MOTHER TERESA WOMEN'S UNIVERSITY
KODAIKANAL-624101

DEPARTMENT OF MICROBIOLOGY

B.Sc.MICROBIOLOGY
Curriculum Framework, Syllabus, and Regulations
(Based on TANSCHE Syllabus under choice Based Credit System–CBCS)

(For the candidates to be admitted from the Academic Year 2023-2024)

B.Sc. MICROBIOLOGY

About the Programme

Our B.Sc. Microbiology is a 3 years undergraduate program and the syllabus is divided into six semesters offering a strong foundation of microbiological concepts. This program involves the study of microorganisms with particular emphasis on the biology of bacteria, viruses, fungi and protozoan parasites. It emphasizes on understanding microorganisms and their interrelationships with other organisms in nature. Students in the microbiology degree program study the background and current findings in the field of microbiology and also acquire the critical thinking skills and the hands-on laboratory and field skills required to succeed in science.

LEARNING OUTCOMES-BASED CURRICULUM FRAMEWORK GUIDELINES BASED REGULATIONS FOR UNDER GRADUATE PROGRAMME	
Programme:	**B.Sc. MICROBIOLOGY**
Programme Code:	**U23MB**
Duration:	**3 Years (UG)**
Programme Outcomes:	**PO1: Disciplinary knowledge:** Capable of demonstrating comprehensive knowledge and understanding of one or more disciplines that form apart of an undergraduate Programme of study **PO2: Communication Skills:** Ability to express thoughts and ideas effectively in writing and orally; Communicate with others using appropriate media; confidently share one's views and express herself / himself; demonstrate the ability to listen carefully, read and write analytically, and present complex information in a clear and concise manner to different groups. **PO3: Critical thinking:** Capability to apply analytic thought to a body of knowledge; analyse and evaluate evidence, arguments, claims, beliefs on the basis of empirical evidence; identify relevant assumptions or implications; formulate coherent arguments; critically evaluate practices, policies and theories by following scientific approach to knowledge development. **PO4: Problem solving:** Capacity to extrapolate from what one has learned and apply their competencies to solve different kinds of non-familiar problems, rather than replicate curriculum content knowledge; and apply one's learning to real life situations. **PO5: Analytical reasoning**: Ability to evaluate there liability and relevance of evidence; identify logical flaws and holes in the argumentsof others; analyze and synthesize data from a variety of sources; draw valid conclusions and support them with evidence and examples, and addressing opposing viewpoints.

	PO6: Research-related skills: A sense of inquiry and capability for asking relevant/appropriate questions, problem arising, synthesising and articulating; Ability to recognise cause-and-effect relationships, define problems, formulate hypotheses, test hypotheses, analyse, interpret and draw conclusions from data, establish hypotheses, predict cause-and-effect relationships; ability to plan, execute and report the results of anexperiment or investigation. **PO7: Cooperation/Team work:** Ability to work effectively and respectfully with diverse teams; facilitate cooperative or coordinated effort on the part of a group, and act together as a group or a team in the interests of a common cause and work efficiently as a member of a team. **PO8: Scientific reasoning**: Ability to analyse, interpret and draw conclusions from quantitative/qualitative data; and critically evaluateideas, evidence and experiences from an open-minded and reasoned perspective. **PO9: Reflective thinking**: Critical sensibility to lived experiences, with self-awareness and reflexivity of both self and society. **PO10: Information/digital literacy:** Capability to use ICT in a variety of learning situations, demonstrate ability to access, evaluate, and use a variety of relevant information sources; and use appropriate software for analysis of data. **PO11: Self-directed learning**: Ability to work independently, identify appropriate resources required for a project, and manage a project through to completion. **PO12: Multicultural competence:** Possess knowledge of the values and beliefs of multiple cultures and a global perspective; and capability to effectively engage in a multicultural society and interact respectfully with diverse groups. **PO13: Moral and ethical awareness/reasoning**: Ability to embrace moral/ethical values in conducting one's life, formulate a position/argument about an ethical issue from multiple perspectives, and use ethical practices in all work. Capable of demonstrating the ability to identify ethical issues related to one's work, avoid unethical behaviour such as fabrication, falsification or misrepresentation of data or committing plagiarism, not adhering to intellectual property rights; appreciating environmental and sustainability issues; and adopting objective, unbiased and truthful actions in all aspects of work. **PO14: Leadership readiness/qualities:** Capability form aping out the tasks of a team or an organization, and setting direction, formulating an Inspiring vision, building a team who can help achieve the vision, motivating and inspiring team members to engage with that vision, and using management skills to guide people to the right destination, in a smooth and efficient way. **PO 15: Lifelong learning:** Ability to acquire knowledge and skills,

	including, learning how to learn, that are necessary for participating in learning activities throughout life, through self-paced and self-directed learning aimed at personal development, meeting economic, social and cultural objectives, and adapting to changing trades and demands of work place through knowledge/skill development/reskilling.
Programme Specific Outcomes:	**PSO1 –Placement:** To prepare the students who will demonstrate respectful engagement with others ideas, behaviors, beliefs and apply diverse frames of reference to decisions and actions. **PSO2-Entrepreneur:** To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate startups and high potential organizations. **PSO3–Research and Development:** Identify and utilize the tools and techniques in there search and development **PSO4 – Contribution to Business World:** To produce employable, ethical and innovative professionals to sustain in the dynamic business world. **PSO5 –Contribution to the Society:** To contribute to the development of the society by collaborating with stake holders for mutual benefit.

Eligibility*:

Candidate for admission to the first year of B.Sc. Degree Course in Microbiology shall be required to have passed the Higher Secondary Examination+2 Pass with Science Subject.

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75Marks
	Total	100Marks
Methods of Assessment		
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions	
Understand/ Comprehend (K2)	MCQ, True/ False, Short essays, Concept explanations, Short summary or Overview	
Application (K3)	Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain	
Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge	
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons	
Evaluate (K5)	Check knowledge in specific or off beat situations, Discussion, Debating or Presentations	
Create (K6)	Simple definitions, MCQ, Recall steps, Concept definitions	

Question Paper Pattern for External examination for all course papers.

Max. Marks: 75 **Time: 3Hrs.**

S.No.	Part	Type	Marks
1	**A**	**10*1 Marks=10** Multiple Choice Questions (MCQs): 2 questions from each Unit	**10**
2	**B**	**5*4=20** Two questions from each Unit with Internal Choice (either/or)	**20**
3	**C**	**3*15=45** Open Choice: Any three questions out of 5: one question from each unit	**45**
Total Marks			**75**

***Minimum credits required to pass:140**

Project Report

A student should select a topic for the Project Work at the end of the fifth semester itself and submit the Project Report at the end of the sixth semester. The Project Report shall not exceed 75 typed pages in Times New Roman font with 1.5-line space.

There is a Viva Voce Examination for Project Work. The Guide and an External Examiner shall evaluate and conduct the Viva Voce Examination. The Project Work carries 100 marks (Internal: 25Marks; External (Viva):75 Marks).

Conversion of Marks to Grade Points and Letter Grade (Performance in a Course/Paper)

Range of Marks	Grade Points	Grade	Description
90–100	9.0–10.0	O	Outstanding
80-89	8.0–8.9	D+	Excellent
75-79	7.5–7.9	D	Distinction
70-74	7.0–7.4	A+	Very Good
60-69	6.0–6.9	A	Good
50-59	5.0–5.9	B	Average

Attendance

Students must have earned 75% of attendance in each course for appearing for the examination. Students with 71% to 74% of attendance must apply for condonation in the prescribed form with prescribed fee. Students with 65% to 70% of attendance must apply for condonation in the prescribed form with the prescribed fee along with the Medical Certificate. Students with attendance lesser than 65% are not eligible to appear for the examination and they shall re-do the course with

the prior permission of the Head of the Department, Principal and the Registrar of the University.

Maternity Leave

The student who avails maternity leave may be considered to appearfortheexaminationwiththeapprovalofStaffi/c,HeadoftheDepartment,ControllerofExaminationa ndthe Registrar.

AnyOtherInformation

Inadditiontotheabovementionedregulations,anyothercommonregulationspertainingtothe UGProgrammesare alsoapplicableforthis Programme.

2023 – Syllabus

SEMESTER-I								
Course Code	**Course Title**	**Hours**			**Credits**	**CIA**	**ESE**	**Total**
		L	**T**	**P**				
U23TAL101/ U23MAL101/ U23FRL101/ U23HIL101	Language – 1: Tamil / Malayalam/French/Hindi	3	3		3	25	75	100
U23ENL101	Language2-English	3	3		3	25	75	100
U23MBT101	Core Theory – 1: Fundamentals of Microbiology and Microbial Diversity	3	2		5	25	75	100
U23MBP102	CorePractical – 2: Fundamentals of Microbiology and Microbial Diversity			5	5	25	75	100
U23MBE11A /U23MBE11B	Department Elective 1: A. Basic and Clinical Biochemistry/ B. DevelopmentalBiology	2	2		3	25	75	100
U23MBS101	Skill Enhancement Course 1 -Social and Preventive Medicine (NME)		2		2	25	75	100
U23MBF101	Foundation Course- Extremophiles		2		2	25	75	100
	Total	**30**			**23**	**-**	**-**	**700**
SEMESTER-II								
U23TAL202/ U23MAL202/	Language – 1: Tamil / Malayalam/French/Hindi	3	3		3	25	75	100

U23FRL202/ U23HIL202								
U23ENL202	Language 2: English	3	3		3	25	75	100
U23MBT203	Core Theory – 3: Microbial Physiology and Metabolism	3	2		5	25	75	100
U23MBP204	Core Practical – 4:Microbial Physiology and Metabolism			5	5	25	75	100
U23MBE22A/ U23MBE22B/U23 MBE22C	Department Elective-2 A – Bio Instrumentation / B – Human Physiology/ C- Nutrition & Health Hygiene	2	2		3	25	75	100
U23MBS202	Skill Enhancement Course2 Soft Skills (NME)		2		2	25	75	100
U23MBNM21	**NaanMudhalvan Course - 1**	2			2	25	75	100
U23MBS203	Skill Enhancement Course 3 - Sericulture		2		2*	25	75	100
	Total	**30**			**23**	**-**	**-**	**700**
SEMESTER-III								
Course Code	**CourseTitle**	**Hours**			**Credits**	**CIA**	**ESE**	**Total**
		L	**T**	**P**				
U23TAL303/ U23MAL303/ U23FRL303/ U23HIL303	Language – 1: Tamil / Malayalam/French/Hindi	3	3		3	25	75	100
U23ENL303	Language2-English	3	3		3	25	75	100
U23MBT305	CoreTheory –5: **Molecular Biology and Microbial Genetics**	3	2		5	25	75	100
U23MBP306	CoreTheort – 6: PracticalIII- **Molecular Biology and Microbial Genetics**			5	5	25	75	100
U23MBE33A	Skill Based Elective 3 Allied - Biophysics & Biostatistics	2	2		3	25	75	100
U23MBS304	SkillEnhancementCourse 4 (**SBE- Organic Farming and Biofertilizer Technology)**		2		1	25	75	100
U23MBNM32	**NaanMudhalvan Course - 2**		2		2	25	75	100
	Total	**30**			**22**	**-**	**-**	**700**
SEMESTER-IV								

U23TAL404/ U23MAL404/ U23FRL404/ U23HIL404	Language – 1: Tamil / Malayalam/French/Hindi	3	3		3	25	75	100
U23ENL404	Language2-English	3	3		3	25	75	100
U23MBT407	CoreTheory – 7: **Immunology and Immunotechnology**	3	2		5	25	75	100
U23MBP408	CorePractical – 8: **Immunology and Immunotechnology**			5	5	25	75	100
U23MBE44A	Skill Based Elective 4 Allied - Biophysics & Biostatistics Practical	2	1		3	25	75	100
U23MBS405	Skill Enhancement Course5		2		2	25	75	100
U23MBNM43	**NaanMudhalvan Course - 3**		2		2	25	75	100
U23EVS401	Environmental Science		2		2	25	75	100
	Total	**31**			**25**	**-**	**-**	**800**
SEMESTER-V								
Course Code	**CourseTitle**	**Hours**			**Credits**	**CIA**	**ESE**	**Total**
		L	**T**	**P**				
U23MBT509	Core Theory – 9: **Bacteriology and Mycology**	3	2		4	25	75	100
U23MBT510	Core Theory – 10: **Virology and Parasitology**	3	2		4	25	75	100
U23MBP511	Core Practical – 11: **Practical V - Bacteriology and Mycology & Virology and Parasitology**			5	4	25	75	100
U23MBPR51	Core - Project : **Group project with viva- voce**			5	4	25	75	100
U23MBE55A	Subject based Elective 5: **Recombinant DNA Technology**	2	1		3	25	75	100
U23MBE56A	Subject based Elective 6: **Biosafety & Bioethics**	2	1		3	25	75	100
U23VAE501	**Value Education**		2		2	25	75	100
U23MBNM54	NaanMudhalvan Course - 4		2		2	25	75	100
U23MBI501	Internship/ Industrial visit/ Field visit		-		2	25	75	100
		30			**28**	**-**	**-**	**800**
SEMESTER-VI								
U23MBT612	Core Theory – 12:**Environmental and Agriculture Microbiology**	3	3		4	25	75	100

U23MBT613	Core Theory – 13: **Food and Dairy Microbiology**	3	3		4	25	75	100
U23MBP614	Core Practical –14: **Environmental and Food Microbiology**			6	4	25	75	100
U23MBE67A	Subject based Elective 7: **Pharmaceutical Microbiology**	3	2		3	25	75	100
U23MBE68A	Subject based Elective 8: **Entrepreneurship and Bio-Business**	3	2		3	25	75	100
U23EAS601	**Extension Activity**		-		1	25	75	100
U23MBNM65	**NaanMudhalvan Course - 5**		2		2	25	75	100
	Total	**30**			**21**	**-**	**-**	**700**

FIRST YEAR
SEMESTER I

Subject Code	**SubjectName**	**Category**	**L**	**T**	**P**	**S**	**Credits**	**Inst. Hours**	**Marks**		
									CIA	**External**	**Total**
U23MBT101	**Fundamentals of Microbiology and Microbial Diversity**	**Core Course–1**	**Y**	**Y**	**-**	**-**	**5**	**5**	**25**	**75**	**100**

Course Objectives	
CO1	Learnthefundamentalprinciplesaboutdifferentaspectsof Microbiologyincludingrecentdevelopment sin the area.
CO2	Describethestructuralorganization,morphologyandreproductionofmicrobes.
CO3	Explainthemethodsof cultivationofmicrobesand measurementofgrowth.
CO4	Understand the microscopyand otherbasic laboratorytechniques– culturing, disinfectionandsterilization in Microbiology.
CO5	Compareandcontrastthedifferentmethodsofsterilization.

UNIT	Details	No.of Hours	Course Objectives
I	History and Evolution of Microbiology, Classification – Threekingdom,fivekingdom,sixkingdomandeightkingdom.Microbialbiodiversity: Introduction to microbial biodiversity-ecologicalniche.BasicconceptsofEubacteria,Archaebacteria andEucarya.ConservationofBiodiversity.	15	CO1
II	General characteristics of cellular microorganisms (Bacteria,Algae, Fungi and Protozoa) and acellular microorganisms - (Viruses,Viroids,Prions),Differencesbetweenprokaryoticandeukaryoticmicroorganisms.StructureofBacterialcellwall,cellmembrane,capsule,flagella,pili,mesosomes,chlorosomes,phycobilisomes,spores,andgasvesicles.Structureoffungi(MoldandYeast),Structureofmicroalgae.	15	CO2
III	Bacterialculturemediaandpureculturetechniques.Modeofcelldivision,Quantitativemeasurementofgrowth.Anaerobic Culturetechniques.	15	CO3
IV	Microscopy – Simple, bright field, dark field, phase contrast,fluorescent, electron microscope – TEM & SEM, Confocalmicroscopy,andAtomicForceMicroscopy.Stainsandstainingmethods.	15	CO4
V	Sterilization–moistheat- autoclaving,dry heat–Hotairoven,radiation–UV,Ionization,filtration–membranefilteranddisinfection, antiseptic; Antimicrobialagents.	15	CO5
	Total	75	

CourseOutcomes		
Course Outcomes	Oncompletionofthiscourse,studentswill;	
CO1	Studythehistoricaleventsthatledtothediscoveriesandinventionsandunderstandtheclassificationofmicroorganisms.	PO5,PO6, PO10
CO2	GainKnowledgeofdetailedstructureandfunctionsof Prokaryoticcellorganelles.	PO10
CO3	Understandthe variousmicrobiologicaltechniques, differenttypesofmedia,andtechniquesinvolvedinculturingmicroorganisms.	PO11
CO4	Explaintheprinciplesandworkingmechanismofdifferentmicroscopes/Microscope,theirfunctionandscopeofapplication.	PO4,PO11
CO5	Understandtheconceptofasepsisandmodesofsterilizationanddisinfectants**.**	PO4,PO11

TextBooks	
1	Pelczar.M. J., Chan E.C.S. and Noel. R.K. (2007). Microbiology. 7thEdition. McGraw –Hill, New York.
2	Willey J., Sherwood L., and Woolverton C. J., (2017). Prescott's Microbiology. 10th Edition., McGraw-Hill International edition.

