B.Sc., MICROBIOLOGY

LEARNINIG OUTCOMES BASED CURRICULUM FRAMEWORK (CBCS - LOCF)
(*Forthecandidatesadmittedin theacademicyear* 2022-2023)

SYLLABUS

PROGRAMME CODE: 3UGSMIC

SENGAMALA THAYAAR EDUCATIONAL TRUST WOMEN'S COLLEGE
(AUTONOMOUS)
(Affiliated to Bharathidasan University, Tiruchirappalli)
Accredited by NAAC- An ISO 9001:2015 Certified Institution
SUNDARAKKOTTAI, MANNARGUDI – 614 016
TAMIL NADU, INDIA.

PROGRAMME OUTCOMES FOR B.Sc., DEGREE

PO No.	Program Outcomes (*Upon completion of the B.Sc. Degree Programme, the Undergraduate will be able to)*
PO-1*	**Disciplinary knowledge**: demonstrate comprehensive knowledge and understanding of one or more disciplines that form a part of an undergraduate programme of study in Bachelor of Science.
PO-2*	**Critical thinking and Problem Solving:** think critically about the issues and identify, critically analyze and solve problems from the disciplines of concern using appropriate tools and techniques and the knowledge, skills and attitudes acquired and extrapolate the same to real life situations.
PO-3*	***Scientific reasoning:*** analyse, interpret and draw conclusions from quantitative/qualitative data; and critically evaluate ideas, evidence and experiences from an open-minded and reasoned perspective.
PO-4*	**Digital literacy and Effective Communication:** use ICT in a variety of learning situations and **s**peak, read, write and listen clearly in person and through electronic media in English and in one or more Indian languages, and make meaning of the world by connecting people, ideas, books, media and technology.
PO-5	**Individual and Team Work:** effectively accomplish tasks individually as well as work effectively and respectfully as member or leader with diverse teams, facilitate cooperative or coordinated effort on the part of a group, and act together as a group or a team in the interests of a common cause and work efficiently as a member of a team.
PO-6*	**Environment and Sustainability:** understand the impacts of technology and business practices in societal and environmental contexts, and sustainable development.
PO-7	**Human values and Gender Issues:** understand major ideas, values, beliefs, the nature of the individual and the relationship between self and the community and aware of the various issues concerning women and society
PO-8*	**Self directed and Lifelong learning:**acquire knowledge and skills, including learning "how to learn", that are necessary for participating in learning activities throughout life and to engage in independent and life-long learning in the broadest context of socio-technological changes.

PROGRAMME SPECIFIC OUTCOME (PSO)

PSO No.	Program Specific Outcomes (B.Sc., Microbiology)
PSO1	Build strong theoretical and practical background in fundamental concepts in Microbiology.
PSO2	Show expertise in the use and applications of various methods in Microbial taxonomy, Genetic engineering, Lab Technology and Agriculture.
PSO3	Plan independently and work on lab protocols involving emerging analytical techniques in Microbiology.
PSO4	Create environmentally and industrially important microbes with a specific emphasis on improving environmental sustainability and human health
PSO5	Formulate entrepreneurship endeavors in Microbiology, Biotechnology and Genetic Engineering.

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B.Sc., MICROBIOLOGY
CHOICE BASED CREDIT SYSTEM - LEARNINIG OUTCOMES BASED CURRICULUM FRAMEWORK (CBCS - LOCF)
(Academic year 2022-2023)

ELIGIBILITY: A Pass in 10+2 with Biology as one of the core subjects

Sem	Part	Course	Course Code	Title of the Paper	Ins. Hours/ Week	Credit	Exam Hours	Marks		Total
								CIA	ESE	
I	I	Language Course–I (LC) – Tamil*/Other Languages ** #	22LC101	IkkalaIlakkiyam	6	3	3	25	75	100
	II	English Language Course - I (ELC)	21ELC101	Language through Literature –I (Prose and Communication Skills)	6	3	3	25	75	100
	III	Core Course–I (CC)	22MB101	Principles of Microbiology	6	5	3	25	75	100
		Core Practical – I (CP)	22MB102P	Principles of Microbiology(P)	3	2	3	40	60	100
		Allied Course–I (AC)	22ABC101	General Biochemistry - I	4	3	3	25	75	100
		Allied Practical–I (AP)	22ABC102P	General Biochemistry – I - Practical	3	2	3	40	60	100
	IV	Value Education	22UGVED	Value Education	2	2	3	25	75	100
					30	**20**	-	-	-	**700**
II	I	Language Course–II (LC)– Tamil*/Other Languages ** #	22LC201	IdaikkalaIlakkiyamumputhinanum	6	3	3	25	75	100
	II	English Language Course–II (ELC)	21ELC201	Language through Literature –II (Poetry and communication skills)	6	3	3	25	75	100
	III	Core Course–II (CC)	22MB203	Microbial Physiology	6	5	3	25	75	100
		Core Practical – II (CP)	22MB204P	Microbial Physiology (P)	3	2	3	40	60	100
		Allied Course–II (AC)	22ABC203	General Biochemistry - II	4	3	3	25	75	100
		Allied Practical–II (AP)	22ABC204P	General Biochemistry – II - Practical	3	2	3	40	60	100
	IV	Environmental Studies	22UGCES	Environmental Studies	2	2	3	25	75	100
			Total		**30**	**20**	-	-	-	**700**
III	I	Language Course – III (LC)– Tamil*/Other Languages ** #	22LC301	KappiyamumNadagamum	6	3	3	25	75	100
	II	English Language Course-III (ELC)	22ELC301	Language Through Literature-III (Drama and Communication Skills)	6	3	3	25	75	100
	III	Core Course – III (CC)	23MB305	Introductory virology	6	5	3	25	75	100
		Core Practical– II (CP)	23MB306	Introductory virology (P)	3	2	3	40	60	100
		Allied Course–III (AC)	23AMB305	Biostatistics	4	3	3	25	75	100
		Allied Practical-III (AP)	23MB306P	Biostatistics (P)	3	2	3	40	60	100
	IV	Non Major Elective I-for those who studied Tamil under Part-I a) Basic Tamilforother language students		-	2	2	3	25	75	100

Sem	Part	Course	Course Code	Title of the Paper	Ins. Hours/ Week	Credit	Exam Hours	Marks		Total
								CIA	ESE	
		b) Special Tamil for those who studied Tamil upto +2 but opt for other languages in degreeprogramme								
			TOTAL		**30**	**20**	-	-	-	**700**
IV	I	Language Course –IV (LC) - Tamil*/Other Languages ** #	22LC401	PandaiyaIlakiyam	6	3	3	25	75	100
	II	English Language Course – IV (ELC)	22ELC401	Language through literature –IV (Short Stories and Communication Skills)	6	3	3	25	75	100
	III	Core Course – IV (CC)	23MB407	Immunology	5	5	3	25	75	100
		Core Practical– II (CP)	23MB408P	Immunology (P)	3	2	3	40	60	100
		Allied Course –IV (AC)	23AMB407	Bioinformatics and Computational Biology	3	3	3	25	75	100
		Allied Practical-IV (AP)	23AMB408P	Bioinformatics and Computational Biology (P)	3	2	3	40	60	100
	IV	Non Major Elective II-for those who studied Tamil under Part I a) Basic Tamil for other language students b) Special Tamil for those who studied Tamil upto +2 but opt for other languages in degree programme		-	2	2	3	25	75	100
		Skill Based Elective – I			2	2	3	25	75	100
			TOTAL		**30**	**22**	-	-	-	**800**
V	III	Core Course – V (CC)	R23MB509	Medical Microbiology	6	6	3	25	75	100
		Core Course – VI (CC)	R23MB510	Agricultural and Environmental Microbiology	6	6	3	25	75	100
		Core Course – VII (CC)	R23MB511	Molecular Biology and Microbial Genetics	6	6	3	25	75	100
		Core Practical– V (CP)	R23MB512P	Medical Microbiology, Agricultural and Environmental Microbiology & and Molecular Biology Microbial Genetics (P)	3	3	3	40	60	100
		Major Based Elective – I	R23MBEMB1	Research Methodology	3	3	3	25	75	100
	IV	Skill Based Elective – II	R23SBEMB2		2	2	3	25	75	100
		Skill Based Elective – III	R23SBEMB3		2	2	3	25	75	100
		Soft Skills Development	23UGSDC	Soft Skills Development	2	2	3	25	75	100
					30	**30**				**800**
VI	III	Core Course – VIII (CC)	R23MB613	Food and Fermentation Technology	6	6	3	25	75	100
		Core Course – IX (CC)	R23MB614	Microbial Biotechnology and Bioethics	6	6	3	25	75	100
		Core Practical– VI (CP)	R23MB615P	Food and Fermentation Technology, Microbial Biotechnology and Bioethics (P)	6	5	3	40	60	100
		Major Based Elective II	R23MBEMB2	Recombinant DNA Technology	5	3	3	25	75	100
		Core Course –X (CC)	R23MBPW	Project	6	6	3	25	75	100
	V	Extension Activities		Extension Activities	-	1	-	-	-	-
		Gender Studies	23UGGS	Gender Studies	1	1	3	25	75	100

Sem	Part	Course	Course Code	Title of the Paper	Ins. Hours/ Week	Credit	Exam Hours	Marks		Total
								CIA	ESE	
			TOTAL		30	28	-	-	-	600
				GRAND TOTAL	180	140	-	-	-	4300

NON MAJOR ELECTIVE (NME) OFFERED BY THE DEPARTMENT

Semester	Part	Course	Course Code	Title of the Paper
III	IV	NME-I	23NMEMB31	Vermiculture
IV		NME-II	23NMEMB42	Aquaculture

SKILL BASED ELECTIVE (SBE) OFFERED BY THE DEPARTMENT

Semester	Part	Course	Course Code	Title of the Paper
Applied Microbiology				
IV	IV	SBE-I	23SBEMB1	Diagnostic Microbiology
V		SBE-II	R23SBEMB2	Medical Laboratory Techniques
V		SBE-III	R23SBEMB3	Medical Coding

