PANSKURA BANAMALI COLLEGE (AUTONOMOUS)

NEP Microbiology Syllabus

PANSKURA BANAMALI COLLEGE (AUTONOMOUS)

Curriculum and Credit Framework for Undergraduate Programmes w.e.f. 2024 - 25

Draft Structure of the UG Programme (B.Sc./B.A./B.Com.) for Single Major

Semester	Major courses		Multi-Disciplinary Courses (MDC)	Minor		Ability Enhancement Courses	Skill Enhancement Courses	Value Added Courses	Total Credits
	Core Courses	Elective (DSE)		GE1	GE2				
I	CC1 (4 credits)		MDC1 (3 credits)	GE1A [4 credits] (Paper 1 from GE1)	×	AECCEL /BL (2 credits) **(Sc. & Com.) / (Arts)**	SEC1 (3credits)	VAC (A/B/C) (4 credits) **(Arts) / (Sc.)/ Com.)**	20
II	CC2(4 credits) *		MDC2 (3 credits)	×	GE2A[4 credits] (Paper 1 from GE2	AECCEL /BL (2 credits) **(Arts) / (Sc. & Com.)**	SEC2 (3credits)	VAC (B/C/A) (4 credits) **(Arts) / (Sc.)/ Com.)**	20
	8		**6**	**4 + 4 = 8**		**4**	**6**	**8**	**40**
Certificate	***Students exiting after completing these courses (40 credits) will be awarded UG Certificate in Main/Major subject provided they secure 4 credits in work based vocational courses offered during summer term or internship / Apprenticeship***								**40**
III	CC3 (4 credits) CC4 (4 credits)		MDC3 (3 credits)	GE1B(4 credits) * (Paper 2 from GE1)	×	AECCEL /BL (2 credits) **(Sc. & Com.) / (Arts)**	SEC3* (3 credits)		20
IV	CC5 (4 credits) CC6 (4 credits)* CC7 (4 credits)		×	×	GE2B(4 credits) * (Paper 2 from GE2)	AECCEL /BL (2 credits) **(Arts) / (Sc. & Com.)**	Community outreach (2 credits)		20
	8 + 20 = 28		**6 + 3 = 9**	**8 + 8 =16**		**4 + 4 = 8**	**6 + 5 = 11**	**8 + 0 = 8**	**80**
Diploma	***Students exiting after completing these courses (80 credits) will be awarded UG Certificate in Main/Major subject provided they secure 4 credits in work based vocational courses offered during summer term or internship / Apprenticeship***								**80**

*indicates practical paper if applicable. **VAC- A** : ENVS; **VAC- B** : **Digital & Technological Solution** , **VAC- C: Yoga & Wellness**

Draft Structure of the UG Programme (B.Sc./B.A./B.Com.) for Single Major

Semester	Major Courses		Multi-Disciplinary Courses (MDC)	Minor		Ability Enhancement Courses	Skill Enhancement Courses	Value Added Courses	Total Credits
	Core Courses	DSE		GE1	GE2				
V	CC 8 (4 credits) CC 9 (4 credits)* CC10 (4 credits) CC11 (4 credits)	DSE1(4 credits)	×	GE1C (4 credits) (Paper 3from GE1)		×		×	24
VI	CC12 (4 credits)* CC13 (4 credits) CC14 (4 credits) CC15 (4 credits)*	DSE2(4 credits)	×	×	GE2C(4 credits) (Paper 3 from GE2)	×	×	×	24
UG Degree	**28 + 32 + 8 = 68**		**9 + 0 = 9**	**16 + 8 = 24**		**8 + 0 = 8**	**11+ 0 = 11**	**8 + 0 = 8**	**80 + 48 =128**
Students who want to undertake 3 – year UG programme will be awarded UG degree in main/major subject i.e core subject upon securing 128 credits.									
VII	CC16 (4 credits) CC17 (4 credits) CC18(4 credits) *	DSE3(4 credits)* DSE4(4 credits)	×	GE1D (4 credits) * (Paper 4 from GE1)	×	×	×	×	24
VIII	CC19 (4 credits) CC20 (4 credits) CC21(4 credits)*	DSE5(4 credits) DSE6(4 credits)**	×	×	GE2D (4 credits) * (Paper 4 from GE2)	×	×	×	24
UG (Hons)	**68 + 40 = 108**		**9**	**24 + 8 = 32**		**8 + 0**	**11 + 0**	**8 + 0**	**128 + 48 = 176**
Students who want to undertake 4 – year UG programme will be awarded UG degree (Honours) in main/major subject i.e. core subject upon securing 176 credits.									

*indicates practical paper if applicable. ** ***Field-based learning/minor project*** paper

Draft Structure of the UG Programme (B.Sc./B.A./B.Com.) Hons with Research for Single Major

Semester	Major Courses		Multi-Disciplinary Courses (MDC)	Minor		Ability Enhancement Courses	Skill Enhancement Courses	Value Added Courses	Total Credits
	Core Courses	DSE		GE1	GE2				
VII	CC16 (4 credits) CC17 (4 credits) CC18(4 credits) *	DSE3(4 credits)*	×	GE1D (4 credits) * (Paper 4 from GE1)	×	×	RCW: Research methodology & ethics (4 credits)	×	24
VIII	CC19 (4 credits) CC20 (4 credits) CC21(4 credits) *		×	×	GE2D (4 credits) * (Paper 4 from GE2)	×	Dissertation project (8 credits)	×	24
UG (Hons)	**68 + 28 = 96**		**9**	**24 + 8 = 32**		**8 + 0**	**11 + 12= 23**	**8 + 0**	**128 + 48 = 176**
Students who want to undertake 4 – year UG programme will be awarded UG degree (Honours with Research) in main/major subject i.e. core subject with Research upon securing 176 credits.									

*indicates practical paper if applicable. ** ***Field-based learning/minor project*** paper

Summer Internship /Apprenticeship (4 credits)

A key aspect of the new UG programme is induction into actual work situations**.** Allstudents will also undergo internships / Apprenticeships in a

i. firm,
ii. industry, or organization or
iii. Training in labs with faculty and researchers in their own or
iv. other HEIs/research institutions during the summer term.

Students will be provided with opportunities internships with

i. local industry,
ii. business organizations,
iii. health and allied areas,
iv. local governments (such as panchayats, municipalities),
v. Parliament or elected representatives,
vi. media organizations,
vii. artists, crafts persons, and a widevariety of organizations

so that students may actively engage with the practical side of their learning and, as a by-product, further improve their employability. Students who wish to exit after the first two semesters will undergo a 4-credit work-based learning/internship during the summer term in order to get a UG Certificate.

Community engagement and service: The curricular component of 'community engagement and service' seeks to expose students to the socio-economic issues in society so that the theoretical learnings can be supplemented by actual life experiences to generate solutions to real-life problems. This can be part of summer term activity or part of a major or minor course depending upon the major discipline.

Field-based learning/minor project: The field-based learning/minor project will attempt to provide opportunities for students to understand the different socio- economic contexts. It will aim at giving students exposure to development-related issues in rural and urban settings. It will provide opportunities for students to observe situations in rural and urban contexts, and to observe and study actual field situations regarding issues related to socioeconomic development. Students will be given opportunities to gain a first-hand understanding of the policies, regulations, organizational structures, processes, and programmes that guide the development process. They would have the opportunity to gain an understanding of the complex socio-economic problems in the community, and innovative practices required to generate solutions to the identified problems. This may be a summer term project or part of a major or minor course depending on the subject of study

Question patterns of End Semester Examination (ESE)

For UGC Curriculum and Credit Framework Undergraduate Programmes

Question pattern for all Courses (Theory only)

	Course	Marksdistribution							
QuestionTypes	**CC/DSE/IDC/GE/ AECC/SEC/VAC (Theoretical)**	ENDSemesterExamination Full Marks:**40,**Time:2 hours,(Weightage100%)*[1]			InternalAssessment (WrittenMid-Sem+CA)			
					MID-Semester(Written)Examination Full Marks:**10,**Time:30min.(Weightage50%)*[2]			CA*[3]
	Objective/Very shorttype	1	Answer05question(outof08)carrying **02** marks each	**02**×5=10	1	Answer05question(outof08)carrying**02**markseach	**02**×5=10	5
	Descriptive/BroadType*[4]	3	Answer 03 questions (out of 05)carrying **10** marks each	**10**×3=30				
				40			**10**	

*[1] 100%weightagemeans totalmarksscoredoutof40will becounted/reflected infullfinally.
*[2] 50%weightagemeanshalfthemarksscoredout of10willbecounted/reflectedfinally.
*[3]CAstandsforContinuousassessment(thatmaybebasedonclassattendance,rolesindepartmentalactivities,*viva*etc.).Fullweightage.
*[4]AnyDescriptive/BroadTypeQuestion,carrying10marks,needsnotnecessarilybeasinglequestion.

Components(AllPracticalPapers)

Course	Marksdistribution		
Practical	END Semester ExaminationFullMarks:50,Time:2hours		
	1	Experiments	30
	2	PracticalNoteBook	15
	3	*Vivavoce*	5
		TOTAL	**50**

Components(ProjectWorksotherthanResearchwork/Dissertation inthe8th Sem.)

Course	Marksdistribution		
ProjectWork (2Cr.)	ENDSemesterExamination, Full Marks:50		
	1	Reportwriting	25
	2	Presentation	15
	3	*Vivavoce*	10
		TOTAL	**50**

The Department of MICROBIOLOGY

CODES & TITLES of the COURSES offered under the NEP Curriculum

(NEP 4 Year Undergraduate Course)

SINGLE MAJOR

Sems.	COURSES		Credits	
	Codes	Course Titles	L–T–P	Total
		1. Major Course Core (MCC)		
Sem.-I	**MCBUMCC101**	Introduction to Microbiology and microbial diversity	3–1–0	4
Sem.-II	**MCBUMCC202**	Introduction to microbiology and microbial diversity	0–1–3	4
Sem.-III	**MCBUMCC303**	Bacteriology	3–1–0	4
	MCBUMCC304	Virology	3–1–0	4
Sem. -IV	**MCBUMCC405**	Biochemistry	3–1–0	4
	MCBUMCC406	Bacteriology and Biochemistry	0–1–3	4
	MCBUMCC407	Microbial physiology and Metabolism	3–1–0	4
Sem.-V	**MCBUMCC508**	Cell Biology	3–1–0	4
	MCBUMCC509	Cell biology and Microbial metabolism	0–1–3	4
	MCBUMCC510	Molecular Biology	3–1–0	4
	MCBUMCC511	Microbial genetics		
Sem.-VI	**MCBUMCC612**	Microbial genetics and molecular biology	0–0–4	4
	MCBUMCC613	Immunology	3–1–0	4
	MCBUMCC614	Medical Microbiology	3–1–0	4
	MCBUMCC615	Medical Microbiology and Immunology		
Sem.-VII	**MCBUMCC716**	Environmental Microbiology	3–1–0	4
	MCBUMCC717	Microbes in sustainable agriculture and development	3–1–0	4
	MCBUMCC718	Environmental Microbiology	0–1–3	4
Sem.-VIII	**MCBUMCC819**	Recombinant DNA Technology	3–1–0	4
	MCBUMCC820	Instrumentation and bio techniques	3–1–0	4
	MCBUMCC821	Recombinant DNA technology		
		2. Major Course Discipline-Specific (MCD)		
Sem.-V	**MCBUMCD501**	Industrial Microbiology	3–1–0	4
Sem.-VI	**MCBUMCD602**	Food and dairy Microbiology	3–1–0	4
Sem.-VII	**MCBUMCD703**	Industrial and Food Microbiology	0–1–3	4
	MCBUMCD704	Bioinformatics	3–1–0	4
	MCBUMCD805	Biostatistics	3–1–0	4

Sem.-VIII	**MCBUMCD806**	Project Work	0–1–3	4
		3. Minor Courses (MIC) **(Offered to the Students from other departments)**		
Sem.-I	**MCBUMIC101**	Introduction to microbiology and microbial diversity	3–1–0	4
Sem.-II	**MCBUMIC201**	Introduction to microbiology and microbial diversity	3–1–0	4
Sem.-III	**MCBUMIC302**	Introduction to microbiology and microbial diversity	0–1–3	4
Sem.-IV	**MCBUMIC402**	Introduction to microbiology and microbial diversity		
Sem.-V	**MCBUMIC503**	Bacteriology and Virology	3–1–0	4
Sem.-VI	**MCBUMIC603**	Bacteriology and Virology		
Sem.-VII	**MCBUMIC704**	Bacteriology and Virology	0–1–3	4
Sem.-VIII	**MCBUMIC804**	Bacteriology and Virology		

		4. Skill Enhancement Course (SEC)		
Sem.-I	**MCBUSEC101**	Biosafety and intellectual Property Rights	2–1–0	3
Sem.-II	**MCBUSEC202**	Microbiological analysis of air and water	2–1–0	3
Sem.-III	**MCBUSEC303**	Microbiological analysis of air and water	0–1–2	3

Programme Learning outcomes of BSc. Hons Microbiology course

- A candidate who is conferred an UG (Hons) degree i.e., B.Sc. in microbiology needs to have acquired/developed following competencies during the programme of the study:
- Acquired knowledge and understanding of the microbiology concept applicable to diverse areas such as medical, industrial, environmental, genetics, agriculture, food and others.
- Demonstrate key practical skills/competencies in working with microbes for the study and use in the laboratory as well as outside, including the use of good microbiological practices.
- Competent enough to use microbiology knowledge and skills to analyze problems involving microbes, articulate the sewithpeers/team members/other stakeholders, and undertake remedial measures/studies.
- Developed abroad perspective of the discipline of Microbiology to enable him to identify challenging social problems and plan his professional career to develop innovative options for such problems.

MCC101: INTRODUCTION TO MICROBIAL WORLD (THEORY)

Semester-I

TOTAL HOURS -50 **CREDIT-4**

Course Learning Outcomes:

Outcome 1: Give a brief knowledge of history of microbiology and microbiologists those who came consecutively with their discoveries and contributions in this field.

Outcomes 2: Provides an information about how to classify cellular microorganisms based on their general characteristics.

Outcomes 3: Establishes a very good understanding of fungi, algae, protozoa in terms of their general characters, reproduction, lifecycle, habits, thallus organization and importance.

Outcome4: Are able to perform basic microbiological laboratory experiments and tools.

Unit 1: History of development of microbiology **No ofHours-3**

Development of microbiology as a discipline, spontaneous generation vs. biogenesis, Contributions of Antony Von Leuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming.

Unit 2: System of classification **No of Hours-4**

Taxonomy and the Linnaean system of classification, Goals of classification, Evolving Trees of Life (Phylogenies), General methods of Classifying Bacteria. Binomial Nomenclature.

Unit 3: Diversity of Microbial world **No of Hours-30**

General Characteristics of different groups

Acellular microorganisms (Viruses, Viroid, Prions) and cellular microorganisms (Bacteria, Algae, Fungi and protozoa) with emphasis on distribution and occurrence, morphology, mode of reproduction and economic importance.