3	Tortora, G.J., Funke, B.R., Case,C.L. (2013). Microbiology. An Introduction 11thEdition., A La Carte Pearson.
4	Salle. A.J (1992). Fundamental Principles of Bacteriology. 7thEdition., McGraw Hill Inc. New York.
5	Boyd, R.F. (1998). General Microbiology,2ndEdition., Times Mirror, Mosby CollegePublishing, St Louis.
References Books	
1	Jeffrey C. Pommerville., Alcamo's Fundamentals of Microbiology (9thEdition). Jones &Bartlett learning 2010.
2	Stanier R.Y, Ingraham J. L., Wheelis M. L., and Painter R. R. (2010). General Microbiology, 5thEdition., MacMillan Press Ltd
3	Tortora, G.J., Funke, B.R. and, Case, C.L (2013). Microbiology-An Introduction, 11thEdition., Benjamin Cummings.
4	Nester E., Anderson D., Roberts C. E., and Nester M. (2006). Microbiology-A Human Perspective, 5thEdition., McGraw Hill Publications.
5	Madigan M.T., Martinko J.M., Stahl D.A, and Clark D. P. (2010). Brock - Biology of Microorganisms, 13th Edition Benjamin-Cummings Pub Co.
WebResources	
1	https://www.cliffsnotes.com/study-guides/biology/microbiology/introduction-to-microbiology/a-brief-history-of-microbiology
2	https://www.keyence.com/ss/products/microscope/bz-x/study/principle/structure.jsp
3	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6604941/#
4	https://bio.libretexts.org/@go/page/9188
5	https://courses.lumenlearning.com/boundless-microbiology/chapter/microbial-nutrition/

MappingwithProgrammeOutcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1					M	M				M	
CO2										M	M
CO3											S
CO4				M							S
CO5				M							S

SubjectCo	SubjectN	Category	L	T	P	S	Credits	Inst.	Marks

de	ame							Hours	CIA	External	Total
U23MBP102	**Practical I-Fundamentals of Microbiologyand Microbial Diversity**	**CoreCourseII-Practical**	**-**	**-**	**Y**	**-**	**5**	**5**	**25**	**75**	**100**

CourseObjectives	
CO1	Acquireknowledgeon Cleaningofglass wares,GLP andsterilization.
CO2	Gainknowledgeonmediapreparationandculturalcharacteristics.
CO3	Learnthepureculturetechnique
CO4	Learnthemicroscopictechniquesandstaining methods.
CO5	Acquireknowledgeon stain and staining methods

UNIT	**Details**	**No.of Hours**	**Course Objectives**
I	Cleaningofglasswares,Microbiologicalgoodlaboratorypractice and safety. Sterilization and assessment ofsterility– Autoclave,hotairoven,andmembranefiltration.	15	CO1
II	Mediapreparation:liquidmedia,solidmedia,semi-solidmedia,agarslants,agardeeps,agarplates.	15	CO2
III	Preparationofbasal,differential,enriched,enrichment,transport, and selective media preparation- quality controlof media, growth supporting properties, sterility check ofmedia. Pureculturetechniques:streakplate,pourplate,decimal dilution.	15	CO3
IV	Culturecharacteristicsofmicroorganisms:growthondifferentmedia,growthcharacteristics,anddescription.Demonstrationofpigment production. Microscopy:lightmicroscopyandbrightfieldmicroscopy.	15	CO4
V	Stainingtechniques:smearpreparation,simplestaining,Gram'sstaining and endosporestaining. StudyonMicrobialDiversityusingHayInfusionBroth-Wetmounttoshowdifferenttypesofmicrobes,hangingdrop.	15	CO5
	Total	75	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Practice sterilization methods; learn to prepare media and their Quality control.	PO4,PO7, PO8, PO9,PO11
CO2	Learn streak plate, pour plate and serial dilution and pigment Production of microbes.	PO4,PO7, PO8, PO9
CO3	Understand Microscopy methods, different Staining Techniques and motility test.	PO4,PO7, PO8, PO9,PO11

CO4	Observe culture characteristics of microorganisms.	PO4,PO7, PO8, PO9
CO5	Study on Microbial Diversity using Hay Infusion Broth Wetmount	PO4, PO7, PO8,PO9
Text Books		
1	James G Cappucino and N. Sherman MB(1996). A lab manual Benjamin Cummins, New York 1996.	
2	Kannan. N (1996). Laboratory manual in General Microbiology. Palani Publications.	
3	Sundararaj T (2005). Microbiology Lab Manual (1st edition) publications.	
4	Gunasekaran, P. (1996). Laboratory manual in Microbiology. New Age International Ld., Publishers, New Delhi.	
5	R C Dubey and D K Maheswari (2002). Practical Microbiology. S. Chand Publishing.	
References Books		
1	Atlas.R (1997). Principles of Microbiology, 2nd Edition, Wm.C.Brown publishers.	
2	Amita J, Jyotsna A and Vimala V (2018). Microbiology Practical Manual. (1st Edition). Elsevier India	
3	Talib VH (2019). Handbook Medical Laboratory Technology. (2nd Edition). CBS	
4	Wheelis M, (2010). Principles of Modern Microbiology, 1st Edition. Jones and Bartlett Publication.	
5	Lim D. (1998). Microbiology, 2ndEdition, WCB McGraw Hill Publications	
WebResources		
1	http://www.biologydiscussion.com/micro-biology/sterilisation-and-disinfection-methods-and-principles-microbiology/24403.	
2	https://www.ebooks.cambridge.org/ebook.jsf?bid=CBO9781139170635	
3	https://www.grsmu.by/files/file/university/cafedry//files/essential_microbiology.pdf	
4	https://microbiologyinfo.com/top-and-best-microbiology-books/	
5	https://www.cliffsnotes.com/studyguides/biology/microbiology/introduction-to-microbiology/a-brief-history-of-microbiology	

MappingwithProgrammeOutcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1				M			L	M	L		M
CO2				S			L	L	L		
CO3				S			M	M	L		M
CO4				S			M	L	L		
CO5				S			M	L	L		

Subject Code	Subject Name	Category	L	T	P	S	Credits	Inst.Hours	Marks		
									CIA	External	Total
U23MBE11A	**Basic andClinicalBiochemistry**	Department Elective 1 (Choice 1)	**Y**	**Y**	**-**	**-**	**3**	**4**	**25**	**75**	**100**

CourseObjectives	
CO1	Attainthoroughknowledgeoncarbohydratesandlipids,theircharacteristicpropertiesandorganization in carryingout all theliving functionswhich constitute thelife.
CO2	Explainthebiologicalactivityofaminoacidsand proteins.
CO3	Identifythemetabolicerrorsinenzymesof carbohydratesandlipids.
CO4	Describethedisordersinaminoacid metabolism.
CO5	Interprettheconsequences,biochemical,clinicalfeatures,diagnosisandtreatmentofmetabolicdiseases of day today life.

UNIT	Details	No.of Hours	Course Objectives
I	Biomolecules-Carbohydrate– Generalproperties,function,structure, classification– monosaccharides (Glucose, Fructose,Galactose),Oligoaccharides(Sucrose,Maltose,Lactose) andpolysaccharides (Starch, Glycogen,) and biological significance.Lipids – General properties, functions, structure, classification(Simple,DerivedandComplex),Cholesterol,LDL,HDL–biologicalsignificance.	12	CO1
II	Biomolecules-Aminoacids– Generalproperties,functions,structure,classificationandbiologicalsignificance.Proteins– Generalstructure,Properties,functions,classificationandbiologicalsignificance.	12	CO2
III	DisordersofMetabolism:Disordersofcarbohydratemetabolism:diabetes mellitus, ketoacidosis, hypoglycemia, glycogenstoragediseases,galactosemiaandlactoseintolerance.Disordersoflipidmetabolism: hyperlipidemia, hyperlipoproteinemia,hypercholesterolemia,hyper triglyceridemia, sphingolipidosis.	12	CO3
IV	**DisordersofMetabolism**: Disordersofamino acidmetabolism: alkaptonuria, phenylketonuria, phenylalaninemia, homocystineuria,tyrosinemia,aminoacidurias.	12	CO4
V	**Evaluation of organ function tests**: Assessment and clinicalmanifestationsofrenal,hepatic,pancreatic,gastricandintestinalfunctions.**Diagnosticenzymes**:Principlesofdiagnosticenzymology. Clinical significance of aspartate aminotransferase,alanine aminotransferase, creatine kinase, aldolase and lactatedehydrogenase.	12	CO5
	Total	60	

CourseOutcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Explain the structure, classification, biochemical functions and significance of carbohydrates and lipids	PO1
CO2	Differentiate essential and non-essential amino acids, biologically important modified amino acids and their functions, Illustrate the role, classification of Proteins and recognize the structural level organization of proteins, its functions and denaturation.	PO1
CO3	Assess defective enzymes and Inborn errors. Recognize diseases related to carbohydrate and lipid metabolism	PO4,PO5, PO6
CO4	Discuss and evaluate the pathology of aminoacid metabolic disorders.	PO4,PO5, PO6
CO5	Appraise the imbalances of enzymes in organ function and relate the role of Clinical Biochemistry in screening and diagnosis.	PO5,PO6, PO9
TextBooks		
1	Satyanarayana, U. and Chakrapani, U(2014).Biochemistry,4th Edition, Made SimplePublisher.	
2	Jain J L, Sunjay Jain and Nitin Jain (2016).Fundamentals of Biochemistry, 7th Edition,S ChandCompany.	
3	AmbikaShanmugam's(2016).FundamentalsofBiochemistryforMedicalStudents,8th Edition.Wolters KluwerIndia Pvt Ltd.	
4	Vasudevan. D.M. Sreekumari. S, KannanVaidyanathan (2019). Textbook Of Biochemistry For Medical Students. Kindle edition, Jaypee Brothers Medical Publishers	
5	Jeremy M. Berg,LubertStryer, John L. Tymoczko, Gregory J. Gatto (2015). Biochemistry, 8th edition. WH Freeman publisher.	
	ReferencesBooks	
1	AmitKessel&Nir Ben-Tal (2018). Introduction to Proteins: structure, function and motion. 2ndEdition, Chapman and Hall.	
2	David L. Nelson and Michael M. Cox (2017). Lehninger Principles of Biochemistry, 7thEdition W.H. Freeman and Co., NY.	
3	LupertStyrer, Jeremy M. Berg, John L. Tymaczko, Gatto Jr., Gregory J (2019). Biochemistry. 9thEdition, W.H.Freeman& Co. New York.	
4	Donald Voet, Judith Voet, Charlotte Pratt (2016). Fundamentals of Biochemistry: Life at the Molecular Level, 5th Edition, Wiley.	
5	Joy PP, Surya S. and Aswathy C (2015). Laboratory Manual of Biochemistry, 1stEdition, Publisher: Kerala agricultural university.	
	WebResources	
1	https://www.abebooks.com›plp	
2	https://kau.in/document/laboratory-manual-biochemistry	
3	https://metacyc.org	
4	https://www.medicalnewstoday.com	
5	https://journals.indexcopernicus.com	

MappingwithProgrammeOutcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	M										
CO2	M										
CO3				S	S	S					
CO4				S	S	S					
CO5					S	S			S		

Subject Code	**Subject Name**	**Category**	**L**	**T**	**P**	**S**	**Credits**	**Inst.Hours**	**Marks**		
									CIA	**External**	**Total**
U23MBE11B	**Developmental Biology**	Department Elective 1(Choice 2)	**Y**	**Y**	**-**	**-**	**3**	**4**	**25**	**75**	**100**

Course objective	
CO1	To understand the mechanisms of development from genes to the formation of an organism.
CO2	To understand how evolutionary processes have shaped life in its varied forms
CO3	To explore selected areas of developmental biology in depth.
CO4	To apply concepts in developmental biology to your development as a biologist.
CO5	

Unit	**Details**	**No.of Hours**	**Course Objectives**
I	**Gametogenesis:** Definition-primordial germ cells-origin-spermatogenesis-physiologicalripeningofsperm-oogenesis-previtellogenesis-vitellogenesis.	12	CO1
II	**Embryo development** –Egg size, shape, egg membranes, tertiary membranes, organization of the egg yolk, pigments, egg cortex, polarity, origin of polarity, types of eggs. Cleavage-Definition, morula, blastula, types of blastula, molecular changes, planes of cleavages, types of cleavage, factors affecting cleavage, cleavage laws, adhesion of blastomeres during cleavage, nuclei of cleaving cells, cytoplasm of cleaving cells.	12	CO2
III	**Gastrulation**: Definition, exogastrulation, metabolism and molecular changes during gastrulation, gene activities during gastrulation. Morphogenic movements- Definition, types epiboly, emboly mechanism of morphogenic movements.	12	CO3
IV	**Organogenesis:** Definition, tabulation, neurogenesis, spermatogenesis, growth and differentiation derivatives of ectoderm and mesoderm.	12	CO4

V	**Regeneration:** Definition – Types, Human Reproduction puberty, Menstrual cycle. Menopause, Pregnancy and related problems parturition and lactation	12	CO5
	Total	60	

Course Out come		
Course Outcome	Upon completion of this course, the students will be able to	
CO1	gather knowledge on gametogenesis.	K1
CO2	acquire information on egg and cleavage.	K2
CO3	recognize the importance of gastrulation	K2
CO4	understand the process of organogenesis	K2
CO5	empathize on regeneration and human reproduction	K2

Textbook	
1	Scott Gilbert. Developmental Biology. 11th ed.Sinauer Associates Inc; 2016. ISBN 13 978-1605356044.
Reference Books	
1	Verma.S and Agarwal V.K. Chordate Embryology.1st ed. S.Chand& Co. New Delhi; 2010.ISBN -13 978-8121902618.
2	Berrill.N.J. Developmental Biology .Mc.Graw Hill, New Delhi;1971.ISBN -13 978-0070050204
3	Patten, B.M. Foundations of Embryology.6th ed. Mc.Graw Hill, New Delhi; 2014. ISBN -13 978-9339205348
4	Saunders.J.W. Developmental Biology – Pattern and Principles.Macmillan New York; 1982. ISBN -13 978-0024063700.
5	Principles of EmbryologY Waddington. . Principles of Embryology. 2021.ISBN -13 9781138956995
E-references	1.https://www.e-libraryme.com/2019/12/developmental-biology.html

MappingwithProgrammeOutcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	M										
CO2	M										
CO3				S	S	S					
CO4				S	S	S					
CO5					S	S			S		

SubjectCode	**SubjectName**	**Category**	**L**	**T**	**P**	**S**	**Credits**	**Inst.Hours**	**Marks**		
									CIA	**External**	**Total**
U23MBS101	**Social andPreventive Medicine**	**SkillenhancementCourse(SEC) I**	**Y**	**-**	**-**	**-**	**2**	**2**	**25**	**75**	**100**

CourseObjectives			
CO1	Describe the concepts of health and disease and their social determinants		
CO2	Summarize the health management system		
CO3	Know about the various health care services		
CO4	Outline the goals of preventive medicine		
CO5	Gain knowledge about alternate medicine		
UNIT	**Details**	**No.of Hours**	**Course Objectives**
I	**Introduction to social medicine:** History of social medicine-concepts of health and disease-social determinants of health and disease-Health and quality of life-Health information system-measures of population health-health policies.	6	CO1
II	**Health management:** Applications of behavioral sciences and psychology in health management- nutritional programs for health management-water and sanitation in human health-national programs for communicable and non-communicable diseases- environmental and occupational hazards and their control.	6	CO2
III	**Health care and services:** Health care of the community-information, education, communication and training in health-maternal & child health-school health services- Geriatrics-care and welfare of the aged-mental health-health services through general practitioners	6	CO3
IV	**Preventive medicine:** Introduction- role of preventive medicine-levels of prevention-Risk assessment in communities and vulnerable population –surveillance, monitoring and reporting of disease outbreaks - forecasting and control measures in community setting – early detection methods.	6	CO4
V	**Prevention through alternate medicine:** Unani, Ayurveda, Homeopathy, Naturopathy systems in epidemic and pandemic outbreaks. International health regulations. Infectious disease outbreak case studies and precautionary response during SARS and MERS coronavirus, Ebola and novel SARS-COV2 outbreaks.	6	CO5
	Total	30	
CourseOutcomes			
Course Outcomes	On completion of this course, students will;		
CO1	Identify the health information system	PO1,PO5,PO6	
CO2	Associate various factors with health management system	PO1,PO2,PO3,PO5, PO6,PO9	
CO3	Choose the appropriate health care services	PO1,PO5,PO6	
CO4	Appraise the role of preventive medicine in community setting	PO4,PO5,PO6	
CO5	Recommend the usage of alternate medicine during outbreaks	PO1,PO5,PO6	
TextBooks			

1.	Park.K (2021). Textbook of preventive and social medicine, 26th edition. BanarsidasBhanot publishers.
2.	Mahajan& Gupta (2013). Text book of preventive and social medicine, 4thedition. Jaypeebrothers medical publishers.
3.	Chun-Su Yuan, Eric J. Bieber, Brent Bauer (2006). Textbook of Complementary and Alternative Medicine. Second Edition. Routledge publishers.
4.	Vivek Jain (2020). Review of Preventive and Social Medicine: Including Biostatics. 12th edition, Jaypee Brothers Medical Publishers.
5.	LalAdarshPankaj Sunder (2011). Textbook of Community Medicine: Preventive and Social Medicine, CBS publisher.
ReferencesBooks	
1	Howard Waitzkin, Alina Pérez, Matt Anderson (2021). Social Medicine and the coming Transformation. First Edition. Routledge publishers.
2	GN Prabhakara (2010). Short Textbook of Preventive and Social Medicine. Second Edition. Jaypee publishers.
3	Jerry M. Suls, Karina W. Davidson, Robert M. Kaplan (2010). Hand book of Health Psychology and Behavioral Medicine. Guilford Press
4	Marie Eloïse Muller, Marie Muller, MarthieBezuidenhout, KarienJooste (2006). Health Care Service Management. Juta and Company Ltd.
5	Geoffrey Rose (2008). .Rose's Strategy of Preventive Medicine: The Complete.OUP Oxford.
WebResources	
1	https://www.omicsonline.org/scholarly/social--preventive-medicine-journals-articles-ppts-list.php
2	https://www.teacheron.com/online-md_preventive_and_social_medicine-tutors
3	https://www.futurelearn.com
4	https://www.healthcare-management-degree.net
5	https://www.conestogac.on.health-care-administration-and-service-management

Mapping with Programme Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	S				S	S					
CO2	S	S		M	S	S			M		
CO3				M	S	S					
CO4	S			S	S	M					
CO5	S				S	S					

Subject Code	SubjectName	Category	L	T	P	S	Credits	Inst.Hours	Marks		
									CIA	External	Total
U23MBF101	**Extremophiles**	**Foundationcourse**	**Y**	**-**	**-**	**-**	**2**	**2**	**25**	**75**	**100**

CourseObjectives	
This course gives insights about the extreme habitats, extremophilic microorganisms, their adaptations and biotechnological potentials	
UNIT	**Details**
I	Definition- Bacterial extremophiles &Archea extremophiles – Factors influencing the growth of microorganisms – pH, Temperature, oxygen Requirements, Pressure and availability of water.
II	Thermophiles - classes, extremely thermophilicarchaebacteria, thermozymes, psychrophiles, psychrophilic archaelextremozymes, Molecular adaptation of extremophiles. Protein stability in extremophilic microbes.
III	Acidophiles -Mechanism of adaptation- application- sulfur cycling and acid mine drainage. Thermoacidiphiles- physical characteristics- cell wall structure. Endolith –definition- environmental condition and survival condition.
IV	Halophiles-osmoregulation, cellular adaptation, structural adaptation, molecular adaptation. Xerophiles. Radiation resistant bacteria. Barophiles- Classification, high pressure habitat, life under pressure, barophile, death under pressure.
V	Psychrophiles - Conditions for microbial life at low temperature Climate of snow and ice, limits for life at subzero temperature. Molecular adaptations to cold habitats –Membrane components and cold sensing, cold adapted enzymes, cryoprotectants and ice binding proteins, role of exopolymers in microbial adaptations to sea ice
CourseOutcomes	
Apply the knowledge to study the extremophilic microorganisms and tap their unique properties for ecological and industrial applications.	
References	
1.	Ronald M. Atlas and Richard Bartha Microbial ecology. Fundamental and applications edition
2.	Thomas D.Brock Thermophiles. General, Molecular and applied Microbiology
3.	Pelczar M.J, Chan ECS, Kreig NR, Microbiology, McGraw Hill
4.	Stanier RY, Ingharam JL., Wheelis ML., General Microbiology

SEMESTERII

Subject Code	**SubjectName**	**Category**	**L**	**T**	**P**	**S**	**Credits**	**Inst.Hours**	**Marks**		
									CIA	**External**	**Total**
U23MBT203	**MicrobialPhysiology andMetabolism**	**CoreCourseIII**	**Y**	**Y**	**-**	**-**	**5**	**5**	**25**	**75**	**100**
CourseObjectives											
CO1	Study the basic principles of microbial growth.										
CO2	Understand the basic concepts of aerobic and anaerobic metabolic pathways.										

