions	**K - Level**		
CIAI	**CO1**	**K1 – K4**	2	K1, K2	2(K2, K2)	2(K3, K3)
	CO2	**K1 – K4**	2	K1, K2	2(K3, K3)	2(K4, K4)
CIAII	**CO3**	**K1 – K4**	2	K1, K2	2(K2, K2)	2(K3, K3)
	CO4	**K1 – K4**	2	K1, K2	2(K3, K3)	2(K4, K4)
Question Pattern CIA I & II		**. of Questions tobe asked**	4		4	4
		No. of Questions to be answered	4		2	2
		Marks for each question	1		5	8
		Total Marks for each section	4		10	16

Distribution of Marks with K Level CIA I & CIA II							
	K Level	**Section A (Multiple Choice Questions)**	**Section B (Either / Or Choice)**	**Section C (Either / Or Choice)**	**Total Marks**	**% of (Marks without choice)**	**Consolidate of %**
CIAI	**K1**	**2**			**2**	**3.6**	**25**
	K2	**2**	**10**		**12**	**21.4**	
	K3		**10**	**16**	**26**	**46.4**	**46.4**
	K4			**16**	**16**	**28.6**	**28.6**
	Marks	**4**	**20**	**32**	**56**	**100**	**100**
CIAII	**K1**	**2**			**2**	**3.6**	**7.2**
	K2	**2**	**10**		**12**	**3.6**	
	K3		**10**	**16**	**26**	**46.4**	**46.4**
	K4			**16**	**16**	**46.4**	**46.4**
	Marks	**4**	**20**	**32**	**56**	**100**	**100**

K1- Remembering and recalling facts with specific answers

K2- Basic understanding of facts and stating main ideas with general answers

K3- Application oriented- Solving Problems

K4- Examining, analyzing, presentation and make inferences with evidences

CO5 will be allotted for individual Assignment which carries five marks as part of CIA component.

Summative Examination – Blue Print Articulation Mapping – K Level with Course Outcomes (COs)						
S. No	COs	K - Level	Section A (MCQs)		Section B (Either / or Choice) With K - LEVEL	Section C (Either / or Choice) With K - LEVEL
			No. of Questions	K – Level		
1	CO1	K1-K4	2	K1, K2	2(K2, K2)	2(K3, K3)
2	CO2	K1-K4	2	K1, K2	2(K3, K3)	2(K4, K4)
3	CO3	K1-K4	2	K1, K2	2(K2, K2)	2(K3, K3)
4	CO4	K1-K4	2	K1, K2	2(K3, K3)	2(K4, K4)
5	CO5	K1-K4	2	K1, K2	2(K3, K3)	2(K4, K4)
No. of Questions to be Asked			10		10	10
No. of Questions to be answered			10		5	5
Marks for each question			1		5	8
Total Marks for each section			10		25	40
(Figures in parenthesis denotes, questions should be asked with the given K level)						

Distribution of Marks with K Level						
K Level	Section A (Multiple Choice Questions)	Section B (Either or Choice	Section C (Either/ or Choice)	Total Marks	% of (Marks without choice)	Consolidated %
K1	5			5	3.6	4
K2	5	20		25	17.8	18
K3		30	32	62	44.3	44
K4			48	48	34.3	34
Marks	10	50	80	140	100	100
NB: Higher level of performance of the students is to be assessed by attempting higher level of K levels.						

Summative Examinations - Question Paper – Format

Q. No.	Unit	CO	K-level		
Answer **ALL** the questions				**PART – A**	**(10 x 1 = 10 Marks)**
1.	**Unit - I**	**CO1**	**K1**		
				a)	b)
				c)	d)
2.	**Unit - I**	**CO1**	**K2**		
				a)	b)
				c)	d)
3.	**Unit - II**	**CO2**	**K1**		
				a)	b)
				c)	d)
4.	**Unit - II**	**CO2**	**K2**		
				a)	b)
				c)	d)
5.	**Unit - III**	**CO3**	**K1**		
				a)	b)
				c)	d)
6.	**Unit - III**	**CO3**	**K2**		
				a)	b)
				c)	d)
7.	**Unit - IV**	**CO4**	**K1**		
				a)	b)
				c)	d)
8.	**Unit - IV**	**CO4**	**K2**		
				a)	b)
				c)	d)
9.	**Unit - V**	**CO5**	**K1**		
				a)	b)
				c)	d)
10.	**Unit - V**	**CO5**	**K2**		
				a)	b)
				c)	d)

Answer **ALL** the questions		**PART – B**		**(5 x 5 = 25 Marks)**
11. a)	**Unit - I**	**CO1**	**K2**	
		OR		
11. b)	**Unit - I**	**CO1**	**K2**	
12. a)	**Unit - II**	**CO2**	**K3**	
		OR		
12. b)	**Unit - II**	**CO2**	**K3**	
13. a)	**Unit - III**	**CO3**	**K2**	
		OR		
13. b)	**Unit - III**	**CO3**	**K2**	
14. a)	**Unit - IV**	**CO4**	**K3**	
		OR		
14. b)	**Unit - IV**	**CO4**	**K3**	
15. a)	**Unit - V**	**CO5**	**K3**	
		OR		
15. b)	**Unit - V**	**CO5**	**K3**	

Answer **ALL** the questions		**PART – C**		**(5 x 8 = 40 Marks)**
16. a)	**Unit - I**	**CO1**	**K3**	
		OR		
16. b)	**Unit - I**	**CO1**	**K3**	
17. a)	**Unit - II**	**CO2**	**K4**	
		OR		
17. b)	**Unit - II**	**CO2**	**K4**	
18. a)	**Unit - III**	**CO3**	**K3**	
		OR		
18. b)	**Unit - III**	**CO3**	**K3**	
19. a)	**Unit - IV**	**CO4**	**K4**	
		OR		
19. b)	**Unit - IV**	**CO4**	**K4**	
20. a)	**Unit - V**	**CO5**	**K4**	
		OR		
20. b)	**Unit - V**	**CO5**	**K4**	

Course Name	Plant and Animal Biotechnology			
Course Code	23UMBEC62	**L**	**P**	**C**
Category	Elective	5	-	3

COURSE OBJECTIVES:

- To understand the basics of plant tissue culture
- To appreciate the methods of producing recombinant plants
- To get accustomed with the methods to produce GM plants
- To understand the concepts in animal cell culture
- To be aware of the methods of recombinant animal production

UNIT - I Plant Tissue Culture **15**

Plant tissue culture, media preparation, surface sterilization, callus culture, suspension culture and application of plant tissue culture. Protoplast preparation - isolation and purification of protoplasts, viability test for protoplasts, protoplast culture, direct transformation of protoplasts by electroporation.

UNIT - II Recombinant plant production **15**

Somatic hybridization-protoplast fusion, cybridization. Production of haploid plants- anther and pollen culture. somoclonal variation, micropropagation, organogenesis, somatic- embryogenesis and artificial seeds.

UNIT - III GM Plants **15**

Tumour induction in plants by *Agrobacterium*. Transgenic plants: Insect resistance, Herbicide resistant plants, virus free plants and golden rice. Plants as bioreactors.

UNIT - IV Animal cell culture **15**

Animal cell culture: Primary and Continuous Cell culture, adherent and suspension cultures; functional characteristics of cultured cells. Composition of animal cell culturemedia. Cryopreservation of animal cells, Applications of animal cell culture.

UNIT - V Animal Cloning **15**

Animal cloning -Dolly (nuclear transfer method), Mice and Fishes. Somatic cell genesis – Apoptosis – Measurement of cell death. Mapping of human genome – PFLP and applications. Ethical issues in animal biotechnology.

Total Lecture Hours **75**

BOOKS FOR STUDY:

- Chawla HS. 2011. Introduction to Plant Biotechnology. Oxford and IBH Publishing Co. Pvt Ltd.
- Sasidhara R.2006. Animal Biotechnology. MJP publishers.
- Rajan. S and Selvi Christy, Experimental Procedures in Life Science CBS Publishers and distributors, 2019.

BOOKS FOR REFERENCES:

- Singh B, D., 2006, Plant Biotechnology, Kalyani Publications
- Aneja K.R, Experiments in Microbiology, Plant pathology and Biotechnology, Fourth edition, New Age International Publishers, Chennai, 2005.