Viruses, Viroid, Prions

A general introduction with special refences to the structure of the following: TMV, Polio virus, T4 and λ phage, lytic and lysogenic cycles, one step multiplication curve.

Bacteria

A precise account of typical eubacteria and archaebacteria(extremophiles)

Algae

General characters of algae including occurrence, thallus organization, algae cellular structure, pigments, flagella, eyespot, food reserves and vegetative, asexual and sexual reproduction. Different types of life cycle in algae with suitable examples: Haplobiontic, Haplontic, Diplontic, Diplobiontic lifecycles, Application of algae in agriculture, environment and food.

Fungi

General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultrastructure, thallus organization and aggregation, fungal cell wall structure and synthesis, asexual and sexual reproduction, heterokaryosis, heterothallism and parasexual mechanisms. Economical importance of fungi with examples in industry, medicine, food, bioderioration, mycotoxins.

Protozoa

General characteristics with special references to Amoeba, Paramecium and Giardia

Unit4: Basic Microbiological techniques **No of Hours-10**

Methods of studying microorganisms, Sterilization techniques - Tyndallization, Pasteurization, Steam under pressure (Autoclave), Incinaration, Hot air oven. Inoculation and Incubation, Principle and application of biological safety cabinates (Laminar air flow).

Unit 5: Importance of Microbiology in Daily Life **No. of Hours-3**

Beneficial and harmful microbes and their role in daily life.
Concept of disease in plant and animal caused by microorganisms.

Tutorial

Students will get to learn about-

1. Microbiology laboratory practices and biosafety
2. Study of principle and the application of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, light microscope, pH meter) used in the microbiological laboratory.
3. Preparation of culture media for bacterial cultivation.
4. Preparation of different media: Synthetic mediaBG-11,complexmedia–nutrient agar
5. Characterization of Bacterial cells and colonies by means of morphological study and staining
   a) Isolation of pure culture of bacteria by streaking method.

6. Estimation of CFU count by spread plate/pour plate method.

SUGGESTED READING

1. Tortora GJ, Funke BR and Case CL. (2008). Microbiology: An Introduction .9 th edition. Pearson Education
2. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology ofMicroorganisms.14thedition. Pearson International Edition
3. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition.Pearson Education Limited
4. Wiley JM, Sherwood L M and Woolverton CJ. (2013) Prescott's Microbiology. 9thedition.McGraw HillInternational.
5. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T. Brown Publishes.Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5thedition. McGrawHillBook Company
6. StanierRY,IngrahamJL,WheelisML,andPainterPR.(2005).GeneralMicro biology.5thedition.McMillan.

SEC101: BIOSAFETY AND INTELLECTUAL PROPERTY RIGHTS (THEORY)

SEMESTER–I

TOTALHOURS:25 **CREDITS:3**

Course learning outcomes: the conclusion of this course, the students have-

Outcome 1. Full knowledge of working in a microbiology laboratory taking all safety measures, handing of live bacteria, disposal of infectious waste, care of the equipment requiring safety audit
Outcome2.Developed knowledge of basic concepts related to IPR.
Outcome 3. Developed knowledge of patent filing, and some well-known/well-publicized case studies related to IPR

Unit1 **NoofHours:3**

Biosafety: Introduction; biosafety issues in biotechnology; Biological Safety Cabinets & their types; Primary Containment for Biohazards; Biosafety Levels of Specific Microorganisms

Unit2 **NoofHours:5**

Biosafety Guidelines: Biosafety guidelines and regulations (National and International);GMOs/LMOs- Concerns and Challenges; Role of Institutional Biosafety Committees (IBSC),RCGM,GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs;Risk Analysis; Risk Assessment; Risk management and communication; Overview of International Agreements-Cartagena Protocol.

Unit3 **NoofHours:3**

AERB /RSD /RES'S guidelines for using radio isotopes in laboratories and precautions.

Unit4 **NoofHours:5**

Introduction to Intellectual Property: Patents, Types, Trademarks, Copyright & Related Rights, Industrial Design and Rights, Traditional Knowledge, Geographical Indications-importance of IPR– patentable and non-patentable – patenting life – legal protection of biotechnological inventions – World Intellectual Property Rights Organization (WIPO).

Unit5 **NoofHours:9**

Grant of Patent and Patenting Authorities: Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; An introduction to Patent Filing Procedures; Patent licensing and agreement; Patent infringement- meaning, scope, litigation, case studies, Rights and Duties of patent owner.

SuggestedReading

2. BareAct,2007.IndianPatentAct1970Acts&Rules,UniversalLawPublishingCo.P vt.Ltd.,NewDelhi.
3. KankanalaC(2007).GeneticPatentLaw&Strategy,1stEdition,ManupatraInfor mationSolutionPvt.Ltd.NewDelhi.
4. Mittal,D.P.(1999).IndianPatentsLaw,Taxmann,AlliedServices(p)Ltd.
5. SinghKK(2015).BiotechnologyandIntelectualPropertyRights:LegalandSoci alImpliocations,SpringerIndia.
6. GoelD&PrasharS(2013).IPR,BiosafetyandBioethics.Pearson
7. SenthilKumarSadhasvisamandMohammedjabbir,M.S.2008.IPR,Bio safety and Biotechnology Management Jasen Publications,Tiruchirappalli,India.

MIC101: INTRODUCTION TO MICROBIAL WORLD (THEORY)

Semester-I

TOTAL HOURS -50 **CREDIT-4**

Course Learning Outcomes:

Outcome 1: Give a brief knowledge of history of microbiology and microbiologists those who came consecutively with their discoveries and contributions in this field.

Outcomes 2: Provides an information about how to classify cellular microorganisms based on their general characteristics.

Outcomes 3: Establishes a very good understanding of fungi, algae, protozoa in terms of their general characters, reproduction, lifecycle, habits, thallus organization and importance.

Outcome4: Are able to perform basic microbiological laboratory experiments and tools.

Unit 1: History of development of microbiology **No ofHours-3**

Development of microbiology as a discipline, spontaneous generation vs. biogenesis, Contributions of Antony Von Leuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming.

Unit 2: System of classification **No of Hours-4**

Taxonomy and the Linnaean system of classification, Goals of classification, Evolving Trees of Life (Phylogenies), General methods of Classifying Bacteria. Binomial Nomenclature.

Unit 3: Diversity of Microbial world **No of Hours-30**

General Characteristics of different groups

Acellular microorganisms (Viruses, Viroid, Prions) and cellular microorganisms (Bacteria, Algae, Fungi and protozoa) with emphasis on distribution and occurrence, morphology, mode of reproduction and economic

Viruses, Viroid, Prions

A general introduction with special refences to the structure of the following: TMV, Polio virus, T4 and λ phage, lytic and lysogenic cycles, one step multiplication curve.

Bacteria

A precise account of typical eubacteria and archaebacteria(extremophiles)

Algae

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Fungi

General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultrastructure, thallus organization and aggregation, fungal cell wall structure and synthesis, asexual and sexual reproduction, heterokaryosis, heterothallism and parasexual mechanisms. Economical importance of fungi with examples in industry, medicine, food, bioderioration, mycotoxins.

Protozoa

General characteristics with special references to Amoeba, Paramecium and Giardia

Unit4: Basic Microbiological techniques **No of Hours-10**

Methods of studying microorganisms, Sterilization techniques - Tyndallization, Pasteurization, Steam under pressure (Autoclave), Incinaration, Hot air oven. Inoculation and Incubation, Principle and application of biological safety cabinates (Laminar air flow).

Unit 5: Importance of Microbiology in Daily Life **No. of Hours-3**

Beneficial and harmful microbes and their role in daily life.
Concept of disease in plant and animal caused by microorganisms.

Tutorial

Students will get to learn about-

1. Microbiology laboratory practices and biosafety

7. Study of principle and the application of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, light microscope, pH meter) used in the microbiological laboratory.
8. Preparation of culture media for bacterial cultivation.
9. Preparation of different media: Synthetic mediaBG-11,complexmedia–nutrient agar
10. Characterization of Bacterial cells and colonies by means of morphological study and staining
    a) Isolation of pure culture of bacteria by streaking method.

11. Estimation of CFU count by spread plate/pour plate method.

SUGGESTED READING

1. Tortora GJ, Funke BR and Case CL. (2008). Microbiology: An Introduction .9 th edition. Pearson Education
2. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology ofMicroorganisms.14thedition. Pearson International Edition
3. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition.Pearson Education Limited
4. Wiley JM, Sherwood L M and Woolverton CJ. (2013) Prescott's Microbiology. 9thedition.McGraw HillInternational.
5. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T. Brown Publishes.Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5thedition. McGrawHillBook Company
6. StanierRY,IngrahamJL,WheelisML,andPainterPR.(2005).GeneralMicro biology.5thedition.McMillan

MCC202: INTRODUCTION TO MICROBIAL WORLD (PRA CTICALS)
SEMESTER–II

TOTALHOURS: 50 **CREDIT: 4**

Course learning outcomes1: At the completion of this course, the students are able to– **Outcome1:** Have developed a good knowledge of the development of the discipline of Microbiology and the contribution made by prominent scientist in this field.
Outcome2: Have developed a very good understanding of the characteristics of different types of microorganisms, methods to organize/classify and basic tools to study the sein the laboratory.
Outcome3: Are able to explain the useful and harmful activities of the microorganisms.
Outcome4: Are able to perform basic experiments to grow and study microorganisms in the laboratory.

a. Microbiology good laboratory practices and biosafety.
b. To study the principle and application of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, light microscope, pH meter) used in the microbiological laboratory.
c. Preparation of cultural media for bacterial cultivation.
d. Sterilization of media using autoclave and assessment for sterility
e. Sterilization of glassware using hot air oven and assessment for sterility
f. Sterilization of heat sensitive material using membrane filter and assessment for sterility
g. Demonstration on the presence of microflora in the environment by exposing nutrient agar plates to air
h. Study of different shapes of bacteria using electron micrograph
i. Study of *Rhizopus, penicillin, Aspergillus* using permanent slides
j. Study of *Spirogyra, Chlamydomonas* and *Volvox* using permanent slides
k. Study of *Amoeba, Entamoeba, Paramecium, Plasmodium* using permanent slides

SEC202: MICROBIOLOGICAL ANALYSIS OF AIR AND WATER (THEORY)

SEMESTER – II

TOTALHOURS: 25 **CREDITS :3**

Course learning outcomes: By the conclusion of this course, the students-

Outcome1.Havedevelopedaverygoodunderstandingandskills of the analysis of air, water and

soil.

Outcome 2. Have developed a very good understanding of how analysis of water, air and soil contribute to control of environmental pollution.

Unit1: Aero microbiology **No of Hours: 4**

Bioaerosols, Air borne microorganisms (bacteria, Viruses, fungi) and their impact on human health and environment, significance in food and pharma industries and operation theatres, allergens

Unit2: Air Sample Collection and Analysis **No of Hours: 7**

Bioaerosol sampling, air samplers, methods of analysis, CFU, culture media for bacteria and fungi, Identification characteristics.

Unit3: Control Measures **No of Hours: 4**

Fate of bioaerosols, inactivation mechanisms–UV light, HEPA filters, desiccation, Incineration

Unit4: Water Microbiology **No ofHours :4**

Water borne pathogens; water borne diseases

Unit5: Microbiological Analysis of Water **No of Hours: 7**

Sample Collection, Treatment and safety of drinking (potable) water, methods to detect potability of water samples: (a)standard qualitative procedure: presumptive / MPN tests, confirmed and completed tests for facial coliforms, (b) Membrane filter technique and (c)Presence/absence tests.

Unit6: Control Measures **No of Hours: 4**

Precipitation, chemical disinfection, filtration, high temperature, UV light.

SuggestedReading

1. daSilvaN, TaniwakiMH,JunqueiraVC, SilveiraN,Nascimento MS,Gomes RAR(2012)MicrobiologicalExaminationMethodsofFoodandWaterALaboratory Manual,CRCPress.
2. AtlasRMandBarthaR.(2000).MicrobialEcology:Fundamentals& Applications. 4thedition. Benjamin/Cummings SciencePublishing, USA
3. MaierRM,Pepper IL and GerbaCP.(2009).EnvironmentalMicrobiology.2nd edition, AcademicPress
4. HurstCJ,CrawfordRL,GarlandJL,LipsonDA(2007)ManualofEnvir onmentalMicrobiology, 3rd edition, ASM press

MIC201: INTRODUCTION TO MICROBIAL WORLD (THEORY)

Semester-II

TOTAL HOURS -50 **CREDIT-4**

Course Learning Outcomes:

Outcome 1: Give a brief knowledge of history of microbiology and microbiologists those who came consecutively with their discoveries and contributions in this field.

Outcomes 2: Provides an information about how to classify cellular microorganisms based on their general characteristics.

Outcomes 3: Establishes a very good understanding of fungi, algae, protozoa in terms of their general characters, reproduction, lifecycle, habits, thallus organization and importance.

Outcome4: Are able to perform basic microbiological laboratory experiments and tools.

Unit 1: History of development of microbiology **No ofHours-3**

Development of microbiology as a discipline, spontaneous generation vs. biogenesis, Contributions of Antony Von Leuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming.

Unit 2: System of classification **No of Hours-4**

Taxonomy and the Linnaean system of classification, Goals of classification, Evolving Trees of Life (Phylogenies), General methods of Classifying Bacteria. Binomial Nomenclature.

Unit 3: Diversity of Microbial world **No of Hours-30**

General Characteristics of different groups

Acellular microorganisms (Viruses, Viroid, Prions) and cellular microorganisms (Bacteria, Algae, Fungi and protozoa) with emphasis on distribution and occurrence, morphology, mode of reproduction and economic

Viruses, Viroid, Prions

A general introduction with special refences to the structure of the following: TMV, Polio virus, T4 and λ phage, lytic and lysogenic cycles, one step multiplication curve.

Bacteria

A precise account of typical eubacteria and archaebacteria(extremophiles). General characters of algae including occurrence, thallus organization, algae cellular structure, pigments, flagella, eyespot, food reserves and vegetative, asexual and sexual reproduction. Different types of life cycle in algae with suitable examples: Haplobiontic, Haplontic, Diplontic, Diplobiontic lifecycles, Application of algae in agriculture, environment and food.

Fungi

General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultrastructure, thallus organization and aggregation, fungal cell wall structure and synthesis, asexual and sexual reproduction, heterokaryosis, heterothallism and parasexual mechanisms. Economical importance of fungi with examples in industry, medicine, food, bioderioration, mycotoxins.

Protozoa

General characteristics with special references to Amoeba, Paramecium and Giardia

Unit4: Basic Microbiological techniques **No of Hours-10**

Methods of studying microorganisms, Sterilization techniques - Tyndallization, Pasteurization, Steam under pressure (Autoclave), Incinaration, Hot air oven. Inoculation and Incubation, Principle and application of biological safety cabinates (Laminar air flow).

Unit 5: Importance of Microbiology in Daily Life **No. of Hours-3**

Beneficial and harmful microbes and their role in daily life.
Concept of disease in plant and animal caused by microorganisms.