CO3	Analyze the role of individual components in overall cell function.		
CO4	Provide information on sources of energy and its utilization by microorganisms.		
CO5	Study the different types of metabolic strategies.		
Unit	Study the basic principles of microbial growth.	**No.of Hours**	**Course Objectives**
I	Physiology of microbial growth: Batch – continuous - synchronous cultures; Growth Curve and measurement method (turbidity, biomass, and cell count). Control of microbial growth.	15	CO1
II	Nutrition requirements - Photoautotrophs, Photoorganotrophs, Chemolithotrophs (Ammonia, Nitrite, Sulfur, Hydrogen, Iron oxidizing Bacteria), Chemoorganotrophs. Nutrition transport mechanisms – Passive diffusion and Active transport. Factors affecting microbial growth.	15	CO2
III	An overview of Metabolism - Embden Meyerhof Pathway, Entner-Doudoroff Pathway, Pentose Phosphate Pathway, Tricarboxylic Acid Cycle. Electron Transport Chain and Oxidative Phosphorylation. ATP synthesis. Fermentation-Homolactic Fermentation, Heterolactic Fermentation, Mixed Acid Fermentation, Butanediol Fermentation.	15	CO3
IV	Photosynthesis - An Overview of chloroplast structure. Photosynthetic Pigments, Light Reaction-Cyclic and non-cyclic Photophosphorylation. Dark Reaction - Calvin Cycle.	15	CO4
V	Bacterial reproduction - Binary fission, Budding, Reproduction through conidia, cyst formation, endospore formation. Fungi asexual and sexual reproduction, Microalgae reproduction. Asexual and sexual reproduction of protozoa.	15	CO5
	Total	75	

CourseOutcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Describe microorganisms based on nutrition.	PO6,PO9
CO2	Know the concept of microbial growth and identify the factors affecting bacterial growth.	PO6,PO7, PO9
CO3	Explain the methods of nutrient uptake.	PO6,PO9
CO4	Describe anaerobic and aerobic energy production	PO6,PO9
CO5	Elaborate on the process of bacterial photosynthesis and reproduction.	PO6,PO9

TextBooks	
1	Schlegal, H.G. (1993). General Microbiology.,7th Edition, Press syndicate of the University of Cambridge.
2	Rajapandian K. (2010). Microbial Physiology, Chennai: PBS Book Enterprises India.

3	MeenaKumari. S. Microbial Physiology, Chennai 1st Edition MJP Publishers 2006.
4	Dubey R.C. and Maheswari, S. (2003). A textbook of Microbiology, New Delhi: S. Chand & Co. & Co.
5	S. Ram Reddy, S.M. Reddy (2008). Microbial Physiology. Anmol Publications Pvt Ltd.
ReferencesBooks	
1	Robert K. Poole (2004). Advances in Microbial Physiology, Elsevier Academic Press, New York, Volume 49.
2	Kim B.H., Gadd G.M. (2008). Bacterial Physiology and Metabolism. Cambridge University Press, Cambridge.
3	Daniel R. Caldwell. (1995). Microbial Physiology & Metabolism Wm.C. Brown Communications, Inc. USA.
4	Moat, A.G and J.W Foaster (1995). Microbial Physiology, 3rd edition. Wiley – LISS, A John Wiley & Sons. Inc. Publications.
5	BhanuShrivastava. (2011). Microbial Physiology and Metabolism: Study of Microbial Physiology and Metabolism. Lambert academic Publication
WebResources	
1	https://sites.google.com/site/microbialphysiologyoddsem/teaching-contents
2	https://courses.lumenlearning.com/boundless-microbiology/chapter/microbial-Nutrition
3	https://onlinecourses.swayam2.ac.in/cec20_bt14/preview
4	http://web.iitd.ac.in/~amittal/2007_Addy_Enzymes_Chapter.pdf
5	https://www..frontiersin.org.microbial-physiology-and-metabolism

MappingwithProgrammeOutcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1						M			M		
CO2						M	L		M		
CO3						M			M		
CO4						M			M		
CO5						M			M		

SubjectCode	**SubjectName**	**Category**	**L**	**T**	**P**	**S**	**Credits**	**Inst. Hours**	**Marks**		
									CIA	**External**	**Total**
U23MBP204	**Practical IIMicrobial Physiology andMetabolism**	**Core Course IV Practical II**	**-**	**-**	**Y**	**-**	**5**	**5**	**25**	**75**	**100**

CourseObjectives			
CO1	Understand the principles of motility test.		
CO2	Understand the basic concepts of staining methods.		
CO3	Learn the bacterial count using different methods and anaerobic culture.		
CO4	Study the morphological demonstration of microorganisms and identification.		
CO5	Study the biochemical identification of the bacteria.		
UNIT	**Details**	**No.of Hours**	**Course Objectives**
I	Motility demonstration: hanging drop, wet mount preparation, semi-solid agar, Craigie's tube method. Staining techniques: Smear preparation, permanent specimen preparation, Capsular, and Acid-fast staining	15	CO1
II	Direct counts – Direct cell count (Petroff-Hausser counting chamber), Turbidometry. Viable count - pour plate, spread plate. Bacterial growth curve.	15	CO2
III	Anaerobic culture methods. Antibiotic sensitivity testing: Disc diffusion test- quality control with standard strains	15	CO3
IV	Morphological variations in algae, fungi and protozoa. Micrometry: Demonstration of the size of yeast, fungal filaments and protozoa	15	CO4
V	Methods of bacterial identification- morphological, physiological, and biochemical methods - IMViC test, H2S, TSI, Oxidase, catalase, urease test, and Carbohydrate fermentation test. Maintenance of pure culture, paraffin method, stab culture, maintenance of mold culture.	15	CO5
	Total	75	
CourseOutcomes			
Course Outcomes	On completion of this course, students will;		
CO1	Describe hanging drop, wet mount preparation, semi-solid agar, Craigie's tube method.	PO6, PO7, PO8, PO9,PO11	
CO2	Demonstrate Smear preparation, permanent specimen preparation, Capsular, and Acid-fast staining.	PO6, PO7, PO8, PO9,PO11	
CO3	Explain antibiotic sensitivity testing: Disc diffusion test- quality control with standard strains.	PO6, PO7, PO8, PO9,PO11	
CO4	Describe demonstration of the size of yeast, fungal filaments and protozoa.	PO6, PO7, PO8, PO9,PO11	
CO5	Elaborate on the bacterial identification- morphological, physiological, and biochemical methods.	PO6, PO7, PO8, PO9,PO11	
Text Books			
1	James G Cappucino and N. Sherman MB (1996). A lab manual Benjamin Cummins, New York.		

2	Kannan. N (1996).Laboratory manual in General Microbiology. Palani Publications
3	Sundararaj T (2005). Microbiology Lab Manual (1st edition) publications
4	Gunasekaran. P (2007). Laboratory manual in Microbiology. New age international publisher.
5	Elsa Cooper (2018). Microbial Physiology: A Practical Approach. Callisto Reference publisher.
ReferencesBooks	
1	David White., James Drummond., Clay Fuqua (2012) Physiology and Biochemistry of Prokaryotes. 4th Ed. Oxford University Press, New York
2	Robert K. Poole (2004). Advances in Microbial Physiology, Elsevier Academic Press, New York, Volume 49.
3	Kim B.H., Gadd G.M. (2008). Bacterial Physiology and Metabolism. Cambridge University Press, Cambridge.
4	Dawes, I.W and Sutherland L.W (1992). Microbial Physiology (2nd edition), Oxford Blackwell Scientific Publications.
5	Moat, A.G and J.W Foaster, (1995). Microbial Physiology, 3rd edition. Wiley – LISS, A John Wiley & Sons. Inc. Publications. .
Web Resources	
1	https://sites.google.com/site/microbialphysiologyoddsem/teaching-contents
2	https://courses.lumenlearning.com/boundless-microbiology/chapter/microbial-Nutrition
3	https://onlinecourses.swayam2.ac.in/cec20_bt14/preview
4	https://www.studocu.com/microbial-physiology-practicals
5	https://www.agr.hokudai.ac.jp/microbial-physiology

MappingwithProgrammeOutcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1						M	L	M	L		M
CO2						M	M	L	M		L
CO3						L	M	M	L		M
CO4						L	M	M	M		M
CO5						M	M	M	M		M

SubjectCode	**SubjectName**	**Category**	**L**	**T**	**P**	**S**	**Credits**	**Inst.Hours**	**Marks**		
									CIA	**External**	**Total**
U23MBE22A	**Bio - Instrumentation**	**Department Elective II(Choice**	**Y**	**Y**	**-**	**-**	**3**	**4**	**25**	**75**	**100**

		1)									

CourseObjectives			
CO1	Understand the analytical instruments and study the basic principles in the field of sciences.		
CO2	To gain knowledge about principles of spectroscopy		
CO3	To understand the analytical techniques of Chromatography and electrophoresis		
CO4	To understand the principle of different types of scans used in medical diagnosis		
CO5	To gain information about the principles of radioactivity and its measurements		
Unit	**Details**	**No.of Hours**	**Course Objectives**
I	Basic instruments: pH meter, Buffer of biological importance, Centrifuge- Preparative, Analytical and Ultra, Laminar Air Flow, Autoclave**,** Hot Air Oven and Incubator. Biochemical calculations- preparations of Molar solutions - Buffers- Phosphate, Acetate, TE, TAE- calculation of Normality, PPM- Ammonium sulphate precipitation.	12	CO1
II	Spectroscopic Techniques: Spectroscopic Techniques: Colorimeter, Ultraviolet and visible, Infrared and Mass Spectroscopy.	12	CO2
III	Chromatographic and Electrophoresis Techniques: Chromatographic Techniques: Paper, Thin Layer, Column, HPLC and GC. Electrophoresis Techniques: Starch Gel, AGE, PAGE.	12	CO3
IV	Imaging techniques: Principle, Instrumentation and application of ECG, EEG, EMG, MRI, CT and PET scan radioisotopes.	12	CO4
V	Fluorescence and radiation-based techniques: Spectrofluorimeter, Flame photometer, Scintillation counter, Geiger Muller counter, Autoradiography.	12	CO5
	Total	60	

CourseOutcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Gain knowledge about the basics of instrumentation.	PO1,PO4,PO11
CO2	Exemplify the structure of atoms and molecules by using the principles of spectroscopy.	PO4,PO10,PO11
CO3	Evaluate by separating and purifying the components.	PO4,PO7,PO11
CO4	Understand the need and applications of imaging techniques.	PO7,PO8,PO11

CO5	Categorize the working principle and applications of fluorescence and radiation.	PO10,PO11
TextBooks		
1.	Jayaraman J (2011). Laboratory Manual in Biochemistry, 2nd Edition. Wiley Eastern Ltd., New Delhi.	
2.	Ponmurugan. P and Gangathara PB (2012). Biotechniques.1stEdition. MJP publishers.	
3	Veerakumari, L (2009).Bioinstrumentation- 5 thEdition -.MJP publishers.	
4	Upadhyay, Upadhyay and Nath (2002). Biophysical chemistry – Principles and techniques 3rd Edition. Himalaya publishing home.	
5	Chatwal G and Anand (1989). Instrumental Methods of Chemical Analysis. S.Himalaya Publishing House, Mumbai.	
ReferencesBooks		
1	Rodney.F.Boyer (2000). Modern Experimental Biochemistry, 3rd Edition. Pearson Publication.	
2	Skoog A., West M (2014). Principles of Instrumental Analysis – 14th Edition W.B.Saunders Co.,Philadephia.	
3	N.Gurumani. (2006). Research Methodology for biological sciences- 1st Edition – MJP Publishers.	
4	Wilson K, and Walker J (2010). Principles and Techniques of Biochemistry and Molecular Biology.7thEdition. Cambridge University Press.	
5	Webster, J.G. (2004). Bioinstrumentation- 4th Edition - John Wiley & Sons (Asia) Pvt.Ltd., Singapore	
WebResources		
1	http://www.biologydiscussion.com/biochemistry/centrifugation/centrifugeintroduction-types-uses-and-other-details-with-diagram/12489	
2	https://www.watelectrical.com/biosensors-types-its-working-andapplications/	
3	http://www.wikiscales.com/articles/electronic-analytical-balance/Page24of75	
4	https://study.com/academy/lesson/what-is-chromatography-definition-typesuses.html	
5	http://www.rsc.org/learn-chemistry/collections/spectroscopy/introduction	

MappingwithProgrammeOutcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	L			M							S
CO2				L						M	S
CO3				L			M				S
CO4							S	S			S
CO5										M	S

SubjectCode	SubjectName	Category	L	T	P	S	Credits	Inst.Hours	Marks		
									CIA	External	Total
U23MBE22B	HumanPhysiology	Department Elective II(Choice 2)	Y	Y	-	-	3	4	25	75	100

CourseObjectives	
CO1	To learn fundamentals of anatomical structures and physiology of body organs.
CO2	To describe the structure and functions of the blood & blood vessels
CO3	To understand how the nervous system controls the body parts.
CO4	To understand the structure and functions liver and pancreas, respiratory organs, urinary System, endocrine System
CO5	

Unit	Details	No.of Hours	Course Objectives
I	**General Anatomy**; Digestion in the mouth, stomach and intestines. Movements of the intestine; Role of Liver and Pancreas – Structure and Functions.	12	CO1
II	**Respiratory System:** Structure of Respiratory organs; Sub – divisions of lung air; Chemistry of Respiration. Physiology of the Urinary System- Structure of kidney and nephron; Formation of urine, Skin – Structure and functions, Regulations of body temperature	12	CO2
III	**Endocrine System** – Structure and functions of thyroid, pituitary, parathyroid, adrenals, islets of langerhans of pancreas. **Reproductive System** – anatomy of the male and female reproductive organs; menstrual cycle; mammary glands; Fertilisation; Development of Embryo; Pregnancy and parturition	12	CO3
IV	**Nervous System:** General classification of nervous system ; Structure of nerve cell and Spinal cord; Basic Knowledge of different parts of the brain – anatomy and functions of cerebrum, cerebellum and medulla oblongata. Structure and function of eye and ear; taste, smell and cutaneous sensations.	12	CO4

V	**Blood:** Composition and Functions of blood; White Blood Cells – Types and function; Red Blood Cells – Structure and functions; Haemoglobin –Structure and functions, Blood coagulation, Blood group – ABO, Rh. Structure of heart and blood vessels; Properties of cardiac muscle; cardiac cycle; origin and conduction of heart beat; measurement of arterial blood pressure.	12	CO5
	Total	60	
Course outcome	Uponcompletionofthiscourse, thestudentswillbeableto		
CO1	Realise and understand the function of digestive system and the role of liver and pancreas.	PO1,PO4,PO11	
CO2	Acquire information on respiratory organs and its regulation.	PO4,PO10,PO11	
CO3	Recognise the importance of endocrine system.	PO4,PO7,PO11	
CO4	Understand the structure and function of nervous system.	PO7,PO8,PO11	
CO5	mpathize on composition and functions of blood.	PO10,PO11	
Textbook	1. Chatterjee C.C .Human Physiology Volume II.13th ed.CBS publishers; 2020. ISBN 13 978-9388902717 .		
References	1. Sembulingam, K. Essentials of Medical Physiology. 8th ed. Jaypee Brothers Medical Publishers (P) Ltd., New Delhi; 2019.ISBN -13 978- 9352706921. 2. Best and Taylor. The Physiological Basis for Medical Practice. 13th ed. Wolterskluwer India Pvt Ltd; 2011.ISBN -13 978- 8184731927.		
E-references	1.https://www.researchgate.net/publication/311934098_introduction_to_human_physiology		

MappingwithProgrammeOutcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	L			M							S
CO2				L						M	S
CO3				L			M				S
CO4							S	S			S
CO5										M	S

Subject Code	**SubjectName**	**Category**	**L**	**T**	**P**	**S**	**Credits**	**Inst.Hours**	**Marks**		
									CIA	**External**	**Total**
U23MBE22C	**Nutrition &HealthHygiene**	**Department Elective II(Choice 3)**	**Y**	**Y**	**-**	**-**	**3**	**4**	**25**	**75**	**100**
CourseObjectives											
CO1	Learn about nutrition and their importance										
CO2	Make student understand the nutritional facts fora better life.										