WEB RESOURCES:

- https://benchfly.com/video/1719/
- https://www.nagwa.com/en/videos/193194203641/
- https://www.youtube.com/watch?v=bOaQzwHkr-s

Nature of Course	EMPLOYABILITY		SKILL ORIENTED	✓	ENTREPRENEURSHIP			
Curriculum Relevance	LOCAL		REGIONAL		NATIONAL		GLOBAL	✓
Changes Made in the Course	Percentage of Change		No Changes Made		New Course	✓		
***Treat 20% as each unit (20*5=100%) and calculate the percentage of change for the course.**								

COURSE OUTCOMES:		**K LEVEL**
After studying this course, the students will be able to:		
CO1	Define plant tissue culture, protoplast fusion, transgenic plants, cell culture and animal cloning	**K1 to K4**
CO2	classify media preparation and transgenic plants	**K1 to K4**
CO3	demonstrate protoplast culture, somatic hybridization, haploid plants, monoclonal variation, micropropagation and mapping of human genome	**K1 to K4**
CO4	illustrate gene transfer methods, gene cloning methods in plant and animals	**K1 to K4**
CO5	outline animal cloning techniques and transgenic plants	**K1 to K4**

MAPPING WITH PROGRAM OUTCOMES:

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	**S**	**S**	**S**				**M**			**M**
CO2	**S**		**S**	**S**						
CO3	**S**					**S**				
CO4			**S**	**S**						
CO5	**S**						**M**			**S**

S- STRONG **M – MEDIUM** **L - LOW**

CO / PO MAPPING:

COS	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO 1	**2**	**3**	**1**	**2**	**2**
CO 2	**1**	**2**	**3**	**2**	**3**
CO 3	**2**	**1**	**2**	**2**	**3**
CO 4	**3**	**3**	**2**	**1**	**2**
CO 5	**3**	**2**	**2**	**3**	**1**
WEIGHTAGE	**11**	**11**	**10**	**10**	**11**
WEIGHTED PERCENTAGE OF COURSE CONTRIBUTION TO POS	**73.3**	**73.3**	**66.6**	**66.6**	**73.3**

LESSON PLAN:			
UNIT	**Plant and Animal Biotechnology**	**HRS**	**PEDAGOGY**
I	Plant tissue culture, media preparation, surface sterilization, callus culture, suspension culture and application of plant tissue culture. Protoplast preparation - isolation and purification of protoplasts, viability test for protoplasts, protoplast culture, direct transformation of protoplasts by electroporation.	**15**	Chalk & Talk, PPT
II	Somatic hybridization- protoplast fusion ,cybridization. Production of haploid plants- anther and pollen culture. somoclonal variation, micropropagation, organogenesis, somatic- embryogenesis and artificial seeds.	**15**	Chalk & Talk, PPT
III	Tumour induction in plants by *Agrobacterium*. Transgenic plants: Insect resistance, Herbicide resistant plants, virus free plants and golden rice. Plants as bioreactors.	**15**	Chalk & Talk, PPT
IV	Animal cell culture: Primary and Continuous Cell culture, adherent and suspension cultures; functional characteristics of cultured cells. Composition of animal cell culture media. Cryopreservation of animal cells, Applications of animal cell culture.	**15**	Chalk & Talk, PPT
V	Animal cloning -Dolly (nuclear transfer method), Mice and Fishes. Somatic cell genesis – Apoptosis – Measurement of cell death. Mapping of human genome – PFLP and applications. Ethical issues in animal biotechnology.	**15**	Chalk & Talk, PPT, Assignment

Learning Outcome Based Education & Assessment (LOBE)
Formative Examination - Blue Print
Articulation Mapping – K Levels with Course Outcomes (COs)

Internal	**Cos**	**K Level**	**Section A**		**Section B Either or Choice**	**Section C Either or Choice**
			MCQs			
			No. of. Questions	**K - Level**		
CI AI	**CO1**	**K1 – K4**	2	K1, K2	2(K2, K2)	2(K3, K3)
	CO2	**K1 – K4**	2	K1, K2	2(K3, K3)	2(K4, K4)
CI AII	**CO3**	**K1 – K4**	2	K1, K2	2(K2, K2)	2(K3, K3)
	CO4	**K1 – K4**	2	K1, K2	2(K3, K3)	2(K4, K4)
Question Pattern CIA I & II		**No. of Questions to be asked**	4		4	4
		No. of Questions to be answered	4		2	2
		Marks for each question	1		5	8
		Total Marks for each section	4		10	16

Distribution of Marks with K Level CIA I & CIA II							
	K Level	Section A (Multiple Choice Questions)	Section B (Either / Or Choice)	Section C (Either / Or Choice)	Total Marks	% of (Marks without choice)	Consolidate of %
CIA I	K1	2			2	3.6	25
	K2	2	10		12	21.4	
	K3		10	16	26	46.4	46.4
	K4			16	16	28.6	28.6
	Marks	4	20	32	56	100	100
CIA II	K1	2			2	3.6	7.2
	K2	2	10		12	3.6	
	K3		10	16	26	46.4	46.4
	K4			16	16	46.4	46.4
	Marks	4	20	32	56	100	100

K1- Remembering and recalling facts with specific answers

K2- Basic understanding of facts and stating main ideas with general answers

K3- Application oriented- Solving Problems

K4- Examining, analyzing, presentation and make inferences with evidences

CO5 will be allotted for individual Assignment which carries five marks as part of CIA component.

Summative Examination – Blue Print Articulation Mapping – K Level with Course Outcomes (COs)						
S. No	COs	K - Level	Section A (MCQs)		Section B (Either / or Choice) With K - LEVEL	Section C (Either / or Choice) With K - LEVEL
			No. of Questions	K – Level		
1	CO1	K1-K4	2	K1, K2	2(K2, K2)	2(K3, K3)
2	CO2	K1-K4	2	K1, K2	2(K3, K3)	2(K4, K4)
3	CO3	K1-K4	2	K1, K2	2(K2, K2)	2(K3, K3)
4	CO4	K1-K4	2	K1, K2	2(K3, K3)	2(K4, K4)
5	CO5	K1-K4	2	K1, K2	2(K3, K3)	2(K4, K4)
No. of Questions to be Asked			10		10	10
No. of Questions to be answered			10		5	5
Marks for each question			1		5	8
Total Marks for each section			10		25	40
(Figures in parenthesis denotes, questions should be asked with the given K level)						

Distribution of Marks with K Level						
K Level	**Section A (Multiple Choice Questions)**	**Section B (Either or Choice**	**Section C (Either/ or Choice)**	**Total Marks**	**% of (Marks without choice)**	**Consolidated %**
K1	**5**			**5**	**3.6**	**4**
K2	**5**	**20**		**25**	**17.8**	**18**
K3		**30**	**32**	**62**	**44.3**	**44**
K4			**48**	**48**	**34.3**	**34**
Marks	**10**	**50**	**80**	**140**	**100**	**100**
NB: Higher level of performance of the students is to be assessed by attempting higher level of K levels.						

Summative Examinations - Question Paper – Format

Q. No.	**Unit**	**CO**	**K-level**		
Answer **ALL** the questions				**PART – A**	**(10 x 1 = 10 Marks)**
1.	**Unit - I**	**CO1**	**K1**		
				a)	b)
				c)	d)
2.	**Unit - I**	**CO1**	**K2**		
				a)	b)
				c)	d)
3.	**Unit - II**	**CO2**	**K1**		
				a)	b)
				c)	d)
4.	**Unit - II**	**CO2**	**K2**		
				a)	b)
				c)	d)
5.	**Unit - III**	**CO3**	**K1**		
				a)	b)
				c)	d)
6.	**Unit - III**	**CO3**	**K2**		
				a)	b)
				c)	d)
7.	**Unit - IV**	**CO4**	**K1**		
				a)	b)
				c)	d)
8.	**Unit - IV**	**CO4**	**K2**		
				a)	b)
				c)	d)
9.	**Unit - V**	**CO5**	**K1**		
				a)	b)
				c)	d)
10.	**Unit - V**	**CO5**	**K2**		
				a)	b)
				c)	d)

Answer **ALL** the questions		**PART – B**		**(5 x 5 = 25 Marks)**
11. a)	**Unit - I**	**CO1**	**K2**	
		OR		
11. b)	**Unit - I**	**CO1**	**K2**	
12. a)	**Unit - II**	**CO2**	**K3**	
		OR		
12. b)	**Unit - II**	**CO2**	**K3**	
13. a)	**Unit - III**	**CO3**	**K2**	
		OR		
13. b)	**Unit - III**	**CO3**	**K2**	
14. a)	**Unit - IV**	**CO4**	**K3**	
		OR		
14. b)	**Unit - IV**	**CO4**	**K3**	
15. a)	**Unit - V**	**CO5**	**K3**	
		OR		
15. b)	**Unit - V**	**CO5**	**K3**	

Answer **ALL** the questions		**PART – C**		**(5 x 8 = 40 Marks)**
16. a)	**Unit - I**	**CO1**	**K3**	
		OR		
16. b)	**Unit - I**	**CO1**	**K3**	
17. a)	**Unit - II**	**CO2**	**K4**	
		OR		
17. b)	**Unit - II**	**CO2**	**K4**	
18. a)	**Unit - III**	**CO3**	**K3**	
		OR		
18. b)	**Unit - III**	**CO3**	**K3**	
19. a)	**Unit - IV**	**CO4**	**K4**	
		OR		
19. b)	**Unit - IV**	**CO4**	**K4**	
20. a)	**Unit - V**	**CO5**	**K4**	
		OR		
20. b)	**Unit - V**	**CO5**	**K4**	

Course Name	Diagnostic Microbiology			
Course Code	23UMBEC63	**L**	**P**	**C**
Category	Elective	5	-	3

COURSE OBJECTIVES:

- To outline the Diagnostic microbiology-Methods, Collection, Transport and Processing of clinical specimens.
- To categorize Culture media, Microscopic examination and Serological test of bacterial infections.
- To describe the Laboratory methods of mycology.
- To understand the Isolation, Identification of virus.
- To gain knowledge about parasitology.

UNIT - I	**Methods of Collection**	**15**

Diagnostic Microbiology- Introduction- Methods of collection, Transport and Processing of clinical specimens- Blood, Urine, CSF.

UNIT - II	**Diagnosis of Bacterial Infections**	**15**

Diagnosis of Bacterial Infections: Microscopic examination Acid – fast staining, Culture media and Incubation,Serologicaltest-Widal.Antimicrobialsusceptibilitytesting-Discdiffusion–Kirby Bauer method.

UNIT - III	**Laboratory methods in basic Mycology**	**15**

Laboratory methods in basic Mycology–Direct Microscopic examination of clinical specimens – Wet mount, Lactophenol cotton blue staining, culture media and incubation – Antifungal Susceptibility testing.