VALUE ADDED COURSE OFFERED BY THE DEPARTMENT

Semester	Nature of the Course	Course Name	Code
I	Value added Course	Traditional Mehandhi	22MBVA1
II		Homemade Herbal Medicine	22MBVA2

Summary of Curriculum Structure of UG Programmes (Science)

Sl. No.	Part	Types of the Courses	No. of Courses	No. of Credits	Marks
1.	I	Language Courses	4	12	400
2.	II	English Courses	4	12	400
3.	III	Core Courses	9	45	900
4.		Core Practical	6	24	600
5.		Allied Courses I & II	4	16	400
6.		Allied Practical	2	4	200
7.		Major Based Elective Courses	2	8	200
8.		Project	1	3	100
9.	IV	Non-Major Elective Courses	2	4	200
10.		Skill Based Elective Courses	2	4	200
11.		Soft Skills Development	1	2	100
12.		Value Education	1	2	100
13.		Environmental Studies	1	2	100
14.	V	Gender Studies	1	1	100
15.		Extension Activities	1	1	---
16.	**Total**		**41**	**140**	**4000**

DEPARTMENT OF MICROBIOLOGY

B.Sc., MICROBIOLOGY

(For the candidates admitted in the academic year 2022-2023)

Question Paper Pattern- (Theory)

Max time: 3 Hours **Max Marks: 75**

Section – A (10 x 2 = 20)
Answer all the questions
Answer in One or Two sentences each

1. } Unit I
2. }
3. } Unit II
4. }
5. } Unit III
6. }
7. } Unit IV
8. }
9. } Unit V
10. }

Section – A (10 x 2 = 20)
Answer all the questions
Answer in One or Two sentences each

11.a or b } Unit I
12.a or b } Unit II
13.a or b } Unit III
14.a or b } Unit IV
15.a or b } Unit V

Section – C (3 x10 = 30)
Answer any <u>THREE questions</u> in 1200 words

16. Unit I
17. Unit II
18. Unit III
19. Unit IV
20. Unit V

Semester: I- CC-I: Principles of Microbiology

Ins Hours / Week: 6 **Course Credit: 5** **Course Code: 22MB101**

UNIT- I: History and Development of Microbiology (18 Hours)

Definition and Scope of Microbiology- History and Milestones in Microbiology –Anton van Leeuwenhoek-FransescoRedi- John Needham-LazaroSpallanzani- Louis Pasteur- John Tyndall- Robert Koch- Joseph Lister- Germ theory of diseases- Koch postulates - Spontaneous generation –Biogenesis $_{Vs}$ Abiogenesis hypothesis. Classification of Microorganisms - Three Kingdom, Whittaker's Five Kingdom and Eight kingdom.

UNIT – II: Microscopic Techniques (18 Hours)

Microscopy – Principles and applications – Bright field, Dark field, Phase contrast, Fluorescence, Confocal, SEM & TEM – Specimen preparation for Electron microscopy.

UNIT- III: Bacterial Morphology (18 Hours)

Structure and organization of bacterial cell wall: Gram positive and Gram Negative bacterial cell wall. Staining – Principles – Types of staining – Simple, Differential (Gram, Spore, AFB), Capsule staining (Negative), Giemsa Staining, LPCB, KOH Mount

UNIT- IV: Sterilization and Disinfection (16 Hours)

Sterilization and Disinfection – Principles – Methods of Sterilization – Physical methods – Dry heat, Moist heat, Filtration (Membrane & HEPA), Radiation – Chemical Sterilization – Chemical agents and their Mode of action – Phenol coefficient test – Sterility testing.

UNIT –V:Culture and Media preparation (20 Hours)

Culture and Media preparation – Solid and Liquid – Types of Media – Synthetic and Complex, Enriched, Enrichment, Selective and Differential media, Natural components as media and Special Purpose Media (one example for each type). Anaerobic culture technique – Wright‟s tube, Roll tube, Mclntosh and filde‟s jar method. Pure culture techniques – Tube dilution, Pour, Spread and Streak plate**Total Lecture Hours - 90**

COURSE OUTCOMES

After the completion of the course, student should be able to,

1. Recall the milestones in Microbiology that leads to discoveries, inventions and contributions
2. Compare the different types of microscopes, functions and its applications
3. Differentiate the group of Microorganisms based on Staining techniques
4. Evaluate the various methods of sterilization and its uses
5. Analyze the preparation methods of media for cultivation of microbes
6. Summarize the methods of pure culture techniques

TEXT BOOKS

1. Ananthanarayan R. and Paniker's. 2013. Text book of Microbiology. University Press (9th edition), Hyderabad.
2. David, B.D., Delbecco,. R., Eisen, H.N and Ginsburg, H.S .1990. Microbiology 5th Edition. Harper & Row, New York.
3. Dubey H.C. 2009. Introduction to Fungi. Vikas publishing pvt. Ltd. New Delhi.
4. Dubey R.C and Maheswari D.K. 2010.A Text Book of Microbiology. S Chand, New Delhi.
5. Johri R.M, Snehlatha, SandhyaShrama.2010. A Textbook of Algae. Wisdom Press, New Delhi.
6. Kanika Sharma.2011. Textbook of Microbiology – Tools and Techniques. 1st edition, Ane Books Pvt. Ltd., New Delhi.
7. Nagamani, B.2018. General Microbiology and Microbial Physiology MarghamPublication,Chennai
8. Rajan S and Selvi Christy R.2015. Essentials of Microbiology, Anjanaa Book House, Chennai.

REFERENCE BOOK(S)

1. Alcamo I.E. 2011.Fundamentals of Microbiology, sixth edition, Addison wesley Longman, Inc. California.
2. Alexopoulos C.J, Mims C.W and Blackwell M. 2000.Introductory Mycology. 5th edition John Wiley and Sons. Chichester.
3. Atlas R.A and Bartha R.2000. Microbial Ecology. Fundamentals and Application, Benjamin Cummings, New York.

4. Cappuccino and Sherman.2012. Microbiology – A Laboratory Manual. 7thedition, Dorling Kindersley (India) Pvt. Ltd., New Delhi.
5. Madigan M.T, Martinko J.M, Dunlap P.V and Clark D.P. 2014. Brock Biology of Microorganisms. 14th edition. Pearson International Edition, London.
6. MoselioSchaechter and Joshua Leaderberg.2004. The Desk encyclopedia of Microbiology. Elseiver Academic press, California.
7. Pelczar M.J, Chan E.C.S and Kreig N.R. 2009.Microbiology, fifth edition. McGraw- Hill. Book Co. Singapore.
8. Prescott L.M, Harley J.P, and Klein D.A.2008. Microbiology (7thedition) McGraw Hill, New York.
9. Schlegel HG. 2008. General Microbiology, Cambridge University Press, U.K.
10. Stanier R.Y, Ingraham J.L, Wheelis M.L, and Painter P.R. 2005. General Microbiology. 5th edition. MacMillan, German
11. Tortora G.J, Funke B.R and Case C.L.2009. Microbiology: An Introduction. 9th Edition, Pearson Education, Singapore.
12. Wiley J.M, Sherwood L.M and Woolverton C.J. 2013 Prescott's Microbiology. 9th Edition. McGraw Hill International. New York.

E- LERANING RESOURCES

1. https://www.slideshare.net/SalmanAli83/historyintroduction-scope-of-microbiology-siws
2. https://www.slideshare.net/krish181958/types-of-microscope-70370614
3. 1.https://bio.libretexts.org/Bookshelves/Microbiology/Book%3A_Microbiology_(Kaiser)/Unit_1%3_Introduction_to_Microbiology_and_Prokaryotic_Cell_Anatomy/1%3A_Fundamentals_of_Micr obiology
4. http://www.wales.nhs.uk/sitesplus/888/agordogfen/149787
5. http://ecoursesonline.iasri.res.in/course/view.php?id=108
6. https://www.cliffsnotes.com/study-guides/biology/microbiology/microbial-cultivation-andgrowth/microbial-cultivation
7. https://www.swayam.gov.in

Semester: I- CP-I: Principles of Microbiology

Ins Hours / Week: 3 **Course Credit: 2** **Course Code:22MB102P**

- Laboratory Operating Procedures (LOPs)
- Basic Requirements of Laboratory –Microscopic slide, Coverslip, Pipette, Petri Dish, Glass Spreader, Inoculation Loop, Beaker, Measuring Cylinder, Squeeze bottle, Conical flask, Boiling tube, Balance, Incubator, Homogenizer, pH Meter, Colony Counter
- Cleaning of Glasswares
- Principle and Methods of sterilization - Moist heat - Autoclave, Pressure cooker, Dry heat – Bunsen burner, Hot air oven and Filtration method – Laminar flow Chamber, Membrane filtration technique.
- Microscopy - Compound microscope - Principle, Operation, Uses and Maintenance.
- Measurement of pH of medium - pH strips and pH meter
- Preparation of Liquid media - Peptone Water and Nutrient Broth
- Solid media - Basal- Nutrient agar & NA Slant
- Enumeration of bacteria– Serial dilution, Pour plate and Spread plate method
- Pure culture method- Streak plate technique (Simple, Continuous, Quadrant)
- Smear Preparation and Simple staining
- Differential Staining-Gram staining
- Staining of fungi- LPCB, KOH Mount
- Demonstration of motility by Hanging drop method
- List of Spotters:
    a. Bacteria*: E.coli, Bacillus, Psedomonous, Streptococcus*
    b. Algae*: Anabena, Nostoc, Spirulina,*
    c. Fungi : *Rhizopus, Saccharomyces, Penicillium, Aspergillus, Agaricus*

d. Protozoa : *Entamoebahistolytica*and*Plasmodium* spp

e. Virus*:* TMV, Rabies, HIV

TEXT BOOKS

1. Aneja, K.R., Jain ,P. and Aneja, R, 2008. Text book of Basic and Applied Microbiology New Age International, Chennai.
2. Experimental Procedures in Life Sciences S. Rajan, R. Selvi Christy, 2018. MJP Publications, Anjana book house Chennai.
3. Kannan N, 2002, Laboratory Manual in General Microbiology, Panima Publishers, New Delhi.
4. Sundararaj T, 2003, Microbiology Laboratory Manual, 2nd Edition, A. Sundararj No.5, I cross street, Thirumalai Nagar, Perungudi, Chennai.