CO3	Learn information to optimize our diet		
CO4	Impart knowledge on different health care programs taken up by India		
CO5	Learn knowledge on different health indicators and types of hygiene methods		
Unit	**Details**	**No.of Hours**	**Course Objectives**
I	**Nutrition** – definition, importance, Good nutrition, and mal nutrition; Balanced Diet: Basics of Meal Planning. Carbohydrates, Lipids, Proteins and Vitamins –functions, dietary sources, effects of deficiency. Macro and micro minerals –functions, effects of deficiency; food sources of Calcium, Potassium, and Sodium; food sources of Iron, Iodine, and Zinc. Importance of water– functions, sources, requirements and effects of deficiency	12	CO1
II	**Nutrition for Life Cycle:** Balanced diet - Normal, Pregnant, lactating women, Infancy, young children Adolescents, Adults, and the Elderly; Diet Chart; Nutritive value of Indian foods.	12	CO2
III	**Improper diets:** Definition, Identification, Signs and Symptoms - malnutrition, under-nutrition, over-nutrition, Protein Energy Malnutrition, obesity; Nutritional Disease and Disorder - hypertension, diabetes, anemia, osteomalacia, cardiovascular disease.	12	CO3
IV	**Health** - Determinants of health, Key Health Indicators, Environment health & Public health; Health-Education: Principles and Strategies. Health Policy & Health Organizations: Health Indicators and National Health Policy of Govt. of India; Functioning of various nutrition and health organizations in India.	12	CO4
V	**Hygiene** – Definition; Personal, Community, Medical and Culinary hygiene; WASH (Water, Sanitation and Hygiene) programme. Rural Community Health: Village health sanitation & Nutritional committee. Community & Personal Hygiene: Environmental Sanitation and Sanitation in Public places.	12	CO5
	Total	60	
CourseOutcomes			
Course Outcomes	On completion of this course, students will;		
CO1	Learn the importance of nutrition for a healthy life	PO5,PO6, PO7,PO8,PO10	
CO2	Study the nutrition for life cycle	PO5,PO6, PO7,PO8,PO10	
CO3	Know the health care programmes of India	PO5,PO6, PO7,PO8,PO10	
CO4	Learn the importance of community and personal health & hygiene measures	PO5,PO6, PO7,PO10	

CO5	Create awareness on community health and hygiene	PO5,PO6, PO7,PO10
TextBooks		
1.	Bamji, M.S., K. Krishnaswamy& G.N.V. Brahmam (2009) Textbook of Human Nutrition(3rd edition) Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi	
2.	Swaminathan (1995)Food &Nutrition(Vol I, Second Edition) The Bangalore Printing &Publishing Co Ltd., Bangalore	
3	SK. Haldar(2022). Occupational Health and Hygiene in Industry. CBS Publishers.	
4	Acharya, Sankar Kr, Rama Das, MinatiSen (2021). Health Hygiene and Nutrition Perception and Practices. Satish Serial Publishing House	
5	Dass (2021).Public Health and Hygiene, Notion Press	
ReferencesBooks		
1	VijayaKhader (2000) Food, nutrition & health, Kalyan Publishers, New Delhi	
2	Srilakshmi, B., (2010) Food Science, (5th Edition) New Age International Ltd., New Delhi	
3	Arvind Kumar Goel (2005). A College Textbook of Health & Hygiene, ABD Publishers	
4	Sharma D. (2015). Text book on Food Science and Human nutrition. Daya Publishing House.	
5	Revilla M. K. F., Titchenal A. and Draper J. (2020).Human Nutrition. University of Hawaii, Mānoa.	
WebResources		
1	NationalRuralHealthScheme: https://nhm.gov.in/index1.php?lang=1&level=1&sublinkid=969&lid=49	
2	NationalUrbanHealthScheme: https://nhm.gov.in/index1.php?lang=1&level=1&sublinkid=970&lid=137	
3	Villagehealthsanitation&Nutritionalcommittee https://nhm.gov.in/index1.php?lang=1&level=1&sublinkid=149&lid=225	
4	HealthImpactAssessment -https://www.who.int/hia/about/faq/en/	
5	HealthyLivinghttps://www.nhp.gov.in/healthylivingViewall	

MappingwithProgrammeOutcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1					S	M	M	M		S	
CO2					S	M	M	M		S	
CO3					S	M	M	M		S	
CO4					S	S	L			S	

CO5					S	S	M			S	

Subject Code	SubjectName	Category	L	T	P	S	Credits	Inst.Hours	Marks		
									CIA	External	Total
U23MBS203	**Sericulture**	**SkillEnhancementCourse-SEC-3**	**Y**	**-**	**-**	**-**	**2**	**2**	**25**	**75**	**100**

CourseObjectives	
CO1	Acquire knowledge on the concepts of origin, growth and study of Sericulture as science and scientific approach of mulberry plant.
CO2	Describe the morphology and physiology of silkworm.
CO3	Discuss effective management of silkworm diseases.
CO4	Demonstrate field skills in mulberry cultivation and silkworm rearing with an emphasis on technological aspects.
CO5	Demonstrate entrepreneurship abilities, innovative thinking, planning, and setting up small-scale enterprises.

Unit	**Details**	**No.of Hours**	**Course Objectives**
I	General introduction to Sericulture, its distribution in India. Botanical distribution and taxonomical characters of mulberry varieties and species. Biology of Mulberry plant and Mulberry crop cultivation and protection.	6	CO1
II	Silkworm- biology-morphology of silkworm. Life cycle of silkworm- egg, larva, pupa, and moth.	6	CO2
III	Silkworm pathology: Introduction to Parasitism, Commensalism, Symbiosis and Parasite relationship - Mulberry Silkworm Diseases: Introduction, types, Pebrine, Grasserie, Muscardine, Flacherie, Symptoms and Pathogens, Mode of Infection, Prevention and Control -Non – mulberry silkworm diseases: Pebrine, Bacterial and viral diseases. Brief Account of Pests and Predators of Silkworms, Nature of damage and control measures.	6	CO3
IV	Rearing of silkworm. Cocoon assessment and processing technologies. Value added products of mulberry and silkworms.	6	CO4
V	Entrepreneurship and rural development in sericulture: Planning for EDP, Project formulation, Marketing, Insectary facilities and equipments: Location, building specification, air conditioning and environmental control, furnishings and equipment, sanitation and equipment, subsidiary facilities.	6	CO5
	Total	**30**	

CourseOutcomes

Course Outcomes	On completion of this course, students will;	
CO1	Discuss the overall aspects of Sericulture and the biology and varieties of mulberry plant.Creates awareness among students about the economic importance and suitability of Sericulture in Indian conditions.	PO1,PO5,PO7
CO2	Familiarize with the lifecycle of silk worm.	PO1,PO2
CO3	Explain common diseases of silkworm encountered during rearing, sources of infection, disease symptoms, pre-disposing factors and their management practices.	PO1,PO5
CO4	Attain thorough knowledge about the cultivation of mulberry, maintenance of the farm, seed technology, silkworm rearing, post cocoon techniques like stifling, reeling, and utilization of by-products.	PO7,PO8, PO10
CO5	Plan the facilities required for establishment of insectary. Competent to transfer the knowledge and technical skills to the Seri-farmers.Analyze the importance of sericulture in entrepreneurship development and emerge as potential entrepreneur.	PO5,PO7, PO8
TextBooks		
1	Ganga, G. and SulochanaChetty (2010). Introduction to Sericulture, J., Oxford and IBH Pub. Co. Pvt. Ltd., New Delhi.	
2	Dr. R. K. Rajan&Dr. M. T. Himantharaj (2005). Silkworm Rearing Technology, Central Silk Board, Bangalore.	
3	Dandin S B, JayantJayaswal and Giridhar K (2010). Handbook of Sericulture technologies, Central Silk Board, Bangalore.	
4	M. C. Devaiah, K. C. Narayanaswamy and V. G. Maribashetty (2010). Advances in Mulberry Sericulture,,CVG Publications, Bangalore	
5	T.V.SatheandJadhav.A.D.(2021). Sericulture and Pest Management, Daya Publishing House.	
ReferencesBooks		
1	S. Morohoshi (2001). Development Physiology of Silkworms 2ndEdition, Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi	
2	Hamamura, Y (2001). Silkworm rearing on Artificial Diet. Oxford & IBH publishing Co., Pvt. Ltd. NewDelhi.	
3	M.Johnson, M.Kesary (2019).Sericulture, 5th.Edition.Saras Publications.	
4	Manisha Bhattacharyya (2019). Economics of Sericulture, Rajesh Publications.	
5	Muzafar Ahmad Bhat, SurakshaChanotra, ZafarIqbalBuhroo, Abdul Aziz and Mohd.Azam (2020).A Textbook on Entrepreneurship Development Programme in Sericulture, IP Innovative Publication.	
WebResources		
1	https://egyankosh.ac.in›bitstream	
2	https://archive.org›details›SericultureHandbook	

3	https://www.academic.oup.com
4	https://www.sericulture.karnataka.gov.in
5	https://www.silks.csb.gov.in

MappingwithProgrammeOutcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	S				S		S				
CO2	M				S						
CO3	S				S						
CO4							S	S		S	
CO5					S		S	S			

SECOND YEAR
SEMESTER III

Subject Code	Subject Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
U23MBT305	**Molecular Biology and Microbial Genetics**	**Core Course V –Theory**	**Y**	**Y**	**-**	**-**	**5**	**5**	**25**	**75**	**100**

Learning Objectives	
CO1	Provide knowledge on structure and replication of DNA.
CO2	Illustrate the significance and functions of RNA in protein synthesis.
CO3	Explain the cause and types of DNA mutation and DNA repair mechanisms.
CO4	Outline the role of plasmids and phages in genetics.
CO5	Examine mechanisms of gene transfer and recombination.

Unit	Details	No. of Hours	Course Objectives
I	**DNA Structure** - Salient features of double helix, forms of DNA. Denaturation and renaturation. DNA topology – Supercoiling, linking number, topoisomerases. DNA organization in prokaryotes, viruses, eukaryotes. Replication of DNA in prokaryotes and eukaryotes - Bidirectional and unidirectional replication, semi-conservative and semi-discontinuous replication. Mechanism of DNA replication – enzymes involved – DNA polymerases, DNA ligase, primase. DNA replication modes - rolling circle, D-loop modes.	15	CO1
II	**Transcription in Prokaryotes**. Concept of transcription. RNA Polymerases - prokaryotic and eukaryotic. General transcription factors in eukaryotes. Distinction between transcription processes in prokaryotes versus eukaryotes. Translation in prokaryotes and eukaryotes - Translational machinery - ribosome structure in prokaryotes and eukaryotes, tRNA structure and processing. Inhibitors of protein synthesis in prokaryotes and eukaryotes. Overview of regulation of gene expression - *lac*, *trp* and *ara* operons as examples. Regulation of gene expression by DNA methylation.	15	CO2
III	**Mutation - Definition and types** - base substitutions, frame shifts, deletions, insertions, duplications, inversions. Silent, conditional, and lethal mutations. Physical and chemical mutagens. Reversion and suppression. Uses of mutations. Repair Mechanisms - Photoreactivation, Nucleotide Repair, Base Excision Repair, Methyl Directed Mismatch Repair and SOS Repair.	15	CO3

IV	**Plasmid replication and partitioning**, host range, plasmid incompatibility, plasmid amplification, regulation of plasmid copy number, curing of plasmids. Types of plasmids – R Plasmids, F plasmids, colicinogenic plasmids, metal resistance plasmids, Ti plasmid, linear plasmids, yeast 2µ plasmid. Bacteriophage-T4, Virulent Phage – Structure and lifecycle. Lambda phage-Structure, Lytic and Lysogenic cycle. Applications of Phages in Microbial Genetics.	15	CO4
V	**Gene Transfer Mechanisms**- Conjugation and its uses. Transduction - Generalized and Specialized, Transformation - Natural Competence and Transformation. Transposition and Types of Transposition reactions. Mechanism of transposition: Replicative and non-replicative transposition. Transposable elements - Prokaryotic transposable elements – insertion sequences, composite, and non-composite transposons. Uses of transposons.	15	CO5
	Total	75	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Analyze the significance of DNA and elucidate the replication mechanism.	PO4, PO5, PO7,PO9
CO2	Illustrate the types of RNA and protein synthesis machinery.	PO4, PO7,PO9
CO3	Infer the causes and types of DNA mutation and summarize the DNA repair mechanisms.	PO5, PO7,PO9
CO4	Evaluate the importance of plasmids and phages in genetics.	PO7,PO9
CO5	Analyze gene transfer and recombination methods.	PO5, PO6, PO7,PO9

Text Books

1. Malacinski G.M. (2008). Freifelder's Essentials of Molecular Biology. 4th Edition. Narosa Publishing House, New Delhi.
2. Gardner E. J. Simmons M. J. and SnustedD.P.(2006). Principles of Genetics. 8th Edition. Wiley India Pvt. Ltd.
3. Trun N. and Trempy J. (2009). Fundamental Bacterial Genetics. 1st Edition. Blackwell Science Ltd.
4. Brown T. A. (2016). Gene Cloning and DNA Analysis- An Introduction. (7th Edition). John Wiley and Sons, Ltd.
5. 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.

References Books

1. Glick B. R. and Patten C.L. (2018). Molecular Biotechnology – Principles and Applications of Recombinant DNA. 5th Edition. ASM Press.
2. Russell P.J. (2010). iGenetics - A Molecular Approach, 3rd Edition., Pearson New International edn.
3. Nelson, D.L. and Cox, M.M. Lehninger(2017). Principles of Biochemistry. 7th Edition, W.H.

	Freeman.
4.	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.
5.	Primrose S.B. and Twyman R. M. (2006). Principles of Gene Manipulation and Genomics. (7th Edition). Blackwell Publishing
Web Resources	
1.	[PDF] Lehninger Principles of Biochemistry (8th Edition) By David L. Nelson and Michael M. Cox Book Free Download - StudyMaterialz.in
2.	https://microbenotes.com/gene-cloning-requirements-principle-steps-applications/
3.	https://courses.lumenlearning.com/boundless-biology/chapter/dna-replication/
4.	Molecular Biology Notes - Microbe Notes
5.	Molecular Biology Lecture Notes & Study Materials | Easy Biology Class

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks

Methods of Assessment	
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, Short summary or overview
Application (K3)	Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain
Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations

Mapping with Programme Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1				S	S	M	S	M	S	M	
CO2				S	M	M	S	M	S	L	
CO3				M	S	M	S	M	S	L	
CO4				M	M	M	S	M	S	L	
CO5				M	S	S	S	M	S	L	

SubjectCode	Subject Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
U23MBP306	**Practical III - Molecular Biology and Microbial Genetics**	**Core Course – VI – Practical III**	**-**	**-**	**Y**	**-**	**5**	**5**	**25**	**75**	**100**

Learning Objectives	
CO1	Provide knowledge on structure and replication of DNA.
CO2	Elucidate the methods of Genomic and Plasmid DNA isolation.
CO3	Explain methods of protein separation.
CO4	Explain artificial transformation method.
CO5	Outline the role of phages in genetics.

Unit	Details	No. of Hours	Course Objectives
I	1. Study of different types of DNA and RNA using micrographs and model / schematic representations. 2. Study of semi-conservative replication of DNA through micrographs / schematic representations.	15	CO1
II	3. Isolation of Genomic and Plasmid DNA from *E. coli* and Analysis by Agarose gel electrophoresis. 4. Estimation of DNA using colorimeter (diphenylamine reagent), UV spectrophotometer (A260 measurement).	15	CO2
III	5. Resolution and visualization of proteins by polyacrylamide gel electrophoresis (SDS-PAGE) – Demonstration. 6. UV induced auxotrophic mutant production and isolation of mutants by replica plating technique – Demonstration.	15	CO3
IV	7. Perform artificial Transformation in *E. coli*. 8. Isolation of antibiotic resistant mutants by gradient plate method. - Demonstration	15	CO4
V	9. Screening and isolation of phages from sewage. 10. Perform RNA isolation. 11. Estimate RNA.	15	CO5
	Total	75	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Illustrate different types of DNA and RNA.	PO4, PO7, PO9, PO11
CO2	Utilize hands-on training in isolation of genomic and plasmid	PO4, PO7, PO9, PO11

	DNA.	
CO3	Analyze importance of experimental microbial genetics.	PO4, PO7, PO9, PO11
CO4	Apply the knowledge of molecular techniques in various fields.	PO4, PO7, PO9, PO11
CO5	Investigate the significance of Phages.	PO4, PO7, PO9, PO11

Text Books	
1.	Crichton. M. (2014). Essentials of Biotechnology. Scientific International PvtLtd.New Delhi.
2.	Sambrook J. and Russell D.W. (2001). Molecular Cloning - A Laboratory Manual – 7th Edition. Cold Spring Harbor, N.Y: Cold Spring Harbor Laboratory Press.
3.	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.
4.	Gunasekaran P. (2007). Laboratory Manual in Microbiology. New Age International.
5.	James G Cappucino. and Natalie Sherman. (2016). Microbiology – A laboratory manual. (5th Edition). The Benjamin publishing company. New York.
References Books	
1	Glick B. R. and Patten C.L. Molecular Biotechnology – Principles and Applications of Recombinant DNA. 5th Edition. ASM Press. 2018.
2	Russell P.J. (2010). iGenetics - A Molecular Approach, 3rd Edition., Pearson New International edn.
3	Nelson, D.L. and Cox, M.M. Lehninger(2017). Principles of Biochemistry. 7th Edition, W.H. Freeman.
4	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.
5	Brown T.A. (2016). Gene Cloning and DNA Analysis. (7th Edition). John Wiley and Jones, Ltd.
Web Resources	
1	https://www.molbiotools.com/usefullinks.html
2	(PDF) Molecular Biology Laboratory manual (researchgate.net)
3	https://www.molbiotools.com/usefullinks.html
4	https://geneticgenie.org3.
5	https://currentprotocols.onlinelibrary.wiley.com/doi/pdf/10.1002/cpet.5

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks

Methods of Assessment	
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, Short summary or overview
Application	Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe,

(K3)	Explain
Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations

Mapping with Programme Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1				S	L	M	S	M	S	M	S
CO2				S	L	M	S	M	S	M	S
CO3				S	L	M	S	M	S	M	S
CO4				S	L	M	S	M	S	M	S
CO5				S	L	M	S	M	S	M	S

Subject Code	**Subject Name**	**Category**	**L**	**T**	**P**	**S**	**Credits**	**Inst. Hours**	**Marks**		
									CIA	**External**	**Total**
U23MBE33A	**BIOPHYSICS AND BIOSTATISTICS**	**Subject Based Elective III (Allied)**	**Y**	**Y**	**-**	**-**	**3**	**4**	**25**	**75**	**100**

Course Objectives	
CO1	To understand the concepts of diffusion, osmosis, centrifugal force, surface tension.
CO2	To understand the techniques for the separation of biomolecules.
CO3	To understand radiology, sonography, Laser techniques for biological and medical application.
CO4	To know to calculate standard deviation, correlation coefficient,
CO5	To learn to calculate chi-square analysis and student 't' test using the formula.