UNIT - IV	**Isolation and Identification of viruses**	**15**

Isolation and Identification of viruses, Viral antigen detection: Fluorescent antibody and Solidphase Immune assays–RTPCR, Phage typing.

UNIT - V	**Laboratory methods for parasitic infections**	**15**

Laboratory methods for parasitic infections–Diagnostic techniques for faecal, Gastrointestinal and Urino-genital specimen Flotation method, Concentration method.

Total Lecture Hours	**75**

BOOKS FOR STUDY:

- Bailey & Scott's (2014), Diagnostic Microbiology, 13th edition, The C.V., Mosby Company.
- Ranjan Kumar D., (2007), Diagnostic Microbiology, Jaypee Brothers publishing, New Delhi.
- Gunasekaran,P.(1995).LaboratoryManualinMicrobiology,NewAgeInternational(P)Ltd. Publishers, New Delhi.

BOOKS FOR REFERENCES:

- Kannan, N. (1996). Laboratory Manual in General Microbiology, Palani Paramount Publication, Palani.
- RajanS and Selvi Christy R., 2015, Experiments in Microbiology, Anjana Books House, Chennai

WEB RESOURCES:

- https://www.youtube.com/watch?v=uAmTgVvTUNk
- https://www.youtube.com/watch?v=KrpooZv5juo
- https://www.youtube.com/watch?v=Oy5uixdzJ_c

Nature of Course	EMPLOYABILITY			SKILL ORIENTED			ENTREPRENEURSHIP		✓			
Curriculum Relevance	LOCAL		REGIONAL		NATIONAL		GLOBAL	✓				
Changes Made in the Course	Percentage of Change			No Changes Made			New Course	✓				
*Treat 20% as each unit (20*5=100%) and calculate the percentage of change for the course.												

COURSE OUTCOMES:		**K LEVEL**
After studying this course, the students will be able to:		
CO1	Discuss about Collection and transport of clinical specimens.	**K1 to K4**
CO2	Identify the Bacterial infections diagnosis.	**K1 to K4**
CO3	Examine the Fungal infections by microscopic and serological tests.	**K1 to K4**
CO4	Focus the Virus isolation, identification and processing.	**K1 to K4**
CO5	Determine the infections about parasites.	**K1 to K4**

MAPPING WITH PROGRAM OUTCOMES:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S				M			M
CO2	S		S	S						
CO3	S					S				
CO4			S	S						
CO5	S						M			S

S- STRONG **M – MEDIUM** **L - LOW**

CO / PO MAPPING:					
COS	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO 1	**2**	**3**	**1**	**2**	**2**
CO 2	**1**	**2**	**3**	**2**	**3**
CO 3	**2**	**1**	**2**	**2**	**3**
CO 4	**3**	**3**	**2**	**1**	**2**
CO 5	**3**	**2**	**2**	**3**	**1**
WEIGHTAGE	**11**	**11**	**10**	**10**	**11**
WEIGHTED PERCENTAGE OF COURSE CONTRIBUTION TO POS	**73.3**	**73.3**	**66.6**	**66.6**	**73.3**

LESSON PLAN:

UNIT	Diagnostic Microbiology	HRS	PEDAGOGY
I	Diagnostic Microbiology- Introduction- Methods of collection, Transport and Processing of clinical specimens- Blood, Urine, CSF.	**15**	**Chalk & Talk, PPT**
II	Diagnosis of Bacterial Infections: Microscopic examination Acid – fast staining, Culture media and Incubation,Serologicaltest-Widal.Antimicrobialsusceptibilitytesting-Discdiffusion–Kirby Bauer method.	**15**	**Chalk & Talk, PPT**
III	Laboratory methods in basic Mycology–Direct Microscopic examination of clinical specimens – Wet mount, Lactophenol cotton blue staining, culture media and incubation – Anti fungal Susceptibility testing.	**15**	**Chalk & Talk, PPT**
IV	Isolation and Identification of viruses, Viral antigen detection: Fluorescent antibody and Solid phase Immune assays–RTPCR, Phage typing.	**15**	**Chalk & Talk, PPT**
V	Laboratory methods for parasitic infections–Diagnostic techniques for faecal, Gastrointestinal and Urino-genital specimen Flotation method, Concentration method.	**15**	**Chalk & Talk, PPT, Assignment**

Learning Outcome Based Education & Assessment (LOBE) Formative Examination - Blue Print Articulation Mapping – K Levels with Course Outcomes (COs)						
Internal	**Cos**	**K Level**	**Section A**		**Section B Either or Choice**	**Section C Either or Choice**
			MCQs			
			No. of. Questions	**K - Level**		
CI AI	**CO1**	**K1 – K4**	2	K1, K2	2(K2, K2)	2(K3, K3)
	CO2	**K1 – K4**	2	K1, K2	2(K3, K3)	2(K4, K4)
CI AII	**CO3**	**K1 – K4**	2	K1, K2	2(K2, K2)	2(K3, K3)
	CO4	**K1 – K4**	2	K1, K2	2(K3, K3)	2(K4, K4)
Question Pattern CIA I & II		**No. of Questions to be asked**	4		4	4
		No. of Questions to be answered	4		2	2
		Marks for each question	1		5	8
		Total Marks for each section	4		10	16

Distribution of Marks with K Level CIA I & CIA II							
	K Level	**Section A (Multiple Choice Questions)**	**Section B (Either / Or Choice)**	**Section C (Either / Or Choice)**	**Total Marks**	**% of (Marks without choice)**	**Consolidate of %**
CIA I	**K1**	**2**			**2**	**3.6**	**25**
	K2	**2**	**10**		**12**	**21.4**	
	K3		**10**	**16**	**26**	**46.4**	**46.4**
	K4			**16**	**16**	**28.6**	**28.6**
	Marks	**4**	**20**	**32**	**56**	**100**	**100**
CIA II	**K1**	**2**			**2**	**3.6**	**7.2**
	K2	**2**	**10**		**12**	**3.6**	
	K3		**10**	**16**	**26**	**46.4**	**46.4**
	K4			**16**	**16**	**46.4**	**46.4**
	Marks	**4**	**20**	**32**	**56**	**100**	**100**

K1- Remembering and recalling facts with specific answers

K2- Basic understanding of facts and stating main ideas with general answers

K3- Application oriented- Solving Problems

K4- Examining, analyzing, presentation and make inferences with evidences

CO5 will be allotted for individual Assignment which carries five marks as part of CIA component.

Summative Examination – Blue Print Articulation Mapping – K Level with Course Outcomes (COs)						
S. No	COs	K - Level	Section A (MCQs)		Section B (Either / or Choice) With K - LEVEL	Section C (Either / or Choice) With K - LEVEL
			No. of Questions	K – Level		
1	CO1	K1-K4	2	K1, K2	2(K2, K2)	2(K3, K3)
2	CO2	K1-K4	2	K1, K2	2(K3, K3)	2(K4, K4)
3	CO3	K1-K4	2	K1, K2	2(K2, K2)	2(K3, K3)
4	CO4	K1-K4	2	K1, K2	2(K3, K3)	2(K4, K4)
5	CO5	K1-K4	2	K1, K2	2(K3, K3)	2(K4, K4)
No. of Questions to be Asked			10		10	10
No. of Questions to be answered			10		5	5
Marks for each question			1		5	8
Total Marks for each section			10		25	40
(Figures in parenthesis denotes, questions should be asked with the given K level)						

Distribution of Marks with K Level						
K Level	Section A (Multiple Choice Questions)	Section B (Either or Choice	Section C (Either/ or Choice)	Total Marks	% of (Marks without choice)	Consolidated %
K1	5			5	3.6	4
K2	5	20		25	17.8	18
K3		30	32	62	44.3	44
K4			48	48	34.3	34
Marks	10	50	80	140	100	100
NB: Higher level of performance of the students is to be assessed by attempting higher level of K levels.						

Summative Examinations - Question Paper – Format

Q. No.	Unit	CO	K-level		
Answer **ALL** the questions				**PART – A**	**(10 x 1 = 10 Marks)**
1.	**Unit - I**	**CO1**	**K1**		
				a)	b)
				c)	d)
2.	**Unit - I**	**CO1**	**K2**		
				a)	b)
				c)	d)
3.	**Unit - II**	**CO2**	**K1**		
				a)	b)
				c)	d)
4.	**Unit - II**	**CO2**	**K2**		
				a)	b)
				c)	d)
5.	**Unit - III**	**CO3**	**K1**		
				a)	b)
				c)	d)
6.	**Unit - III**	**CO3**	**K2**		
				a)	b)
				c)	d)
7.	**Unit - IV**	**CO4**	**K1**		
				a)	b)
				c)	d)
8.	**Unit - IV**	**CO4**	**K2**		
				a)	b)
				c)	d)
9.	**Unit - V**	**CO5**	**K1**		
				a)	b)
				c)	d)
10.	**Unit - V**	**CO5**	**K2**		
				a)	b)
				c)	d)

Answer **ALL** the questions		**PART – B**		**(5 x 5 = 25 Marks)**
11. a)	**Unit - I**	**CO1**	**K2**	
		OR		
11. b)	**Unit - I**	**CO1**	**K2**	
12. a)	**Unit - II**	**CO2**	**K3**	
		OR		
12. b)	**Unit - II**	**CO2**	**K3**	
13. a)	**Unit - III**	**CO3**	**K2**	
		OR		
13. b)	**Unit - III**	**CO3**	**K2**	
14. a)	**Unit - IV**	**CO4**	**K3**	
		OR		
14. b)	**Unit - IV**	**CO4**	**K3**	
15. a)	**Unit - V**	**CO5**	**K3**	
		OR		
15. b)	**Unit - V**	**CO5**	**K3**	