Tutorial

Students will get to learn about-

2. Microbiology laboratory practices and biosafety

12. Study of principle and the application of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, light microscope, pH meter) used in the microbiological laboratory.
13. Preparation of culture media for bacterial cultivation.
14. Preparation of different media: Synthetic mediaBG-11,complexmedia–nutrient agar
15. Characterization of Bacterial cells and colonies by means of morphological study and staining
    a) Isolation of pure culture of bacteria by streaking method.

16. Estimation of CFU count by spread plate/pour plate method.

SUGGESTED READING

1. Tortora GJ, Funke BR and Case CL. (2008). Microbiology: An Introduction .9 th edition. Pearson Education
2. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology ofMicroorganisms.14thedition. Pearson International Edition
3. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition.Pearson Education Limited
4. Wiley JM, Sherwood L M and Woolverton CJ. (2013) Prescott's Microbiology. 9thedition.McGraw HillInternational.
5. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T. Brown Publishes.Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5thedition. McGrawHillBook Company
6. StanierRY,IngrahamJL,WheelisML,andPainterPR.(2005).GeneralMicro biology.5thedition.McMillan

MCC303: BACTERIOLOGY (Theory)

Semester-III

Total Hours -50 **Credit– 4**

Course learning outcomes: At the completion of this course, the students are able to–

Outcome 1. Describe characteristics of bacterial cells, cell organelles, cell wall composition and various appendages like capsules, flagella or Pilli.

Outcome 2. Differentiate a large number of common bacteria by their salient characteristics and classify bacteria into groups.

Outcome3. Describe the nutritional requirements of bacteria for growth, developed knowledge and understanding that besides common bacteria there are several other microbes which grow under extreme environment.

Outcome 4. Perform basic laboratory experiments to study microorganisms, methods to preserve bacteria in the laboratory, calculate generation time of growing bacteria.

Unit1: Cell organization **No ofHours-14**

Cell size, shape and arrangement, glycocalyx, flagella, Endo flagella, fimbriae and Pilli

Cell wall: composition and detailed structure of Gram Positive and Gram-Negative cell walls, archaebacterial cell wall, Gram and acid-fast staining mechanisms, Lipopolysaccharides (LPS), Spheroplast, protoplast, and L form, Effect of antibiotics and enzymes on cell wall.

Cell Membrane: structure, function and chemical composition of bacterial and archaeal cell membranes.

Cytoplasm: Ribosome, mesosome, inclusion body, nucleoid, chromosome and plasmid, Endospore: structure, formation and stages of sporulation.

Unit2: Bacteriological techniques **No. of Hours: 5**

Pure culture isolation: Streaking, serial dilution, plating methods, cultivation, maintenance and preservation /stocking of pure cultures, cultivation of anaerobic bacteria.

Unit3: Microscopy **No.ofHours:6**

Bright field and dark field microscope, phase contrast microscope, Fluorescence microscope, Transmission electron microscope, Scanning electron microscope

Unit4: Growth and nutrition **No. ofHours:8**

Nutritional requirements of bacteria and nutritional categories.

Culture media: components of media, natural, synthetic, chemically defined, complex, selective differential, indicator, enriched and enrichment me

Unit5: Reproduction in Bacteria **No. of Hours:7**

Asexual methods of reproduction, logarithmic representation of bacterial populations, phases of growth, calculation of generation time and specific growth rate.

Unit6: Bacterial Systematics **No. of Hours:10**

Aims and principles of classification, systematics and taxonomy, concept of species, taxa, strain; conventional, molecular and recent approaches to polyphasic bacterial taxonomy, evolutionary chromometers, rRNA oligonucleotide sequencing, signature sequences and protein sequences, Difference between eubacteria and archaebacteria.

SUGGESTEDREADING

1. AtlasRM.(1997).PrinciplesofMicrobiology.2ndedition.WM.T.BrownPublishers.
2. BlackJG.(2008).Microbiology:PrinciplesandExplorations.7thedition.PrenticeHall
3. Madigan MT, and Martinko JM. (2014). Brock Biology of Micro-organisms.14th editionParkerJ. PrenticeHallInternationalInc.
4. PelczarJr MJ,Chan ECS,andKriegNR.(2004).Microbiology.5theditionTataMcGraw Hill.
5. SrivastavaSandSrivastavaPS.(2003).UnderstandingBacteria.KluwerAcademicPublishers
6. DordrechtStanierRY,IngrahamJL,WheelisMLandPainterPR.(2005).GeneralMicrobiology.5thedi tionMcMillan.
7. TortoraGJ,FunkeBR,andCaseCL.(2008).Microbiology:AnIntroduction.9thedition PearsonEduca tion.
8. WilleyJM,SherwoodLM,andWoolvertonCJ.(2013).Prescott'sMicrobiology.9thedition.Mc GrawHillHigherEdu

MCC304: VIROLOGY (THEORY)
Semester: III

TOTALHOURS: 50 **CREDIT: 4**

Course learning outcomes: At the completion of this course, the students are able to–
Outcome1: Understand about viruses and the chemical nature of viruses, different types of viruses infecting plant, animal and bacteria.
Outcome 2: Understanding about the biology of bacteriophages.
Outcome 3: Gain knowledge of a variety of plant and animal viruses.
Outcome4: describe the role of viruses in the causation of the cancer.

Unit1: Nature and Properties of Viruses **No.ofHours:12**

Introduction: Discovery of viruses, nature and definition of viruses, general properties, Concept of viroid, virusoids, satellite viruses and Prions. Theories of viral origin
Structure of Viruses: Capsid symmetry, enveloped and non- enveloped viruses Isolation, purification and cultivation of viruses Viral taxonomy: Classification and nomenclature of different groups of viruses

Unit2: Bacteriophages **No of Hours: 10**

Diversity, classification, one step multiplication curve, lytic and lysogenic phages (lambda phage) concept of early and late proteins, regulation of transcription in lambda phage

Unit3: Viral Transmission, Salient features of viral nucleic acids **No. of Hours:10**

Modes of viral transmission: Persistent, non- persistent, vertical and horizontal Salient features of viral Nucleic acid: Unusual bases (TMV, T4phage), overlapping genes (ϕX174, Hepatitis B virus), alternate splicing (HIV), terminal redundancy (T4phage), terminal cohesive ends (lambda phage), partial double stranded genomes (Hepatitis B), long terminal repeats (retrovirus), segmented (Influenza virus), and non-segmented genomes (picornavirus), capping and tailing (TMV)

Unit4: Viruses and cancer **No. ofHours:6**

Introduction to oncogenic viruses, Types of oncogenic DNA and RNA viruses, Concepts of oncogene and protoonco gene.

Unit5: Prevention and control of viral diseases **No. ofHours:8**

Antiviral compounds and their mode of action, Interferon and their mode of action, General principle of viral vaccination.

Unit6: Application of Virology **No. ofHours:4**

Use of viral vector in cloning and expression, Gene therapy and phage display.

SUGGESTEDREADING

1. DimmockNJ,Easton,AL,Leppard, KN(2007).IntroductiontoModern Virology.6th edition,Blackwell Publishing Ltd.
2. CarterJandSaundersV(2007).Virology:Principlesand Applications. JohnWileyandSons.
3. FlintSJ, Enquist, LW, Krug, RM, Racaniello, VR, Skalka, AM (2004). Principles ofVirology,Molecularbiology,PathogenesisandControl.2ndedition.ASMpressWashin gtonDC.
4. LevyJA,ConratHF,OwensRA.(2000).Virology.3rdedition.PrenticeHallpublic ation,New York.
5. Wagner EK,HewlettMJ.(2004).BasicVirology.2ndedition.BlackwellPublishing.
6. Mathews.(2004).PlantVirology.Hull R.AcademicPress,New York.
7. NayuduMV.(2008).PlantViruses.TataMcGrawHill, India.
8. BosL.(1999)Plantviruses-A textbook ofplantvirologyby. Backhuys Publishers.
9. VersteegJ. (1985).AColorAtlasofVirology.WolfeMedicalPublication.

SEC303: MICROBIOLOGICAL ANALYSIS OF AIR AND WATER (PRACTICAL)

SEMESTER – III

TOTALHOURS: 25 **CREDITS: 3**

Course learning outcomes: By the conclusion of this course, the students-

Outcome 1. Have developed a very good understanding and skills of the analysis of air, water and soil.

Outcome2.Havedevelopedaverygoodunderstandingofhowanalysisofwater,air and soil contribute to control of environmental pollution.

1. Isolation and characterizationofbacteriaandfungifromdifferentsourcesofenvironment.
2. Microbial analysis of water collected fromdifferentsourcesinPanskuraBana maliCollege (TBC,MPN,PotentiallyHarmfulMicroorganisms).

MIC302: INTRODUCTION TO MICROBIAL WORLD (PRA CTICALS)
SEMESTER–III

TOTALHOURS: 50 **CREDIT: 4**

Course learning outcomes1: At the completion of this course, the students are able to– **Outcome1:** Have developed a good knowledge of the development of the discipline of Microbiology and the contribution made by prominent scientist in this field.
Outcome2: Have developed a very good understanding of the characteristics of different types of microorganisms, methods to organize/classify and basic tools to study the sein the laboratory.
Outcome3: Are able to explain the useful and harmful activities of the microorganisms.
Outcome4: Are able to perform basic experiments to grow and study microorganisms in the laboratory.

- **a)** Microbiology good laboratory practices and biosafety.
- **b)** To study the principle and application of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, light microscope, pH meter) used in the microbiological laboratory.
- **c)** Preparation of cultural media for bacterial cultivation.
- **d)** Sterilization of media using autoclave and assessment for sterility
- **e)** Sterilization of glassware using hot air oven and assessment for sterility
- **f)** Sterilization of heat sensitive material using membrane filter and assessment for sterility
- **g)** Demonstration on the presence of microflora in the environment by exposing nutrient agar plates to air
- **h)** Study of different shapes of bacteria using electron micrograph
- **i)** Study of *Rhizopus, penicillin, Aspergillus* using permanent slides
- **j)** Study of *Spirogyra, Chlamydomonas* and *Volvox* using permanent slides
- **k)** Study of *Amoeba, Entamoeba, Paramecium, Plasmodium* using permanent slides

MCC405: BIOCHEMISTRY THEORY)
SEMESTER – III

TOTALHOURS: 50 **CREDITS:4**

Course learning outcomes: At the completion of this course, the students are able to–
Outcome1: Developed a very good understanding of various biomolecules which are required for development and functioning of abacterial cell.
Outcome2: Developed how the carbohydrates make the structural and functional components such as energy generate ion and as storage food molecules for the bacterial cell.
Outcome3: Well conversantaboutmultifarious function of protein, are able to calculate enzyme activity and other quantitative and qualitative parameters of enzyme kinetics, also knowledge about lipids and nucleic acids.
Outcome 4: Students are able to make buffers, study enzyme kinetics and calculate Vmax, Km and Kcat values.

Unit1: Bioenergetics **No of Hours : 4**

First and second laws of Thermodynamics. Definitions of Gibb's Free Energy, enthalpy, and Entropy and mathematical relationship among them, Standard free energy change and equilibrium constant Coupled reactions and additive nature of standard free energy change,

Unit2: Carbohydrates **No of Hours : 12**

Families of monosaccharides: aldoses and ketoses, trioses, tetroses, pentoses, and hexoses. Stereo isomerism of monosaccharides, epimers, Mutarotation and anomers of glucose. Furanose and pyranose forms of glucose and fructose, Haworth projection formulae for glucose; chair and both forms of glucose Sugar derivatives, glucosamine, galactosamine, muramic acid, N- acetyl neuraminic acid, Disaccharides; concept of reducing and non-reducing sugars, occurrence and Haworth projections of maltose, lactose, and sucrose, Polysaccharides, storage polysaccharides, starch and glycogen. Structural Polysaccharides, cellulose, peptide glycan and chitin

Unit 3: Lipids **No of Hours :10**

Definition and major classes of storage and structural lipids. Storage lipids. Fatty acid's structure and functions. Essential fatty acids. Triacyl glycerols structure, functions and properties. Saponification, Structural lipids. Phospho glycerides: Building blocks, General structure, functions and properties. Structure of phosphatidyl ethanolamine and phosphatidyl choline, Sphingolipids: building blocks, structure of sphingosine, ceramide. Special mention of sphingomyelins, cerebrosides and gangliosides Lipidfunctions: cell signals, cofactors, prostaglandins.

Unit4: Proteins **No of Hours :12**

Functions of proteins, Primary structures of proteins: Amino acids, the building blocks of proteins. General formula of amino acid and concept of zwitterion. Titration curve of amino acid and its Significance, Classification, biochemical structure and notation of standard protein amino acids Ninhydrin reaction. Natural modifications of amino acids in proteins hydrolysine, cystine and hydroxyproline, Oligopeptides: Structure and functions of naturally occurring glutathione and insulin and Synthetic aspartame, Secondary structure of proteins: Peptide unit and its salient features. The alpha helix, the beta-pleated sheet and their occurrence in proteins, Tertiary and quaternary structures of proteins. Forces holding the polypeptide together. Human hemoglobin structure, Quaternary structures of proteins

Unit5: Enzymes **No of Hours :12**

Structure of enzyme: Apoenzyme and cofactors, prosthetic group-TPP, coenzyme NAD, metal cofactors, Classification of enzymes, Mechanism of action of enzymes: active site, transition state complex and activation energy. Lock and key hypothesis, and Induced Fit hypothesis. Significance of hyperbolic, double reciprocal plots of enzyme activity, Km, and allosteric mechanism Definitions of terms – enzyme unit, specific activity and turn over number, Multi enzyme complex: pyruvate dehydrogenase ; isozyme: lactate dehydrogenase, Effect of pH and temperature on enzyme activity. Enzyme inhibition: competitive- sulfadrugs; non-competitive- heavy metal salts.

SUGGESTEDREADING

1. Campbell,MK(2012) Biochemistry,7thed.,PublishedbyCengageLearning.
2. Campbell,PNandSmithAD(2011)BiochemistryIllustrated,4thed.,PublishedbyChu rchillLivingstone.
3. TymoczkoJL,BergJMandStryerL(2012)Biochemistry:Ashortcourse,2nded.,W.H.Free man.
4. Berg JM, Tymoczko JL and StryerL (2011) Biochemistry, W.H. Freeman andCompany
5. NelsonDLandCox MM(2008)Lehninger PrinciplesofBiochemistry,5thEdition.W. H.Freeman andCompany.
6. WilleyMJ,Sherwood, LM&WoolvertonCJ(2013)Prescott,Harleyand Klein'sMicrobiologyby.9thEd., McGrawHill
7. Voet,D.andVoetJ.G(2004)Biochemistry3rdedition,JohnWileyandSons,

MCC406: BACTERIOLOGY & BIOCHEMISTRY (PRACTICALS)

SEMESTER: IV

TOTAL HOURS: 50 **CREDITS: 4**

Course learning outcomes: By the end of this course the students-

Outcome 1. Developed a very good understanding of various biomolecules which are required for development and functioning of a bacterial cell.

Outcome2.