UNIT	**Details**	**No.of Hours**	**Course Objectives**
I	**BiophysicalPrinciples:**Physicallawsinlivingsystem:diffusion–Factors affecting diffusion- types of diffusion – Fick's law – Biological significanceofdiffusion–Osmosis–Osmoticpressure(endocytosis, pinocytosis, phagocytosis, exocytosis plasmolysis and haemolysis) Principlesofviscosity–Brownianmovement–surfacetension–turgor pressure–Centrifugation:Principle–types–applications.	12	CO1
II	**Applications of Biophysics**: Principle and applications of colorimeter – electrophoresis –principle, instrumentation – applications of gel electrophoresis. Radioactivity: Types of radioactive decay – Radioactive isotopes – Autoradiography –	12	CO2

	biological impacts – Geiger-Muller counter: Principle – working procedure – advantages and disadvantages. Medical and biological uses of X-rays, Ultrasound and Laser		
III	**Collection and Classification of Data**: Introduction to biostatistics: Definition – characteristics, importance and applications of biostatistics. Collection of data: Primary – secondary data. Statistical population and sampling in biological studies. Types of Classification: Qualitative – quantitative. Variables: discrete – continuous. Frequency distributions.	12	CO3
IV	**Presentation of Data: Tabulation**: Types – Components – advantages. Diagrammatic and graphical representations of data: Bar diagrams (Simple, multiple, subdivided and percentage) – Pie diagram – Frequency diagram: histograms – frequency polygon – frequency curve – line graphs.	12	CO4
V	**Descriptive & Inferential Statistics:** Measure of central tendency: Arithmetic mean – median– mode. Measures of dispersion: Standard deviation – Standard error– Coefficient of variance. Test of significance: Chi-square test for goodness of fit – Student 't' test.	12	CO5
	Total	60	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Understand and recall the basic biophysical concepts, statistical data and formula.	PO5, PO6, PO10
CO2	Apply suitable physical techniques and statistical methods to solve biological problems	PO10
CO3	Identify and relate the bioanalytical techniques and statistical principles for the application of biological experiments.	PO11
CO4	Select suitable biophysical techniques to study the biological process and statistical approach to assess the experimental results	PO4, PO11
CO5	Integrate the bioanalytical techniques and statistical methods to validate research investigations	PO4, PO11

Text Books

1	Das,D.,1996.BiophysicsandBiophysicalChemistryforMedicalandBiology students, Academic,Calcutta. 302pp.
2	Subramanian,M.A.,2016.Biophysics–PrinciplesandTechniques,MJP,Chennai. 324pp.
3	Gurumani,N.,2005.AnintroductiontoBiostatistics,MJP,Chennai, 250pp.
4	Palanichamy,SandM.Shanmugavelu,1991.PrinciplesofBiostatistics.Palani Paramount.India. 350pp

5	Roy, R.N. 1996. A Text Book of Biophysics, New Central Book Agency Ltd, Calcutta. 992pp.
References Books	
1	Daniel,W.W.,2000.Biostatistics:Afoundationforanalysisinthehealthsciences, 7th Ed.JohnWiley&SonsLtd.NewYork. 328pp.
2	Harvey Motulsky, 2015. Essentials of Biostatistics. A non mathematical approach.OxfordUniversityPress.NewYork. 208pp
3	EdwardK.Yeargers,2018.BasicBiophysicsforBiology,CRCPress,USA.195pp
4	BettyKarasek,2015.Advancedconceptsofbiophysics,CallistroReference, 198pp.
5	Antonisamy, B., Solomon Christopher and P. Prasanna Samuel, 2011. Biostatistics:Principlesandpractices.MacGrawHillEducationPvt.Ltd.New Delhi. 349pp.
6	Ronser,B.,2006.FundamentalsofBiostatistics, Thomson Brooks Cole,6th Ed. Duxbury press,Singapore.784pp
Web Resources	
1	http://www.life.uiuc.edu/molbio/geldigest/electro.html
2	http://users.stat.ufl.edu/~winner/sta6934/st4170_int.pdf
3	http://www.biostathandbook.com/analysissteps.html
4	https://bit.ly/3nXUIrD
5	https://onlinecourses.nptel.ac.in/noc19_bt19

Subject Code	**Subject Name**	**Category**	**L**	**T**	**P**	**S**	**Credits**	**Inst. Hours**	**Marks**		
									CIA	**External**	**Total**
U23MBS304	**Organic Farming &Biofertilizer Technology**	**Skill Enhancement Course IV (SBE)**	**-**	**Y**	**-**	**-**	**1**	**2**	**25**	**75**	**100**

Learning Objectives			
CO1	Impart knowledge about the significance of organic farming and strategies to increase the yield to conserve environment.		
CO2	To encourage organic farming in urban areas.		
CO3	Comprehensive knowledge about bacterial biofertilizers, its advantages and future perspective.		
CO4	Structure and characteristic featuresofCyanobacterial and fungal biofertilizer		
CO5	Develop the knowledge and skill to produce, analyze the quality of packaging, storage and assess the shelf life and bioefficacy of biofertilizers.		
Unit	**Details**	**No.of Hours**	**Course Objectives**
I	**Principle of organic farming**: principles of health, fairness, ecological balance, and care.Environmental benefits of organic farming:	6	CO1

	sustainability- reduces non-renewable energy by decreasing agrochemical need. Biodiversity-crop rotation, inter-cropping. Ecological services – biological control, soil formation and nutrient cycling.		
II	**Organic farming for urban space**: Create a Sustainable Organic Garden (Backyard- Square Foot Gardening, Small Space Gardening, Mini Farming) Composting, Vermicomposting	6	CO2
III	**Biofertilizers**: Introduction, advantages and future perspective. Structure and characteristic features of bacterial biofertilizers- *Azospirillum, Azotobacter, Bacillus, Pseudomonas, Rhizobium* and *Frankia*	6	CO3
IV	**Structure and characteristic features of Cyanobacterialbiofertilizers**- *Anabaena, Nostoc ;*Structure and characteristic features offungalbiofertilizers- AM mycorrhiza	6	CO4
V	**Production**: *Rhizobium, Azotobacter, Anabena*andVAMBiofertilizers - Storage, shelf life, quality control and marketing	6	CO5
	Total	30	
Course Outcomes			
Course Outcomes	On completion of this course, students will;		
CO1	Become an Entrepreneur with wide knowledge about farming and sustainable resources.	PO1, PO2, PO7, PO8, PO10	
CO2	Implement organic farming in urban areas with knowledge on compost.	PO1, PO5, PO10	
CO3	Gain knowledge about the bacterial biofertilizers and its advantages	PO1, PO5, PO7, PO8, PO10	
CO4	Understand the significance about Cyanobacterial and fungal biofertilizers	PO1, PO5, PO7, PO8, PO10	
CO5	Understand and implement the use of bio fertilizers.	PO1, PO5, PO7, PO8, PO10	
Text Book			
1.	A.K. Sharma (2006). Hand book of Organic Farming		
2.	A.C.Gaur (2017). Hand book of Organic Farming and Biofertilizers		
3.	N.S. Subbarao (2017). Bio-fertilizers in Agriculture and Forestry (4th Edition) Med tech publisher		
4.	SubbaRao, N. S. (2002). Soil Microbiology. Soil Microorganisms and Plant Growth. (4th Edition), Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.		
5.	Dubey, R. C. (2008). A Textbook of Biotechnology. S. Chand & Co., New Delhi.		
References Books			
1	Masanobu Fukuoka, Frances Moore Lappe Wendell Berry (2009). The One-Straw Revolution: An Introduction to Natural Farming, 1st edition, YRB Classics.		
2	SujitChakrabarty(2018). Organic Home Gardening Made Easy, 1st Edition,		
3	Singh and Purohit (2008). Biofertilizer technology. Agrobios, India.		

4	Bansal M (2019). Basics of Organic Farming CBS Publisher.	
5	Hurst, C.J., Crawford R.L., Garland J.L., Lipson D.A., Mills A.L. and Stetzenbach L.D. (2007). Manual of Environmental Microbiology. (3rd Edition). American Society for Microbiology.	
Web Resources		
1.	https://agritech.tnau.ac.in/org_farm/orgfarm_introduction.html	
2.	https://www.fao.org/organicag/oa-faq/oa-faq6/en/	
3.	https://www.india.gov.in/topics/agriculture/organic-farming	
4.	https://agriculture.nagaland.gov.in/bio-fertilizer/	
5.	https://vlab.amrita.edu/index.php?sub=3&brch=272	
Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks
Methods of Assessment		
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions	
Understand / Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, Short summary or overview	
Application (K3)	Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain	
Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge	
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons	
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations	

Mapping with Programme Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	S	S					S	S		S	
CO2	S				S					S	
CO3	S				S		S	S		S	
CO4	S				S		S	S		S	
CO5	S				S		S	S		S	

SEMESTER IV

Subject Code	Subject Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
U23MBT407	**Immunology and Immunotechnology**	**Core Course – VII**	**Y**	**-**	**-**	**-**	**5**	**5**	**25**	**75**	**100**

Course Objectives			
CO1	To gain knowledge about immune system, organs of immunity and cells involved.		
CO2	To distinguish the types of antigens and antibodies; their properties.		
CO3	To provide in-depth knowledge on immuno-techniques.		
CO4	To discuss the role of MHC system in transplantation; functions of Tumor specific antigens.		
CO5	To impart knowledge on immunological disorders.		
Unit	**Details**	**No.of Hours**	**Course Objectives**
I	**Organs and Cells in Immune System and Immune Response:**Primary lymphoid organs, secondary lymphoid organs, and lymphoid tissues; T – cell and B –cell membrane bound receptors – apoptosis; T - cell processing, presentation and regulation; T –cell subpopulation, properties, functions and T – cell suppression; Physiology of immune response- innate, humoral and cell mediated immunity; Immunohematology.	15	CO1
II	**Antigen and Antibody:Antigens** - Properties of haptens, epitopes, adjuvants, and cross reactivity; Antibodies- structure, properties, classes; Antigen and Antibody Reactions: precipitation, agglutination, complement fixation, opsonization, neutralization; Vaccines – active and passive immunization; Classification of vaccines; Other approaches to new vaccines; Types of vaccine - antibacterial, antiviral; Vaccination schedule.	15	CO2

III	**Immunoassay and Immunotechniques -** Preparation and standardization of bacterial antigens; Raising of monoclonal and polyclonal antibodies; Purification of antibodies. Immunotechniques - RIA, RAST, ELISA, Immuno fluorescence techniques and Flow cytometry	15	CO3
IV	**Transplantation and TumorImmunology** - MHC Antigens - structure and function; HLA system - Regulation and response to immune system; Transplantation immunology - tissue transplantation and grafting; Mechanism of graft acceptance and rejection; HLA typing; Tumor specific antigens; Immune response to tumors; Immune diagnosis; cancer immune therapy.	15	CO4
V	**Immunological disorders and diseases -** Hypersensitivity reactions (Type I, II, III and IV); acquired immunodeficiency syndrome; Auto immune disorders and diseases: organ specific and non-organ specific.	15	CO5
	Total	75	

Course Outcomes

Course Outcomes	On completion of this course, students will;	
CO1	Assess the fundamental concepts of immunity, contributions of the organs and cells in immune responses.	PO1, PO4, PO6, PO9,
CO2	Investigate the structures of Ag and Ab; Immunization.	PO1, PO4, PO5, PO9
CO3	Justify the Immunoassay and Immunotechniques.	PO1, PO4, PO5, PO7
CO4	Explain about the immunologic processes governing graft rejection and therapeutic modalities for immunosuppression in transplantation	PO1, PO3, PO4, PO5, PO9
CO5	Analyze the overreaction by our immune system leading to hypersensitive conditions and its consequences.	PO1, PO4, PO5, PO6

Text Books

1.	Richard Coico, Geoffrey Sunshine, Eli Benjamini. (2003). Immunology – A Short Course. 5thEdition., Wiley-Blackwell, New York.
2.	Judith A.Owen, Jenni Punt, Sharon A. Stranford, Janis Kuby. (2013). Immunology, 7thEdition., W. H. Freeman and Company, New York.
3.	Abul K. Abbas, Andrew H. Lichtman, Shiv Pillai. (2021). Cellular and Molecular Immunology, 10thEdition., Elsevier.
4.	Robert R. Rich, Thomas A. Fleisher, William T. Shearer, Harry Schroeder, Anthony J. Frew, Cornelia M. Weyand. (2018).Clinical Immunology: Principles and Practice, 5th Edition. Elsevier.

5.	Pravash Sen. Gupta. (2003). Clinical Immunology. Oxford University Press.
References Books	
1	Janeway Travers. (1997). Immunobiology- the immune system in health and disease. Current Biology Ltd. London, New York. 3rd Edition.
2	Peter J. Delves, Seamus Martin, Dennis R. Burton, Ivan M. Roitt. (2006). Roitt's Essential Immunology, 11thEdition., Wiley-Blackwell.
3	William R Clark. (1991). The Experimental Foundations of Modern Immunology. 3rdEdition. John Wiley and Sons Inc. New York.
4	Frank C. Hay, Olwyn M. R. Westwood. (2002). Practical Immunology, 4thEdition., Wiley-Blackwell.
5	Noel R. Rose, Herman Friedman, John L. Fahey. (1986). Manual of Clinical Laboratory Immunology. ASM.3rd Edition.
Web Resources	
1	https://www.ncbi.nlm.nih.gov/books/NBK279395/
2	https://med.stanford.edu/immunol/phd-program/ebook.html
3	https://ocw.mit.edu/courses/hst-176-cellular-and-molecular-immunology-fall-2005/pages/lecture-notes/
4	Immunology Overview - Medical Microbiology - NCBI Bookshelf (nih.gov)
5	Immunology - an overview | ScienceDirect Topics

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks

Methods of Assessment	
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, Short summary or overview
Application (K3)	Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain
Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations

Mapping with Programme Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	S			M		S			M
CO2	S			M	M				M
CO3	S			S	S		S		

CO4	S		M	S	S				M
CO5	S			S	M	M			

Subject Code	Subject Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
U23MBP408	**Practical IV - Immunology and Immunotechnology**	**Core Course – VIII- Practical IV**	**-**	**-**	**Y**	**-**	**5**	**5**	**25**	**75**	**100**

Course Objectives	
CO1	To gain hands-on knowledge to identify Blood group and typing.
CO2	To acquire adequate skill to perform latex agglutination reactions.
CO3	To analyze precipitation reactions in gels.
CO4	To investigate the antigen & antibody reactions in electrophoresis.
CO5	To familiarize with Separation of Lymphocytes.