Answer **ALL** the questions		**PART – C**		**(5 x 8 = 40 Marks)**
16. a)	**Unit - I**	**CO1**	**K3**	
		OR		
16. b)	**Unit - I**	**CO1**	**K3**	
17. a)	**Unit - II**	**CO2**	**K4**	
		OR		
17. b)	**Unit - II**	**CO2**	**K4**	
18. a)	**Unit - III**	**CO3**	**K3**	
		OR		
18. b)	**Unit - III**	**CO3**	**K3**	
19. a)	**Unit - IV**	**CO4**	**K4**	
		OR		
19. b)	**Unit - IV**	**CO4**	**K4**	
20. a)	**Unit - V**	**CO5**	**K4**	
		OR		
20. b)	**Unit - V**	**CO5**	**K4**	

Course Name	Entrepreneurship and Bio - Business			
Course Code	23UMBEC64	**L**	**P**	**C**
Category	Elective	5	-	3

COURSE OBJECTIVES:

- Understanding basic concepts in the area of entrepreneurship, the role and importance of entrepreneurship for economic development
- Developing personal creativity and entrepreneurial initiative, adopting the key steps in the elaboration of business idea.
- Understanding the stages of the entrepreneurial process and the resources needed for the successful development of entrepreneurial ventures.
- Explain the central components of successful business strategies in biotechnology, and create a business plan.
- Understand the various funding resources and develop as Entrepreneur

UNIT - I **15**

Bio Entrepreneurship: Introduction to bio-business, SWOT analysis of bio-business. Ownership Development of Entrepreneurship; Stages in entrepreneurial process; Governments Schemes and funding Small scale industries : Definition; Characteristics; Need and rationale.

UNIT - II **15**

Entrepreneurship Opportunity in Agricultural Biotechnology: Business opportunity, Essential requirement, marketing, strategies, schemes, challenges and scope-with case study on Plant cell and tissue culture technique. Herbal bulk drug production, Nutraceuticals, value added herbal products. Bioethanol production using Agricultural waste, Algal source. Integration of system biology for agricultural applications. Biosensor development in Agriculture management.

UNIT - III **15**

Entrepreneurship Opportunity in Industrial Biotechnology: Business opportunity, Essential requirement, marketing strategies, schemes, challenges, and scope-Pollution monitoring and Bioremediation for Industrial pollutants. Integrated compost production- microbe enriched compost. Bio pesticide/ insecticide production. Biofertilizer. Single cell protein.

UNIT - IV **15**

Therapeutic and Fermented products: Stem cell production, stem cell bank, production of monoclonal/polyclonal antibodies, secondary metabolite production–antibiotics, probiotic and prebiotics

UNIT - V **15**

Project Management, Technology Management and Startup Schemes: Building Biotech business challenges in Indian context-biotech partners (BIRAC, DBT, Incubation centers. etc.,), operation al biotech parks in India. Indian Company act for Biobusiness - schemes and subsidies. Project proposal preparation, Successful start-ups-case study.

Total Lecture Hours **75**

BOOKS FOR STUDY:

- Craig Shimasaki. (2014).Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies. Academic Press.
- Ashton Acton, O. (2012). Biological Pigments –Advances in Research and Application Scholorly Editions: Atlanta, Georgia.
- Jennifer Merritt, Jason Feifer (2018). Start Your Own Business,7th edition, Entrepreneur Press publisher.
- Peter F. Drucker (2006). Innovation and Entrepreneurship. Harper Business publisher.
- Leah Cannon (2017).How to Start a Life Science Company: A Comprehensive Guide for First-Time Entrepreneurs. International Kindle paperwhite.

BOOKS FOR REFERENCES:

- Crueger, W, and Crueger. A.(2000). Biotechnology: A Text Book of Industrial microbiology, 2nd Edition, Sinauer Associates: Sunderland. Mass.
- PaulS Teng.(2008).Bioscience Entrepreneurship in Asia World Scientific Publishing Company.
- CharlesE. Bamford, GarryD. Bruton (2015). ENTREPRENEURSHIP : The Art, Science, and Process for Success, 2ndEdition, McGraw Hill publisher.
- Yali Friedman(2014). Building Biotechnology: Biotechnology Business, Regulations, Patents, Law, Policy and Science 4th Edition, Logos press publication.
- Stephanie A. Wisner (2022). Building Backwards to Biotech: The Power of Entrepreneurship to Drive Cutting-Edge Science to Market, International Kindle paper white.

WEB RESOURCES:

- **https://www.bio-rad.com/webroot/web/pdf/lse/literature/Biobusiness.pdf**
- **https://www.crg.eu/biobusiness-entrepreneurship**
- **https://www.entrepreneur.com**
- **https://www.birac.nic.in**
- **https://www.springer.com**

Nature of Course	EMPLOYABILITY			SKILL ORIENTED			ENTREPRENEURSHIP			✓
Curriculum Relevance	LOCAL		REGIONAL		NATIONAL			GLOBAL		✓
Changes Made in the Course	Percentage of Change	**10%**		No Changes Made			New Course			

***Treat 20% as each unit (20*5=100%) and calculate the percentage of change for the course.**

COURSE OUTCOMES:		K LEVEL
After studying this course, the students will be able to:		
CO1	Describe and apply several entrepreneurial ideas and business theories in practical framework.	**K1 to K4**
CO2	Analyze the business environment in order to identify business opportunities, identify the elements of success of entrepreneurial ventures, evaluate the effectiveness of different entrepreneurial strategies and interpret their own business plan.	**K1 to K4**
CO3	Express the mass production of microbial inoculants used as Biofertilizers and Bioinsecticides in response with field application and crop response.	**K1 to K4**
CO4	Analyze the application and commercial production of Monoclonal antibodies, Cytokines. TPH and teaching kits. Monoclonal antibodies, Cytokines. TPH and teaching kits.	**K1 to K4**
CO5	Integrate and apply knowledge of the regulation of biotechnology industries, utilize effective team work skills within an effective management team with a common objective, and gain effective team work skills, with an awareness of cultural diversity and social inclusiveness.	**K1 to K4**

MAPPING WITH PROGRAM OUTCOMES:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	S	S	M	M	S	M	M	S
CO2	S	S	M	S	S	S	M	S	S	M
CO3	S	M	M	M	S	S	M	S	S	S
CO4	S	M	M	S	M	M	S	M	S	S
CO5	M	S	S	M	M	M	M	S	M	S

S- STRONG **M – MEDIUM** **L - LOW**

CO / PO MAPPING:

COS	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	2	3	3	3	2
CO 2	1	2	3	3	2
CO 3	3	2	2	3	3
CO 4	3	2	3	3	3
CO 5	3	2	2	2	2
WEIGHTAGE	12	11	13	14	12
WEIGHTED PERCENTAGE OF COURSE CONTRIBUTION TO POS	80%	73%	86%	93%	80%

LESSON PLAN:

UNIT	Entrepreneurship and Bio-Business	HRS	PEDAGOGY
I	Bio Entrepreneurship: Introduction to bio-business, SWOT analysis of	15	Chalk & Talk,

	bio-business. Ownership, Development of Entrepreneurship; Stages in entrepreneurial process; Government schemes and funding. Small scale industries: Definition; Characteristics; Need and rationale.		**PPT**
II	Entrepreneurship Opportunity in Agricultural Biotechnology: Business opportunity, Essential requirement, marketing, strategies, schemes, challenges and scope-with case study on Plant cell and tissue culture technique, poly house culture. Herbal bulk drug production, Nutraceuticals, value added herbal products. Bioethanol production using Agricultural waste, Algal source. Integration of system biology for agricultural applications. Biosensor development in Agriculture management.	**15**	**Chalk & Talk, PPT**
III	Entrepreneurship Opportunity in Industrial Biotechnology: Business opportunity, Essential requirement, marketing strategies, schemes, challenges, and scope-Pollution monitoring and Bioremediation for Industrial pollutants. Integrated compost production-microbe enriched compost. Bio pesticide/ insecticide production. Biofertilizer. Single cell protein.	**15**	**Chalk & Talk, PPT**
IV	Therapeutic and Fermented products: Stem cell production, stem cell bank, production of monoclonal/polyclonal antibodies, secondary metabolite production–antibiotics, probiotic and prebiotics	**15**	**Chalk & Talk, PPT**
V	Project Management, Technology Management and Startup Schemes: Building Biotech business challenges in Indian context-biotech partners (BIRAC, DBT, Incubation centers. etc.,),operational biotech parks in India. Indian Company act for Biobusiness- schemes and subsidies. Project proposal preparation, Successful start-ups-case study.	**15**	**Chalk & Talk, PPT**

Learning Outcome Based Education & Assessment (LOBE)
Formative Examination - Blue Print
Articulation Mapping – K Levels with Course Outcomes (COs)

Internal	**Cos**	**K Level**	**Section A**		**Section B Either or Choice**	**Section C Either or Choice**
			MCQs			
			No. of. Questions	**K - Level**		
CI AI	**CO1**	**K1 – K4**	2	K1, K2	2(K2, K2)	2(K3, K3)
	CO2	**K1 – K4**	2	K1, K2	2(K3, K3)	2(K4, K4)
CI AII	**CO3**	**K1 – K4**	2	K1, K2	2(K2, K2)	2(K3, K3)
	CO4	**K1 – K4**	2	K1, K2	2(K3, K3)	2(K4, K4)
Question Pattern CIA I & II		**No. of Questions to be asked**	4		4	4
		No. of Questions to be answered	4		2	2
		Marks for each question	1		5	8
		Total Marks for each section	4		10	16

Distribution of Marks with K Level CIA I & CIA II							
	K Level	Section A (Multiple Choice Questions)	Section B (Either / Or Choice)	Section C (Either / Or Choice)	Total Marks	% of (Marks without choice)	Consolidate of %
CIA I	K1	2			2	3.6	25
	K2	2	10		12	21.4	
	K3		10	16	26	46.4	46.4
	K4			16	16	28.6	28.6
	Marks	4	20	32	56	100	100
CIA II	K1	2			2	3.6	7.2
	K2	2	10		12	3.6	
	K3		10	16	26	46.4	46.4
	K4			16	16	46.4	46.4
	Marks	4	20	32	56	100	100

K1- Remembering and recalling facts with specific answers

K2- Basic understanding of facts and stating main ideas with general answers

K3- Application oriented- Solving Problems

K4- Examining, analyzing, presentation and make inferences with evidences

CO5 will be allotted for individual Assignment which carries five marks as part of CIA component.