REFERENCE BOOK(S)

1. Benson, Harold. J, 1995. Microbiological Applications: A laboratory Manual in general Microbiology, London: Irwin.
2. Cappuccino J.G. and N. Sherman 2002, Microbiology: A Laboratory Manual, Addison-Wesley, United States
3. Holt J.G, N.R. Krieg, 2000. Bergey's Manual of Determinative Bacteriology. Ninth edition, Lippincott Williams &Wilkin Publishers, United States.
4. Johnson, Ted R and Christine L. 1995. Case, Laboratory Experiments in Microbiology "California": Benjamin/ Cummings Publishing. Co. Inc. United States.

E –LEARNING RESOURCES

1. https://www.slideshare.net/brunobasil/laboratory-wares
2. https://www.slideshare.net/ADILRAZA15/microscopy-73595943
3. https://www.slideshare.net/saivivekkosaraju/sterilization-methods-32401134
4. https://www.slideshare.net/RESHMASOMAN3/staining-techniques
5. https://www.slideshare.net/praveg/fungus-part-i
6. https://www.slideshare.net/SnehalPatel98/method-of-isolation-of-pure-culture-82727765

Semester II- CC-II– Microbial Physiology

Ins Hours / Week: 6 **Course Credit: 5** **Course Code: 22MB203**

UNIT-I: Nutrition and growth of microorganisms (18 Hours)

Basic concept of Metabolism. Nutritional types of microorganisms, Nutritional requirements. Factors influencing the growth of microorganisms – temperature, pH, osmotic pressure, moisture, radiations and different chemicals.Physiology of growth – Significance of various phases of growth. Measurement of bacterial growth cell number byHaemocytometer. Growth measurements – batch, continuous and synchronous. Uptake of nutrients – passive and active transport.

UNIT- II: Bacterial enzymes (16 Hours)

Enzyme - Classification and nomenclature, Active site, apoenzyme, holoenzyme, prosthetic group, co enzymes, cofactors, isozymes properties and its functions, kinetics of enzyme action – MichaelisMenton equation for simple enzymes- Models for enzyme action- Lock and Key, Allosteric enzymes - properties, mechanism of action.

UNIT- III: Metabolism of Carbohydrates (20 Hours)

Metabolism of carbohydrates : Anabolism – photosynthesis – oxygenic – anoxygenic, synthesis of carbohydrate – catabolism of glucose – Embden Mayer – Hoff – Parnas pathway- Entner-Doudoroff Pathway- Glyoxylate Pathway- Pentose Phosphate Pathway, Kreb's cycle (TCA) - Calvin cycle and its regulation - Bioenergitics- Electron transport system and ATP production. Phosphorylation - Oxidative Phosphorylation, Substrate level Phosphorylation.

UNIT –IV: Metabolism of Protein (18 Hours)

Metabolism of protein – synthesis and degradation of amino acids – glycine, tyrosine, cysteine, serine, glutamine, synthesis of peptides and proteins – urea cycle.

UNIT-V: Metabolism of Lipids **(18 Hours)**

Anaerobic Respiration – Nitrate, Sulphate and Methane respiration – Fermentations – alcohol, mixed acid, lactic acid fermentation. Microbes in extreme environment-Extremophiles.Metabolism of lipids – biosynthesis of fatty acids and cholesterol – oxidation of fatty acids.

Total Lecture Hours -90

COURSE OUTCOME

After the completion of the course, student should be able to,

1. Understand the growth requirements of the microorganisms
2. Acquire knowledge about kinds of enzymes and their functions
3. Outline the microbial metabolic pathways of carbohydrate.
4. Summarize the metabolism of protein.
5. Compare and differentiate the aerobic and anaerobic respiration
6. Explain about the lipid metabolism

TEXT BOOKS

1. Albert G.Moat, John W. Foster, Michael P.Spector, 2006. Microbial Physiology, 4th Edition, John Wiley & Sons. United Kingdom.
2. Dubey CL. Parson WW and Vance DE, 1994. Principles of Biochemistry – Wim. C. Brown Publishers, Oxford, England.
3. Madigan MT, and Martinko JM, Brock, 2014. Biology of Microorganisms.14th Edition, Prentice Hall International Inc. United States.
4. MeenaKumari S. 2006. Microbial Physiology, 1st Edition, Lightning Source, USA.
5. Prescott. L.M., Harley. J.P., Klein. D.A. 1993. Microbiology. 2nd Edition. Wm. C. Brown publishers, Dubugue.
6. Reddy SR and Reddy SM., 2005. Microbial Physiology. Scientific Publishers, India.
7. Salle AJ, 1996. Fundamental principles of Bacteriology, 7th edition, Tata McGrawHill publishing company limited, New Delhi.

REFERENCE BOOK(S)

1. Doelle HW, 2005. Microbial Metabolism, Academic Press, United States.
2. Gerhart G, 1986. Bacterial Metabolism, Springer Verlag, Berlin, Germany.

3. Hall DC and Rao KK, 1999. Phototsynthesis, 6thEdition, Cambridge University Press, United Kingdom.
4. Jain,J.L, 2005. Fundamentals of Biochemistry 6 th edition S.Chand& Co, India.
5. Lansing M. Prescott JP, Harley and Donald A Klein, 2003. Microbiology, 5th edition, McGraw-Hill Company, New York.
6. Mathews CK and Holde KEV, 2003. Biochemistry – The Benjamin/Cummings Publishing company, Inc., New York.
7. Michael T. Madigan, John M Martinko, Brock's, 2006. Biology of Microorganisms, 11th Edition, Pearson Prentice Hall, United States.
8. Murray RK, Granner DK, Mayes PA and Rodwell VW, 2004. "Harper's Biochemistry, Appleton and Lange: New York, .
9. Murray RK, Granner MD, Mayes PA and Rodwell VW, 2000. Biochemistry – Prentice Hall International Inc., London.
10. Nelson David L, Albert L Lehninger and Michael M Cox, 2008. Lehninger. Principles of Biochemistry. Macmillanm, India.
11. Pelczar,M.J., Chan,E.C.S and Kraig, 1977. Microbiology. McGraw-Hill, India.
12. Stryer L, 1995. Biochemistry, 4th edition, W.H. Freeman and company, New York.
13. Talaro, K.P.,andTalaro A, 2004. Foundations of Microbiology 5th edition, McGrawHill, India.

E-LEARNING RESOURCES

1. https://courses.lumenlearning.com/boundless-microbiology/chapter/microbial-nutrition/
2. https://www.lamission.edu/lifesciences/lecturenote/mic20/Chap06Growth.pdf
3. https://www.tandfonline.com/doi/abs/10.3109/07388558409082583?journalCode=ibty20
4. https://wew.sciencedirect.com/topics/neuroscience/microbial-respiration
5. https://www.britannica.com/science/photosynthesis

Semester II- CP-II– Microbial Physiology

Ins Hours / Week: 3 **Course Credit: 2** **Course Code: 22MB204P**

- Determination of Growth – Growth curve and generation time.
- Effect of temperature on bacterial growth
- Effect of pH on bacterial growth
- Effect of Water Activity on bacterial growth
- Effect of salt concentration on bacterial growth
- Demonstration of alcoholic fermentation
- Physiology of various bacteria - Bio Chemical tests
    a. Acid and gas production
    b. Starch hydrolysis
    c. Lipid hydrolysis
    d. IMViC test
    a) Catalase test
    b) H_2S production
    c) Oxidase test
    d) Urease test
- **List of Spotters**
    a) Instruments: Spectrophotometer, Colony Counter,Water Bath, Anaerobic jar
    b) Reagents: Indole, Phenol red,Kovac's reagent, Methyl red, Bromothymol blue

TEXT BOOKS

1. Aneja, K.R., Jain ,P. and Aneja, R, 2008. Text book of Basic and Applied Microbiology New Age International, New Delhi.
2. Atlas R.M., A.E.Brown and L.C. Parks, Mosby, St. Louis , 1995, Laboratory Manual of Experimental Microbiology, St Louis Mosby, USA.

3. Sundararaj T, 2003. Microbiology Laboratory Manual, 2nd Edition, A. Sundaraj No.5, I cross street, Thirumalai Nagar, Perungudi, Chennai.

REFERENCE BOOK(S)

1. Cappuccino J.G. and N. Sherman, 2002. Microbiology: A Laboratory Manual, Addison-Wesley, United States.
2. Holt J.G, N.R.Krieg, 2000. Bergey's Manual of Determinative Bacteriology. Ninth edition, Lippincott Williams &Wilkin Publishers. USA.
3. John P Harley (2007), Microbiology Lab Manual McGraw-Hill Publication. 1st Edition, USA
4. Kannan N, 2002. Laboratory Manual in General Microbiology, Panima Publishers, New Delhi.

E- LEARNING RESOURCES

1. https://www.slideshare.net/martyynyyte/bacteria-enumeration
2. https://www.slideshare.net/merojeevan/bacterial-growth-and-ph-50744013
3. https://www.slideshare.net/kps_senthil/biochemical-test-of-bacteria

Semester: III- CC-III: Introductory Virology

Ins. Hours / Week: 6 **Course Credit: 5** **Course Code:23MB305**

UNIT-I: General Characteristics of Viruses (18 Hours)

History of virology, General Characteristics of Viruses, Concepts of origin of viruses, Symmetry of Viruses- helical, icosahedral and complex viruses. Ultra Structure of Viruses..Classification of viruses- LHT, Baltimore and ICTV system of classification.

UNIT-II: Techniques in Virology (18 Hours)

Techniques in Virology, Cultivation, Purification, Characterization, Assay Methods in Virology, quantification of viruses, Separation and characterization of viral components. **Recent trends in Virus Diagnostic Methods**

UNIT-III: Microbial viruses (18 Hours)

Bacteriophages- Life Cycle, Classification, Morphological groups, the virulent dsDNA phage, the therapy, (bacteriophage therapy),Phages as Vectors, Cyanophages, Mycoviruses (Mycophages), Rhizobiophages.