Unit	**Details**	**No.of Hours**	**Course Objectives**
I	1. Identification of blood group and typing. 2. Coomb's test. TPHA	15	CO1
II	3. T cell identification (Demonstration) 4. Latex Agglutination reactions- RF, ASO, CRP	15	CO2
III	5. Ouchterlony's Double Diffusion Method (antigen pattern). 6. Single Radial Immuno Diffusion Method.	15	CO3
IV	7. Electrophoresis - Serum, Counter and Immuno.	15	CO4
V	8. Separation of Lymphocytes by gradient centrifugation method. 9. ELISA: Hepatitis/ HIV	15	CO5
	Total	75	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Assess the blood groups and types	PO1,PO5, PO6, PO7, PO8
CO2	Competently perform serological diagnostic tests such as RF, ASO, CRP	PO4, PO5, PO6, PO7, PO8
CO3	Illustrate the antigen antibody reactions in gel.	PO5, PO6, PO7, PO8, PO9

CO4	Compare & contrast antigens and antibodies in electrophoresis	PO5, PO6, PO7, PO8, PO9
CO5	Examine the concept of ELISA.	PO5, PO6, PO7, PO8, PO9

Text Books	
1.	Talwar. (2006). Hand Book of Practical and Clinical Immunology, Vol. I, 2nd edition, CBS.
2.	Asim Kumar Roy. (2019). Immunology Theory and Practical**,** Kalyani Publications.
3.	Richard Coico, Geoffrey Sunshine, Eli Benjamini. (2003). Immunology – A Short Course. 5th Edition., Wiley-Blackwell, New York.
4.	Judith A.Owen, Jenni Punt, Sharon A. Stranford, Janis Kuby. (2013). Immunology, 7th Edition., W. H. Freeman and Company, New York.
5.	Pravash Sen. Gupta. (2003). Clinical Immunology. Oxford University Press.
References Books	
1	Frank C. Hay, Olwyn M. R. Westwood. (2008).Practical Immunology, 4th Edition, Wiley-Blackwell.
2	Wilmore Webley. (2016). Immunology Lab Manual, LAD Custom Publishing.
3	Rose. (1992). Manual of Clinical Lab Immunology, ASM.
4	Janeway Travers. (1997). Immunobiology- the immune system in health and disease. Current Biology Ltd. London, New York. 3rd Edition.
5	Peter J. Delves, Seamus Martin, Dennis R. Burton, Ivan M. Roitt. (2006). Roitt's Essential Immunology, 11th Edition., Wiley-Blackwell.
Web Resources	
1	https://www.researchgate.net/publication/275045725_Practical_Immunology-_A_Laboratory_Manual
2	https://www.urmc.rochester.edu/MediaLibraries/URMCMedia/labs/frelinger-lab/documents/Immunology-Lab-Manual.pdf
3	https://webstor.srmist.edu.in/web_assets/downloads/2021/18BTC106J-lab-manual.pdf
4	Immunology Overview - Medical Microbiology - NCBI Bookshelf (nih.gov)
5	Immunology - an overview | ScienceDirect Topics

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks

Methods of Assessment	
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, Short summary or overview
Application (K3)	Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain
Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations

Mapping with Programme Outcomes:

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

Subject Code	Subject Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
U23MBE44A	**BIOPHYSICS AND BIOSTATISTICS PRACTICAL**	**Skill Based Elective 4 (Allied)**	**Y**	**Y**	**-**	**-**	**3**	**4**	**25**	**75**	**100**

Course Objectives			
CO1	To understand the techniques for estimation of Biomolecules		
CO2	To understand the the representation of data		
CO3	To know to calculate standard deviation		
CO4	To know to calculate the correlation coefficient, chi-square analysis		
CO5	To know to calculatestudent 't' test using the formula.		
UNIT	**Details**	**No.of Hours**	**Course Objectives**
I	1. Estimation of Biomolecules using spectrophotometer - • carbohydrate, • protein	12	CO1
II	2. Collection and Tabulation of Data 3. Representation of data - Simple bar diagram, Multiple bar diagram, Sub divided bar diagram, Percentage bar diagram, Pie diagram	12	CO2
III	4. Measures of central Tendancy – Mean median mode – Raw data, discrete data, and continuous data. 5. Measures of dispersion – range, mean of deviation, standard deviation, co-efficient of variance	12	CO3
IV	6. Chi-Square analysis	12	CO4
V	7. Test of significance - t-test analysis	12	CO5
	Total	60	
Course Outcomes			

Course Outcomes	On completion of this course, students will;	
CO1	Assess the estimation of Biomolecules	PO5, PO6, PO10
CO2	Understand and recall the statistical data and formula.	PO10
CO3	Apply suitable statistical methods to solve biological problems	PO11
CO4	Calculate the correlation coefficient, chi-square analysis	PO4, PO11
CO5	Integrate statistical methods to validate research investigations	PO4, PO11
Text Books		
1	Das,D.,1996.BiophysicsandBiophysicalChemistryforMedicalandBiology students, Academic,Calcutta. 302pp.	
2	Subramanian,M.A.,2016.Biophysics–PrinciplesandTechniques,MJP,Chennai. 324pp.	
3	Gurumani,N.,2005.AnintroductiontoBiostatistics,MJP,Chennai, 250pp.	
4	Palanichamy,SandM.Shanmugavelu,1991.PrinciplesofBiostatistics.Palani Paramount.India. 350pp	
5	Roy, R.N. 1996. A Text Book of Biophysics, New Central Book Agency Ltd, Calcutta. 992pp.	
References Books		
1	Daniel,W.W.,2000.Biostatistics:Afoundationforanalysisinthehealthsciences, 7th Ed.JohnWiley&SonsLtd.NewYork. 328pp.	
2	Harvey Motulsky, 2015. Essentials of Biostatistics. A non mathematical approach.OxfordUniversityPress.NewYork. 208pp	
3	EdwardK.Yeargers,2018.BasicBiophysicsforBiology,CRCPress,USA.195pp	
4	BettyKarasek,2015.Advancedconceptsofbiophysics,CallistroReference, 198pp.	
5	Antonisamy, B., Solomon Christopher and P. Prasanna Samuel, 2011. Biostatistics:Principlesandpractices.MacGrawHillEducationPvt.Ltd.New Delhi. 349pp.	
6	Ronser,B.,2006.FundamentalsofBiostatistics, Thomson Brooks Cole,6th Ed. Duxbury press,Singapore.784pp	
Web Resources		
1	http://www.life.uiuc.edu/molbio/geldigest/electro.html	
2	http://users.stat.ufl.edu/~winner/sta6934/st4170_int.pdf	
3	http://www.biostathandbook.com/analysissteps.html	
4	https://bit.ly/3nXUIrD	
5	https://onlinecourses.nptel.ac.in/noc19_bt19	

Subject Code	Subject Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
U23MBS44	**Food Fermentation Techniques**	**Skill Enhancement course 6 (NME- II)**	**Y**	**-**	**-**	**-**	**2**	**2**	**25**	**75**	**100**

Course Objectives	
CO1	To know the Concept and principles of Fermented Foods - Types, Advantages and Health Benefits
CO2	To Know the Preparation of milk based fermented foods – Buttermilk, Cheese
CO3	To Know Preparation of grain based fermented foods and vegetables based fermented foods
CO4	To develop skill in Preparation of wine and beer
CO5	To know how to preserve the foods
Unit	**Details**
	1. Food – Constituents of food properties and significance 2. Fermented Foods – Definition, Types, Advantages and Health Benefits 3. Preparation of milk based fermented foods – Buttermilk, Cheese 4. Preparation of grain based fermented foods – Bread, Soy Sauce, Idli 5. Preparation of vegetables based fermented foods – Pickles, Jam 6. Preparation of wine and beer 7. Probiotic Foods – Definition and types 8. Food Preservation –Methods of food preservation

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Learn the nutritional values in foods.	PO1, PO4,PO5,PO6, PO7, PO8
CO2	Know the food fermentation process.	PO5,PO6, PO7, PO8
CO3	Know the preparation of grain based and vegetables based fermented foods	PO1,PO8
CO4	Acquire knowledge on Probiotic Foods	PO1
CO5	Acquire knowledge on food preservatives	PO1,PO7,PO8

Text Books	
1.	Frazier WG and Westhoff Dc. Food Microbiology. 2014. Tata McGraw Hill Publishing Company, 5thedition
2.	Adams M.R and Moss M.O. Food Microbiology. 2003 Royal Society of Chemistry Publication, Cambridge
3.	Bandwart GJ. Basic Food Microbiology, 2nd Edition, SK Jain for CBS Publishers & Distribution ISBN:9788123906461
4.	Lund BM, Baird Parker AC, and Gould GW. The Microbiological Safety and Quality of Foods. (2000) Vol. 1-2, ASPEN Publication, Gaithersberg, MD.
5.	Tortora GJ, Funke BR, and Case CL. Microbiology: An Introduction. (2008) 9th edition. Pearson

	Education.
References Books	
1	HarshadKiranKalwit, Sanjeevkurmar Sharma - Objectives of food science (2021) 11th Edition ISBN: 978-81-944137-9-0
2	Jim Mclauchlin, Christi. Food Poisoning and Food Hygiene (2007) 7th Edition
3	Robinson R.K. Dairy Microbiology Handbook:The microbiology of milk and milk products(2005) 3rd Edition ISBN 978-0-471-2275
4	Rajamanickam, C.2001 Experimental protocols in basic molecular biology, Osho Scientific Publications, Madurai.
5	Frazier WG and Westhoff Dc. Food Microbiology. 2014. Tata McGraw Hill Publishing Company, 6th edition
Web Resources	
1	https://micobenotes.com/fields-of-microbiology/
2	https://bio.libretexts.org
3	https://en.wikipedia.org/wiki/Food_spoilage#:~:text=Food%20spoilage%20is%20the%20process,product%20is%20packaged%20and%20stored
4	https://www.sfamjournals.onlinelibrary.wiley.com
5	https://www.britannica.com/topic/food-preservation

Methods of Evaluation

Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks

Methods of Assessment

Recall (KI)	Simple definitions, MCQ, Recall steps, Concept definitions
Understand / Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, Short summary or overview
Application (K3)	Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain
Analyse (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations

THIRD YEAR

V- SEMESTER

Subject Code	SubjectName	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
U23MBT509	**Bacteriology and Mycology**	**Core Course IX**	**Y**	**-**	**-**	**-**	**4**	**5**	**25**	**75**	**100**

Course Objectives	
CO1	Understand the role of normal flora and pathogenic microbes of various diseases and clinical microbiological techniques.
CO2	Basic knowledge about Gram positive pathogenic bacteria and their epidemiology
CO3	Acquire knowledge about Gram negative pathogenic bacteria and nosocomial infections
CO4	Comprehensive knowledge about medically important, its classification and its significance
CO5	Gain knowledge about the general characteristics and mode of action of various antibacterial agents

Unit	Details	No.of Hours	Course Objectives
I	**Classification of Medically Important Microbes**- History, 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.	12	CO1
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) Staphylococcal infections (*Staphylococcus aureus*), (c) Tetanus (*Clostridium tetani*)(d) Diphtheria (*Corynebacteriumdiphtheriae*) (e) Anthrax (*Bacillus anthracis*) (f) Tuberculosis (*Mycobacterium tuberculosis*), (g) Leprosy (*Mycobacterium leprae*).	12	CO2
III	**Medically important Gram-Negative infections** - Causative agent,	12	CO3

	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 (*Shigelladysenteriae*); Sexually Transmitted disease (syphilis–*Treponemapallidum*.Gonorrhoea - *Neisseria gonorrhoeae*); Nosocomial infections – definition, importance, and their control (*Pseudomonas aeruginosa*).		
IV	**Medically important Fungi** - Classification of medically important fungi; Superficial mycoses: PityriasisVersicolor; TineaNigra; Piedra. Cutaneous mycoses: *Microsporum*spps., *Trichophyton*spps., and *Epidermophytonfloccosum*. Subcutaneous mycoses: Chromoblastomycosis; Sporotrichosis; Systemic Mycoses - Blastomycosis; Histoplasmosis; Opportunistic Infections - Candidiasis; Cryptococcosis; Zygomycosis; Mycotoxins: Aflatoxin	12	CO4
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, Griseofulvin.	12	CO5
	Total	60	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Understand the importance of normal flora of human body and acquire knowledge on the process of infectious disease.	PO1, PO3, PO5, PO7, PO10, PO11
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.	PO1, PO3, PO5, PO7, PO10, PO11
CO3	Compile a list of disease-causing bacteria and compare their modes of infection, symptoms, diagnosis and treatment.	PO1, PO3, PO5, PO7, PO10, PO11
CO4	Comprehend human-fungal interaction, which can be applied to	PO1, PO3, PO5, PO7, PO10, PO11

	obtain in-depth knowledge on fungal diseases and the mechanism behind the disease process.	
CO5	Explain the types of mycoses caused in humans and categorize the modes of infection, pathogenesis, and treatment with introduction to mycotoxins.	PO1, PO3, PO4, PO5,PO6, PO7,PO9, PO10
Text Books		
1	Tom Parker, M. Leslie H. Collier. (1990). Topley&Wilson's Principles of Bacteriology, Virology and Immunity,8th Edition. London: Edward Arnold.	
2	Greenwood, D., Slack, R.B. and Peutherer, J.F. (2012) Medical Microbiology, 18thEdition. Churchill Livingstone, London.	
3	Finegold, S.M. (2000) Diagnostic Microbiology, 10th Edition. C.V. Mosby Company, St. Louis.	
4	Ananthanarayanan, R. and JayaramPanicker C.K. (2020) Text book of Microbiology. Orient Longman, Hyderabad.	
5	JagdishChander (2018). Textbook of Medical Mycology, 4th edition, Jaypeebrothers medical publishers.	
References Books		
1	Gerhardt, P., Murray, R.G., Wood, W.A. and Kreig, N.R. (Editions) (1994) Methods for General and Molecular Bacteriology. ASM Press, Washington, DC.	
2	Kevin Kavanagh, (2018). Fungi Biology and Applications 3rd Edition. Wiley Blackwell publishers.	
3	C.J. Alexopoulos, C.W. Mims, M. Blackwell, (2007). Introductory Mycology, 4th edition. Wiley publishers.	
4	A.J. Salle (2007). Fundamental principles of bacteriology, fourth edition, Tata McGraw-Hill Publications.	
5	Christopher C. Kibbler ,RichardBarton,Neil A. R. Gow, Susan Howell,Donna M. MacCallum, Rohini J. Manuel (2017). Oxford Textbook of Medical Mycology. Oxford University Press.	
Web Resources		
1	http://textbookofbacteriology.net/nd	
2	https://microbiologysociety.org/members-outreach-resources/links.html	
3	http://mycology.cornell.edu/fteach.html	
4	https://www.adelaide.edu.au/mycology/	
5	https://www.isham.org/mycology-resources/mycological-links	
Methods of Evaluation		

Internal Evaluation	**Continuous Internal Assessment Tests**	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participitation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks
Methods of Assessment		
Recall (KI)	Simple definitions, MCQ, Recall steps, Concept definitions	
Understand / Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, Short summary or overview	
Application (K3)	Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain	
Analyse (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge	
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons	
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations	

Mapping with Programme Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	S		S		S		S			M	S
CO2	S		S		S		S			M	S
CO3	S		S		S		S			M	S
CO4	S		S		S		S			M	S
CO5	S		S	M	S	M	S		S	M	

SubjectCode	**Subject Name**	**Category**	**L**	**T**	**P**	**S**	**Credits**	**Inst. Hours**	**Marks**		
									CIA	**External**	**Total**
U23MBT510	**Virology and**	**Core Course X**	**Y**	**-**	**-**	**-**	**4**	**5**	**25**	**75**	**100**

	Parasitology										
Course Objectives											
CO1	To gain knowledge on properties and classification of viruses and collection of relevant clinical samples for diagnosing viral infections.										
CO2	To understand pathogenic microorganisms of viruses and the mechanisms by which they cause disease in the human body.										
CO3	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.										
CO4	Understand the types of parasites causing infections in the intestine.										
CO5	To develop skills in the diagnosis of parasitic infections.										

Unit	**Details**	**No.of Hours**	**Course Objectives**
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.	12	CO1
II	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, 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.	12	CO2
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.	12	CO3
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	12	CO4

	(*Giardia lamblia*, *Leishmaniadonovani*), Sporozoa- *Plasmodium*spps.		
V	Introduction to Helminthes, Platyhelminthes – *Taenia* – *Fasciola* – *Paragonimus* – *Schistosoma*spps.. Nemathelminthes – Ascaris– *Ankylostoma* – *Enterobius* – *Trichuris* – *Trichinella* – *Wuchereria* – *Dracanculus.* Collection, transport and examination of specimen Laboratory techniques in parasitology Examination of faeces for ova and cyst by direct wet mount and iodine wet mount, Concentration methods (Floatation and Sedimentation techniques), Examination of blood for parasites. Cultivation of parasites.	12	CO5
	Total	60	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Understand the structure and properties of viruses, cultivation methods and diagnosis of viral diseases.	PO5,PO10
CO2	Knowledge of basic and general concepts of causation of disease by the pathogenic microorganisms and various parameters of assessment of their severity and the methods of diagnosis.	PO5,PO10
CO3	Insights to treatment options of viral diseases.	PO5,PO10
CO4	Knowledge about the importance of protozoans in the intestine.	PO5,PO10
CO5	Knowledge of Nematodes as infectious agent	PO5,PO10

TEXT BOOKS

1.	S., Rajan(2007). Medical microbiology, MJP publisher.
2.	JeyaramPaniker, C.K. (2006). Text Book of Parasitology Jay Pee Brothers,NewDelhi.
3	AroraD.R. and AroraB. (2002). Medical Parasitology, 1st Edition CBS Publishers & Distributors, New Delhi.
4	Chatterjee (1986). Medical Parasitology. Tata McGraw Hill, Calcutta.
5	Parija S. C. (1996). Text Book of Medical Parasitology.4th edition, Orient Longman, AllIndia Publishers & Distributors.

References Books

1	Jawetz, E., Melnick, J.L. and Adelberg, E.A. (2000). Review of Medical Microbiology, 19th Edition. Lange Medical Publications, U.S.A.
2	Ananthanarayan, R. and JeyaramPaniker, C.K. (2009). Text Book of Microbiology, 8th Edition. Orient Longman, Chennai .
3	Conrat HF, Kimball PC and Levy JA. (1988). Virology. II edition. Prentice Hall, Englewood Cliff, New Jersey..
4	Topley& Wilsons's (1990). Principles of Bacteriology, Virology and Immunity, 8th Edition, Vol.