Summative Examination – Blue Print Articulation Mapping – K Level with Course Outcomes (COs)						
S. No	COs	K - Level	Section A (MCQs)		Section B (Either / or Choice) With K - LEVEL	Section C (Either / or Choice) With K - LEVEL
			No. of Questions	K – Level		
1	CO1	K1-K4	2	K1, K2	2(K2, K2)	2(K3, K3)
2	CO2	K1-K4	2	K1, K2	2(K3, K3)	2(K4, K4)
3	CO3	K1-K4	2	K1, K2	2(K2, K2)	2(K3, K3)
4	CO4	K1-K4	2	K1, K2	2(K3, K3)	2(K4, K4)
5	CO5	K1-K4	2	K1, K2	2(K3, K3)	2(K4, K4)
No. of Questions to be Asked			10		10	10
No. of Questions to be answered			10		5	5
Marks for each question			1		5	8
Total Marks for each section			10		25	40
(Figures in parenthesis denotes, questions should be asked with the given K level)						

Distribution of Marks with K Level						
K Level	**Section A (Multiple Choice Questions)**	**Section B (Either or Choice**	**Section C (Either/ or Choice)**	**Total Marks**	**% of (Marks without choice)**	**Consolidated %**
K1	**5**			**5**	**3.6**	**4**
K2	**5**	**20**		**25**	**17.8**	**18**
K3		**30**	**32**	**62**	**44.3**	**44**
K4			**48**	**48**	**34.3**	**34**
Marks	**10**	**50**	**80**	**140**	**100**	**100**
NB: Higher level of performance of the students is to be assessed by attempting higher level of K levels.						

Summative Examinations - Question Paper – Format

Q. No.	**Unit**	**CO**	**K-level**		
Answer **ALL** the questions				**PART – A**	**(10 x 1 = 10 Marks)**
1.	**Unit - I**	**CO1**	**K1**		
				a)	b)
				c)	d)
2.	**Unit - I**	**CO1**	**K2**		
				a)	b)
				c)	d)
3.	**Unit - II**	**CO2**	**K1**		
				a)	b)
				c)	d)
4.	**Unit - II**	**CO2**	**K2**		
				a)	b)
				c)	d)
5.	**Unit - III**	**CO3**	**K1**		
				a)	b)
				c)	d)
6.	**Unit - III**	**CO3**	**K2**		
				a)	b)
				c)	d)
7.	**Unit - IV**	**CO4**	**K1**		
				a)	b)
				c)	d)
8.	**Unit - IV**	**CO4**	**K2**		
				a)	b)
				c)	d)
9.	**Unit - V**	**CO5**	**K1**		
				a)	b)
				c)	d)
10.	**Unit - V**	**CO5**	**K2**		
				a)	b)
				c)	d)

Answer **ALL** the questions		**PART – B**		**(5 x 5 = 25 Marks)**
11. a)	**Unit - I**	**CO1**	**K2**	
		OR		
11. b)	**Unit - I**	**CO1**	**K2**	
12. a)	**Unit - II**	**CO2**	**K3**	
		OR		
12. b)	**Unit - II**	**CO2**	**K3**	
13. a)	**Unit - III**	**CO3**	**K2**	
		OR		
13. b)	**Unit - III**	**CO3**	**K2**	
14. a)	**Unit - IV**	**CO4**	**K3**	
		OR		
14. b)	**Unit - IV**	**CO4**	**K3**	
15. a)	**Unit - V**	**CO5**	**K3**	
		OR		
15. b)	**Unit - V**	**CO5**	**K3**	

Answer **ALL** the questions		**PART – C**		**(5 x 8 = 40 Marks)**
16. a)	**Unit - I**	**CO1**	**K3**	
		OR		
16. b)	**Unit - I**	**CO1**	**K3**	
17. a)	**Unit - II**	**CO2**	**K4**	
		OR		
17. b)	**Unit - II**	**CO2**	**K4**	
18. a)	**Unit - III**	**CO3**	**K3**	
		OR		
18. b)	**Unit - III**	**CO3**	**K3**	
19. a)	**Unit - IV**	**CO4**	**K4**	
		OR		
19. b)	**Unit - IV**	**CO4**	**K4**	
20. a)	**Unit - V**	**CO5**	**K4**	
		OR		
20. b)	**Unit - V**	**CO5**	**K4**	

Course Name	Genetics and Biostatistics			
Course Code	23UMBEC65	**L**	**P**	**C**
Category	Elective	5	-	3

COURSE OBJECTIVES:

- To describe the genetics of microbes, Gene transfer mechanisms.
- To identify the genetic exchange Transduction, Conjugation.
- To understand the Mutation and its types.
- To interpret the Data collection, validation and diagrammatic representation.
- To gain the knowledge to explore students in central tendency and dispersion

UNIT – I Nucleic Acids **15**

DNA: Genetic material–experiment of Griffith, Avery, MacLeod and McCarty, Harshey and Chase; RNA: Genetic material–Gierer and Schramm experiments.

UNIT - II Genetic exchange **15**

Transduction(Specialized&Generalized),Transformation,Conjugation–Hfr mapping.

UNIT - III Mutation **15**

spontaneous and induced–Mutagen &Mutagenesis – DNA repair mechanism

UNIT - IV Data Collection **15**

Collection of data–Primary data-Secondary data-Types of Variables-Tabulation and presentation Of data-Kinds of biological data-Functions of statistics and limitation of statistics.

UNIT - V **15**

Measures of central tendency-Mean, Median and Mode–Measurement of dispersion–range, standard deviation

Total Lecture Hours **75**

BOOKS FOR STUDY:

- DavidRHyde.2010, Genetics and Molecular biology. Special Indian edition, Tata McGraw Hill P. Ltd, New Delhi.
- Guruman iN, 2004. An Introduction to Biostatistics. MJP publishers, Chennai.

BOOKS FOR REFERENCES:

- Daniel W.W, 2006. Biostatistics-Afoundationforanalysisinhealthsciences,JohnWiley(Asia) & sons, Singapore.
- GuptaS.P,1987,StatisticalMethods.SultanChand&SonsPublishers,NewDelhi

WEB RESOURCES:

- **https://www.youtube.com/watch?v=JQByjprj_mA**
- **https://www.youtube.com/watch?v=QcBYTA7uVXk**
- **https://www.youtube.com/watch?v=EMDuf_kBJcs**
- **https://microbenotes.com/primary-data-and-secondary-data**
- **https://www.youtube.com/watch?v=0lZRAShqft0**

Nature of Course	EMPLOYABILITY		SKILL ORIENTED	✓	ENTREPRENEURSHIP			
Curriculum Relevance	LOCAL		REGIONAL		NATIONAL		GLOBAL	✓
Changes Made in the Course	Percentage of Change		No Changes Made	✓	New Course			
***Treat 20% as each unit (20*5=100%) and calculate the percentage of change for the course.**								

COURSE OUTCOMES:		**K LEVEL**
After studying this course, the students will be able to:		
CO1	Classify DNA, RNA as a genetic material.	**K1 to K4**
CO2	Transfer DNA via mechanisms.	**K1 to K4**
CO3	Distinguish mutation and its types.	**K1 to K4**
CO4	Correlate Data collection and validation.	**K1 to K4**
CO5	Use central tendency and dispersion.	**K1 to K4**

MAPPING WITH PROGRAM OUTCOMES:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S				M			M
CO2	S		S	S						
CO3	S					S				
CO4			S	S						
CO5	S						M			S

S- STRONG **M – MEDIUM** **L - LOW**

CO / PO MAPPING:

COS	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	2	3	1	2	2
CO 2	1	2	3	2	3
CO 3	2	1	2	2	3
CO 4	3	3	2	1	2
CO 5	3	2	2	3	1
WEIGHTAGE	11	11	10	10	11
WEIGHTED PERCENTAGE OF COURSE CONTRIBUTION TO POS	73.3	73.3	66.6	66.6	73.3

LESSON PLAN:			
UNIT	**Genetics and Biostatistics**	**HRS**	**PEDAGOGY**
I	**DNA AS A GENETIC MATERIAL -** DNA: Genetic material – experiment of Griffith, Avery, MacLeodand Mc Carty, Harshey and Chase; RNA: Genetic material – Gierer and Schramm experiments.	**15**	**Chalk & Talk, PPT**
II	**GENETIC EXCHANGE -** Genetic exchange – Transduction (Specialized &Generalized), Transformation, Conjugation–Hfr mapping.	**15**	**Chalk & Talk, PPT**
III	**MUTATION-**Mutation–spontaneous and induced–Mutagen& Mutagenesis – DNA repair mechanism.	**15**	**Chalk & Talk, PPT**
IV	**DATACOLLECTION-**Collection of data–Primary data-Secondary data - Types of Variables-Tabulation and presentation of data - Kinds of biological data - Functions of statistics and limitation of statistics.	**15**	**Chalk & Talk, PPT**
V	**CENTRALTENDENCYANDDISPERSION-**Measures of central tendency- Mean, Median and Mode – Measures of dispersion – range, standard deviation.	**15**	**Chalk & Talk, PPT, Assignment**