UNIT-IV: Animal Viruses (18 Hours)

Viruses of Animals and Human beings-General characteristics and multiplication of DNA containing viruses, Adenoviruses, Herpes viruses, Poxviruses. RNA containing viruses- Rhabdo viruses, SARS and H1N1- Influenza A virus, Corona Virus-Covid-19, Animal Virus- FMD Virus and Kuru, Sub viral agents - Viroids, Prions.Antiviral Agents. **Novel Vaccines and their importance in Pandemic**.

UNIT-V: Plant Viruses (15 Hours)

History, Classification and nomenclature of plant viruses, Transmission, Multiplication, symptoms and control of plant viral diseases - DNA containing virus - Cauliflower mosaic virus, RNA containing virus - Tobacco mosaic virus - Tomato spotted wilt, Potato leaf roll virus, **Regional specificViral Diseases and their control** - Rice tungro virus, Mosaic disease of sugarcane, Bunchy Top of Banana. Sub viral agents –Virusoids and Satellite virus.

Total Lecture Hours - 90

COURSE OUTCOME

After the successful completion of the course the students should be able to,

1. Acquire knowledge on the nature, origin and properties of viruses

2. Apply skills on basic plant diseases and its control
3. Understand the basic concept of characterization of viruses and viral components
4. Analyse various Viruses, Morphology and History of Virology
5. Attain skills in various diagnostic techniques of virology
6. Understand the lifecycle and multiplication patterns of Bacteriophages and Cyanophages.
7. Explain vaccine strategies and mechanism of antiviral drugs

TEXT BOOKS

1. Baijayanthimala Mishra. 2010. "Text Book of Virology" UBS Publishers and Distributers, Mumbai.
2. Harsh Mohan, 2018. "Text Book of Pathology" 8thEdition, JayPee Brothers Medical Publishers (P)Ltd., New Delhi.
3. Nicklin J Greame Cook and Killington R. 2003. Instant notes in Microbiology, 2nd Edition, Viva Books private Limited, New Delhi.
4. Rajan. S V.Kumaresan, 2015. "Virology" SarasPublications,Kanyakumari, Tamilnadu.
5. Trikha. A, Anshal Jain, 2021. "COVID-19- Comprehensive Review" Evangal Publications, India.
6. Vinoth Singh, 2010. Text Book of Virology,IDBCPublishers,New Delhi.

REFERENCE BOOK(S)

1. Alan J Cann, 2015. Principles of Molecular Virology.6th edition, Academic press, California.
2. Ann GiudiciFettner. 2004. The science of viruses.2nd edition, Quill, William Marrow, New York.
3. Anna Marie Skalka and Vincent Racaniello, 2010. "Principles of Virology" Wiely Publications, NewYork,USA.
4. Atlas Ronald M. 2013. Hand book of media for clinical and public health microbiology, Boca Raton, FL: CRC press, Francis.
5. Bernard N. 2013. Fields, "Fields Virology" sixth edition,Wolters Kluwer Publications, US Netherlands
6. Calum R. Wilson, 2012. "Applied Plant Virology" CABI Publications, United Kingdom.
7. Dimmock NJ, Easton AJ and Leppard K. 2007. Introduction to Modern Virology, (Oxford: Blackwell Publishers, London.
8. Morag C Timbury. 1997. Medical virology.11th edition. Churchill Livingston, London.
9. Peter M. Howley, David M. Knipe, Sean Whelan, 2020. "Fields Virology: Emerging Viruses"7thEdition ,Wolters Kluwer Publications, USA .
10. R C Matthews, 2012. "Fundamentals of Plant Virology" Academic Press , London
11. Robert I Krasner. 2002. The Microbial challenge: Human Microbe Interaction, American Society for Microbiology, 2nd edition, Washington.

12. Roger Hull, 2001. “Plant Virology” Elsevier Publications, USA.
13. Roger Hull. Mathews’, 2005.Plant Virology, 4th edition, Academic press- A Harcourt Science and technology company, United States.
14. S.J. Flint, L.W. Enquist, V.R. Racaniello, and A.M. Skalka, 2004. Principles of Virology: Molecular Biology, Pathogenesis and Control of Animal Viruses 2nd edition, ASM Press, Washington, DC.
15. Topley and Wilson’s, 2005. Principles of bacteriology, Virology and immunity.11th edition, vol 4, Edward Arnold, London.

E -RESOURCES

1. https://www.slideshare.net/raghunathp/general-properties-of-viruses
2. https://www.slideshare.net/MicrobeswithMorgan/virology-2014
3. https://www.slideshare.net/AfraFathima5/lytic-lysogenic-cycle
4. https://www.slideshare.net/doctorrao/viral-infections-in-humans-basics
5. https://www.slideshare.net/utmang/plant-viruses

Semester: III- CP-III: Introductory Virology

Ins. Hours / Week: 3 **Course Credit: 2** **Course Code:23MB306P**

1. Isolation of Bacteriophage from sewage.
2. Demonstration of mechanical transfer of viruses in plants
3. Sap, aphid and graft transmission of plant viruses.
4. Demonstration of cultivation of viruses by embryonated egg method.
5. Detection of viral antibodies in given sample using agglutination assay.
6. Study of virus infected plant material
7. Observation of selected bacterial, plant and animal viruses – Pox Viruses, Rice Tungro Viruses, Cyanophages and Mycoviruses
8. Determination of stability of plant virus in cell sap- TIP, DEP, LIV.
9. Determination of chlorophylls in healthy and virus infected leaves.

TEXT BOOKS

1. Atlas Ronald M. 2013. Hand book of media for clinical and public health microbiology, Boca Raton, FL: CRC press, Francis.
2. Goldman, Emanuel and Lorrence H Green, 2009. Practical Handbook of Microbiology, Boca Raton, FL: CRC press, Francis.
3. Varsha Sharma, Dr. 2015. " Systematic Veterinary Virology- A Practical Manual" Sathis serial Publishing, New Delhi, India.

REFERENCE BOOK(S)

1. Florence G Burleson, Thomas M Chambers and Danny L Wiedbrauk. 1992. Virology: A laboratory Manual. Academic Press, UK.
2. Haaheim, R. Pattison, R, R J Whitley, 1998."A Practical guide to Clinical Virology" Second Edition Jhon Wiley Incl Publications, New York, United States.
3. James G Cappuccino. 1996. Microbiology. The Benjamin / Cummings Pub. Co. California.
4. Jeanne Dijkstra , C.P.Jager,1999. "Practical Plant Virology" Springer Lab Manuals, US.

5. Levins.on W, Jawetz E, 2001. Medical Microbiology and Immunology, Lange publication.
6. Li Zongxi, Zheng Li, FengHui, Cao Yan, Li Cheng and Pang Wei.2006. Immunology Methods for Medical Students.Department of Immunology, China Medical University.
7. Morag C Timbury. 1994. Medical Virology.10th edition, Churchill Livingston.
8. B.W.J. Mahy and H.O. Kangro. Virology Methods Manual, (1996). Academic Press
9. D.R. Harper. Virology Lab Fax. (1993). Molecular Virology: A Practical Approach. (1993) Oxford University Press. Bioscientific Publication. Academic Press.

E-LEARNING RESOURCES

1. https://www.slideshare.net › doctorrao › bacteriophages
2. https://www.slideshare.net/doctorrao/agglutination-tests-and-immunoassys
3. https://www.slideshare.net/vivekaiden/cultivation-of-virus-120166509

Semester: III- AC-III: Biostatistics

Ins. Hours / Week: 4 **Course Credit: 3** **Course Code:23AMB305**

UNIT-I: Introduction to biostatistics (10 Hours)

Introduction to biostatistics – Definition, statistical methods, biological measurement, kinds of biological data, functions of statistics and limitation of statistics.

UNIT-II: Collection and sampling of data (14 Hours)

Collection of data, sampling and sampling design, classification and tabulation, Diagrammatic and graphical representation of data; bar diagrams, pie diagrams and curves frequency distributions and cumulative frequency distributions; histogram, frequency polygon, stem and leaf chart and Ogives.

UNIT- III: Skewness and Kurtosis (14 Hours)

Skewness, Kurtosis, Moments, Meaning, test of skewness, characteristics of dispersion and skewness.Measures of skewness, objectives.Karl Pearson's Coefficient of skewness, Bowley's coefficient of skewness.

UNIT- IV: Measures of central tendency (9 Hours)

Measures of central tendency, mean, median, mode, geometric mean, harmonic mean.

UNIT-V: Measures of dispersion (13 Hours)

Measures of dispersion and variability - changes. Deviations–Mean Deviation, Standard Deviation, **ANOVA- One way, Two way** ,Coefficient of variation, Loren Zen's curve. Sampling Distributions-chi-square distribution; F and t statistics, Chi-square test for goodness of fit.

Total Lecture Hours - 60

COURSE OUTCOME

After the completion of the course the students should able to,

1. Understand knowledge about the basics of Biostatistics.
2. Acquire skills about statistical tools and techniques to analyze their experimental data
3. Analyze the experimental data using statistics
4. Attain the concept of a random, representative sample from a population.

5. State and design their experiments, predict, interpret and conclude on the basis of statistical analysis.
6. Summarize and interpret measures of association for continuous and categorical data.

TEXT BOOKS

1. Arora, P. N and Malhan P. K. 2008. Biostatistics. Himalaya Publishing house.
2. Dutta, N. K. 2004. Fundamentals of Biostatistics, Kanishka Publishers.
3. Gurumani N. 2005. An Introduction to Biostatistics, MJP Publishers, Chennai.
4. IndranilSaha and Bobby Paul. 2020. Essentials of Biostatistics & Research Methodology (3rd Ed.). Academic Publishers, Kolkata.
5. Kulkarni, A.P. 2020. Basics of Biostatistics (2nd Ed.). CBS Publications & Distributions Pri. Ltd., New Delhi.
6. Masthan, K.M.K. (Ed.). 2017. Guide to research methodology and Biostatistics. CBS Publications & Distributions Pri. Ltd., New Delhi.
7. Pranab Kumar Banerjee, 2014. Introduction to Biostatistics. 4thedition, S. Chand and company Ltd. Karnataka.
8. Roland Ennos. 2011. Statistical and Data Handling Skills in Biology, Pearson, New York.
9. Rosner. 2011. Fundamentals of Biostatistics, 7th ed. Brooks/Cole, Boston, MA, United States
10. SundarRao and Richard. 2012. Introduction to Biostatistics and Research Methods, 5thedition, PHI Learning Pvt. Ltd. New Delhi.
11. Shyam Sunder Deepti, 2019. Fundamentals of Epidemiology and biostatistics. CBS Publications & Distributions Pri. Ltd., New Delhi.
12. Stanton A. Glantz, 2001. Primer of Biostatistics McGraw-Hill, New York.
13. Wayne W. Daniel, 2006. Biostatistics- A foundation for analysis in the Health Sciences. 7th edition. Wiley India publication, New Delhi.