	III Bacterial Diseases, Edward Arnold, London.
5	Finegold, S.M. (2000). Diagnostic Microbiology, 10th Edition. C.V. Mosby Company,St.Louis.
Web Resources	
1	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4047123/
2	https://www.ncbi.nlm.nih.gov/pubmed/21722309
3	https://www.sciencedirect.com/science/article/pii/S2211753919300193
4	https://cmr.asm.org/content/30/3/811
5	https://www.nejm.org/doi/full/10.1056/NEJMoa1811400

Methods of Evaluation

Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks

Methods of Assessment

Recall (KI)	Simple definitions, MCQ, Recall steps, Concept definitions
Understand / Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, Short summary or overview
Application (K3)	Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain
Analyse (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations

Mapping with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1					M					M	
CO2					M					M	
CO3					M					M	
CO4					M					M	
CO5					M					M	

Subject	Subject Name	Category	L	T	P	S	Credits	Inst.	Marks

Code								Hours	CIA	External	Total
U23MBP511	**Practical V - Bacteriology and Mycology & Virology and Parasitology**	**Core course XI**	**Y**	**-**	**-**	**-**	**4**	**5**	**25**	**75**	**100**

Course Objectives			
CO1	To familiarize students with medical microbiology techniques and technical knowledge on collection and processing of clinical samples.		
CO2	To learn the techniques for isolation and identification of bacterial pathogens.		
CO3	To gain expertise in various techniques of clinically important viral pathogens and their identification.		
CO4	To get acquainted with medically important fungi and their metabolism.		
CO5	To categorize parasites and understand their role in infections.		
Unit	**Details**	**No.of Hours**	**Course Objectives**
I	1. Collection and Transport of Clinical specimens. 2. Simple, Differential and Special staining of Clinical materials. 3. Culture techniques used to isolate microorganisms.	12	CO1
II	4. Identification of bacterial pathogens by their biochemical reactions. 5. Antimicrobial susceptibility testing by disc-diffusion technique and determination of Minimum Inhibitory Concentration.	12	CO2
III	6. Isolation of Bacteriophages from Sewage and other natural sources. 7. Identification of Viruses in Slides/Smears/Spotters. Demonstration of Negri bodies (Staining). 8. Cultivation of Viruses in Embryonated eggs – Amniotic, Allantoic, Yolk sac routes and Chorio-allantoic membrane.	12	CO3
IV	9. Microscopic identification of medically important Fungi – KOH and Lactophenol cotton Blue staining. 10. Slide culture techniques for fungal Identification 11. Identification of Dermatophytes. 12. Germ tube test, Carbohydrate fermentation and assimilation tests for Yeasts.	12	CO4
V	13. Direct Examination of Faeces – wet mount and Iodine mount – Demonstration of Protozoan cysts and Helminthes eggs. 14. Concentration techniques of stool specimen – Floatation and Sedimentation methods. 15. Examination of blood for Malarial parasites – thin and thick smear preparations.	12	CO5

	16. Identification of Medically important parasites in slides / specimens as spotters.		
	Total	60	
Course Outcomes			
Course Outcomes	On completion of this course, students will;		
CO1	Demonstrate methods to observe and measure microorganisms by standard microbiological techniques	PO4, PO5, PO7.	
CO2	Identify pathogenic microorganisms in the laboratory set-up and interpret their sensitivity towards commonly administered antibiotics.	PO4, PO5, PO7, PO8.	
CO3	Understand experimental tools used to cultivate and characterize clinically important viruses and bacteriophages	PO4, PO5, PO7, PO8.	
CO4	Elucidate clinically important fungi.	PO4, PO5, PO7, PO8.	
CO5	Investigate Parasites of medical importance and identify them from clinical specimens.	PO4, PO5, PO7, PO8.	
Text Books			
1.	Dubey, R.C. and Maheswari, D.K. (2020). S. Chand Publishers. ISBN-13: 978-8121921534, ISBN-10: 8121921538.		
2.	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.		
3	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.		
4	Prince CP (2009). Practical Manual of Medical Microbiology, Ist edition, Jaypee digital publishing.		
5	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		
References Books			
1	Patricia M. Tille (2021). Bailey & Scott's Diagnostic Microbiology, 15th Edition. Elsevier. ISBN-10: 0323681050, ISBN-13: 978-0323681056.		
2	Monica Cheesbrough (2006). District Laboratory Practice in Tropical Countries. Part 1. 2ndEdition. Cambridge University Press. ISBN-10: 0521171571, ISBN-13: 978-0521171571.		
3	Michael A. Pfaller (ed.) (2015). Manual of Clinical Microbiology. Vol. 1 and 2. 11th Edition. ASM Press. ISBN-10: 9781555817374, ISBN-13: 978-1555817374.		
4	Josephine A. Morello, Paul A. Granato and Helen EckelMizer (2002). Laboratory Manual and Workbook in Microbiology. 7th Edition. The McGraw Hill Company. ISBN: 0-07-246354-6.		
5	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	
1	https://www.microcarelab.in/media/microcarelab.in/files/Sample-Collection-Manual.pdf
2	http://ssu.ac.ir/cms/fileadmin/user_upload/Daneshkadaha/pezeshki/microb/file_amuzeshi/Lab_QA_Microbiology_QA.pdf
3	https://www.academia.edu/11977315/Basic_Laboratory_Procedures_in_Clinical_Bacteriology
4	https://cmr.asm.org/content/31/3/e00062-17.full.pdf
5	https://microbiologyinfo.com/techniques-of-virus-cultivation/

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks

Methods of Assessment	
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, Short summary or overview
Application (K3)	Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain
Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations

Mapping with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1				S	M		S				
CO2				S	S		S	L			
CO3				S	S		S	L			
CO4				S	S		S	L			
CO5				S	S		S	L			

Subject Code	Subject Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total

U23MBPRO	**Group Project**	**Project with Viva-Voce CC-XII**	**-**	**-**	**-**	**-**	**4**	**5**	**25**	**75**	**100**

Group projects enable students to get hands-on training in microbiological techniques needed for research. 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, thereby 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 a research 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.

Subject Code	**Subject Name**	**Category**	**L**	**T**	**P**	**S**	**Credits**	**Inst. Hours**	**Marks**		
									CIA	**External**	**Total**
U23MBE55A	**Recombinant DNA Technology**	**Subject based Elective 5 (Department)**	**Y**		**-**	**-**	**3**	**3**	**25**	**75**	**100**

Course Objectives	
CO1	Understand the principles of rDNA technology.
CO2	Illustrate the molecular tools employed in gene cloning.
CO3	Discuss the importance of various molecular techniques and their importance in Biotechnology.
CO4	Acquire knowledge about the concepts of tissue culture methods and transgenic organisms.
CO5	Examine recent trends in genetic engineering and its application in human welfare.

Unit	**Details**	**No. of Hours**	**Course Objectives**

I	MilestonesinrDNATechnology-GeneManipulation-StepsinvolvedinGeneCloning.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	CO1
II	**Artificial Gene Transfermethods**- Calcium ChlorideInduction, Electroporation, Microinjection, Biolistic method, Liposome and Viral-mediated delivery. Cloning vectors –Properties and Applications - Plasmid Based Vectors- Natural Vectors-pSC101 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 cDNAlibrary-Construction and Screening.	12	CO2
III	**Molecular Tools**- PCR- Types. Gel Electrophoresis- AGE and PAGE Blotting Techniques-Southern, Western & Northern.DNAsequencingmethods-Sanger'sandAutomated method. Recent Trends in Genetic Engineering- Targeted Genome Editing- ZFNs, TALENs, CRISPRs. GeneTargeting-Knock-in &Knock-outs.DNAFingerPrinting.	12	CO3
IV	**Plant Biotechnology** – Media, Growth Regulators and Equipment for Plant Tissue Culture-Explant Culture-Micropropagation- Callus and Protoplast Culture-Production of Bio-ActiveSecondary Metabolites by Plant Tissue Culture -Agrobacterium and Crown Gall Tumors, TiPlasmidandRiPlasmid-AnimalBiotechnology-PrinciplesofAnimalCellCulture,MediaandEquipment for Animal Cell Culture – Primary and Secondary Cultures-Cell Lines- Types, Establishment and MaintenanceofCellLines.	12	CO4
V	**Applications of Genetic Engineering** - Transgenic Animals – Mice and Sheep-Recombinant Cytokines and their use in the Treatment of Animal infections-	12	CO5

	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 inGeneTherapy – ViralandNon-ViralVectors.TransgenicPlants– Bt-Cotton,Bt-Corn, RoundReadysoybean,FlavrSavrTomatoandGoldenRice.		
	Total	60	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Illustrate the steps involved in introduction and expression of foreign DNA into bacteria, animal and plants cells and their screening.	PO4, PO6, PO7, PO9
CO2	Discuss the various cloning vectors and their applications.	PO4, PO6, PO7, PO9
CO3	Assess the usage and advantages of molecular tools.	PO4, PO6, PO7, PO9
CO4	Explain plant and animal tissue culture protocols and gene transfer mechanism.	PO4, PO6, PO7, PO9
CO5	Elucidate and understand the application of genetic engineering and gene therapy.	PO4, PO6, PO7, PO9

Text Books	
1.	Brown T.A.(2016). Gene Cloning and DNA Analysis. 7thEdition . John Wiley and Jones, Ltd.
2.	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.
3.	Keya Chaudhuri (2013). Recombinant DNA technology. The Energy and Resources Institute
4.	SiddraIjaz, Imran UlHaq (2019). Recombinant DNA Technology. Cambridge Scholars Publishing.
5.	Monika Jain (2012). Recombinant DNA Techniques: A Textbook, I Edition,Alpha Science International Ltd
References Books	
1.	Maloy S. R., Cronan J.E. Jr. and FreifelderD.(2011). Microbial Genetics. 2nd Edition. Narosa Publishing Home Pvt Ltd.
2.	Glick B. R. and Patten C.L.(2018). Molecular Biotechnology – Principles and Applications of Recombinant DNA. 5th Edition. ASM Press.
3.	Russell P.J. (2010). iGenetics - A Molecular Approach, 3rd Edition. Pearson New International Edition.
4.	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.
5.	James D.Watson, Michael Gilman, Jan Witkowski, Mark Zoller (1992). Recombinant DNA. Scientific American Books
Web Resources	

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

Methods of Evaluation

Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks

Methods of Assessment

Recall (KI)	Simple definitions, MCQ, Recall steps, Concept definitions
Understand / Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, Short summary or overview
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Analyse (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge
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Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations

Mapping with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1				S	L	S	S	M	S		
CO2				S	L	S	S	M	S		
CO3				S	L	S	S	M	S		
CO4				S	L	S	S	M	S		
CO5				S	L	S	S	M	S		

Subject Code	**Subject Name**	**Category**	**L**	**T**	**P**	**S**	**Credits**	**Inst. Hours**	**Marks**		
									CIA	**External**	**Total**
U23MBE56A	**Biosafety & Bioethics**	**Subject based Elective 6(Department)**	**Y**	**-**	**-**	**-**	**3**	**3**	**25**	**75**	**100**

Course Objectives											
CO1	To create a research environment - encourage investigation, analysis and studying the bioethical principles, values, concepts, and social and juridical implications contained in the Universal Declaration on Bioethics and Human										
CO2	Rights in order to assist their application and promotion in the areas of science, biotechnology and medicine.										
CO3	To discuss about various aspects of biosafety regulations, IPR and bioethics concerns arising from the commercialization of biotech products.										
CO4	To introduce fundamental aspects of Intellectual property Rights to students who are going to play a major role in development and management of innovative projects in industries.										
CO5	To understand the importance of IPR, Patents and Patent laws.										
Unit	**Details**								**No.of Hours**	**Course Objectives**	
I	**Basics of Biosafety -** Laboratory Hazards and Hazard symbols. Definitions on Biohazard, Biosafety and Biosecurity- Biohazard- LAI, BP. Biohazard Classification. Biological Risk Groups. Need and application of biosafety. Good Laboratory Practices (GLP), Good Manufacturing Practices (GMP).								12	CO1	
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	CO2	
III	**Biological Safety Containment in Laboratory -** Primary and secondary containments - Physical and biological containment. Types of biosafety containments (level I, II, III), PPE, Biosafety guidelines in India - Roles of Institutional Biosafety Committee, RCGM, GEAC.								12	CO3	
IV	**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.								12	CO4	
V	**IPR, Patents and Patent laws -** Intellectual property rights-TRIP-GATT International conventions patents, Methods of application of								12	CO5	

	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	60	
Course Outcomes			
Course Outcomes	On completion of this course, students will;		
CO1	Understand the control measures of laboratory hazards (chemical, biological and physical) and to practice safety strategies and personal protective equipment	PO1, PO2, PO3, PO7, PO10	
CO2	Develop stratagems for the use of genetically modified organisms and Hazardous materials	PO1, PO3, PO4	
CO3	Develop skills of critical ethical analysis of contemporary moral problems in medicine and health care.	PO1, PO6	
CO4	Analyze and respond to the comments of other students regarding philosophical issues.	PO3, PO4	
CO5	Pave the way for the students to catch up Intellectual Property(IP) as a career option a. R&D IP Counsel b. Government Jobs – Patent Examiner c. Private Jobs d. Patent agent and Trademark agent e. Entrepreneur	PO1, PO7, PO10	
Text Books			
1.	Usharani .B, S Anbazhagi, C K Vidya, (2019). Biosafety in Microbiological Laboratories- 1st Edition, Notion Press, ISBN-101645878856		
2.	Satheesh.M.K.,(2009). Bioethics and Biosafety- 1st Edition, J. K International Publishing House Pvt. Ltd: Delhi, ISBN :9788190675703		
3	DeepaGoel and ShominiParashar, (2013). IPR, Biosaftey and Bioethics- 1st Edition, Pearson education: Chennai, ISBN-13: 978-8131774700		
4	Rajmohan Joshi (2006). Biosafety and Bioethics. Gyan Books publisher.		
5	Sateesh. M.K. (2013). Bioethics and Biosafety. i.K. International pvt,Ltd.		
References Books			
1	Nithyananda, K V. (2019). Intellectual Property Rights: Protection and Management, India, IN: Cengage Learning India Private Limited, ISBN-10: 9386668572		
2	Neeraj, P., &Khusdeep, D. (2014). Intellectual Property Rights, India, IN: PHI learning Private Limited, ISBN : 9788120349896		
3	Ahuja, V K. (2017). Law relating to Intellectual Property Rights, India, IN: Lexis Nexis,		

	ISBN-10: 8131251659.
4	Edited by Sylvia Uzochukwu, Nwadiuto (Diuto) Esiobu, Arinze Stanley Okoli, Emeka Godfrey Nwoba, EzebuiroNwagboChristpeace, Charles OluwaseunAdetunji, Abdulrazak B. Ibrahim, Benjamin EwaUbi (2022). Biosafety and Bioethics in Biotechnology-Policy, Advocacy, and Capacity Building,1st edition. CRC Press
5	Sree Krishna. V (2007). Bioethics and Biosafety in Biotechnology. New age international publishers.

Web Resources

1	Subramanian, N., &Sundararaman, M. (2018). Intellectual Property Rights – An Overview. Retrieved from http://www.bdu.ac.in/cells/ipr/docs/ipr-eng-ebook.pdf.
2	World Intellectual Property Organisation. (2004). WIPO Intellectual propertyHandbook. Retrieved from https://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo_pub _489.pdf.
3	https://www..niehs.nih.gov/bioethics
4	https://www.sist.sathyabama.ac.in
5	https://www.longdom.org/bioethics-and-biosafety

Methods of Evaluation

Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks

Methods of Assessment	
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, Short summary or overview
Application (K3)	Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain
Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations

Mapping with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	S	S	S				M			M	
CO2	S		S	S							
CO3	S					S					
CO4			S	S							
CO5	S						M			S	

VI - SEMESTER

Subject Code	Subject Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
U23MBT612	**Environmental and Agriculture Microbiology**	Core Course –XIII	**Y**	**-**	**-**	**-**	**4**	**6**	**25**	**75**	**100**

Course Objectives	
CO1	To discuss the distribution and association of microorganism in various ecosystems and to know about the role of microorganism in water pollution and water quality.
CO2	To acquire knowledge about the role of microorganism in water pollution and water quality
CO3	Gain knowledge about microbes as biofertilizers and the aspects of application.
CO4	To learn about the process of solid waste management and sewage water treatment.
CO5	Gain knowledge on various plant diseases and pathogens

Unit	Details	No. of Hours	Course Objectives
I	**Microorganisms and their Habitats: Structure and function of ecosystems** Terrestrial Environment: Soil profile and soil microflora, Microbial succession in decomposition of soil organic matter. Role of microorganisms in elemental cycles in nature: Carbon, Nitrogen. Aquatic Environment: Microflora of fresh water and marine habitats, factors influencing microbial growth in the aquatic environments. Atmosphere: Aeromicroflora and dispersal of microbes, Assessment of air quality, Enumeration of microorganism in air, 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) and pollution related, spread and control of these diseases. Environmental Protection Agency (EPA) - role in environmental protection.	12	CO1

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 water analysis. Water borne diseases. Central Pollution Control Board (CPCB) standards**.**	11	CO2
III	**Microbial Interactions**: Rhizospheremicroflora. 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. Mass production of Rhizobialbiofertilizer. Biocontrol agents – Bacterial, viral, fungal.	12	CO3
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.	15	CO4
V	**Plant pathology**: Mode of entry of pathogens, Microbial enzymes, toxins, growth regulators and suppressor of plant defense in plant diseases. Plant defense mechanisms. Bacterial diseases – Citrus canker, Blight of paddy. Viral disease – TMV, CMV. Fungal disease- red rot of sugarcane, Tikka disease. Plant disease management.	10	CO5
	Total	60	

Course Outcomes

Course Outcomes	On completion of this course, students will;	
CO1	Describe about the structure and function of ecosystems and understand the role of microbes in various environments	PO1
CO2	Identify the cause of water pollution, and perform methods to assess the quality of water.	PO4,PO5,PO6,PO7,PO8

CO3	Explain the productionof biofertilizers and biopesticides.	PO1, PO7,PO8
CO4	Explainabout waste treatment process and microbial decomposition and bio-remediation process.	PO6
CO5	Describe about plant diseases caused by microbes and acquire a clear idea on plant pathogenic interaction	PO1,PO5
Text Books		
1.	Joseph C. Daniel. (2006). Environmental aspects of Microbiology 2nd Edition. BrightSunPublications.	
2.	Pradipta. K.M. (2008). Textbook of Environmental Microbiology.I.K.Publishing. House.	
3.	Ramanathan, and Muthukaruppan SM. (2005). Environmental Microbiology.OmSakthiPathipagam, Annamalai Nagar.	
4.	K. Vijaya Ramesh.(2004).Environmental Microbiology. 1st Edition. MJP Publishers.	
5.	SubbaRao.N.S.(2017). Soil Microbiology.4th Edition. Oxford and IBH Publishing Pvt.Ltd.	
References Books		
1	Dirk, J. Elasas, V., Trevors, J.T., Wellington, E.M.H. (1997). Modern SoilMicrobiology, Marcel Dekker INC, New York, Hong Kong.	
2	EcEldowney S, Hardman D.J., Waite D.J., Waite S.(1993). Pollution: Ecology and Biotreatment – Longman Scientific Technical.	
3	Mitchel, R.(1992). Environmental Microbiology. Wiley –John Wiley and Sons. Inc. Publications, New York.	
4	Clescri, L.S., Greenberg, A.E. and Eaton, A.D.(1998). Standard Methods for Examination of Water and Wastewater, 20thEdition. American Public Health Association.	
5	Atlas, R.M. and Bartha, R.(1992). Microbial Ecology: Fundamentals andApplications, 2nd Edition. The Benjamin / Cummings Publishing Co.,Redwood City, CA.	
Web Resources		
1	https://nptel.ac.in/courses/126105016	
2	https://www.classcentral.com/course/swayam-plant-pathology-and-soil-health-14236	
3	https://www.wasteonline.org.uk/resources/InformationSheets/WasteDisposal.htm	
4	https://plantpath.cornell.edu/labs/enelson/PDFs/Hill_et_al_2000.pdf	
5	https://onlinelibrary.wiley.com/doi/full/10.1111/j.1365-2389.2005.00781.x	
Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External	End Semester Examination	75 Marks