Havedevelopedhowthecarbohydratesmakethestructuralandfunctionalcomponentssucha s energy generation and as storage food molecules for the bacterial cells.

Outcome 3. Well conversant about multifarious function of proteins; are able to calculate enzyme activity and other quantitative and qualitative parameters of enzyme kinetics; also, knowledge about lipids and nucleic acids.

Outcome4. Student are able to make buffers, study enzyme kinetics and calculate Vmax, Km, Kcat values.

1. Properties of water, Concept of pH and buffers, preparation of buffers and Numerical problems to explain the concepts
2. Numerical problems on calculations of Standard Free Energy Change and Equilibrium constant.
3. Standard Free Energy Change of coupled reactions.
4. Qualitative/ Quantitaive tests for carbohydrates, reducing sugars, non-reducing sugars.
5. Qualitative/Quantitative tests for lipids and proteins
6. Study of protein secondary and tertiary structures with the help of models (RASMOL)
7. Study of enzyme kinetics–calculation of V_{max}, Km, Kcat values
8. Study effect of temperature, pH and heavy metals on enzymatic activity.
9. Estimation of any one vitamin.
10. Preparationofdifferentmedia:SyntheticmediaBG-11,complexmedia–nutrient agar
11. Simple Staining
12. Negative Staining
13. Gram's staining
14. Acid fast–permanent slides

15. Endospore staining
16. Isolation of pure culture of bacteria by streaking method
17. Study on preservation of bacteria by various techniques
18. Estimation of CFU count by spread plate/pour plate method.

MCC407: MICROBIAL PHYSIOLOGY AND METABOLISM (THEORY)
SEMESTER–IV

TOTALHOURS: 50 **CREDITS: 4**

Course learning outcomes: By the conclusion of this course, the students are capable of -

Outcome 1. Describing the growth characteristics of the microorganisms capable of growing under unusual environmental condition of temperature, oxygen, and solute and water activity.
Outcome2.Describingthegrowthcharacteristicsofthemicroorganismswhich require different nutrient for growth and the associated mechanisms of energy generation for their survival like autotrophs, heterotrophs, chemo litho-autotrophs etc.
Outcome3.Differentiating conceptsofaerobicandanaerobicrespirationandhowthesearemanifestedin the form of different metabolic pathways in microorganisms.

Unit1: Microbial Growth and Effect of Environment on Microbial Growth **No.ofHours:12**

Definitions of growth, Batch culture, Continuous culture, generation time and specific growth rate Temperature and temperature ranges of growth pH and pH ranges of growth. Effect of solute and water activity on growth Effect of oxygen concentration on growth Nutritional categories of microorganisms.

Unit2: Nutrient uptake and Transport **No.ofHours:10**

Passive and facilitated diffusion Primary and secondary active transport, concept of uniport, symport and antiport Group translocation Iron uptake.

Unit3: Chemoheterotrophic Metabolism-Aerobic Respiration **No.ofHours:11**

Concept of aerobic respiration, anaerobic respiration and fermentation Sugar degradation pathways.

Electron transport chain: components of respiratory chain, comparison of mitochondrial and bacterial ETC, electron transport phosphorylation, uncouplers and inhibitor.

Unit4: Chemo heterotrophic Metabolism-Anaerobic respiration and fermentation **No.ofHours:6**

Anaerobic respiration with special reference to dissimilatory nitrate reduction (Denitrification; nitrate/Nitrite and nitrate/ammonia respiration; fermentative nitrate reduction) Fermentation- Alcohol fermentation and Pasteur effect; Lactate fermentation (homofermentative and hetero fermentative pathways), concept of linear and branched fermentation pathways.

Unit5: Chemo lithotrophic and Phototrophic Metabolism

No.ofHours:5

Introduction to aerobic and anaerobic chemo-lithotrophy with an example each.
Hydrogen oxidation(definitionandreaction)andmethanogenesis(definitionandreaction)
Introduction to phototrophic metabolism-anoxygenicvs. Oxygenic photosynthesis

Unit6: Nitrogen Metabolism **No.ofHours:6**

IntroductiontobiologicalnitrogenfixationAmmoniaassimilationAssimila
tory nitrate reduction

SUGGESTEDREADINGS

1. Madigan MT, and Martinko JM (2014). Brock Biology of Microorganisms. 14th edition.PrenticeHallInternationalInc.
2. MoatAGandFosterJW.(2002).MicrobialPhysiology.4thedition.JohnWiley&Sons
3. ReddySRandReddySM.(2005).MicrobialPhysiology.ScientificPublishers India
4. GottschalkG.(1986).BacterialMetabolism.2ndedition.SpringerVerlag
6. StanierRY,IngrahmJI,WheelisMLandPainterPR.(1987).GeneralMicrobiology.5thedition,McMillanPress.
7. WilleyJM,SherwoodLM, andWoolverton CJ.(2013).Prescott'sMicrobiology.9thedition.McGrawHillHigherEducation

MIC402:INTRODUCTIONAND SCOPEOFMICROBIOLOGY(PRACTICALS)

SEMESTER–III/IV

TOTALHOURS:50 **CREDITS:4**

Course learning outcomes:At the conclusion of this course the students–

Outcome1.Have developed a good knowledge of the development of the discipline of Microbiology and the contributions made by prominent scientists in this field.

Outcome2.Havedevelopedaverygoodunderstandingofthecharacteristicsofdifferenttypesof microorganisms, methods to organize/classify these into and basic tools to study these in the laboratory.

Outcome 3. Are able to explain the useful and harmful activities of the microorganisms.

Outcome4.Areabletoperformbasicexperimentstogrowandstudymicroorganisms in the laboratory.

1. Microbiology Laboratory Management and Biosafety.
2. To study the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter) used in the microbiology laboratory
3. Preparation of culture media for bacterial cultivation
4. SterilizationofmediumusingAutoclaveandassessmentforsterility5.Sterilizationofglasswareusi ng Hot Air Oven and assessment for sterility
5. Demonstrationofpresenceofmicrofloraintheenvironmentbyexposingnutrientagarplatestoair.
6. Study of different shapes of bacteria using permanent slides
7. Study of Rhizopus and Penicillium using permanent mounts
8. StudyofSpirogyraandChlamydomonasusingpermanentMounts11.Studyofthefollowingprotozo ans using permanent mounts/photographs: Amoeba, Entamoeba, Paramecium and Plasmodium

SUGGESTEDREADING

1. TortoraGJ, FunkeBRandCaseCL. (2008).Microbiology:AnIntroduction.9thedition.PearsonEducation.
2. MadiganMT,MartinkoJM,DunlapPVandClarkDP.(2014).BrockBiologyofMicroorganisms.14th edition. Pearson International Edition
3. CappucinoJandShermanN.(2010).Microbiology:ALaboratoryManual.9th edition.Pearson Education Limited.
4. 4.WileyJM,SherwoodLMandWoolvertonCJ.(2013)Prescott'sMicrobiology.9thEdition.McGrawHillInternational.
5. AtlasRM. (1997). PrinciplesofMicrobiology.2nd edition. WM.T.BrownPublishers.
6. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw HillBook Company.
7. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology.5thedition. McMillan.

MCC508: CELL BIOLOGY (THEOR Y)
SEMESTER–V

TOTALHOURS:50 **CREDITS:4**

Outcomes:Studentswillhavebasicknowledgeofcell organization-

Outcome1.Abletodistinguish
prokaryoticandeukaryoticcellsintermsoftheirstructuresandinternalorganization.
Outcome2. Understoodthestructuresofnucleus.
Outcome3. Describedtherolesofribosomes,
endoplasmicreticulum,Golgiapparatus,lysosomesinproteintargeting, folding, processing, sorting andtransporting.
Outcome4. Abletounderstandcellsignallingverywell.

Unit1:Structureof Cell **No.ofHours:12**

Plasmamembrane:Structureandtransportofsmallmolecules
Cell Wall: Eukaryotic cell wall, Extra cellular matrix and cell matrix interactions, Cell-CellInteractions-
adhesionjunctions,tightjunctions,gapjunctions,andplasmodesmata(onlystructuralaspects)
Mitochondria,chloroplastsandperoxisomes
Cytoskeleton:Structureandorganizationofactinfilaments,intermediatefilaments,mic rotubules

Unit2:Nucleus **No.ofHours:4**

Nuclearenvelope,nuclearporecomplexandnuclearlaminaChromatin–Molecularorganization
Nucleolus

Unit3:ProteinSortingandTransport **No.ofHours:12**

Endoplasmic Reticulum – Structure, targeting and insertion of proteins in the ER, proteinfolding,processingandqualitycontrolinER,smoothERandlipidsynthesis,exportofproteins and lipids Golgi Apparatus – Organization, protein glycosylation, protein sorting and exportfromGolgiApparatus
Lysosomes

Unit4:CellSignaling **No.ofHours:10**

SignallingmoleculesandtheirreceptorsFunctionofcellsurfacereceptors Pathwaysofintra-cellularreceptors–CyclicAMPpathway,cyclicGMPandMAPkinasepathway

Unit5:CellCycle,CellDeathandCellRenewal **No. of Hours:12**Eukaryoticcellcycleanditsregulation,MitosisandMeiosisDevelopmentof cancer, causesandtypesProgrammed celldeath

SUGGESTEDREADING

1. HardinJ,BertoniGand KleinsmithLJ.(2010).Becker'sWorldoftheCell.8thedition.Pearson.
2. KarpG .(2010)Cell and Molecular Biology:Concepts and Experiments.6th edition.JohnWiley&Sons.Inc.
3. DeRobertis,EDPandDeRobertisEMF.(2006).CellandMolecularBiology.8th edition.LipincottWilliamsandWilkins,Philadelphia.
4. Cooper,G.M.andHausman,R.E.(2009).TheCell:AMolecularApproach.5th Edition.ASM Press&Sunderland,Washington,D.C;SinauerAssociates,MA.

MCC509: CELL BIOLOGYAND MICROBIAL METABOLISM(PRACTICAL)

SEMESTER–V

TOTALHOURS: 50 **CREDITS:4**

1. Studyandplotthegrowthcurveof*E.coli*byturbidimetric.
2. Calculationsofgenerationtimeandspecificgrowthrateofbacteriafromthegraphplotte dwiththe given data
3. Effectoftemperatureongrowthof*E.coli*
4. EffectofpHongrowthof*E.coli*
5. Demonstrationofalcoholicfermentation
6. Demonstrationofthethermaldeathtimeanddecimalreductiontimeof*E.coli.*
7. Studyarepresentativeplantandanimalcellbymicroscopy.
8. Studyofthestructureofcellorganellesthroughelectronmicrographs
9. CytochemicalstainingofDNA–Feulgen
10. Identificationandstudyofcancercellsbyphotomicrographs
11. StudyofdifferentstagesofMitosis
12. StudyofdifferentstagesofMeiosis
13. Isolation of Sulphur lithotropic bacteria.
14. Preparation of winogradsky column.

MCC510:MOLECULAR BIOLOGY(THEORY)

SEMESTER–V

TOTALHOURS:50 **CREDITS:4**

Outcome-

Outcome1. Studentswillhavebasic knowledgeofcellorganization,DNAstructureandfunction,RNAstructureandfunction,Central Dogma,Geneexpressionand protein biosynthesis,cell signaling.

Outcome2. Studentswill gettoknowthe connectionbetweenGenome organizationandevolution.

Outcome3. Theywill learnhowto assessandreport alaboratory experiments.

Outcome4. Overall,thiscourseintegrateslectureandlaboratorysessionsthroughoutthesemester.

Unit1:StructuresofDNAandRNA/GeneticMaterial **No.ofHours:10**DNA Structure:Miescherto WatsonandCrick- historic perspective, DNA structure,Salient features of double helix, Types of DNA, Types of genetic material, denaturation andrenaturation,cotcurves.DNAtopology-linkingnumber,topoisomerases;OrganizationofDNAProkaryotes,Viruses,Eukaryotes.RNAStructure,OrganelleDNA—mitochondriaandchloroplastDNA.

Unit2:ReplicationofDNA(ProkaryotesandEukaryotes)

No.ofHours:10 Bidirectional and unidirectional replication, semi-conservative, semi-discontinuousreplicationMechanism of DNA replication: Enzymes and proteins involved in DNA replication –DNApolymerases,DNAligase,primase, telomerase–forreplicationoflinearends VariousmodelsofDNAreplicationincludingrollingcircle,D-loop(mitochondrial) ,Θ(theta)modeof replicationandotheraccessoryprotein,Mismatchandexcisionrepair

Unit3:Transcription inProkaryotesand Eukaryotes **No. of Hours: 8**Transcription: Definition, difference from replication, promoter- concept and strength ofpromoterRNAPolymeraseandthetranscriptionunit TranscriptioninEukaryotes:RNApolymerases,generalTranscriptionfactors

Unit4Post-TranscriptionalProcessing

No.ofHours:8 Splitgenes, concept of introns and exons, RNA splicing, splice of some machinery conceptofalternative splicing, Poly adenylation and capping, Processing of rRNA, RNA interference:siRNA,miRNAanditssignificance

Unit5:Translation(ProkaryotesandEukaryotes) No.of Hours:10 Translationalmachinery,Chargingoft-RNA,aminoacyltRNAsynthetases,Mechanismsofinitiation,elongationandterminationofpolypeptidesinbothprokaryotesandeukaryotes,Fidelity oftranslation,Inhibitors of proteinsynthesisinprokaryotes andeukaryote

Unit6RegulationofgeneExpressioninProkaryotesandEukaryotes No.of Hours:4 Principlesoftranscriptionalregulation,regulationatinitiationwithexamplesfrom*lac*and*trp*operons,Yeastmatingtypeswitching.

SUGGESTEDREADINGS

1. WatsonJD, BakerTA, BellSP, GannA, LevineM and Losick R (2008) MolecularBiologyoftheGene,6th edition,ColdSpringHarbour LabPress,PearsonPublication
2. BeckerWM, KleinsmithLJ, HardinJ and BertoniGP (2009) The World of the Cell,7th edition,PearsonBenjaminCummingsPublishing,SanFrancisco
3. DeRobertisEDPandDeRobertisEMF(2006)CellandMolecularBiology,8th edition. LippincottWilliamsandWilkins,Philadelphia
4. KarpG (2010) Cell and Molecular Biology: Concepts and Experiments, 6th edition, JohnWiley & Sons. Inc.
5. SambrookJandRussellDW.(2001).MolecularCloning:ALaboratoryManual.4thEdition,ColdSpringHarbourLaboratorypress.
6. KrebsJ,GoldsteinE,KilpatrickS(2013).Lewin'sEssentialGenes,3rdEd.,JonesandBartlettLearning
7. GardnerEJ,SimmonsMJ,SnustadDP(2008).PrinciplesofGenetics.8thEd.Wiley-India

MCC 511: MICROBIAL GENETICS AND GENOMICS (Theory)

SEMESTER-V

TOTALHOURS:50 **CREDITS:4**

Courselearningoutcomes:

Outcome1: Understoodgenomeorganizationofmodelorganismsandthemolecularmechanismsthatunderlinemutations.