REFERENCE BOOK(S)

1. Balaji, K. Raghavaiaha A.V.S. and Jayaveera, K.N. 2020. Biostatistics, Wiley Publication, Hoboken, New Jersey, United States
2. Bernard Rosner. 2010. Fundamentals of Biostatistics,7thedition, Cengage Learning, USA.

3. Beth Dawson Robert G. Trapp Beth Dawson Robert Trapp, 2004. Basic and Clinical Biostatistics (LANGE Basic Science), McGraw-Hill, New York.
4. MaicelloPaganoandKimberleeGauvreau.2000. 2nd edition Principles of Biostatistics, Duxbury Press, USA.
5. Zar, J.H. (1996). Biostatistical analysis. Prentice Hall, Upper saddle River, New Jersey, USA

E-RESOURCES

1. https://onlinecourses.swayam2.ac.in/cec20_bt23/preview
2. https://faculty.franklin.uga.edu/dhall/sites/faculty.franklin.uga.edu.dhall/files/lec1.pdf
3. https://www.slideshare.net/rajkumarteotia/skewness-40437601
4. https://www.slideshare.net/AmbaPant/introduction-to-kurtosis
5. https://www.slideshare.net/BirinderSinghGulati/measures-of-dispersion-111028342

Semester: III- AP-III: Biostatistics

Ins. Hours / Week: 3 **Course Credit: 2** **Course Code:23AMB306P**

1. Collection of data, sampling designs, tabulation and graphic representation using biological materials.
2. To find Mean, Mode, Median, Co-efficient of variance using biological materials.
3. Test of significance‘t’ test, ‘chi’square, standard error and standard deviation.
4. **Introduction to Statistical Computing in SPSS**
5. **Test of normality, One Sample t test, One sample Wilcoxon test, independent samples t test, Mann Whitney U test.**
6. **Repeated Measures ANOVA, Friedman Test**

TEXT BOOKS

1. Arora PN and Malhan PK. 2008. Biostatistics. Himalaya Publishing house, Bengaluru.
2. Gurumani N. 2005 . An Introduction to Biostatistics, MJP Publishers, Chennai.
3. IndranilSaha and Bobby Paul. 2020. Essentials of Biostatistics & Research Methodology (3rd Ed.). Academic Publishers, Kolkata.
4. Maicello Pagano, KimberleeGauvreau, 2000. Principles of Biostatistics, 2nd edition, Duxbury Press.
5. Nimai C. Luwang, Mukhopadhyay, B.B. 2016. Manual of Biostatistics & Epidemiology practical’s. Current Books International, Kolkata.
6. Roland Ennos. 2011. Statistical and Data Handling Skills in Biology, 3rd edition. Pearson, New York.
7. Stanton A. Glantz, 2001. Primer of Biostatistics. McGraw-Hill, New York.
8. Sundaram, K.R. 2010. Medical Statistics-Principles & Methods, BI Publications, New Delhi

REFERENCE BOOK(S)

1. Daniel, W. W. (2007). Biostatistics- A Foundation for Analysis in the HealthSciences, Wiley, New Delhi.
2. Der, G. and Everitt, B.S.(2006). Statistical Analysis of Medical Data Using SAS, CRC Press, London.

3. Preston S.H., Heuveline P. &Guillot M. Demography-Measuring and Modelling Population Processes, Wiley, New Delhi.
4. Rohatgi, V.K. &Saleh, A.K. Md. (2001). An Introduction to Probability and Statistics, John Wiley & Sons. New Jersey.
5. SundarRao and Richard. 2012. Introduction to Biostatistics and Research Methods, 5th edition, PHI Learning Pvt. Ltd. New Delhi.
6. Wayne W. Daniel, 2006. Biostatistics- A foundation for analysis in the Health Sciences. 7th edition. Wiley India publication, New Delhi.

E- LEARNING RESOURCES

1. https://onlinecourses.swayam2.ac.in/cec20_bt23/preview
2. https://faculty.franklin.uga.edu/dhall/sites/faculty.franklin.uga.edu.dhall/files/lec1.pdf
3. https://www.slideshare.net/jibansingh88/standard-deviation-65544813
4. https://www.slideshare.net/RamakanthGadepalli/chi-squared-test-52755609
5. https://www.slideshare.net/costarch/students-t-test-28408399
6. http://www.sus.ac.in/uploads/bos/Syllabus%202020/MSc%20Part%20I%20Biostatistics%2015072020.pdf

Semester: III- NME-I: Vermiculture

Ins. Hours / Week: 2 **Course Credit: 2** **Course Code:23NMEMB31**

UNIT – I: Vermi-Technology (6 Hours)

Scope ofvermiculture and vermicomposting – difference between vermiculture and vermicomposting. Vermi-tech practices in India.

UNIT – II: Earthworm Diversity (6 Hours)

Ecological groups of earthworms, anatomical features of earthworm, biology of composting earthworms – Eoisena*foeitida*, *Eudriluslugeniae*.

UNIT – III: Vermi culture techniques (7 Hours)

Vermiculture process – site selection -collection of species mono and poly culture - Essential parameters for vermiculture–bedding. Methods of harvesting worms- general manual methods, self-harvesting and mechanical method , vermin wash and applications, Natural enemies of earthworms, pests, parasites and pathogen

UNIT – IV: Vermicomposting (5 Hours)

Types, small and large scale pit method, heap method**.** Nutritive value of vermicompost, storing and packing - Applications of vermicomposting in agricultural and horticultural practices - nationalized bank, NABARD support for vermiculture.

UNIT – V Economic importance of Earthworms

In sustainable agriculture, organic farming, earthworm activities, soil fertility & texture, soil aeration, water impercolation, decomposition & moisture, bait & food.

Total Lecture Hours -30

COURSE OUTCOME

After completion of the course the students should able to,

1. Gain knowledge about the characteristics and role of earthworm in sustainable agriculture.
2. Impart knowledge on the significance of earthworms.
3. Understand the importance of waste degradation by eco-friendly method.
4. Apply the significance of Vermicomposting method
5. Expertise in Vermiculture Techniques Creating Opportunities for self employment

TEXT BOOKS

1. A hand book of Organic Farming, Agrobios, Jodhpur, India
2. Aravind Kumar, 2005.Verms &Vermitechnology, A.P.H. Publishing Corporation, New Delhi.
3. Arun K. Sharma. (2002). Vermiculture and Vermicomposting. Kalyani Publishers, New Delhi.
4. Bhatnagar& Patla,2007. Earthworm vermiculture and vermin-composting, Kalyani Publishers, New Delhi.
5. Gupta P.K. (2008). Vermicomposting for Sustainable Agriculture. Agrobios. India
6. Jordan & Verma,2009. Invertebrate Zoology , Chand & Company Ltd.
7. Sultan Ahmed Ismail, 2005. The Earthworm Book, Second Revised Edition. Other India Press, Goa, India.

REFERENCE BOOK(S)

1. Edwards, C.A J. R. Lofty 1977. *Biology of earthworms London : Chapman and Hall*, Wiley, New York.
2. Edwards, C.A., Arancon, N.Q. & Sherman, R. (eds) 2011. Vermiculture Technology: Earthworms, Organic Wastes, and Environmental Management. CRC Press, Boca Raton, Florida.
3. Edwards, C.A & P.J Bohlen, 1996. Biology and ecology of earthworms III Edn. Chapman & Hall N.Y.U.S.A.
4. Edwards, C.A & J.R Lofty Vermicoloogy – The Biology of earthworm, 1997 Chapman & Hall Publications N.Y.U.S.A.
5. Lee, K.E. (1985) "Earthworms: Their ecology and Relationship with Soils and Land Use", AcademicPress, Sydney
6. Satchel, J.E. (1983). "Earthworm Ecology", Chapman Hall, London

E-RESOURCES

1. https://www.slideshare.net/BirenDaftary88/vermiculture-44813996
2. https://www.earthwormsoc.org.uk/earthworm-ecology
3. https://www.slideshare.net/krishnaSethi1/vermicomposting-118274903
4. https://www.slideshare.net/sudharajput/vermicomposting-47669414
5. https://www.slideshare.net/hrfchennai/tamil-nadu-government-welfare-schemes-2017-80290561

Semester: IV- CC-IV: Immunology

Ins. Hours / Week: 5 **Course Credit: 5** **Course Code:23MB407**

UNIT-I Immunity and their types (15 Hours)

Introduction-History of immunology- Immunohematology – Blood groups, Blood transfusion, Rh- *Erythroblastosisfaetalis*–immunity–types of immunity– innate and acquired immunity.

UNIT-II: Lymphoid organ and cells of the immune system (15 Hours)

Immune systems – Anatomy of lymphoid organ-Primary and Secondary Lymphoid organs- Cells of the immune system- Stem cell, Lymphocytes, Macrophage, Leukocyte, Antigen Presenting Cell, Mast cell and Platelets.Humoral and cell mediated immune response – activation and function, Complement-Components, mode of activation, classical and alternate pathway and its functions and MHC- structure & functions.