Evaluation		
	Total	100 Marks

Methods of Assessment	
Recall (KI)	**Simple definitions, MCQ, Recall steps, Concept definitions**
Understand / Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, Short summary or overview
Application (K3)	Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain
Analyse (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations

Mapping with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	S										
CO2				M	S	S	S	S			
CO3	S						S	S			
CO4						S					
CO5	M				M						

Subject Code	**Subject Name**	**category**	**L**	**T**	**P**	**S**	**Credits**	**Inst. Hours**	**Marks**		
									CIA	**External**	**Total**
U23MBT613	**Food and Dairy Microbiology**	**core course – XIV**	**Y**	**-**	**-**	**-**	**4**	**6**	**25**	**75**	**100**

Course Objectives	
CO1	To impart current knowledge of basic and applied microbiological aspects of fluid milks and dairy products for improved quality and food safety.
CO2	Gives an insight into various types of food borne diseases and their prevention
CO3	To gain information about microflora of milk
CO4	To study about the production of fermented dairy products
CO5	To impart current knowledge of probiotics, prebiotics and functional dairy foods for the health benefits and To create a sustainable environmentally and technologically advanced

	dairy farm		
UNIT	**Details**	**No.of Hours**	**Course Objectives**
I	**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 - Low temperature - Drying - Food additives. Nanoscience in food preservation; microencapsulation.	12	CO1
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.	15	CO2
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.	15	CO3
IV	**Food fermentations**: Indian Pickles Bread,vinegar, fermented vegetables (sauerkraut), fermented dairy products (yoghurt, cheese, AcidophilusMilk,Kefir,Koumiss). Oriental fermented foods-Miso – Tempeh Ontjom . Natto, Idli Spoilage and defects of fermented dairy products -. Functional fermented foods and nutraceuticals, bioactive proteins and bioactive peptides, genetically modified foods.	15	CO4
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.Biopreservation.	15	CO5

	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	72	
Course Outcomes			
Course Outcomes	On completion of this course, students will;		
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,	PO7,PO8,PO10	
CO2	Acquire a thorough understanding of food borne diseases, testing methods, and preventive technique	PO5,PO10	
CO3	Gain information about spoilage of milk and its products and its antimicrobial properties	PO5,PO7	
CO4	Learn about the various fermented product and its various stage spoilage	PO7,PO8,PO10	
CO5	Impart current knowledge of probiotics, prebiotics and functional dairy foods for the health benefits	PO5,PO6	
Text Books			
1.	Frazier WC and West off DC. (2017). Food microbiology. 5th Edition TATA McGraw Hill Publishing Company Ltd. New Delhi.		
2.	Adams, M.R., Moss, M.O.(2018). Food Microbiology 1stedition. New Age Publishers by New Age International (P) Ltd., Publishers.		
3	R.C. Dubey. (2014). Advanced Biotechnology. S. Chand publishers.		
4	Banwart GJ. (1989). Basic food microbiology, Chapman & Hall, New York.		
5	Sugumar D. (1997). Outlines of dairy technology, Oxford University press. 1997.		
References Books			
1	Jay JM, Loessner MJ and Golden DA.(2005). Modern Food Microbiology. 7th Edition CBS Publishers and Distributors, Delhi, India.		
2	Prescott, Harley and Klein Wim.(2008). Microbiology, 7th Edition McGraw Hill Publications.		
3	Robinson, R. K.(2002). Dairy Microbiology Handbook - The Microbiology of Milk and Milk		

	Products (Third Edition), A John Wiley & Sons, Inc., New York.
4	Yuankunlee,Sepposalminen. (2008). Handbook of probiotics and prebiotics Second Edition. A John Wiley & Sons publication Inc.
5	DharumauraiDhansekaran, AlwarappanSankaranarayanan. (2021). Advances in Probiotics Microorganisms in Food and Health 1st Edition. eBook ISBN:9780128230916.
WEB RESOURCES	
1	https://www.researchgate.net/publication/15326559_A_Dynamic_Approach_to_Predicting_BacterialGrowth_in_Food/link/5a1d2e02aca2726120 b28eba/download
2	https://www.fda.gov/food/laboratory-methods-food/bam-foodsamplingpreparation-sample-homogenate
3	https://www.researchgate.net/publication/243462186_Foodborne_diseases_in_India_-_A_review
4	https://www.researchgate.net/publication/228662659_Fermented_Dairy_Products_Starter_Cultures_and_Potential_Nutritional_Benefits/link/000084160cf23f86393d5764/ download
5	https://www.fda.gov/food

Methods of Evaluation

Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks

Methods of Assessment

Recall (KI)	Simple definitions, MCQ, Recall steps, Concept definitions
Understand / Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, Short summary or overview
Application (K3)	Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain
Analyse (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations

Mapping with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1							S	S		M	

CO2					S					M	
CO3					S		M				
CO4							S	S		M	
CO5					M	M					

Subject Code	**Subject Name**	**Category**	**L**	**T**	**P**	**S**	**Credits**	**Inst. Hours**	**Marks**		
									CIA	**External**	**Total**
U23MBP614	**Practical VI-Environmental and Food Microbiology**	**Core Course – XV-Practical VI**	**Y**	**-**	**-**	**-**	**4**	**6**	**25**	**75**	**100**

Course Objectives	
CO1	Toassess the water quality and potability.
CO**2**	To acquire knowledge on enumeration of bacteria from milk and milk quality analysis
CO3	To investigate various extracellular enzyme producers in soil and to gain knowledge on preparation of biofertilizers
CO4	Improve knowledge on plant pathogens
CO5	To acquire knowledge on preparation of probiotics and prebiotics

Unit	**Details**	**No.of Hours**	**Course Objectives**
I	1. Physical, chemical, and microbiological assessment of water and potability test forwater. o Physical a – Color, pH, o Chemical - alkalinity, acidity, DO, BOD, COD o Microbiological – MPN index (Presumptive, Completed and Confirmatorytest) 2. Study of air microflora by settle plate method.	12	CO1
II	3. Isolation and identification of bacteria and fungi from fruits and vegetables 4. Direct microscopic count of milk. 5. Methylene blue reductase test and Resazurin test 6. Microbiological examination of milk by SPC.	12	CO2
III	7. Isolation of extracellular enzyme producers –Amylase, protease, lipase 8. Microbiological assay of antibiotics by cup plate method and other methods 9. Isolation of *Rhizobium*/ *Azotobacter*/ phosphate solubilizing organisms 10. Preparation of biofertilizers – Demonstration	12	CO3
IV	11. Study of plant pathogens- Tikka Disease, Red rot of sugarcane, Citrus canker, Blight of paddy.	10	CO4

	12. Study of fungi - *Mucor,Curvularia, Alternaria, Rhizopus, Aspergillus*		
V	13. Isolation of constituent flora of fermented milk. 14. Growth of probiotic LAB in broth, milk and whey. 15. Preparation of probiotic fermented milks like dahi, yoghurt, lassi and whey drink. 16. Effect of prebiotics on the growth of LAB in milk and broth. 17. Survivability of probiotic organisms in fermented milks. 18. Antimicrobial potential of the functional dairy products.	14	CO5
	Total	60	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Assess the microbial quality of water and relate the experimental results to the prescribed standards by the statutory bodies	PO1, PO4,PO5,PO6, PO7, PO8
CO2	Evaluate the quality of milk and enumerate bacteria in milk by standard plate count method	PO5,PO6, PO7, PO8
CO3	Identify extracellular enzyme producing and nitrogen fixing microorganism form soil and to prepare a biofertilizer.	PO1,PO8
CO4	Identifyvarious plant pathogenic bacteria	PO1
CO5	Synthesize probiotic fermented milks using microorganisms	PO1,PO7,PO8

Text Books

1.	Cappucino J and Sherman N.(2010). Microbiology: A Laboratory Manual. 9th Edition. Pearson Education Limited.
2.	Kannan. N. (1996). Laboratory manual in General Microbiology. Palani Publications.
3.	R C Dubey and D K Maheswari.(2002). Practical Microbiology. S. Chand Publishing.
4.	NeelimaGarg, K.L. Garg, K.G. Mukerji (2010).Laboratory Manual of Food Microbiology, Wiley publication
5.	Aneja, KR.(2010). Experiments in Microbiology, Plant pathology and Biotechnology. New Age International (P) Limited.

References Books

1	Christon J. Hurst Editor in Chief, Ronald L. Crawford, Jay L. Garland, David A. Lipson, Aaron L. Mills, Linda D. Stetzenbach (2007). Manual of Environmental Microbiology, Third Edition,Wiley publication.
2	James G Cappucino and Natalie Sherman.(2016). Microbiology – A laboratory manual. 4th Edition. The Benjamin publishing company, New York.
3	Marylynn V. Yates, Cindy H. Nakatsu, Robert V. Miller, Suresh D. Pillai 2016). Manual of Environmental Microbiology, 4thEdition,ASM press.
4	Burns, Richard G (2005). Environmental MicrobiologyA Laboratory Manual, 2nd Edition .Lippincott Williams & Wilkins, Inc.
5	Ian Pepper, Charles Gerba, Jeffrey Brendecke (2004). Environmental Microbiology-A laboratory manual, Elsevier.

Web Resources

1	https://micobenotes.com/fields-of-microbiology/
2	https://bio.libretexts.org
3	https://www.google.com

4	https://www.sfamjournals.onlinelibrary.wiley.com
5	https://www.degruyter.com

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks

Methods of Assessment	
Recall (KI)	Simple definitions, MCQ, Recall steps, Concept definitions
Understand / Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, Short summary or overview
Application (K3)	Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain
Analyse (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations

Mapping with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S			M	S	S	S	S
CO2					M	M	M	M
CO3	M							S
CO4	M							
CO5	M						S	S

Subject Code	**Subject Name**	**Category**	**L**	**T**	**P**	**S**	**Credits**	**Inst Hours**	**Marks**		
									CIA	**External**	**Total**
U23MBE67A	**Pharmaceutical Microbiology**	**Subject based Elective 7 (Department)**	**Y**	**-**	**-**	**-**	**3**	**5**	**25**	**75**	**100**

Course Objectives			
CO1	To provide the knowledge on basics of chemotherapy		
CO2	To learn the assays and testing methods of antibiotics.		
CO3	To gain information about spoilage of pharmaceutical products		
CO4	To provide the knowledge on drug discovery and clinical trials		
CO5	To learn about regulations in pharmaceutical industry		
Unit	**Details**	**No.of Hours**	**Course Objective**
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.	12	CO1
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.	10	CO2
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.	12	CO3
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.	16	CO4
V	Quality Assurance and Validation:Good Manufacturing Practices (GMP) and Good Laboratory Practices (GLP) in pharmaceutical	10	CO5

	industry; Regulatory aspects of quality control; Quality assurance and quality management in pharmaceuticals – BIS (IS), ISI, ISO, WHO and US certification.		
	Total	60	
Course Outcomes			
Course Outcomes	On completion of this course, students will;		
CO1	Learn the basics of chemotherapy and action of antibiotics	PO1,PO10	
CO2	Carry out the microbiological assay of antibiotics	PO7	
CO3	Analyse Microbiological standardization of Pharmaceuticals, sterility testing of pharmaceutical products. Applysterilization in pharmaceutical industry	PO5,PO8,PO10	
CO4	Evaluate the process and develop new strategies for rational drug design	PO9,PO10	
CO5	Learn the Regulatory guidelines in pharmaceuticals product.	PO3,PO5	
Text Books			
1.	Chand Pasha Kedernath. (2021). Text book of Pharmaceutical Microbiology. Ramnath Publisher.		
2.	Hugo WB and Russell AD. (2004).Pharmaceutical Microbiology VII edition. Blackwell Scientific Publication, Oxford.		
3	Franklin,DJ. and Snow, GA. (2013). Biochemistry of antimicrobial action.Chapman& Hall.		
4	Kuntal Das (2019). Pharmaceutical Microbiology, second edition, NiraliPrakashan.		
5	PriyatamaPowar, ShitalNimbargi, VaijayantiSapre (2020). Pharmaceutical Microbiology, I edition, Technical publications.		
References Books			
1	Handa, S.S. and Kapoor, V.K. (2022) .Pharamcognosy. 4thEdition.VallabhPrakashanPublishers,New Delhi.		
2	Kokate, C.K., Durohit, A.P. and Gokhale, S.R.,(2002). Pharmacognosy. 12thedition NiraliPrakasham Publishers, Pune.		
3	S. P. Vyas& V. K. Dixit.(2003). Pharmaceutical Biotechnology. CBS Publishers & Distributors, New Delhi.		
4	Wallis, T.E. (2005). Text book of Pharmacognosy. 5th edition. CBS publishers and distributors, New Delhi.		
5	Garrod, L.P., Lambert, HP. And C'Grady, F. (1973). Antibiotics and Chemotherapy. (eds). Churchill Livingstone.		
Web Resources			
1	https://www.pharmapproach.com/introduction-to-pharmaceutical-microbiology/		

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

Methods of Evaluation

Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks

Methods of Assessment

Recall (KI)	Simple definitions, MCQ, Recall steps, Concept definitions
Understand / Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, Short summary or overview
Application (K3)	Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain
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Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations

Mapping with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	M									M	
CO2							M				
CO3					S			M		M	
CO4									L	M	
CO5			L		M						

Subject Code	**Subject Name**	**Category**	**L**	**T**	**P**	**S**	**Credits**	**Inst. Hours**	**Marks**		
									CIA	**External**	**Total**
U23MBE68A	**Entrepreneurship and Bio-business**	**Subject based Elective 8**	**Y**	**-**	**-**	**-**	3	5	**25**	**75**	**100**

	(Department)										
Course Objectives											
CO1	Understanding basic concepts in the area of entrepreneurship, the role and importance of entrepreneurship for economic development										
CO2	Developing personal creativity and entrepreneurial initiative, adopting the key steps in the elaboration of business idea.										
CO3	Understanding the stages of the entrepreneurial process and the resources needed for the successful development of entrepreneurial ventures.										
CO4	Explain the central components of successful business strategies in biotechnology, and create a business plan.										
CO5	Understand the various funding resources and develop as Entrepreneur										
Unit	**Details**							**No.of Hours**		**Course Objectives**	
I	Bio Entrepreneurship: Introduction to bio-business, SWOT analysis of bio-business. Ownership, Development of Entrepreneurship; Stages in entrepreneurial process; Government schemes and funding. Small scale industries: Definition; Characteristics; Need and rationale.							12		CO1	
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, polyhouse 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.							12		CO2	
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.							12		CO3	
IV	Therapeutic and Fermented products: Stem cell production, stem cell							12		CO4	

	bank, production of monoclonal/polyclonal antibodies, secondary metabolite production – antibiotics, probiotic and prebiotics.		
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 Bio business-schemes and subsidies. Project proposal preparation, Successful start-ups-case study.	12	CO5
	Total	60	

Course Outcomes		
Course Outcome	On completion of this course, students will;	
CO1	Describe and apply several entrepreneurial ideas and business theories in practical framework.	PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO8, PO9, PO10, PO11, PO12, PO13, PO14
CO2	Analyse 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.	PO2, PO5, PO7, PO8, PO10, PO12, PO14
CO3	Express the mass production of microbial inoculants used as Biofertilizers and Bioinsecticides in response with field application and crop response.	PO4, PO6, PO9, PO11
CO4	Analyze the application and commercial production of Monoclonal antibodies, Cytokines. TPH and teaching kits.	PO5, PO6, PO9, PO11
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.	PO2,PO7, PO8

Text Books	
1.	Craig Shimasaki. (2014). Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies. Academic Press.
2.	Ashton Acton, O. (2012). Biological Pigments– Advances in Research and Application

	Scholorly Editions: Atlanta, Georgia.
3.	Jennifer Merritt, Jason Feifer (2018). Start Your Own Business, 7th edition, Entrepreneur Press publisher.
4.	Peter F. Drucker (2006). Innovation and Entrepreneurship. Harper Business publisher.
5.	Leah Cannon (2017). How to Start a Life Science Company: A Comprehensive Guide for First-Time Entrepreneurs. International Kindle paperwhite.
References Books	
1	Crueger, W, and Crueger. A.(2000). Biotechnology: A Text Book of Industrialmicrobiology, 2nd Edition, Sinauer Associates: Sunderland.Mass.
2	Paul S Teng. (2008). Bioscience Entrepreneurship in AsiaWorld Scientific Publishing Company.
3	Charles E. Bamford, Garry D. Bruton (2015). ENTREPRENEURSHIP: The Art, Science, and Process for Success, 2nd Edition, McGraw Hill publisher.
4	Yali Friedman (2014). Building Biotechnology: Biotechnology Business, Regulations, Patents, Law, Policy and Science 4th Edition, Logos press publication.
5	Stephanie A. Wisner (2022). Building Backwards to Biotech: The Power of Entrepreneurship to Drive Cutting-Edge Science to Market, International Kindle paperwhite.
Web Resources	
1	https://www.bio-rad.com/webroot/web/pdf/lse/literature/Biobusiness.pdf
2	https://www.crg.eu/biobusiness-entrepreneurship
3	https://www.entrepreneur.com
4	https://www.birac.nic.in
5	https://www.springer.com

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks

Methods of Assessment	
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, Short summary or overview
Application (K3)	Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain
Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons

Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations

Mapping with Programme Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	S	S	S	S	S	S	S	S	S	S	S
CO2		S			M		S	S		M	
CO3											
CO4				S		S			S		S
CO5		S					S	S			