Outcome2: Developedafairlygoodknowledgeaboutthethreewellknownmechanismsbywhichgeneticmaterialistransferredamongthemicroorganismsnamelytransformation,transductionandconjugation.

Outcome3: Areabletodescribedifferenttypesoftheextrachromosomalelementsortheplasmids;thenatureofthetransposableelement in the prokaryoticandeukaryotic.

Unit1:Mutations **No. ofhours: 14**

Mutation and Mutagenesis: Definition and types of mutations; Physical and chemical mutagens; Molecularbasis of mutations; Functional mutants (loss and gain of function mutants); use of mutation; Reversion andsuppression;Truerevertants; Intraand inter genic suppression;Ames test;Mutatorgenes**.**

Unit 2:Plasmid **No. ofhours: 14**

Typesofplasmid-Fplasmid,Rplasmid,Colicinogenicplasmid,Tiplasmid,LinerPlasmids,yeast-2µplasmid,Plasmid replication and partitioning, Host range, Plasmid-incompatibility, Plasmid amplification, Regulationofcopy number, Curingof plasmids.

Unit3:Mechanisms ofgeneticexchange **No.ofhours: 8**

Transformation-Discovery,mechanismofnaturalcompetence

Conjugation-Discovery,Hfrand F^+Strains,Interruptedmattingtechniqueandtimeofentrymapping Transduction-Generalizedtransduction, specializedtransduction, LFT& HFTlysates.

Unit4:PhageGenetics **No. ofhours: 8**

FeaturesofT4genetics,Geneticbasisoflyticversuslysogenicswitchofphagelambda.

Unit5:Transposableelements **No. ofhours: 10**

Prokaryotictransposableelements-Insertionsequence,Compositeandnon-compositetransposons,Replicativeand Non replicativetransposition, Mu transposon,Eukaryotictransposableelement.

SUGGESTEDREADING

1. KlugWS,CummingsMR,Spencer,C,Palladino,M(2011).ConceptsofGenetics,10thEd.,Benja minCummings
2. KrebsJ,GoldsteinE,KilpatrickS(2013).Lewin'sEssentialGenes,3rdEd.,JonesandBartlettLearning
3. PierceBA(2011)Genetics:AConceptualApproach,4thEd.,MacmillanHigherEducationLearning
4. .WatsonJD,BakerTA,BellSPetal.(2008)MolecularBiologyoftheGene,6thEd.,BenjaminCummings
5. GardnerEJ,SimmonsMJ,SnustadDP(2008).PrinciplesofGenetics.8thEd.Wiley-India
6. RussellPJ.(2009).iGenetics-AMolecularApproach.3rdEd,BenjaminCummings
7. SambrookJandRussellDW.(2001).MolecularCloning:ALaboratoryManual.4thEdition,ColdSpring HarbourLaboratorypress.
8. MaloySR,CronanJEandFriefelderD(2004)MicrobialGenetics2ndEDITION.,JonesandBarlettPublis her

MCD501: INDUSTRIAL MICROBIOLOGY(THEORY)

SEMESTER-V

TOTAL HOURS: 50 **CREDITS: 4**

Courselearning outcomes: By theconclusion ofthis course,the students-

Outcome1:Arecapableofdescribingalargenumberofsubstratesthatareusedfortheindustrialfermentationprocesses.

Outcome 2: Heredeveloped anunderstandingofdifferenttypesof reactorsor fermenterswhichareusedforlaboratory,pilot and industrial scale fermentationand theirprocesses parameters.

Outcome3: Haveacquiredadetailedknowledgeofnumberofproductswhichareproducedbyindustrialfermentation process.

Unit1:Introductiontoindustrialmicrobiologyandfermentationprocess **No. of hours: 10**Briefhistoryanddevelopmentsinindustrialmicrobiology,Typesoffermentationprocess:Solidstateandliquidstate(StationaryandSubmerged)fermentation,Batchfermentation,Fed-batchfermentation(e.g.Baker'syeast)andcontinuous fermentation.

Unit2:Typesofbioreactorsandmeasurementoffermentation parameters **No of Hours: 10**Componentsofatypicalbioreactor,Typesofbio-reactors:laboratory,PilotScaleandProductionfermenter,ConstantlyStirredtankbio-reactorsandair-liftbioreactor,MeasurementandControloffermentationparameters-pH, temperature, dissolved oxygen, foaming and aeration.

Unit 3: Isolation of industrially important microbial strain and fermentation mediaNo. of Hours: 10 Source of industrially important microbes and methods for their isolation, Preservation and maintenance ofindustrialstrain,Strainimprovements,Crudeandsyntheticmedia,molasses,corn-steepliquor,Sulphatewasteliquor,Whey, Yeast extraction and protein hydrolysates.

Unit4:Downstream Processing **No. ofhours: 10**
Celldisruption,filtration,Centrifugation,SolventExtraction,LyophilizationandSpraydrying.

Unit5:MicrobialProductionofindustrialproducts(microorganismsinvolved,media,fermentationcondition,downstreamprocessinganduses) **No. of hours: 10**Citricacid, Ethanol, Penicillin, Glutamicacid, VitaminB12, Wine,Beer.

SUGGESTEDREADINGS

1. PatelA.H.(1996).IndustrialMicrobiology.1stedition,Macmillan IndiaLimited
2. Okafor N. (2007).Modern Industrial Microbiology and Biotechnology.1st edition. Bios ScientificPublishersLimited.USA
3. WaitesM.J.,MorganN.L.,RockeyJ.S.andHigtonG.(2001).IndustrialMicrobiology:AnIntroduction.1st edition.Wiley–Blackwell
4. GlazeA.N.andNikaidoH.(1995).MicrobialBiotechnology:FundamentalsofAppliedMicrobi ology.1stedition.W.H.FreemanandCompany
5. CasidaLE.(1991).IndustrialMicrobiology.1stedition.WileyEasternLimited.
6. CruegerWandCruegerA.(2000).Biotechnology:AtextbookofIndustrialMicrobiology.2ndeditio n.PanimaPublishingCo.NewDelhi.
7. tanburyPF,WhitakerAandHallSJ.(2006).PrinciplesofFermentationTechnology.2ndedition,Els evierScienceLtd

MIC503: BACTERIOLOGY AND VIROLOGY (THEORY)
SEMESTER– V

TOTALHOURS50 **CREDITS:4**

Courselearningoutcomes:Atthecompletionofthiscourse,thestudentsareableto–

Outcome 1. Describe characteristics of bacterial cells, cell organelles, cell wall composition andvariousappendages likecapsules, flagella or pili.
Outcome 2. Differentiate a large number of common bacteria by their salient characteristics;classifybacteriaintogroups.
Outcome3.Describethenutritionalrequirementsofbacteriaforgrowth;developedknowledgeandunder standing that besides common bacteria there are several other microbes which grow underextremeenvironments.
Outcome 4. Perform basic laboratory experiments to study microorganisms; methods to preservebacteriain thelaboratory;calculategeneration time ofgrowingbacteria.
Outcome 5. Understood what are viruses and the chemical nature of viruses, different types ofvirusesinfectinganimals,plants andbacteria(bacteriophages)
Outcome6.Understandingabout thebiologyofbacteriophages.
Outcome7.Gainedknowledgeofavarietyofplantvirusesandanimalviruses.
Outcome8. Theabilitytodescriberoleofvirusesinthecausationofthecancer'

Unit1:Cellorganization **No. ofHours:10**

Cellsize,shapeandarrangements,capsule,flagellaandpili,Compositionanddetailedstructureof gram- positive and gram- negative cell wall and archaeal cell wall, Structure, chemicalcomposition and functions of bacterial and archaeal cell membranes, Ribosomes, inclusions,nucleoid,plasmids, structure, formation andstagesof sporulation

Unit2:Bacterial growthandcontrol **` No.ofHours: 8**

Culture media: Components of media, Synthetic or defined media, Complex media,enrichedmedia, selective media, differential media, enrichment culture media Pure culture isolation:Streaking, serial dilution and plating methods, cultivation, maintenance and stocking of purecultures,cultivation of anaerobicbacteria Growth: Binaryfission, phasesofgrowth

Unit3:Bacterial SystematicsandTaxonomy **No.ofHours:8**

Taxonomy,nomenclature,systematics,typesofclassificationsMorphology,ecologicalsignificance andeconomicimportanceofthefollowinggroups:Archaea:methanogens,thermophilesandhalophil es

Unit4:IntroductiontoViruses **No.ofHours:8**

Propertiesofviruses;generalnatureandimportantfeaturesSubviralparticles;viroid's,prionsandtheir importanceIsolationand cultivationofviruses

Unit5:Structure,andmultiplicationofviruses **No.ofHours:8**

Morphologicalcharacters:Capsidsymmetryanddifferentshapesofviruseswithexamples Viralmulti plication in the Cell: Lytic and lysogenic cycle Description of important viruses: salientfeatures of the viruses infecting different hosts - Bacteriophages (T4 & Lambda); Plant (TMV&CauliflowerMosaicVirus), Human(HIV)

Unit6:RoleofVirusesinDiseaseanditsprevention **No.ofHours:8**

Virusesaspathogens:Roleofvirusesincausingdiseases Preventionandcontrolofviruses:interferons and antiviralcompounds

SuggestedReadings:

1. AtlasRM.(1997). PrinciplesofMicrobiology.2nd edition.WM.T.Brown Publishers
2. Madigan MT, Martinko JM, Dunlap PV and Clark DP (2014). Brock Biology of Microorganisms.14thedition. Pearson Education,Inc.
3. StanierRY, IngrahamJL,WheelisMLandPainterPR.(2005).GeneralMicrobiology.5thedition. McMillan
4. CarterJandSaunders V(2007).Virology;principlesandApplications.JohnWileyandSons
5. FlintSJ,Enquist, LW,Krug,RM, Racaniello,VRSkalka, AM(2004)Principles ofVirology,MolecularBiology, Pathogenesis and Contro*l*.2nd edition.ASM Press
6. ShorsTeri(2013)UnderstandingViruses2ndeditionJonesandBartlettLearningBurlingtonUSA
7. Pelczar Jr MJ, Chan ECS, and Krieg NR. (2004). Microbiology. 5th edition Tata McGrawHill.
8. TortoraGJ, FunkeBR,and CaseCL.(2008).Microbiology: AnIntroduction.9theditionPearsonEducation.
9. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition.McGraw Hill Higher Education.
10. Dimmock,NJ,Easton,AL,Leppard,KN(2007). IntroductiontoModernVirology.6thedition,Blackwell Publishing Ltd.
11. CannAJ(2012)PrinciplesofMolecularVirology, AcademicPressOxfordUK

MCC612:Microbial Genetics and Molecular Biology(Practical)
Semester-VI

TotalHour:50 **Credits:4**

Courselearningoutcomes: Bytheconclusionofthiscourse,thestudentshave-
Outcome1. Understoodgenomeorganizationof modelorganismsnamely *E.coli*and*Saccharomyces*,andthemolecularmechanisms that underlinemutations.
Outcome2. Developedafairlygoodknowledge aboutthe threewellknownmechanismsbywhichgeneticmaterialistransferredamongthemicroorganismsnamelytransformation,transduction,conjugation.
Outcome3. Areable todescribedifferent typesof the extrachromosomalelementsor theplasmids;thenatureofthe transposableelements in the prokaryoticand eukaryotic cells.
Outcome4. HandsonskillsofisolationofplasmidDNAfrombacterialcellandit'svisualizationbyperforming agarosegel electrophoresis.

1. PreofMasterand replicaplatespreparation.
2. Studyoftheeffectof chemical(HNO2) andphysical(UV) mutagensonbacterialcells.
3. Studyof survival curveof bacteriaafter exposureto UVlight.
4. IsolationofPlasmidDNAfrom*E.coli*
5. Studyofdifferentconformations ofplasmidDNAthrough Agarosegelelectrophoresis.
6. Genetic mapping by interrupted mating-Conjugation.
7. StudyofdifferenttypesofDNAandRNAusingmicrographmodel/schematicrepresentations.
8. DemonstrationofBacterialConjugation.
9. Studyofsemiconservativereplicationof DNAusingmicrographmodel/schematicrepresentations.
10. IsolationofgenomicDNAfromE.coli.
11. Estimationofsalmon sperm/calfthymusDNA usingcolorimeter(diphenylaminereagent)orUVspectrophotometer(A◦260 measurement).
12. Estimation of RNA using colorimeter (orcinol reagent) or UV spectrophotometer (A◦ 260measurement).
13. ResolutionandvisualizationofDNAbyagarosegelelectrophoresis.
14. ResolutionandvisualizationofproteinbyPolyacrylamidegelelectrophoresis(PAGE).

MCC613:IMMUNOLOGY(THEORY)
SEMESTER–VI

TOTALHOURS:50 **CREDITS:4**

Courselearningoutcomes: Bytheconclusionofthiscourse,thestudentsclearly-

Outcome 1. Understood the basic and general concepts of causation of disease by the pathogenicmicroorganisms and the various parameters of assessment of their severity including the broadcategorizationofthe methods of diagnosis.

Outcome 2. Developed a thorough understanding of common bacterial, viral, fungal, parasiticdiseasesofhumanbeing including someveryimportantdiseases of theanimalsalso.

Outcome 3. Conceptualized the protective role of the immune system of the host and developedan understanding of the basic components as well as the mechanisms underlyingthe immunesystemandits response to pathogenicmicroorganisms.

Outcome 4. Are able to conduct experiments for growing common bacteria indifferentmicrobiologicalmedia,antibioticsensitivitydeterminationandantigenantibodyreaction(precipitationtest in theagarose)

Unit1:Introduction **No.ofHours:4**

ConceptofInnateandAdaptiveimmunity;Contributionsoffollowingscientiststothedevelopmentof field of immunology - Edward Jenner, Karl Landsteiner, Robert Koch, Paul Ehrlich, ElieMetchnikoff, Peter Medawar, MacFarlane Burnet, Neils K Jerne, Rodney Porter and SusumuTonegawa

Unit2:ImmuneCellsandOrgans **No.ofHours:7**

Structure,FunctionsandPropertiesof:ImmuneCells– Stemcell,Tcell,Bcell,NKcell,Macrophage, Neutrophil, Eosinophil, Basophil, Mastcell, Dendriticcell and Immune Organs– BoneMarrow,Thymus,LymphNode,Spleen,GALT,MALT,CALT

Unit3:Antigens **No.ofHours:4**

Characteristicsofanantigen(Foreignness,MolecularsizeandHeterogeneity);Haptens;Epitopes(T&B cellepitopes);T-dependent andT-independentantigens;Adjuvants

Unit4:Antibodies **No.ofHours:4**

Structure,Types,FunctionsandPropertiesofantibodies;Antigenicdeterminantsonantibodies(Isotypic, allotypic, idiotypic); Monoclonal andChimericantibodies

Unit5:MajorHistocompatibilityComplex

No.ofHours:5 Orga nizationofMHClocus(Mice&Human);StructureandFunctionsof MHCI&IImolecules;Antigenprocessingandpresentation(CytosolicandEndocyticpathways)

Unit6:ComplementSystem **No. ofHours:4**ComponentsoftheComplementsystem;Activationpathways(Classical,Alternativeand Lectinpathways);BiologicalconsequencesofcomplementActivation.