UNIT-III: Components of Immune system (15 Hours)

Antigen-Types, properties, Antigenic drift, antigenic shift, haptens - adjuvants-vaccines-types-toxoids. Immunoglobulins.-Properties, Structure, types and **functions.** Theories of antibody formation- side chain, **direct template theory, indirect template theory, natural selection theory**, clonal selection theory, **two genes for one polypeptide chain theory and class switch hypothesis.**

UNIT-IV: Immunological Techniques (15 Hours)

Antigen – antibody reaction- Production of antisera- *in-vitro* methods- Agglutination – Precipitation, Complement fixation, Immunofluorescence, ELISA, RIA, *in-vivo* methods- Skin test, immunodeficiency disorder – AIDS.

UNIT-V: Hypersensitivity, Autoimmune, Transplantation and Tumor immunology (15 Hours)

Hypersensitivity – definition and classification – type I, II, III, IV and V mechanism involved diagnosis and treatment. Lymphokines and Cytokines. Autoimmunity Concept, mechanism & autoimmune diseases – Classification of autoimmune diseases – **autoimmune haemolyticanaemia, thyrotoxicosis, Addison disease, myasthenia gravis,** Grave's diseases, serum sickness and Rheumatoid arthritis. Transplantation – types, genetics of transplantation –

graft versus host reactions.Tumor immunology – immune surveillance, tumor antigens, immune response to tumors, immunotherapy of tumors.

Total Lecture Hours-75

COURSE OUTCOME

After the completion of the course the students should able to,

1. Understand the knowledge about immune system and the functions
2. State the art of immunological techniques
3. Analyze the antigen and their types
4. Acquire skills about immunological reactions, and they acquire the knowledge to be considered in the clinical laboratories
5. Impact on hypersensitivity and autoimmune diseases
6. Summarize about immune transplantation and tumour immunology

TEXT BOOKS

1. Gupta S.K, 2017.Essentials of Immunology, Arya Publications, New Delhi.
2. Kuby, T. 1994. Immunology, W.H. Freeman & company, New York.
3. Nandini.S. 1994 – Immunology Introductory text book. New age Int, (P) Ltd. Publication, New Delhi.
4. ShyamasreeGhosh, 2017. Immunology and Immunotechnology, Books and Allied (P) Ltd. Kolkata.
5. SudhaGangal and ShubhangiSontakke, 2013. Textbook of Basic and clinical Immunology, Universities Press, (India) Pvt. Ltd, Hyderabad, India.

REFERENCE BOOK(S)

1. Charles A Janeway, Jr. Paul Travers, Mark Walport and Donald Capra J 1999 Immunobiology – The immune system in health and disease, 4thedition, Current Biology Publications, London.
2. Goldsby RA, Kindt TK, Osborne BA and Kuby J. 2007. Immunology, 5thedition, W.H. Freeman and Company, New York.
3. Ivan Roitt, Jonathan Brostoff and David Male 2012. Immunology, 8thedition, Elsevier science Ltd., New York.
4. Kuby J.2008. Immunology, 7thedition WH Freeman and company, New York.
5. Nicole M. Valanzuela and Elaine F Reed, 2013. Antibodies in transplantation: the effects

of HLA and non-HLA apntibody binding and mechanism of injury**.** In: Transplantation immunology: Methods and protocols. (Eds: Andrea A. Zachary, Mary S. Leffell), Humana Press, New York.

6. PatricksSandLarkinMJ.1995. Immunological and molecular aspects of bacterial virulence. John wiley and sons, England.
7. Playfair JHL.1996. Immunologyataglance.6thedition, Blackwell Science, London.
8. Richard Coico, Geoffrey Sunshine, Eli Benjamini. 2003. Immunology – A Short Course.5th Edition. Wiley-Liss, New York.
9. SudhaGangal and ShubhangiSontakke, 2013. Textbook of Basic and clinical Immunology, Universities Press, (India) Pvt. Ltd, Hyderabad, India.
10. Tak W Mak and Mary Saunders, 2014. Primer to the Immune Response. 2nd edition from *TakMak*, *Mary Saunders*, Bradley Jett. New York.
11. Tak W Mak and Mary Saunders. 2014. Primer to the Immune Response. 2ndedition, Bradley Jett. New York.
12. William E Paul. 2012. Fundamental Immunology. 7th revised edition, Raven press, New York.

E-RESOURCES

1. https://www.researchgate.net/publication/313343876_Immunology_Lecture_ Notes_Immune_responses
2. https://hmmcollege.ac.in/uploads/3._Immunology.pdf
3. https://www.austincc.edu/sziser/Biol%202404/2404LecNotes/2404LNExIV/k .Immunity.pdf
4. https://mlinjawi.kau.edu.sa/Files/0001735/files/20284_LECTURE_6_TRAN SPLANTATION_AND%20_REJECTION_Part1.pdf
5. http://studymaterial.unipune.ac.in:8080/jspui/bitstream/123456789/5824/1/Le cture%20%232%20Hypersensitive%20Reactions-converted.pdf

Ins. Hours / Week: 3 **Course Credit: 2** **Course Code:23MB408P**

- Separation of serum from blood
- ABO Blood grouping
- Rh typing
- WBC Count
- RBC Count
- WIDAL **tube and slide** Test
- RPR
- CRP
- ASO
- Visit to blood bank
- Double immunodiffusion
- Demonstration of ELISA

TEXT BOOKS

1. Benjamini, E., Sunshine, G., and Leskowitz, S. 1996. Immunology: A Short Course. WileyLiss, New York.

REFERENCE BOOK (S)

1. Atlas Ronald M. 2013. Hand book of media for clinical and public health microbiology, Boca Raton, FL:CRC press, Francis.
2. Fleming, Diane O, Debralong and Hunt. 2006. Biological safety: Principles and practices,4thedition, ASM press, Washington, DC.
3. Kaufmann, S.H.E., Sher, A., and Ahmed, R. (eds.) 2002. Immunology of Infectious Diseases. ASM Press, Washington.
4. Li Zongxi, Zheng Li, FengHui, Cao Yan, Li Cheng and Pang Wei. Immunology Methods for Medical Students. Department of Immunology, China medical university.2006.
5. O'Gorman, Manrice RG and Albert David Donnenberg. 2008. Hand book of human Immunology. Boca Raton, FL: CRC press, Francis.
6. Richard A Glodsby, Thosmas J Kindt and Barbera A Osborne. Kuby 2000. Immunology (4thedition).W.H. Freeman and Company, New York.

7. Roitt I Brostoff J and Male D. 1985. Immunological Tests. In:Immunology. Toronto: The C.V. Mosby Company, United States. .

E-LEARNING RESOURCES

1. https://youtu.be/0f9p9JX4qJk
2. https://youtu.be/12Vr2DKD8qs
3. https://youtu.be/J8vwLQgVuQk
4. https://youtu.be/hmK7yYr2T54
5. https://youtu.be/-jKzLLHjRfs

SENGAMALA THAYAAR EDUCATIONAL TRUST WOMEN'S COLLEGE

(AUTONOMOUS)

SUNDARAKKOTTAI, MANNARGUDI–614016.

(For the Candidates admitted in the academic year 2022-2023)

DEPARTMENT OF MICROBIOLOGY

B.Sc., MICROBIOLOGY

Semester: IV- AC-IV: Bioinformatics and Computational Biology

Ins. Hours / Week: 3 **Course Credit: 3** **Course Code: 23AMB407**

UNIT-I: Introduction to Computers (9 Hours)

Computers – historic evolution of computers, Characteristics of Computers, classification of computers, micro computer, mini computer, main frames, super computers, personal computers, desktop, laptops, Palmtop, tablet PC, I-P-O Cycle. Components of Computers-Hardware and Software-Operating Systems.

UNIT-II: Introduction to Internet (9 Hours)

Internet –History of Internet- Computer networks- www, websites, URL, browsers, search engines. Types of Networks – LAN, WAN & MAN, Intranet–Wireless communication – Internet services, Uses of internet.

UNIT-III: Introduction to bioinformatics (9 Hours)

Introduction to bioinformatics – history and its development – Scope and applications of bioinformatics.Functional Genomics, Comparative genomics. Phylogenetic Analysis.

UNIT-IV: Biological databases (9 Hours)

Biological database – NCBI – Gen Bank, EMBL, DDBJ. Sequence Alignment-Pair wise (BLAST and FASTA) and Multiple sequence alignment (Clustal W).

UNIT-V: Introduction to Proteomics (9 Hours)

Structure of Protein, Classification – PDB, Swiss – PROT, SCOP, CATH. Protein visualization tools-RASMOL, Swiss PDB viewer. Methods used in protein structure prediction, PROSITE, DNA Micro array (DNA chip).

Total Lecture Hours- 45

COURSE OUTCOME

After the completion of the course the students should be able to,

1. Understand about the basic concepts of Bioinformatics and its significance in Biological data analysis.
2. Acquire skills about the computer and internet principles and motivated to analyze the biological information using computer and internet
3. Predict the knowledge about application of information technology
4. Analyze the biological data bases and technique of accessing it
5. Summarize the biological macromolecular structures and structure prediction methods.

TEXT BOOKS

1. Baxevanis A.D and B.F. Francis Ouellette (Eds.) Wiley – Inter science, 2001. Bioinformatics - A Practical Guide to the Analysis of Genes and ProteIns..
2. Behrouz A. Forouzan and FirouzMosharraf. 2017. Computer Networks - A top down approach. McGraw Hill (India) Pri. Ltd., Uttar Pradesh.
3. Bittu Kumar. 2017. Mastering Ms Office. V&S Publishers, New Delhi.
4. Higginns. D and W. Taylor (Eds.) 2000. Bioinformatics. Sequence, Structure and databanks- A Practical Approach by Oxford University Press, London.
5. Prakash S Lohar. 2009. Bioinformatics, MJP Publisher, Chennai.
6. Rastogi, S.C., NamitaMendiratta, ParagRastogi. 2019. Bioinformatics Concepts, Skills & Applications (2nd Ed.). CBS Publications & Distributions Pri. Ltd., New Delhi.
7. Rastogi. S. C, N. Mendiratta and P. Rastogi, 2008. Bioinformatics- Methods and Applications Genomics, Proteomics and Drug Discovery 3rd edition. PHI Learning Publishers, New Delhi.
8. SrinivasaVallabhan SV. 2006. Computer Applications in Business, 3rd edition, Sultan Chand and sons, Educational publishers. New Delhi.