Learning Outcome Based Education & Assessment (LOBE)
Formative Examination - Blue Print
Articulation Mapping – K Levels with Course Outcomes (COs)

Internal	Cos	K Level	Section A MCQs		Section B Either or Choice	Section C Either or Choice
			No. of. Questions	K - Level		
CI AI	CO1	K1 – K4	2	K1, K2	2(K2, K2)	2(K3, K3)
	CO2	K1 – K4	2	K1, K2	2(K3, K3)	2(K4, K4)
CI AII	CO3	K1 – K4	2	K1, K2	2(K2, K2)	2(K3, K3)
	CO4	K1 – K4	2	K1, K2	2(K3, K3)	2(K4, K4)
Question Pattern CIA I & II		No. of Questions to be asked	4		4	4
		No. of Questions to be answered	4		2	2
		Marks for each question	1		5	8
		Total Marks for each section	4		10	16

Distribution of Marks with K Level CIA I & CIA II							
	K Level	Section A (Multiple Choice Questions)	Section B (Either / Or Choice)	Section C (Either / Or Choice)	Total Marks	% of (Marks without choice)	Consolidate of %
CIA I	K1	2			2	3.6	25
	K2	2	10		12	21.4	
	K3		10	16	26	46.4	46.4
	K4			16	16	28.6	28.6
	Marks	4	20	32	56	100	100
CIA II	K1	2			2	3.6	7.2
	K2	2	10		12	3.6	
	K3		10	16	26	46.4	46.4
	K4			16	16	46.4	46.4
	Marks	4	20	32	56	100	100

K1- Remembering and recalling facts with specific answers

K2- Basic understanding of facts and stating main ideas with general answers

K3- Application oriented- Solving Problems

K4- Examining, analyzing, presentation and make inferences with evidences

CO5 will be allotted for individual Assignment which carries five marks as part of CIA component.

Summative Examination – Blue Print Articulation Mapping – K Level with Course Outcomes (COs)						
S. No	COs	K - Level	Section A (MCQs)		Section B (Either / or Choice) With K - LEVEL	Section C (Either / or Choice) With K - LEVEL
			No. of Questions	K – Level		
1	CO1	K1-K4	2	K1, K2	2(K2, K2)	2(K3, K3)
2	CO2	K1-K4	2	K1, K2	2(K3, K3)	2(K4, K4)
3	CO3	K1-K4	2	K1, K2	2(K2, K2)	2(K3, K3)
4	CO4	K1-K4	2	K1, K2	2(K3, K3)	2(K4, K4)
5	CO5	K1-K4	2	K1, K2	2(K3, K3)	2(K4, K4)
No. of Questions to be Asked			10		10	10
No. of Questions to be answered			10		5	5
Marks for each question			1		5	8
Total Marks for each section			10		25	40
(Figures in parenthesis denotes, questions should be asked with the given K level)						

Distribution of Marks with K Level						
K Level	**Section A (Multiple Choice Questions)**	**Section B (Either or Choice**	**Section C (Either/ or Choice)**	**Total Marks**	**% of (Marks without choice)**	**Consolidated %**
K1	**5**			**5**	**3.6**	**4**
K2	**5**	**20**		**25**	**17.8**	**18**
K3		**30**	**32**	**62**	**44.3**	**44**
K4			**48**	**48**	**34.3**	**34**
Marks	**10**	**50**	**80**	**140**	**100**	**100**
NB: Higher level of performance of the students is to be assessed by attempting higher level of K levels.						

Summative Examinations - Question Paper – Format

Q. No.	**Unit**	**CO**	**K-level**		
Answer **ALL** the questions				**PART – A**	**(10 x 1 = 10 Marks)**
1.	**Unit - I**	**CO1**	**K1**		
				a)	b)
				c)	d)
2.	**Unit - I**	**CO1**	**K2**		
				a)	b)
				c)	d)
3.	**Unit - II**	**CO2**	**K1**		
				a)	b)
				c)	d)
4.	**Unit - II**	**CO2**	**K2**		
				a)	b)
				c)	d)
5.	**Unit - III**	**CO3**	**K1**		
				a)	b)
				c)	d)
6.	**Unit - III**	**CO3**	**K2**		
				a)	b)
				c)	d)
7.	**Unit - IV**	**CO4**	**K1**		
				a)	b)
				c)	d)
8.	**Unit - IV**	**CO4**	**K2**		
				a)	b)
				c)	d)
9.	**Unit - V**	**CO5**	**K1**		
				a)	b)
				c)	d)
10.	**Unit - V**	**CO5**	**K2**		
				a)	b)
				c)	d)

Answer **ALL** the questions		**PART – B**		**(5 x 5 = 25 Marks)**
11. a)	**Unit - I**	**CO1**	**K2**	
		OR		
11. b)	**Unit - I**	**CO1**	**K2**	
12. a)	**Unit - II**	**CO2**	**K3**	
		OR		
12. b)	**Unit - II**	**CO2**	**K3**	
13. a)	**Unit - III**	**CO3**	**K2**	
		OR		
13. b)	**Unit - III**	**CO3**	**K2**	
14. a)	**Unit - IV**	**CO4**	**K3**	
		OR		
14. b)	**Unit - IV**	**CO4**	**K3**	
15. a)	**Unit - V**	**CO5**	**K3**	
		OR		
15. b)	**Unit - V**	**CO5**	**K3**	

Answer **ALL** the questions		**PART – C**		**(5 x 8 = 40 Marks)**
16. a)	**Unit - I**	**CO1**	**K3**	
		OR		
16. b)	**Unit - I**	**CO1**	**K3**	
17. a)	**Unit - II**	**CO2**	**K4**	
		OR		
17. b)	**Unit - II**	**CO2**	**K4**	
18. a)	**Unit - III**	**CO3**	**K3**	
		OR		
18. b)	**Unit - III**	**CO3**	**K3**	
19. a)	**Unit - IV**	**CO4**	**K4**	
		OR		
19. b)	**Unit - IV**	**CO4**	**K4**	
20. a)	**Unit - V**	**CO5**	**K4**	
		OR		
20. b)	**Unit - V**	**CO5**	**K4**	

Course Name	Fundamentals of Botany and Zoology			
Course Code	23UMBEC66	**L**	**P**	**C**
Category	Elective	5	-	3

COURSE OBJECTIVES:

- To understand the classification of plant system
- To appreciate the features of plants in different groups
- To get accustomed to the development of plants
- To the understand the features of animal taxonomy
- To become familiar with human physiology

UNIT - I	**Plant Taxonomy**	**15**

Introduction to plant kingdom, Plant nomenclature- Binomial system, International code of Botanical Nomenclature (ICBN). Classification - Artificial and Natural system.

UNIT - II	**Plant Characteristics**	**15**

Salient features, distribution and economic importance gymnosperms, pteridophytes, bryophytes and Lichens.

UNIT - III	**Plant Embryology**	**15**

Tissues - Meristematic and permanent tissues. Structure of mature anther. Structure of mature ovule and its types. Fertilization. Photosynthesis – light reaction - Calvin cycle. Mendelism - Monohybrid and dihybrid crosses.

UNIT - IV	**Introduction To Animal Kingdom**	**15**

General classification of invertebrates and vertebrates, Evolution – theories of Lamarckism and Darwinism – stages of gamete formation, fertilization, development of chick embryo.

UNIT - V	**Human Physiology**	**15**

Digestive and respiratory system, blood – components, structure and functions of heart, excretion – structure of kidney and mechanism of urine formation.

Total Lecture Hours	**75**

BOOKS FOR STUDY:

- Ashok Bendre, A.K and Pandey P.C, 1975. Introductory Botany. Rastogi Publication Meerut.
- Ekambaranatha Ayyar and Ananthakrishnan T.N, 1993. Outlines of Zoology, Vol I & II, Viswanathan and Co, Madras.
- Ganguly A.K and Kumar N.C, 1971. General Botany Vol. I & Vol. II, Emkay Publication, Delhi.

BOOKS FOR REFERENCES:

- Rao, K. N, Krishnamoorthy, K.VandRaoG,1975. Ancillary Botany. S. Viswanathan Private. Ltd., Chennai.
- Sambasiviah I, Kamalakara Rao A.P, Augustine Chellappa S, 1983. Text book of Animal Physiology, Chand S & Co., New Delhi.