Unit7:GenerationofImmuneResponse

No.ofHours:10P rimary and Secondary Immune Response; Generation of Humoral Immune Response(Plasma and Memory cells); Generation of Cell Mediated Immune Response (Self MHCrestriction,Tcell activation,Co-stimulatorysignals);KillingMechanismsbyCTL.

Unit8:ImmunologicalDisordersand TumorImmunity **No.ofHours:6** Types ofAutoimmunityandHypersensitivitywith examples;Immunodeficiencies-Animalmodels (Nude and SCID mice), SCID, DiGeorgesyndrome,ChediakHigashisyndrome,Leukocyteadhesiondeficiency,CG D;

Unit9:ImmunologicalTechniques **No. of Hours:6**PrinciplesofPrecipitation,Agglutination,Immunodiffusion,Immunoelectrophoresis,E LISA,ELISPOT,Westernblotting,Immunofluoresence,

SUGGESTEDREADINGS

1. AbbasAK,LichtmanAH,PillaiS.(2007).CellularandMolecularImmunology.6theditionSa undersPublication,Philadelphia.
2. DelvesP,MartinS,BurtonD,RoittIM.(2006).Roitt'sEssentialImmunology.11theditionWi ley-BlackwellScientificPublication,Oxford.
3. GoldsbyRA,KindtTJ,OsborneBA.(2007).Kuby'sImmunology.6theditionW.H.Freemana ndCompany,NewYork.
4. MurphyK,TraversP,WalportM.(2008).Janeway'sImmunobiology.7theditionGarlandSci encePublishers,NewYork.
5. PeakmanM,andVerganiD.(2009).BasicandClinicalImmunology.2ndeditionChurchillLi vingstonePublishers,Edinberg.
6. RichardCandGeiffreyS.(2009).Immunology.6thedition.WileyBlackwellPublication

MCC614:MEDICAL MICROBIOLOG Y(THEORY)

SEMESTER–VI

TOTALHOURS:50 **CREDITS:4**

Courselearningoutcomes: Bytheconclusionofthiscourse,thestudentsclearly-

Outcome 1. Understood the basic and general concepts of causation of disease by the pathogenicmicroorganisms and the various parameters of assessment of their severity including the broadcategorizationofthe methods of diagnosis.

Outcome 2. Developed a thorough understanding of common bacterial, viral, fungal, parasiticdiseasesofhumanbeing including someveryimportantdiseases of theanimalsalso.

Outcome 3. Conceptualized the protective role of the immune system of the host and developedan understanding of the basic components as well as the mechanisms underlyingthe immunesystemandits response to pathogenicmicroorganisms.

Outcome 4. Are abletoconductexperimentsfor growingcommonbacteria indifferentmicrobiologicalmedia,antibioticsensitivitydetermination andantigenantibodyreaction (precipitationtest in theagarose)

Unit1:Normalmicrofloraofthehumanbodyandhost-pathogeninteraction **No.ofHours:8**

Normalmicrofloraofthehumanbody:Importanceofnormalmicroflora,normalmicrofloraofskin,throat, gastrointestinaltract,urogenitaltract

Hostpathogeninteraction:Definitions,Infection,Invasion,Pathogen,Pathogenicity,Virulence,Toxigenic ity,Carriersandtheirtypes,Opportunisticinfections,Nosocomialinfections.Transmissionofinfection,Pat hophysiologic effectsof LPS.

Unit2Bacterialdiseases **No. ofHours:12**

List of diseases of various organ systems and their causative agents. The following diseases in detailwith Symptoms, mode of transmission, prophylaxis and control respiratory diseases: *Streptococcuspyogenes, Haemophilus influenzae, Mycobacterium tuberculosis* Gastrointestinal Diseases: *Escherichiacoli, Salmonella typhi, Vibrio cholerae, Helicobacter pylori* Others: *Staphylococcus aureus, Bacillusanthracis, Clostridiumtetani*

Unit3Viraldiseases **No.ofHours:12**

ListofdiseasesofvariousorgansystemsandtheircausativeagentsThefollowingdiseasesindetailwithSymptoms, modeof transmission, prophylaxisandcontrol
Polio,Herpes,Hepatitis,Rabies,Dengue,AIDS,Influenzawithbriefdescriptionofswineflu,Ebola,Chikungunya,JapaneseEncephalitis

Unit4Protozoandiseases **No.ofHours:5**

ListofdiseasesofvariousorgansystemsandtheircausativeagentsThefollowingdiseasesindetailwithSymptoms,modeoftransmission,prophylaxisandcontrolMalaria,Kala-azar

Unit5Fungaldiseases **No.ofHours:5**
Briefdescriptionofeachofthefollowingtypesofmycosesandonerepresentativediseasetobestudiedwithrespectto transmission,symptomsandprevention
Cutaneousmycoses:Tineapedis(Athlete'sfoot)Systemicmycoses:HistoplasmosisOpportunisticmycoses: Candidiasis

Unit6Antimicrobialagents:Generalcharacteristicsand modeofaction **No. of Hours:8**Antibacterialagents:Fivemodesofactionwithoneexampleeach:Inhibitorofnucleicacidsynthesis;Inhibitorofcellwallsynthesis;Inhibitorofcellmembranefunction;Inhibitorofproteinsynthesis;InhibitorofmetabolismAntifungalagents:MechanismofactionofAmphotericinB,GriseofulvinAnti-viralagents:MechanismofactionofAmantadine,Acyclovir,AzidothymidineAntibioticresistance,MDR,XDR,MRSA,NDM-1

MCC615: MEDICAL MICROBIOLOGY AND IMMUNOLOGY (PRACTICAL)
SEMES TER–VI

TOTALHOURS:50 **CREDITS:4**

Courselearningoutcomes: Bytheconclusionofthiscourse,thestudentsclearly-

Outcome 1. Understood the basic and general concepts of causation of disease by the pathogenicmicroorganisms and the various parameters of assessment of their severity including the broadcategorizationofthe methods of diagnosis.

Outcome 2. Developed a thorough understanding of common bacterial, viral, fungal, parasiticdiseasesofhumanbeing including someveryimportantdiseases of theanimalsalso.

Outcome 3. Conceptualized the protective role of the immune system of the host and developedan understanding of the basic components as well as the mechanisms underlyingthe immunesystemandits response to pathogenicmicroorganisms.

Outcome4. Areabletoconductexperimentsforgrowingcommonbacteriaindifferentmicrobiological media,antibioticsensitivitydeterminationandantigenantibodyreaction(precipitationtestin theagarose)

1. Identify pathogenic bacteria (any three of *E. coli, Salmonella,Pseudomonas, Staphylococcus, Bacillus*) on the basis of cultural,morphologicalandbiochemicalcharacteristics:IMViC,TSI,nitratereduction,ureaseproductionandcatalasetests
2. Study of composition and use of important differential media for identificationofpathogenicbacteria:EMBAgar,McConkeyagar,Mannitolsaltagar, Deoxycholatecitrateagar,TCBS
3. Studyofbacterialfloraofskinbyswabmethod
4. PerformantibacterialsensitivitybyKirby-Bauermethod
5. Study symptoms of the diseases with the help of photographs: Polio, anthrax,herpes,chickenpox,HPV,warts,AIDS(candidiasis),dermatomycoses(ringworms)
6. Studyofvariousstages ofMalarialparasiteinRBCsuingpermanentmounts.
7. Identificationofhumanbloodgroups.
8. PerformTotalLeukocyteCountofthegivenbloodsample.
9. PerformDifferentialLeukocyteCountofthegivenbloodsample.
10. Separateserumfromthebloodsample(demonstration).
11. PerformimmunodiffusionbyOuchterlonymethod.

12. StudyonDOTELISA.
13. Studyonimmuneelectrophoresis.

MCD602: FOOD AND DAIRY MICROBIOLOGY
(THEORY)
SEMESTER-VI

TOTALHOURS:50 **CREDITS: 4**

Courselearningoutcomes:

Outcome1: Developedaclear understandingof themultifariousroles of microorganisms infood.

Outcome 2: Are able to describe the role of microorganisms in the production of food, its spoilage includingtheirrolein homemade fermented foods.

Outcome3: Areabletoidentifytheroleofmicroorganismsinthecausationofthediseasesandhowtoprotectagainstfood-bornepathogens.

Outcome 4: Developedexperimentalskillsfor testingthemilk anddifferentfoodsfor thepresenceofmicroorganism.

Unit 1:Food as a substrateformicroorganisms **No.ofHours: 10**

Intrinsicandextrinsicfactorsthataffectgrowthandsurvivalofmicrobesin foods,naturalfloraandsourceofcontaminationof foods in general.

Unit2:Microbial spoilageof variousfoods **No.of hours: 10**

Principle,Spoilageofvegetables,fruits,meat eggs,milkandbutter,bread andcannedfoods.

Unit3:Principlesandmethods offoodpreservation **No. ofhours: 12**

Physical methods of food preservation: Low temperature, high temperature, Canning, drying, irradiation,hydrostatic pressure, high voltage pulse, microwave processing and aseptic packing. Chemical methods offood preservation:Salt,Sugar, Organic acids,SO_2,nitrite andnitrate, ethylene oxides,antibioticsandbacteriocins.

Unit4:Fermented foods **No.ofhours: 10**

Dairy starter cultures, fermented dairy products: yogurt, acidophilus milk, Kumiss, Kefir, Dahi and Cheese,otherfermentedfoods:Dosa,Sauerkaut,Soysauceandtemph,Probiotics:Healthbenefits,typesofmicroorg anismsused , probiotic foods available inmarket.

Unit5:FoodsanitationandControl **No.of hours:5**

HACCP,Indicesoffoodsanitaryqualityandsanitizers.

Unit 6: Culture and rapid detection method of food borne pathogens in foods and introduction topredictivemicrobiology **No. ofhours: 2**

SUGGESTEDREADING

1. AdamsMRandMossMO.(1995).FoodMicrobiology.4th edition,NewAgeInternational(P) Limited Publishers,NewDelhi,India.
2. BanwartJM.(1987).BasicFoodMicrobiology.1stedition.CBSPublishersandDistributors,Delhi,India.
3. DavidsonPMandBrannenAL.(1993).AntimicrobialsinFoods.MarcelDekker,NewYork.
4. DillionVMandBoardRG.(1996).NaturalAntimicrobialSystemsandFoodPreservation.CABInternational,Wallingford,Oxon.
5. FrazierWCandWesthoffDC.(1992).FoodMicrobiology.3rdedition.TataMcGraw
   a. -HillPublishingCompanyLtd,NewDelhi,India.
6. GouldGW.(1995).NewMethodsofFoodPreservation.BlackieAcademicandProfessional,London.
7. JayJM,LoessnerMJandGoldenDA.(2005).ModernFoodMicrobiology.7th edition,CBSPublishersandDistributors,Delhi,India.
8. LundBM,BairdParkerAC,andGouldGW.(2000).TheMicrobiologicalSafetyandQualityofFoods.Vol.1-2,ASPENPublication,Gaithersberg,MD.
9. TortoraGJ,FunkeBR,andCaseCL.(2008).Microbiology:AnIntroduction.9th edition.PearsonEducation.

MIC603: BACTERIOLOGY AND VIROLOGY (THEORY)
SEMESTER–VI

TOTALHOURS50 **CREDITS:4**

Courselearningoutcomes:Atthecompletionofthiscourse,thestudentsareableto–

Outcome 1. Describe characteristics of bacterial cells, cell organelles, cell wall compositionandvariousappendageslikecapsules, flagellaor pili.
Outcome 2. Differentiate a large number of common bacteria by their salient characteristics;classifybacteriaintogroups.
Outcome3.Describethenutritionalrequirementsofbacteriaforgrowth;developedknowledgeand understanding that besides common bacteria there are several other microbes which growunderextremeenvironments.
Outcome 4. Perform basic laboratory experiments tostudymicroorganisms;methodstopreservebacteriain thelaboratory; calculategeneration timeofgrowingbacteria.
Outcome5.Understoodwhatarevirusesandthechemicalnatureofviruses,differenttypesofvirusesi nfectinganimals,plantsand bacteria(bacteriophages) **Outcome6**.Understandingaboutthebiologyof bacteriophages.
Outcome7.Gainedknowledgeofavarietyofplantviruses andanimalviruses.
Outcome8. Theabilitytodescriberoleofvirusesinthecausationofthecancer'

Unit1:Cellorganization **No. ofHours: 10**

Cell size, shape and arrangements, capsule, flagella and pili, Composition and detailedstructure of gram- positive and gram- negative cell wall and archaeal cell wall, Structure,chemical composition and functions of bacterial and archaeal cell membranes, Ribosomes,inclusions,nucleoid, plasmids, structure, formationand stages of sporulation

Unit2:Bacterial growthandcontrol **No.ofHours: 8**

Culturemedia:Componentsofmedia,Syntheticordefinedmedia,Complexmedia,enrichedmedi a,selectivemedia,differentialmedia,enrichmentculturemediaPureculture isolation:Streaking, serialdilutionandplatingmethods,cultivation,maintenanceandstockingofpurecultures,cultiva tion ofanaerobic bacteria Growth: Binaryfission,phasesof growth

Unit3:Bacterial SystematicsandTaxonomy **No.ofHours:8**

Taxonomy, nomenclature, systematics, types of classifications Morphology, ecologicalsignificance and economic importance of the followinggroups: Archaea: methanogens,thermophilesandhalophiles

Unit4:IntroductiontoViruses **No.ofHours:8**

Properties of viruses; general nature and important features Subviral particles; viroid's,prionsand theirimportanceIsolationand cultivationofviruses

Unit5:Structure,andmultiplication ofviruses **No.ofHours:8**

Morphological characters: Capsid symmetry and different shapes of viruses with examplesViralmultiplicationintheCell:LyticandlysogeniccycleDescriptionofimportantvirus es:salient features of the viruses infecting different hosts - Bacteriophages (T4 & Lambda);Plant(TMV& Cauliflower MosaicVirus),Human(HIV)

Unit6:RoleofVirusesinDiseaseanditsprevention **No.ofHours:8**

Virusesaspathogens:Roleofviruses incausingdiseasesPreventionandcontrolofviruses:interferons and antiviralcompounds

SuggestedReadings:

1. AtlasRM.(1997). PrinciplesofMicrobiology.2nd edition.WM.T.Brown Publishers
2. Madigan MT, Martinko JM, Dunlap PV and Clark DP (2014). Brock Biology of Microorganisms.14thedition. Pearson Education,Inc.
3. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology. 5thedition. McMillan
4. CarterJandSaunders V(2007).Virology;principlesandApplications.JohnWileyandSons
5. Flint SJ, Enquist, LW, Krug, RM, Racaniello, VR Skalka, AM (2004) Principles of Virology,MolecularBiology, Pathogenesis and Contro*l*.2nd edition.ASMPress
6. Shors Teri (2013) Understanding Viruses 2nd edition Jones and Bartlett Learning BurlingtonUSA
7. Pelczar Jr MJ, Chan ECS, and Krieg NR. (2004). Microbiology. 5th edition Tata McGrawHill.
8. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th editionPearsonEducation.
9. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition.McGraw Hill Higher Education.
10. Dimmock, NJ, Easton, AL, Leppard, KN (2007). Introduction to Modern Virology. 6thedition,Blackwell Publishing Ltd.
11. CannAJ(2012)PrinciplesofMolecularVirology, AcademicPressOxfordUK

MCC716:ENVIRONMENTALMICROBIOLOGY(THEORY)
SEMESTER–VII

TOTALHOURS:50 **CREDITS:4**

Courselearningoutcomes: Bythecompletionofthiscourse,thestudents -

Outcome1.Havedevelopedafairlygoodknowledgeandunderstandingofdifferenttypesof environments and habitats where microorganisms grow including the microbiomes ofthehuman gut andanimalgut.