REFERENCE BOOK(S)

1. Andreas D. Baxevanis, Gary D. Bader, David S. Wishart, 2020, Bioinformatics: A Practical Guide to the Analysis of Genes and ProteIns. 4th Edition, Wiley Publishing company, United States
2. Bryan Bergeron, 2003. Bioinformatics computing First Indian Edition, Prentice Hall.
3. Chavali LN. 2009. Bioinformatics and Bio programming in C, Universities Press, (India)Pvt. Ltd, Hyderabad, India.
4. Claverie J-M and C. Notredame, 2003. Bioinformatics for Dummies, Wiley Publishing, Inc.
5. David W. Mount, Cold Bioinformatics, 2001. Sequence and Genome Analysis, Spring Harbor Laboratory Press, New York.
6. DesHiggIns.and Willie Taylor, 2002. Bioinformatics: Sequence, Structure and data banks. Oxford University Press, London
7. Harisha, S. 2019. Fundamentals of Bioinformatics. Dream tech Press, New Delhi.
8. James F. Kurose, Keith W. Ross. 2017. Computer Networking. Pearson Publication, New York.

9. Ruchi Singh and Richa Sharma. 2010. Bioinformatics: Basics, algorithms and applications, Universities Press,(India) Pvt. Ltd, Hyderabad, India.
10. ZhumurGhosh and Bibekan and Mallick, 2008. Bioinformatics: Principles and Applications. Oxford University Press, London.

E- LEARNING RESOURCES

1. http://en.m.wikipedia.org/wiki/Nucleotidesequencedatabase
2. www.bioinformatics.org>wiki>sequencealignment
3. http://en.m.wikipedia.org/wiki/Multiplesequencealignment
4. blast.ncbi.nlm.nih.gov
5. http://en.m.wikipedia.org/wiki/Proteomics
6. http://en.m.wikipedia.org>wiki>SwissPDBviewer
7. http://en.m.wikipedia.org>wiki>Rasmol
8. www.rasmol.org

SENGAMALA THAYAAR EDUCATIONAL TRUST WOMEN'S COLLEGE

(AUTONOMOUS)

SUNDARAKKOTTAI, MANNARGUDI–614016.

(For the Candidates admitted in the academic year 2022-2023)

DEPARTMENT OF MICROBIOLOGY

B.Sc., MICROBIOLOGY

Semester: IV- AP-IV: Bioinformatics and Computational Biology

Ins. Hours / Week: 3 **Course Credit: 2** **Course Code: 23AMB408P**

1. Applications of computers in biology using MS-Office - A) MS-Word B) Excel C) Power Point
2. Study of Nucleic acid sequence databanks – Gen Bank, EMBL nucleotide sequence data bank, DDBJ.
3. Study of Protein Structure and Classification databases – PDB, SCOP and CATH.
4. Multiple alignment – Clustal W.
5. Evaluation of protein structure by RASMOL.
6. Open access bibliographic resources and literature databases a. PubMed
7. Bioinformatics Resources at the species level a. ICTV Database

TEXT BOOKS

1. Baxevanis A.D and B.F. Francis Ouellette (Eds.) Wiley-Interscience, 2001. Bioinformatics - A Practical Guide to the Analysis of Genes and Proteins. Wiley Inter science, New York.
2. Behrouz A. Forouzan and FirouzMosharraf. 2017. Computer Networks - A top down approach. McGraw Hill (India) Pri. Ltd., Uttar Pradesh
3. Bittu Kumar. 2017. Mastering Ms Office. V&S Publishers, New Delhi.
4. Higginns. D and W. Taylor (Eds.) 2000. Bioinformatics. Sequence, Structure and data banks- A Practical Approach by Oxford University Press, London.
5. Prakash S Lohar. 2009. Bioinformatics, MJP Publisher, Chennai.
6. Rastogi. S. C, N. Mendiratta and P. Rastogi, 2008. Bioinformatics- Methods and Applications Genomics, Proteomics and Drug Discovery 3rd edition. PHI Publishers, New Delhi.
7. SrinivasaVallabhan S V. 2006. ComputerApplicationsinBusiness,3rdedition, Sultan Chandand sons, Educational publishers. New Delhi.

REFERENCE BOOK(S)

1. Andreas D. Baxevanis, Gary D. Bader, David S. Wishart, 2020, Bioinformatics: A Practical Guide to the Analysis of Genes and ProteIns. 4th Edition, Wiley Publishing company, United States
2. Attwood T.K. and D.J. Parry-Smith, 2001. Introduction to Bioinformatics, Pearson Education Asia.

3. ChavaliL. N.2009.Bioinformatics and Bio programming in C, Universities Press,(India)Pvt. Ltd, Hyderabad, India.
4. Claverie J-M and C. Notredame, 2003. Bioinformatics for Dummies, Wiley Publishing, Inc.
5. David W. Mount, Cold Bioinformatics, 2001. Sequence and Genome Analysis, Spring Harbor Laboratory Press, New York.
6. ZhumurGhosh and Bibekan and Mallick. 2008. Bioinformatics: Principles and Applications. Oxford University Press, London.

E-LEARNING RESOURCES

1. http://en.m.wikipedia.org/wiki/Nucleotidesequencedatabase
2. http://en.m.wikipedia.org/wiki/Multiplesequencealignment
3. http://en.m.wikipedia.org>wiki>SwissPDBviewer
4. www.bioinformatics.org>wiki>sequencealignment
5. blast.ncbi.nlm.nih.gov

SENGAMALA THAYAAR EDUCATIONAL TRUST WOMEN'S COLLEGE

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(For the Candidates admitted in the academic year 2022-2023)

DEPARTMENT OF MICROBIOLOGY

B.Sc., MICROBIOLOGY

Semester: IV- NME-II: Aquaculture

Ins. Hours / Week: 2 **Course Credit: 2** **Course Code:23NMEMB42**

UNIT-I: Introduction to aquaculture (6 Hours)

Principle, Scope, Importance and needs of aquaculture - National and International status of aquaculture - Environmental problems caused by aquaculture.

UNIT-II: Aquaculture practices (7 Hours)

Site selection- Fish pond construction, Types of fish culture - Monoculture, Polyculture, Pen culture, Cage culture, Integrated fish farming, Brackish water prawn culture and Marine culture.

UNIT-III: Feed Formulation (5 Hours)

Fish and prawn feed requirements and formulation of artificial feed – Live feed culture - Probiotics in aquaculture feed.

UNIT-IV: Common diseases of Aquaculture (6 Hours)

Bacterial, fungal and viral infections - Fish diseases and Treatments - Host, pathogen and environment interaction.

UNIT – V: Development of new techniques in aquaculture (6 Hours)

Cryopreservation and Vaccination - Aquaculture economics: Starting investments, Economic returns, Banking facility and Marketing

Total Lecture Hours - 30

COURSE OUTCOME

After completion of the course the students should able to,

1. Acquire knowledge about the importance of aquaculture and its scopes.
2. Understand type of culture and which aquatic organisms are suitable for culture in his locality.
3. Gain knowledge about probiotics, and live feed culture techniques.
4. Identify the symptoms of bacterial, viral and fungal diseases to culture fishes and its remedial measures.
5. Explore and guide the farmers to get loans from nationalized banks for fish farming.

TEXT BOOKS

1. Ahilan.B. and Felix, N. 2013.Text book of aquaculture. Daya publishing house, New Delhi.
2. Arumugam, N. 2014.Aquaculture, Saras publications, Nagercoil.
3. Handbook of fisheries and aquaculture – ICAR publication, New Delhi. . services (IBS), New Delhi.

4. Jhingran, V.G., 1991 Fish and fisheries of India, Hindustan publishing corporation, Delhi.
5. Patel, A. &Pathak, S.N. (2010): Introduction to Aquaculture. Pub. by: Pacific Books International, Delhi, India.
6. Reddy, M.S. 2018. A text Book of Aquaculture, Discovery Publishing House Pvt. Ltd. New Delhi
7. S.H. Ahmad and A.K. Singh, 2011Freshwater aquaculture, Daya publishing house, New Delhi.
8. Shanmugham, K.1990. Fishery biology and aquaculture, Leo Pathippagam, . Chennai.
9. Venugopal, S 2005 Aquaculture, Pointer Publishers. Jaiphur , India

REFERENCE BOOK(S)

1. McEvoy, L.A. and Stottrup, J.G. 2003. Live feeds in marine aquaculture , Blackwell publishing company, UK.
2. Mathew landau, 1994.. Introduction to aquaculture landau, Mathew John Wiley & Sons New York.
3. *Pillay*, *T.V.R.* (1990) *Aquaculture: Principles and. Practices*. Fishing News Books, A Division of. Blackwell Publishing *Ltd*, Oxford.
4. Robert R. Stickney, Granvil D. Treece 2012. History of Aquaculture. Willey online Library, New York.
5. *Donald R. Swift 1993. Aquaculture training manual Fishing News Books*. 3rd Edition. Blackwell Scientific Publications, London.

E- LEARNING RESOURCES

1. https://www.slideshare.net/kumarsaurabh544/introduction-to-aquaculture-61492749
2. https://slideplayer.com/slide/13726446/
3. https://www.slideshare.net/vishnurajporedom/feed-formulation-52672093
4. https://slideplayer.com/slide/16717103/
5. https://slideplayer.com/slide/13678856/

Semester: IV- SBE-I: Diagnostic Microbiology

Ins. Hours / Week: 2 **Course Credit: 2** **Course Code:23SBEMB1**

UNIT–I Specimen collection and transport (5 Hours)

Collection, Processing, transport and storage of specimens – Blood, Urine, Stool, Sputum, CSF and Pus.

UNIT–II Blood smear preparations (6Hours)

Staining, blood smears examination and morphological abnormalities. Differential WBC count – Peripheral - Reticulocyte count- absolute eosinophil count – E.S.R, P.C.V, Blood indices - Platelet count: BT, CT, CRT- Prothrombin time, A.P.P.T, FDP estimation.

UNIT–IIIExamination of urine (7 Hours)

Physical and chemical tests, microscopic examination – crystals, casts, sediments, pregnancy tests – Diagnosis (Protocol Outline) of Urinary tract infection.