WEB RESOURCES:

- **https://www.hematology.org/education/patients/blood-basics**
- **https://www.embibe.com/questions/What-are-the-economic-importance-of-gymnosperms%3F/EM8785832**
- **https://www.khanacademy.org/science/ap-biology/cellular-energetics/photosynthesis/a/calvin-cycle**
- **https://study.com/academy/lesson/photosynthesis-i-photolysis-and-the-light-reactions.html**

Nature of Course	EMPLOYABILITY		SKILL ORIENTED	✓	ENTREPRENEURSHIP					
Curriculum Relevance	LOCAL		REGIONAL		NATIONAL		GLOBAL	✓		
Changes Made in the Course	Percentage of Change		No Changes Made		New Course	✓				

***Treat 20% as each unit (20*5=100%) and calculate the percentage of change for the course.**

COURSE OUTCOMES:		**K LEVEL**
After studying this course, the students will be able to:		
CO1	Define nomenclature, salient features of plant kingdom, plant physiology, animal kingdom and human physiology.	**K1 to K4**
CO2	Identify the application of Mendelism.	**K1 to K4**
CO3	Classify plant and animal kingdom, fertilisation, invertebrates and vertebrates.	**K1 to K4**
CO4	Organise plant kingdom, theory of evolution, Mendelism and functions of body parts.	**K1 to K4**
CO5	Contrast the distribution, economic, environmental importance of plant and animal kingdom.	**K1 to K4**

MAPPING WITH PROGRAM OUTCOMES:

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	**S**	**S**	**S**				**M**			**M**
CO2	**S**		**S**	**S**						
CO3	**S**					**S**				
CO4			**S**	**S**						
CO5	**S**						**M**			**S**

S- STRONG	M – MEDIUM	L - LOW

CO / PO MAPPING:

COS	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	2	3	1	2	2
CO 2	1	2	3	2	3
CO 3	2	1	2	2	3
CO 4	3	3	2	1	2
CO 5	3	2	2	3	1
WEIGHTAGE	11	11	10	10	11
WEIGHTED PERCENTAGE OF COURSE CONTRIBUTION TO POS	73.3	73.3	66.6	66.6	73.3

LESSON PLAN:

UNIT	Fundamentals of Botany And Zoology	HRS	PEDAGOGY
I	Introduction to plant kingdom, Plant nomenclature- Binomial system, International code of Botanical Nomenclature (ICBN). Classification - Artificial and Natural system.	15	Chalk & Talk, PPT
II	Salient features, distribution and economic importance gymnosperms, pteridophytes, bryophytes and Lichens.	15	Chalk & Talk, PPT
III	Tissues - Meristematic and permanent tissues. Structure of mature anther. Structure of mature ovule and its types. Fertilization. Photosynthesis – light reaction - Calvin cycle. Mendelism - Monohybrid and dihybrid crosses.	15	Chalk & Talk, PPT
IV	Introduction to animal kingdom – General classification of invertebrates and vertebrates, Evolution – theories of Lamarckism and Darwinism – stages of gamete formation, fertilization, development of chick embryo.	15	Chalk & Talk, PPT
V	Human physiology: Digestive and respiratory system, blood – components, structure and functions of heart, excretion – structure of kidney and mechanism of urine formation.	15	Chalk & Talk, PPT, Assignment

Learning Outcome Based Education & Assessment (LOBE) Formative Examination - Blue Print Articulation Mapping – K Levels with Course Outcomes (COs)						
Internal	**Cos**	**K Level**	**Section A**		**Section B Either or Choice**	**Section C Either or Choice**
			MCQs			
			No. of. Questions	**K - Level**		
CI AI	**CO1**	**K1 – K4**	2	K1, K2	2(K2, K2)	2(K3, K3)
	CO2	**K1 – K4**	2	K1, K2	2(K3, K3)	2(K4, K4)
CI AII	**CO3**	**K1 – K4**	2	K1, K2	2(K2, K2)	2(K3, K3)
	CO4	**K1 – K4**	2	K1, K2	2(K3, K3)	2(K4, K4)
Question Pattern CIA I & II		**No. of Questions to be asked**	4		4	4
		No. of Questions to be answered	4		2	2
		Marks for each question	1		5	8
		Total Marks for each section	4		10	16

Distribution of Marks with K Level CIA I & CIA II							
	K Level	**Section A (Multiple Choice Questions)**	**Section B (Either / Or Choice)**	**Section C (Either / Or Choice)**	**Total Marks**	**% of (Marks without choice)**	**Consolidate of %**
CIA I	**K1**	**2**			**2**	**3.6**	**25**
	K2	**2**	**10**		**12**	**21.4**	
	K3		**10**	**16**	**26**	**46.4**	**46.4**
	K4			**16**	**16**	**28.6**	**28.6**
	Marks	**4**	**20**	**32**	**56**	**100**	**100**
CIA II	**K1**	**2**			**2**	**3.6**	**7.2**
	K2	**2**	**10**		**12**	**3.6**	
	K3		**10**	**16**	**26**	**46.4**	**46.4**
	K4			**16**	**16**	**46.4**	**46.4**
	Marks	**4**	**20**	**32**	**56**	**100**	**100**

K1- Remembering and recalling facts with specific answers

K2- Basic understanding of facts and stating main ideas with general answers

K3- Application oriented- Solving Problems

K4- Examining, analyzing, presentation and make inferences with evidences

CO5 will be allotted for individual Assignment which carries five marks as part of CIA component.

Summative Examination – Blue Print Articulation Mapping – K Level with Course Outcomes (COs)						
S. No	COs	K - Level	Section A (MCQs)		Section B (Either / or Choice) With K - LEVEL	Section C (Either / or Choice) With K - LEVEL
			No. of Questions	K – Level		
1	CO1	K1-K4	2	K1, K2	2(K2, K2)	2(K3, K3)
2	CO2	K1-K4	2	K1, K2	2(K3, K3)	2(K4, K4)
3	CO3	K1-K4	2	K1, K2	2(K2, K2)	2(K3, K3)
4	CO4	K1-K4	2	K1, K2	2(K3, K3)	2(K4, K4)
5	CO5	K1-K4	2	K1, K2	2(K3, K3)	2(K4, K4)
No. of Questions to be Asked			10		10	10
No. of Questions to be answered			10		5	5
Marks for each question			1		5	8
Total Marks for each section			10		25	40
(Figures in parenthesis denotes, questions should be asked with the given K level)						

Distribution of Marks with K Level						
K Level	Section A (Multiple Choice Questions)	Section B (Either or Choice	Section C (Either/ or Choice)	Total Marks	% of (Marks without choice)	Consolidated %
K1	5			5	3.6	4
K2	5	20		25	17.8	18
K3		30	32	62	44.3	44
K4			48	48	34.3	34
Marks	10	50	80	140	100	100
NB: Higher level of performance of the students is to be assessed by attempting higher level of K levels.						

Summative Examinations - Question Paper – Format

Q. No.	Unit	CO	K-level		
Answer **ALL** the questions				**PART – A**	**(10 x 1 = 10 Marks)**
1.	**Unit - I**	**CO1**	**K1**		
				a)	b)
				c)	d)
2.	**Unit - I**	**CO1**	**K2**		
				a)	b)
				c)	d)
3.	**Unit - II**	**CO2**	**K1**		
				a)	b)
				c)	d)
4.	**Unit - II**	**CO2**	**K2**		
				a)	b)
				c)	d)
5.	**Unit - III**	**CO3**	**K1**		
				a)	b)
				c)	d)
6.	**Unit - III**	**CO3**	**K2**		
				a)	b)
				c)	d)
7.	**Unit - IV**	**CO4**	**K1**		
				a)	b)
				c)	d)
8.	**Unit - IV**	**CO4**	**K2**		
				a)	b)
				c)	d)
9.	**Unit - V**	**CO5**	**K1**		
				a)	b)
				c)	d)
10.	**Unit - V**	**CO5**	**K2**		
				a)	b)
				c)	d)

Answer **ALL** the questions		**PART – B**		**(5 x 5 = 25 Marks)**
11. a)	**Unit - I**	**CO1**	**K2**	
		OR		
11. b)	**Unit - I**	**CO1**	**K2**	
12. a)	**Unit - II**	**CO2**	**K3**	
		OR		
12. b)	**Unit - II**	**CO2**	**K3**	
13. a)	**Unit - III**	**CO3**	**K2**	
		OR		
13. b)	**Unit - III**	**CO3**	**K2**	
14. a)	**Unit - IV**	**CO4**	**K3**	
		OR		
14. b)	**Unit - IV**	**CO4**	**K3**	
15. a)	**Unit - V**	**CO5**	**K3**	
		OR		
15. b)	**Unit - V**	**CO5**	**K3**	

Answer **ALL** the questions		**PART – C**		**(5 x 8 = 40 Marks)**
16. a)	**Unit - I**	**CO1**	**K3**	
		OR		
16. b)	**Unit - I**	**CO1**	**K3**	
17. a)	**Unit - II**	**CO2**	**K4**	
		OR		
17. b)	**Unit - II**	**CO2**	**K4**	
18. a)	**Unit - III**	**CO3**	**K3**	
		OR		
18. b)	**Unit - III**	**CO3**	**K3**	
19. a)	**Unit - IV**	**CO4**	**K4**	
		OR		
19. b)	**Unit - IV**	**CO4**	**K4**	
20. a)	**Unit - V**	**CO5**	**K4**	
		OR		
20. b)	**Unit - V**	**CO5**	**K4**	

Course Name	Microbial Quality Control and Testing			
Course Code	23UMBSC61	**L**	**P**	**C**
Category	Skill	2	-	2

COURSE OBJECTIVES:

- To understand the use of various advanced techniques for application in the field of quality control and quality assurance
- Tocultivateskillsinvolvedexecutionofmicrobiologicaltechniquesandtodevelop the good laboratory practices
- To ensure the food safety regulations and its standards
- To acquire knowledge on laboratory testing, Control & safety process.
- To analyze microbial standards to establish the quality of food products.

UNIT - I Microbial quality control **6**

Microbial quality control: definition, history and introduction. Standard Methods involved in assessment of microbial quality control. Q.A and Q.C definitions and importance. Traditional Microbiological Quality Controlling methods: Sampling methods, TVC, APC and serial dilution techniques. Good laboratory practices, Good microbiological practices.