Outcome 2. Are able to identify the important role microorganisms play in maintaininghealthyenvironmentbydegradationofsolid/liquidwastes;howtheseactivitiesof microorganisms are used insewage treatment plants, production of activated sludge andfunctioning ofseptictanks

Outcome 3. Have understood the significance of BOD/COD and various tests involvinguseofenumeratingfecal*E.coli*forassessingqualityofwater.

Outcome 4. Have developed the practical skills for conducting experiments to assesstheBOD/CODofwastewaters andtheirinterpretation;practicallyassesstheportabilityofdrinking waterbytheuseofstandard microbiological tests.

Unit1-Microorganismsand theirHabitats **No. ofHours:10**

Structure and function of ecosystems Aquatic Environment: Microflora of fresh waterandmarinehabitatsAtmosphere:Aeromicrofloraand dispersalofmicrobes AnimalEnvironment:Microbesin/onhumanbody(Microbiomics)&animal(ruminants)bod y. Extreme Habitats: Extremophiles: Microbes thriving at high& lowtemperatures,pH,highhydrostatic& osmoticpressures,salinity,&lownutrientlevels.

Unit2-MicrobialInteractions **No.ofHours:12**

Microbeinteractions:Mutualism,synergism,commensalism,competition,amensa lism, parasitism, predation Microbe-Plant interaction: Symbiotic andnonsymbiotic interactions Microbe animal interaction: Microbes in ruminants,nematophagusfungiandsymbioticluminescentbacteria

Unit3-BioGeochemical Cycling **No.ofHours:10**

Carbon cycle: Microbial degradation of cellulose, hemicelluloses, lignin andchitinNitrogencycle:Nitrogenfixation,ammonification,nitrification,denitrifi cationandnitratereductionPhosphoruscycle:Phosphateimmobilizationandsolubi lizationSulphurcycle:Microbesinvolved inSulphurcycle

Unit4-WasteManagement **No.ofHours:12**

Solid Waste management: Sources and types of solid waste, Methods of solid wasted is posal(composting andsanitarylandfill)
Liquid waste management: Composition and strength of sewage (BOD and COD), Primary,secondary (oxidation ponds, trickling filter, activated sludge process and septic tank) and tertiarysewagetreatment

Unit5-MicrobialBioremediation **No.ofHours:2**

Degradationofcommon pesticides,organic(hydrocarbons,oilspills)biosurfactants

Unit6-WaterPotability **No.ofHours:4**

Treatment and safety of drinking(potable) water, methods to detect potability of watersamples:
(a) standard qualitative procedure: presumptive test/ MPN test, confirmed and completed testforfaecalcoliforms
(b) Membrane filter technique
and(c)Presence/absencetests

SUGGESTEDREADINGS

1. AtlasRMand BarthaR.(2000).MicrobialEcology:Fundamentals&Applications.4thedition.Benja min/Cummings SciencePublishing, USA
2. Madigan MT,Martinko JM and ParkerJ.(2014).Brock Biology of Microorganisms.14th edition.Pears on/BenjaminCummings
3. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology.2nd edition,AcademicPress
4. Okafor,N(2011).EnvironmentalMicrobiologyofAquatic&Wastesystems.1stedition,Spri nger,NewYork
5. SinghA,Kuhad,RC&WardOP(2009).AdvancesinAppliedBioremediation.Volume17,Spring er-Verlag,BerlinHedeilberg
6. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USACampbellRE.(1983).MicrobialEcology.BlackwellScientificPublication,Oxford,Engl and.
7. CoyneMS.(2001).SoilMicrobiology:AnExploratoryApproach.DelmarThomsonLearning.

8. LynchJM&HobbieJE.(1988).MicroorganismsinAction:Concepts&Applic ationinMicrobialEcology.BlackwellScientificPublication, U.K.
9. MartinA.(1977).AnIntroduction to SoilMicrobiology.2ndedition.JohnWiley&SonsInc.NewYork&Lon don.
10. StolpH.(1988).MicrobialEcology:OrganismsHabitatsActivities.CambridgeUniversityPress, Cambridge,England.
11. SubbaRaoNS.(1999).SoilMicrobiology.4thedition.Oxford&IBHPublishingCo.NewDelhi.
12. WilleyJM,SherwoodLM,and WoolvertonCJ.(2013).Prescott'sMicrobiology.9thedition.McGrawHillHig herEducation.

MCC717: MICROBES IN SUSTAINABLE AGRICULTURE AND DEVELOPMENT (THEORY)

SEMESTER–VII

TOTALHOURS:50 **CREDITS:4**

Outcome 1. Developed a clear understanding of the multifarious roles ofmicroorganisms insoil, inassociation with plants and thus in thefieldof agriculture
Outcome2. AreabletodescribetheMicrobialControlofsoilborneplantpathogens.**Outcome3**. Areabletoidentifytheroleofmicroorganismsin Biofertilization,Phytostimulation,Bioinsectic ides.
Outcome4. DevelopedSecondaryAgricultureBiotechnology.

Unit1-SoilMicrobiology **No.ofHours:8**

SoilasMicrobialHabitat,Soilprofileandproperties,Soilformation,Diversityanddistributionofmicroorganismsinsoil

Unit2-Soilorganicmatter **No. ofHours:4**

Mineralizationofcellulose,hemicelluloses,ligninandhumus

Unit4-MicrobialControlofsoilborneplantpathogen **No of Hours: 8**Biocontrol mechanisms and ways,Microorganisms used as biocontrol agents againstMicrobial plant pathogens, Insects,Weeds

Unit5-Biofertilization,Phytostimulation,Bioinsecticide **No of Hours: 14**Plantgrowthlimitingcompounds,biofertilizers–symbiotic(Bradyrhizobium,Rhizobium,Frankia),Non-Symbiotic (Azospirillum, Azotobacter,Mycorrhizae,MHBs, Phosphatesolubilizers,algae)PGPRs

Unit6-SecondaryAgricultureBiotechnology **No ofHours:10**

Biotechfeed,Silage,Biomanure,biogas,biofuels–advantagesandprocessingparameters

Unit7-GMcrops **No ofHours:6**

Advantages,socialandenvironmentalaspects,Bt-crops,goldenrice,transgenicanimals.

SUGGESTEDREADINGS-

1. AgriosGN.(2006).PlantPathology.5thedition.Academicpress,SanDiego,
2. SinghRS.(1998).PlantDiseasesManagement.7thedition.Oxford&IBH,NewDelhi.
3. GlickBR,PasternakJJ,andPattenCL(2010)MolecularBiotechnology4thedition,ASMPress,
4. AtlasRM andBarthaR.(2000).MicrobialEcology:Fundamentals&Applications.4thedition.Benjamin/CummingsSciencePublishing,USA
5. MaierRM,PepperIL andGerbaCP.(2009).EnvironmentalMicrobiology.2ndedition,AcademicPress
6. BartonLL&NorthupDE(2011).Microbial Ecology.1st edition,Wiley Blackwell,USACampbellRE.(1983).MicrobialEcology.BlackwellScientificPublication,Oxford,England.
7. CoyneMS.(2001).SoilMicrobiology:AnExploratoryApproach.DelmarThomsonLearning

MCC718: ENVIRONMENTAL MICROBIOLOGY (PRACTICAL)

SEMESTER–VII

TOTALHOURS:50 **CREDITS:4**

Courselearningoutcomes: Bythecompletionofthis course,thestudents-

Outcome 1. Have developed a fairly good knowledge and understanding of differenttypes of environments and habitats where microorganisms grow including themicrobiomesofthe human gut andanimalgut.

Outcome 2. Are able to identify the important role microorganisms play in maintaininghealthy environment by degradation of solid/liquid wastes; how these activities ofmicroorganisms are used insewage treatment plants, production of activated sludge andfunctioning ofseptictanks

Outcome 3.Have understood the significance of BOD/COD and various tests involvinguseofenumeratingfecal*E.coli*forassessingqualityofwater.

Outcome 4. Have developed the practical skills for conducting experimentsto assess the BOD/COD of wastewaters and their interpretation; practicallyassess the portability of drinkingwater by the use of standard microbiologicaltests.

1. Analysis of Soil-pH, moisture content, water holding capacity, percolation, capillaryaction.
2. Isolationofmicrobes(bacteria&fungi)fromsoil(28ºC&45ºC).
3. Isolationofmicrobes(bacteria&fungi)fromrhizosphereandrhizoplane.
4. Assessmentofmicrobiologicalqualityofwater.
5. Determination ofBOD ofwastewatersample.
6. StudythepresenceofMicrobialactivitybydetecting(qualitatively)enzymes(de hydrogenase,amylase,urease)insoil.
7. Isolationof*Rhizobium*fromrootnodules.
8. Studysoilprofile
9. Azotobacterassoilinoculantscharacteristicsandfieldapplications.

8.

MCD703: FOOD AND INDUSTRIAL MICROBIOLOGY (PRACTICAL)

SEMESTER-VII

TOTALHOURS:50 **CREDITS:4**

Courselearningoutcomes:

Outcome1: Arecapableofdescribingalargenumberofsubstratesthatareusedfortheindustrialfermentationproc esses.

Outcome2: Areabletodescribetheroleofmicroorganismsintheproductionoffood,itsspoilageincludingtheir role in homemadefermented foods.

Outcome3: Areabletoidentifytheroleofmicroorganismsinthecausationofthediseasesandhowtoprotectagainst food-bornepathogens.

Outcome4: Developedexperimentalskillsfortestingthemilkanddifferentfoodsforthepresenceofmicroorganis m.

1. MBRTofsuppliedmilkSamplesandtheirstandardplatecount.
2. Alkalinephosphatasetesttocheck the efficiencyofpasteurizationofmilk.
3. Isolationofanypathogenicbacteria(StaphylococcusorSalmonella)from foodproducts.
4. IsolationofSpoilagemicroorganismsfromSpoiledvegetables/fruits.
5. Isolationofspoilagemicroorganismsfrombread.
6. PreparationofYogurt/Dahi.
7. Studydifferentpartsof fermenter.
8. Microbialfermentation fortheproduction anddestimation(qualitativeandquantitative)of:
    a) Enzymes:Amylaseand Protease.
    b) Aminoacid:Glutamicacid
    c) Organicacid:Citricacid
    d) Alcohol:Ethanol.
9. Avisittoanyindustrialinstitute/industrytoseeanindustrialfermenter,andotherdownstreamprocessing operation.

MCD704: BIOINFORMATICS THEORY)

SEMESTER-VII

TOTALHOURS:50 **CREDITS:4**

Courselearningoutcomes:

Outcome1: Developedskills to usecomputersfor analysis ofbiologicaldata.

Outcome2: Skilltouseimportantbiologicaldatabase,usetoolstoretrievedata,andcomparethedataofthebiologic al macromolecules.

Outcome3: Developed basicskills forthedataretrieval, representation,analysisandinterpretation.

Unit1:IntroductiontoComputerFundamentals **No. ofhours:8**

Bioinformaticsbasics,RDBMS-Definitionofrelationaldatabase.

Modeofdatatransfer(FTP,SFTP,SCP), advantagesofencrypteddatatransfer.

Unit2:IntroductiontobioinformaticsandBiologicaldatabase **No. ofhours: 14**

Biological database- nucleic acid, genome, protein sequence and structure, gene expression database,Databaseofmetabolicpathways,Modeofdatastorage,Fileformat-FASTA,GenebankandUniport,Datasubmissionand retrievalfrom NCBI, EMBL, DDBJ, Uniport,PDB.

Unit3:SequenceAlignment,PhylogenyandPhylogenetictree **No. ofhours: 16**

Localandglobalsequencealignment,Pairwiseandmultiplesequencealignment.Scoringanalignment,Scoringm atrices, PAM& BLOSUM series of matrices.

Typesofphylogenetictrees,Differentapproachesofphylogeneticstreeconstruction-UPGMA,Neighbourjoining,Maximum Parasomy.

Unit4:Genomeorganization and analysis **No.ofhours: 14** Diversityofgenome-Viral,Prokaryotic&Eukaryoticgenomes.Genome,Transcriptome,Proteome,MaldiToff Spectroscopy.Major featuresofcompletegenome-*E.coli,S. cerevisae,*Human.

Unit5:Protein StructurePredictions **No. ofhours:12**

HierarchyofproteinStructure-

Primary,Secondaryandtertiarystructure,ModelingStructureClasses,Motifs,Fold and Domain.

SUGGESTEDREADING

1. SaxenaSanjay(2003)AFirstCourseinComputers,VikasPublishingHouse
2. PradeepandSinhaPreeti(2007)FoundationsofComputing,4thed.,BPBPublications
3. LeskM.A.(2008)IntroductiontoBioinformatics.OxfordPublication,3rd International StudentEdition
4. RastogiS.C.,MendirattaN.andRastogiP.(2007)Bioinformatics:methodsandapplicatio ns,genomics,proteomicsanddrugdiscovery,2nded.PrenticeHallIndiaPublication
5. PrimroseandTwyman(2003)PrinciplesofGenomeAnalysis&Genomics.Blackwell

6.