UNIT - II Instruments associated in QC & QA **6**

Instruments associated in QC & QA: Principle involved, working conditions, uses and precautions of Laminar Air Flow (LAF), Autoclave, Incubator, pH meter, Colony counter, Hot air oven, Centrifuges, colorimeter/ spectrophotometer, ELISA and storage devices. Methodology of Disinfection, Autoclaving &Incineration.

UNIT - III Culture media used in QC and QA **6**

Culture media used in QC and QA: Design of specialized media for identification of pathogens. Good laboratory practices in culture media preparation: raw material, water, pH. Uses of media. Enrichment culture technique, Detection of specific microorganisms - on XLD agar, Salmonella Shigella Agar, Mannitol salt agar, EMB agar, Mac Conkey Agar, Saboraud Dextrose Agar.

UNIT - IV Determining Microbes in Pharmaceutical Samples **6**

Determining Microbes in Pharmaceutical Samples: Sterility testing for pharmaceutica l products, Bioburden, pyrogen test, In process and final process control, safety and sterility test.

UNIT - V HACCP **6**

HACCP for Food Safety and Microbial Standards: Hazard analysis of critical control point (HACCP) - Principles, flow diagrams, limitations. Microbial Standards for Different Foods and Water – BIS standards for common foods and drinking water. Ascertaining microbial quality of milk by MBRT, Rapid detection methods of microbiological quality of milk at milk collection centers**.**

Total Lecture Hours **30**

BOOKS FOR STUDY:

- W.B. Hugo & A.D. Russell.(1998).Pharmaceutical Microbiology.6thEdition. Blackwell scientifi Publications.
- Kulkarni A. K. Bewoor V. A. ()Quality Control, Wiley India Pvt. Ltd,
- Chandrakant Kokare (2016). Pharmaceutical Microbiology, 1st Edition, Nirali
- Publication.
- Brown. M.R.W. (2017).Microbiological Quality Assurance
- AGuideTowardsRelevanceandReproducibilityofInocula,1stEdition.CRC press
- DevRaj Rakesh Sharma And VK Joshi(2011).Quality Control For Value Addition In Foo Processing, New India Publishing Agency.

BOOKS FOR REFERENCES:

- Rosamund M.Baird, Norman A. Hodges, Stephen P.Denyer. (2000). Hand book of Microbiological Quality Control in Pharmaceuticals and Medical Devices. 1stEdition, CRC Press
- Konieczka, (2012). Quality Assurance and Quality Control in the Analytical ChemicalLaboratoryAPracticalApproach(Hb),Routledge,TaylorandFrancis group
- SinghGajjar,Budhrani,Usman.(2021).QualityControlAndQualityAssurance (M.Pharm) SVikas And Company.
- DavidRoesti,MarcelGoverde(2019).PharmaceuticalMicrobiologicalQuality AssuranceandControl:PracticalGuideforNon-SterileManufacturing,Wiley publication.
- AmihudKramerBernardA.Twigg(2017).QualityControlForTheFoodIndustry Fundamentals & Applications (Vol.1) 3rd Edition, MEDTEC publication.

WEB RESOURCES:

- **https://www.study.com/microbiology-quality-control-testing-definition-procedures**
- **https://www.sigmaaldrich.com**
- **https://www.coursera.org**
- **https://www.atcc.org**
- **https://www.fao.org**

Nature of Course	EMPLOYABILITY		SKILL ORIENTED		ENTREPRENEURSHIP	✓				
Curriculum Relevance	LOCAL		REGIONAL		NATIONAL		GLOBAL	✓		
Changes Made in the Course	Percentage of Change		No Changes Made		New Course	✓				

***Treat 20% as each unit (20*5=100%) and calculate the percentage of change for the course.**

COURSE OUTCOMES:		K LEVEL
After studying this course, the students will be able to:		
CO1	Understand the theoretical assessment of microbial quality methods and its good laboratory practices.	K1 to K4
CO2	Describe the microbiological aspects of quality control of food and pharmaceutical products.	K1 to K4
CO3	Explain the identification of pathogenic microorganisms and good laboratory practices.	K1 to K4
CO4	Acquire the knowledge of different sterility test for the pharmaceutical products.	K1 to K4
CO5	Illustrate the safety concern management and regulations of food and pharmaceutical industry and learn the basic standard methods and procedures for the microbiological analysis of food.	K1 to K4

MAPPING WITH PROGRAM OUTCOMES:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	M	L	S	M	S	M	S	M	L
CO2	M	M	L	M	S	M	M	S	M	M
CO3	M	M	M	M	M	S	M	M	M	M
CO4	M	L	M	M	S	S	M	M	M	S
CO5	M	M	M	M	S	M	M	M	M	M

S- STRONG M – MEDIUM L - LOW

CO / PO MAPPING:

COS	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	1	3	2	2	2
CO 2	2	2	2	2	2
CO 3	2	2	3	2	3
CO 4	2	2	3	3	2
CO 5	2	1	3	3	3
WEIGHTAGE	9	10	13	12	12
WEIGHTED PERCENTAGE OF COURSE CONTRIBUTION TO POS	60%	66.6%	86.6%	80 %	80%

LESSON PLAN:

UNIT	Microbial Quality Control and Testing	HRS	PEDAGOGY
I	Microbial quality control: definition, history and introduction. Standard Methods involved in assessment of microbial quality control. Q.A and Q.C definitions and importance. Traditional Microbiological Quality Controlling methods: Sampling methods, TVC, APC and serial dilution techniques. Good laboratory practices, Good microbiological practices.	6	Chalk & Talk,PPT

II	Instruments associated in QC & QA: Principle involved, working conditions, uses and precautions of Laminar Air Flow (LAF), Autoclave, Incubator, pH meter, Colony counter, Hot air oven, Centrifuges, colorimeter/ spectrophotometer, ELISA and storage devices. Methodology of Disinfection, Autoclaving &Incineration.	**6**	**Chalk & Talk,PPT**
III	Culture media used in QC and QA: Design of specialized media for identification of pathogens. Good laboratory practices in culture media preparation: raw material, water, pH. Uses of media. Enrichment culture technique, Detection of specific microorganisms - on XLD agar, Salmonella Shigella Agar, Mannitol salt agar, EMB agar, Mac Conkey Agar, Saboraud Dextrose Agar	**6**	**Chalk & Talk,PPT**
IV	Determining Microbes in Pharmaceutical Samples: Sterility testing for pharmaceutica l products, Bioburden, pyrogen test, In process and final process control, safety and sterility test.	**6**	**Chalk & Talk,PPT**
V	HACCP for Food Safety and Microbial Standards: Hazard analysis of critical control point (HACCP) - Principles, flow diagrams, limitations. Microbial Standards for Different Foods and Water – BIS standards for common foods and drinking water. Ascertaining microbial quality of milk by MBRT, Rapid detection methods of microbiological quality of milk at milk collection centers**.**	**6**	**Chalk & Talk,PPT**

Learning Outcome Based Education & Assessment (LOBE)
Formative Examination - Blue Print
Articulation Mapping – K Levels with Course Outcomes (COs)

Internal	**Cos**	**K Level**	**Section A**	
			MCQs	
			No. of. Questions	**K - Level**
CI AI	**CO1**	**K1 – K2**	**25**	**K1,K2**
	CO2	**K1 – K2**	**25**	**K1,K2**
CI AII	**CO3**	**K1 – K2**	**25**	**K1,K2**
	CO4	**K1 – K2**	**25**	**K1,K2**
Question Pattern CIA I & II		**No. of Questions to be asked**	**50**	
		No. of Questions to be answered	**50**	
		Marks for each question	**1**	
		Total Marks for each section	**50**	

* Two Formative examinations will be conducted as a part of Continuous Internal Assessment under which, 50 MCQ's will be asked [50X1=50 marks] from any 4 CO's. (Ist Test-2 CO's & IInd Test-2 CO's) in equal weightage

Distribution of Marks with K Level CIA I & CIA II					
	K Level	**Section A (Multiple Choice Questions)**	**Total Marks**	**% of (Marks without choice)**	**Consolidate of %**
CIA I	**K1**	**30**	**30**	**60**	**100**
	K2	**20**	**20**	**40**	
	K3				
	K4				
	Marks	**50**	**50**	**100**	**100**
CIA II	**K1**	**30**	**30**	**60**	**100**
	K2	**20**	**20**	**40**	
	K3				
	K4				
	Marks	**50**	**50**	**100**	**100**

K1- Remembering and recalling facts with specific answers

K2- Basic understanding of facts and stating main ideas with general answers

K3- Application oriented- Solving Problems

K4- Examining, analyzing, presentation and make inferences with evidences

CO5 will be allotted for individual Assignment which carries five marks as part of CIA component.

Summative Examination – Blue Print Articulation Mapping – K Level with Course Outcomes (COs)				
S. No	COs	K - Level	Section A (MCQs)	
			No. of Questions	K – Level
1	CO1	K1-K2	15	K1,K2
2	CO2	K1-K2	15	K1,K2
3	CO3	K1-K2	15	K1,K2
4	CO4	K1-K2	15	K1,K2
5	CO5	K1-K2	15	K1,K2
No. of Questions to be Asked			75	
No. of Questions to be answered			75	
Marks for each question			1	
Total Marks for each section			75	
(Figures in parenthesis denotes, questions should be asked with the given K level)				

In summative examinations, 75 MCQ's will be asked [75X1=75 marks] from all 5 CO's in equal weightage.

Distribution of Marks with K Level				
K Level	Section A (Multiple Choice Questions)	Total Marks	% of (Marks without choice)	Consolidated %
K1	40	40	53	100
K2	35	35	47	
K3				
K4				
Marks		75	100	100
NB: Higher level of performance of the students is to be assessed by attempting higher level of K levels.				