MIC704: BACTERIOLOGY AND VIROLOGY(PRACTI CAL)
SEMESTER –VII

TOTALHOURS:50 **CREDITS:4**

Courselearningoutcomes:Atthecompletionofthiscourse,thestudentsareableto–

Outcome 1. Describe characteristics of bacterial cells, cell organelles, cell wall composition andvariousappendageslikecapsules, flagella or pili.
Outcome2.Differentiatealargenumberofcommonbacteriabytheirsalientcharacteristics;classifyb acteriaintogroups.
Outcome 3. Describe the nutritional requirements of bacteria for growth;developedknowledgeandunderstandingthatbesidescommonbacteriathereareseveral othermicrobeswhich grow underextremeenvironments.
Outcome 4. Perform basic laboratory experiments to study microorganisms; methods topreservebacteriainthelaboratory;calculate generationtime ofgrowingbacteria.
Outcome5.Understoodwhatarevirusesandthechemicalnatureofviruses,differenttypesofv iruses infectinganimals,plantsand bacteria(bacteriophages)
Outcome6.Understandingaboutthebiologyof bacteriophages.
Outcome7.Gainedknowledgeofavarietyofplantviruses andanimalviruses.
Outcome8. Theabilityto describeroleofvirusesinthecausation ofthecancer'

1. Preparationofdifferentmedia:Nutrientagar,Nutrientbroth
2. ToperformsimplestainingandGram'sstainingofthebacterialsmear
3. Toperformsporestaining
4. Isolationofpureculturesofbacteriabystreakingmethod
5. Enumerationofcolonyformingunits(CFU)countbyspreadplatemethod/pourplate.
6. Studyofthemethods ofisolationandpropagationofplantviruses
7. Studyofcytopathiceffects ofvirusesusingphotographs

SUGGESTEDREADINGS

1. AtlasRM. (1997).Principles ofMicrobiology.2nd edition.WM.T.BrownPublishers
2. Madigan MT, Martinko JM, Dunlap PV and Clark DP (2014). Brock Biology of Micro-organisms.14th edition. Pearson Education, Inc.
3. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology.5th edition.McMillan
4. Carter J and Saunders V(2007). Virology; principles and Applications. John Wiley andSons
5. Flint SJ, Enquist, LW, Krug,RM, Racaniello, VR Skalka, AM (2004) Principles ofVirology,MolecularBiology,Pathogenesis andControl.2ndedition.ASMPress
6. Shors Teri (2013) Understanding Viruses 2nd edition Jones and Bartlett LearningBurlington USA
7. Pelczar Jr MJ, Chan ECS, and Krieg NR. (2004). Microbiology. 5th edition TataMcGraw Hill.
8. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9theditionPearson Education.
9. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9thedition.McGraw Hill Higher Education.
10. Dimmock, NJ, Easton, AL, Leppard, KN (2007). Introduction to Modern Virology. 6thedition,BlackwellPublishingLtd.
11. Cann AJ (2012)Principles of Molecular Virology, Academic Press Oxford UK

MCC819:RECOMBINANT DNA TECHNOLOGY (THEORY)
SEMESTER–VIII

TOTALHOURS:50 **CREDITS:4**

Courselearning outcomes: Bytheconclusionofthiscourse, thestudentshave–

Outcome1.Developedanunderstandinghowmicrobiologyisrelevanttotechnologicaldevel opments foragricultureand environment.
Outcome2.Developedanunderstandinghowmicrobiologyisrelevanttotechnologicaldeve lopments forindustries related tofoodand fermentations.
Outcome 3. Developed an understanding how developments in recombinantDNAtechnologyisjustaposedwithmicrobially-basedtechnologicaldevelopments foragriculture, industryandenvironment.

Unit1Molecularcloning-ToolsandStrategies **No. ofHours: 20**

Cloning Tools; Restriction modification systems: Types I, II and III. Mode of action,nomenclature,applicationsofType IIrestriction enzymesin geneticengineering DNA modifying enzymes and their applications: DNA polymerases.Terminal deoxynucleotidyl transferase, kinases and phosphatases, and DNA ligasesCloning Vectors: Definition and Properties Plasmidvectors: pBRand pUC seriesBacteriophagelambdaand M13based vectors Cosmids, BACs, YACs UseoflinkersandadaptorsExpressionvectors:E.coli lacandT7promoter-basedvectors,yeastYIp,YepandYCp vectors, Baculovirus-based vectors,mammalianSV40-basedexpression vectors.

Unit2Methodsinmolecularcloning **No.ofHours:16**

TransformationofDNA:Chemicalmethod,Electroporation, Genedelivery:Microinjection,electroporation,biolisticmethod(genegun),lipos ome and viral-mediated delivery, *Agrobacterium*-mediated deliveryDNA,RNAandProteinanalysis:Agarosegelelectrophoresis,Southern-andNorthern-blottingtechniques,dotblot,DNAmicroarrayanalysis,SDS-PAGEandWesternblotting.

Unit3DNAAmplificationandDNAsequencing **No.ofHours:10**

PCR:BasicsofPCR,RT-PCR,Real-TimePCR
Sanger'smethodofDNASequencing:traditionalandautomatedsequencingPrimerw alkingandshotgunsequencing.

Unit4ConstructionandScreeningofGenomicandcDNAlibraries No. ofHours: 2

GenomicandcDNAlibraries:Preparationanduses,Screeningoflibraries:Colonyhyb ridizationandcolony PCR.

Unit5ApplicationsofDNATechnology No.ofHours:2

ProductsofrecombinantDNAtechnology:Productsofhumantherapeuticinterest- insulin,hGH,antisense molecules.Bttransgenic-cotton,brinjal,Genetherapy.

SUGGESTEDREADING-

1. BrownTA.(2010).GeneCloningandDNAAnalysis.6thedition.BlackwellPublishing,Oxford,U.K.
2. ClarkDP andPazdernikNJ.(2009).Biotechnology:ApplyingtheGeneticRevolution.ElsevierAcademic Press,USA
3. PrimroseSB and TwymanRM.(2006).PrinciplesofGeneManipulationandGenomics,7thedition.Bl ackwellPublishing,Oxford,U.K.
4. Sambrook J and Russell D.(2001).Molecular Cloning-ALaboratoryManual.3rdedition.ColdSpringHarborLaboratoryPress
5. WileyJM,SherwoodLMandWoolvertonCJ.(2008).Prescott,HarleyandKlein'sMicrobiology.McGr awHillHigherEducation
6. BrownTA.(2007).Genomes-3.GarlandSciencePublishers
7. Primrose SB and TwymanRM.(2008).Genomics:Applicationsinhumanbiology.BlackwellP ublishing ,Oxford,U.K.

MCC820:INSTRUMENTATION AND BIOTECHNIQUES(THEORY)
SEMESTER– VIII

TOTALHOURS:50 **CREDITS:4**

Courselearning outcomes: Bytheconclusionofthiscourse,thestudentshave-

Outcome1.Developedunderstandingofprincipals,andapplicationsofdifferentmicroscopicandspectrophotometricmethods.

Outcome2. Developed understanding of principals, and applications ofdifferentseparationtechniquesespeciallychromatographic,electrophoretic andcentrifugation techniques.

Outcome3.Skills inhandling and use of light microscope, spectrophotometer andcentrifugationequipmenttostudy/analyzevariousmicrobiologicalsamples.

Unit1-Chromatography **No.ofHours:10**

Principlesandapplicationsofpaperchromatography(includingDescendinga nd2-D),Thinlayer chromatography.Gelfiltrationchromatography, ion- exchange chromatography and affinitychromatography, GLC, HPLC.

Unit2-Electrophoresis **No.ofHours:10**

Principleandapplicationsofnativepolyacrylamidegelelectrophoresis,SDS-polyacrylamide gel electrophoresis, 2D gel electrophoresis,Isoelectricfocusing.

Unit3Spectrophotometry **No.ofHours:10**

Principle and use of study of absorption spectra of biomolecules. AnalysisofbiomoleculesusingUVandvisiblerange.Colorimetryandturbido metry.

Unit4-Centrifugation **No.ofHours:10**

Preparative and analytical centrifugation, fixed angle and swinging bucketrotors.RCFandsedimentationcoefficient,differentialcentrifugation,d ensitygradient centrifugation andultracentrifugation.

SUGGESTEDREADINGS:

1. Wilson K and Walker J. (2010). Principles and Techniques of Biochemistry andMolecularBiology.7thEd,
2. CambridgeUniversityPress.
3. NelsonDL and CoxMM. (2008).Lehninger Principles ofBiochemistry,5thEd.,W.H.FreemanandCompany.
4. WilleyMJ,SherwoodLM&WoolvertonCJ.(2013).Prescott,HarleyandKlein'sMicrobiol ogy.9thEd.,McGrawHill.
5. Karp G. (2010) CellandMolecularBiology: ConceptsandExperiments.6thedition.JohnWiley&Sons.Inc.
6. DeRobertisEDPandDeRobertisEMF. (2006). CellandMolecularBiology.8thedition.LipincottWilliamsandWilkins,Phil adelphia.
7. CooperG.M.andHausmanR.E.(2009).TheCell:AMolecularApproach. 5thEdition.ASMPress&Sunderland,WashingtonD.C., SinauerAssociates,MA.
8. NigamAandAyyagariA. 2007.LabManualinBiochemistry, ImmunologyandBiotechnology.TataMcGrawHill.

MCC821:RECOMBINANT DNA TECHNOLOGY(PRACTICAL)
SEMESTER–VIII

TOTALHOURS: 50 **CREDITS:4**

Courselearning outcomes: Bytheconclusionofthiscourse,thestudentshave-

Outcome1.Developedanunderstandinghowmicrobiologyisrelevanttotechnologicaldevelopmentsfor agricultureand environment.

Outcome2. Developed an understanding howmicrobiology is relevant totechnologicaldevelopmentsforindustries relatedto foodand fermentations.

Outcome3.Developedanunderstandinghow developmentsinrecombinantDNA technologyisjust a posed with microbially-based technological developments for agriculture, industry andenvironment.

1. Preparation ofcompetentcellsfortransformation
2. DemonstrationofBacterialTransformationandcalculationoftransformationefficiency.
3. DigestionofDNAusingrestrictionenzymesandanalysisbyagarosegelelectrophoresis
4. LigationofDNAfragments
5. CloningofDNAinsertandBluewhitescreeningofrecombinants.
6. Interpretationofsequencinggel-electropherograms
7. DesigningofprimersforDNAamplification
8. AmplificationofDNAbyPCR
9. DemonstrationofSouthern-blotting
10. Studyoffluorescent micrographstovisualizebacterialcells.
11. Raydyagramsofphase contrastmicroscopyandElectronmicroscopy.
12. Separationofmixturesbypaper/thinlayerchromatography.
13. Demonstrationofcolumnpackinginanyformofcolumnchromatography.
14. Separationofproteinmixturesbyanyformofchromatography.
15. SeparationofproteinmixturesbyPolyacrylamide GelElectrophoresis(PAGE).
16. Determination ofλ_{max}foranunknownsampleand calculation ofextinctioncoefficient.
17. Separation ofcomponentsofagiven mixtureusingalaboratoryscalecentrifuge.
18. Understanding densitygradientcentrifugation withthehelp ofpicture.

MCD805: BIOSTATISTICS (THEORY)

SEMESTER- VIII

TOTALHOURS: 50 **CREDITS:4**

Courselearningoutcome:
Outcome1: Understandthebasicphysicalparametersofcellorbiologicalsampleandbasicmethodusedtostudy these.
Outcome2: Have developed basic knowledge of mathematical as applied to biological phenomenon.
Outcome3: Have developed basic concepts of statistics and their importance.

Unit1:Basic of Statistics **No. ofhours: 10**
Basicintroductiontomultivariatestatistics.Basicknowledgeaboutdata,sample&population.Typesofdata,colle ction ofdata.

Unit2: Statistical methods **No. ofhours:15**
Statistical methods: Scope ofStatistics:utilityandmisuse.Principalofstatisticalanalysisofbiologicaldata. Measureofcentraltendency:Mean,MedianandMode.Measureofdispersion,Skewness,Kurtosis,ElementaryPr obability and basic laws;Discrete and continuous Randomvariable.

Unit3: Sampling parameters **No. ofhours: 15**
Sampalingparametes,DifferencebetweenSampleandPopulation ,Samplingerrors,Differencebetweenparamet ricand non-parametric statistics.
SamplingDistribution,Standarddeviation&Standarderror,Testinghypothesis,LevelofsignificanceandDegre eoffreedom.

Unit4:Sample based test **No. ofhours: 10**
MathematicalExpectation:CurveFitting,CorrelationandRegression
LargeSampletestbasedonnormaldistribution,smallsampletestbasedont-test,Z-testandF-test,Distribution– freetest: Chi-squaretest. ANOVA.

SUGGESTEDREADINGS

1. A.EdmondsonandD.Druce:AdvancedBiologyStatistics,OxfordUniversityPress;1996.
2. W.Danial:Biostatistics:AfoundationforAnalysisinHealthSciences,Joh nWileyandSonsInc;2004.

MCD806: PROJECT WORK (PRATICALS)

SEMESTER-VIII

TOTALHOURS: 50 **CREDITS: 4**

Project work or fieldwork

G1D/2D:BACTERIOLOGYANDVIROLOGY(PRACTICAL)SEMESTER –VII/VIII

TOTALHOURS:50 **CREDITS:4**

Courselearningoutcomes:Atthecompletionofthiscourse,thestudentsareableto–

Outcome 1. Describe characteristics of bacterial cells, cell organelles, cell wall composition andvariousappendageslikecapsules, flagella or pili.
Outcome2.Differentiatealargenumberofcommonbacteriabytheirsalientcharacteristics;classifyb acteriaintogroups.
Outcome 3. Describe the nutritional requirements of bacteria for growth;developedknowledgeandunderstandingthatbesidescommonbacteriatherearesseveral othermicrobeswhich grow underextremeenvironments.
Outcome 4. Perform basic laboratory experiments to study microorganisms; methods topreservebacteriainthelaboratory;calculate generationtime ofgrowingbacteria.
Outcome5.Understoodwhatarevirusesandthechemicalnatureofviruses,differenttypesofv iruses infectinganimals,plantsand bacteria(bacteriophages)
Outcome6.Understandingaboutthebiologyof bacteriophages.
Outcome7.Gained knowledgeofavarietyofplantvirusesand animal viruses.
Outcome8. Theabilitytodescriberoleofvirusesinthecausationofthe cancer'

1. Preparationofdifferentmedia:Nutrientagar,Nutrientbroth
2. ToperformsimplestainingandGram'sstainingofthebacterialsmear
3. Toperformsporestaining
4. Isolationofpureculturesofbacteriabystreakingmethod
5. Enumerationofcolonyformingunits(CFU)countbyspreadplatemethod/pourplate.
6. Studyofthemethods ofisolationandpropagationofplantviruses
7. Studyofcytopathiceffects ofvirusesusingphotographs

SUGGESTEDREADINGS

1. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T.BrownPublishers
2. Madigan MT, Martinko JM, Dunlap PV and Clark DP (2014). Brock BiologyofMicro-organisms. 14th edition.Pearson Education, Inc.
3. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). GeneralMicrobiology.5thedition. McMillan
4. Carter J and Saunders V(2007). Virology; principles and Applications. JohnWileyandSons
5. Flint SJ, Enquist, LW, Krug,RM, Racaniello, VR Skalka, AM (2004)Principles of Virology, Molecular Biology, Pathogenesis and Control.2ndedition.ASM Press
6. Shors Teri (2013) Understanding Viruses 2nd edition Jones and BartlettLearningBurlington USA
7. Pelczar Jr MJ, Chan ECS, and Krieg NR. (2004). Microbiology. 5th editionTataMcGraw Hill.
8. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction.9thedition Pearson Education.
9. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott'sMicrobiology.9thedition. McGraw Hill HigherEducation.
10. Dimmock, NJ, Easton, AL, Leppard, KN (2007). Introduction to ModernVirology.6th edition, BlackwellPublishingLtd.
11. Cann AJ (2012)Principles of Molecular Virology, Academic Press Oxford UKB.Sc(HON