UNIT–IV Examination of Stool (7 Hours)

Physical, Chemical and Microscopic examination and its significance.

UNIT–VExamination of Sputum (5 Hours)

Microscopic examination – Diagnosis (Protocol Outline) of Respiratory tract infections (Upper and Lower). **Total Lecture Hours :30**

COURSE OUTCOMES

After completion of the course the students should able to,

1. Understand the collection, transport, preservation and processing of clinical samples.
2. Evaluate the blood components using blood smear preparation
3. Acquire skills to examine urine sample.
4. Identify the different techniques to examine stool samples.
5. Apply the method to diagnose respiratory tract infections by examining sputum sample.

TEXT BOOKS

1. Ananthanarayanan R and CK JayaramPanicker, Textbook of Microbiology, 10thEd. (2017). Orient Longman. Hyderabad.
2. Abdul Khader, (2003). Medical laboratory techniques 1stEd. Frontline Publications.
3. Chakraborty P, (1995). A Text book of Microbiology, New Central Book Agency Pvt. Ltd. Kolkota, West Bengal
4. Dubey, R.C. & D.K. Maheshwari. Practical Microbiology. S. Chand & Co, New Delhi

REFERENCE BOOKS

1. Bailey and Scott‟s, (2013). Diagnostic Microbiology 13thEd. The Mosby Company.
2. James Cappuccino. Microbiology: A Laboratory Manual 10thEd. Pearson, London
3. David Greenwood, Richard C B Slack, Michael R. Barer, Will L Irving, (2012), Medical Microbiology, 18thEd.Elsevier Ltd.

E -LEARNING RESOURCES:

1. https://www.youtube.com/watch?v=uAmTgVvTUNk
2. https://www.youtube.com/watch?v=KrpooZv5juo
3. https://www.youtube.com/watch?v=Oy5uixdzJ_c
4. https://www.slideshare.net/ankur16491/blood-smear-staining
5. https://www.slideshare.net/pathologybasics/sputum-examination-29540726

Semester: V- CC-V: Medical Microbiology

Ins. Hours / Week: 6 **Course Credit: 6** **Course Code:R23MB509**

UNIT- I Introduction to medical microbiology (18 Hours)

History, Classification of Medically Important Microbes.Koch's and River's postulates. Normal microbial flora of the healthy human body – Host-pathogen interactions: virulence factors of human pathogens –infectious disease cycle.

UNIT-II: Medical Bacteriology (18 Hours)

Diseases of various organ systems: Causative agent ,clinical symptoms, pathogenesis, mode of transmission, prevention and treatment of the following bacterial diseases (a) Streptococcal infections, (b) Staphylococcal infections, (c) Meningitis,(d) Leprosy,(e) Leptospirosis, (f) Lyme Disease, (g) Respiratory diseases: Tuberculosis (h) Gastrointestinal disorders: typhoid, cholera, bacillary dysentery, (i) Sexually transmitted diseases: Syphilis, gonorrhea. (j)Anaerobic wound infection–tetanus, gas gangrene.

UNIT-III: Medical Virology (18 Hours)

Diseases of various organ systems: Causative agent, clinical symptoms, pathogenesis and mode of transmission, prevention and treatment of the following viral diseases (a) Respiratory diseases: common cold, influenza, measles, Corona virus and Ebola Viral Disease (EVD) (b) Neurological diseases: Dengue, Rabies (c) Liver diseases: Viral hepatitis (d) Immunodeficiency disease:-AIDS.

UNIT-IV: Medical mycology and Parasitology (18 Hours)

Causative agent, clinical symptoms, pathogenesis, mode of transmission, prevention and treatment of the following fungal and protozoan diseases (a) Fungal – superficial and subcutaneous mycoses, (b) Protozoan: Amoebiasis, Malaria (c) Helminths –Filariasis, Ascariasis, Zoonotic diseases. Nosocomial infection.

UNIT-V: Clinical diagnostic methods (18 Hours)

Steps involved in the isolation and identification of pathogens from an infected patient: Collection and transport of various clinical specimens for diagnosis – General methods of isolation and identification of bacterial, fungal and viral pathogens and protozoan parasites.

Total Lecture Hours - 90

COURSE OUTCOME

After the completion of the course, students should be able to,

1. Acquire knowledge on the Normal flora of human body and infectious Diseases
2. Understand the concepts about bacterial diseases
3. Distinguish various types of viral diseases and their diagnosis
4. Diagnose protozoan and fungal infections
5. Expertise on various laboratory Procedures and Diagnostic Methods.

TEXT BOOKS

1. Ananthanarayanan R and JeyaramPanicker CK. 2004. Textbook of Medical Parasitology. 5th Ed. Jay Pee brothers Medical publisher, Pvt Ltd., New Delhi.
2. Chakroborty P. 2003. A Text book of Microbiology. 2nd Ed. New Central Book Agency (P) Ltd., Calcutta.
3. JegadishChander, 2018. A Text Book of Medical Mycology. 4th Edition, Jaypee Brothers Medical Publishers,Interprint, New Delhi. 23
4. Mehrotra, R.S. and Aneja, K.R. 2015. An introduction to Mycology. 2ndEdition, New Age International (P) Ltd, New Delhi.
5. Rajan S. 2007. Medical Microbiology, MJP Publishers Chennai.

REFERENCE BOOK(S)

1. Alexpoulos, C.J., Mims, C.W. and Blackwell, M. 2014. Introductory Mycology.4th Edition, John Wiley & sons, New Delhi.
2. Collee JC, DuguidJP,FraserAC,Marimon BP. Mackie and Mc Carteny,1989. PracticalMedicalMicrobiology–13thedition, Churchill Livingstone
3. David Greenwood. Mike Barer, Richard Slack and Will Irving. 2012. Medical Microbiology. A Guide to Microbial Infections: Pathogenesis, immunity, Laboratory investigation and Control, 18th edition, Churchill Livingstone.

4. Dimmock, N.J., Easton, A.J. and Lappard, K.N. 2009. Introduction to ModernVirology. Wiley Blackwell.
5. Edward Arnold, A division of Hodder and Stoughton. Huge WB and RussellAD. 1989.PharmaceuticalMicrobiology.4thedition.BlackwellScientificPublicaiton, Oxford, United Kingdom.
6. Errol Reiss, Jean Shadomy, H. and Marshall Lyon, G. 2011. Fundamental Medical Mycology. 1stEdition,Wiley Blackwell. United States.
7. Flint, S.J., Enquist L.W., Racaniello, V.R. and Skalka, A.M. 2009. Principles ofVirology-1-Molecular Biology, 3 rd Edition. ASM Press, Washington.
8. Jawetz, Melnickand and Adelberg's 2001. Medical Microbiology, 22nd edition McGraw Hill Medical Publication division.
9. JoanstokesE,RidgwayGLandWren MWD. 1993. Clinical Microbiology 7thedition,EdwardArnold. Adivision of Hodder and Stoughton
10. Morag, C. and Timbury, M.C. 1994. Medical Virology, 10th Edition. Churchill Livingston, London.
11. SchaechterM,MedoffGandEisenstein BC.1993. MechanismofMicrobialDiseases.2ndedition.Williams and WilkIns., Baltimore.
12. Topley and Wilson 1995. Principles of Bacteriology, Virology and Immunity, 9thEdition. Edward Arnold, London..
13. VinayKumar,AbulKAbbasandJonCA ster. RobbIns.andCotran, 2014. PathologicBasis of Disease: South Asia Edition.

E-RESOURCES

1. http://www.mednotes.net/notes/microbiology/
2. http://dmoz.org/Science/Biology/Microbiology/
3. http://microbiology.mtsinai.on.ca/manual/default.asp
4. http://fdjpkc.fudan.edu.cn/_upload/article/files/4d/8a/0337d0b94956b709eaed117489c9/2e232f50-d708-4783-a40d-5e970d1142f0.pdf
5. https://www.aacc.org/store/books/8300/lecture-notes-medical-microbiology-and-infection-5th-edition
6. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2158889/

Semester: V- CC-VI: Agricultural and Environmental Microbiology

Ins. Hours / Week: 6 **Course Credit: 6** **Course Code:R23MB510**

UNIT- I: Biofertilizers (18 Hours)

Microorganisms in the rhizosphere, rootsurfaces and phylloplane – Biofertilizer –types, production - quality control - Isolation, mass inoculum production, field application, importance and marketing of bioinoculants– *Rhizobium,Azotobacter,Azospirillum,Frankia*,Cyanobacteria,*Azolla* and Phosphate solubilizing microorganisms- Mycorrhizalbiofertilizers.Role of biofertilizer in integrated nutrient management.Organic farming practices in India (Crop rotation ,Panchakavya, Vermicompost).

UNIT-II: Phyto Pathology and Control Mechanisms (18 Hours)

Plant diseases (Mode of entry of pathogens, Symptoms ,Disease cycle and control measures) Bacterial disease – Citrus canker - Fungal disease – Rust of wheat- Mycoplasmal disease – Grassy shoot of sugar cane -Viral disease –Cauliflower mosaic-Microbial Pesticides–types and applications–*Pseudomonas fluorescens, Bacillus thuringiensis,* Beauveriabassiana, *Trichodermaviride*and Nuclear Polyhedrosis Virus (NPV), Cytoplasmic Polyhedrosis Virus(CPV), Granulosis Virus (GV).

UNIT-III: Aero Microbiology (18 Hours)

Concepts of microbial ecology: Relationship between microorganism and different environments Land, Water and Air. .Microbiology of air – distribution and sources.Droplet nuclei, Aerosol, assessment of air quality-Air borne transmission of harmful microbes.Microorganisms inhabiting extreme environments

UNIT-IV: Aquatic Microbiology (18 Hours)

Types of aquatic ecosystems: freshwater – ponds, lakes, streams. Marinehabitats – estuaries, mangroves, deep sea.Zonations – upwelling – eutrophication – food chain. Potability of water – microbial assessment of water quality – water purification – waterborne diseases.

UNIT-V: Waste Management (18 Hours)

Solid Waste management: Sources and types of solid waste, Methods of solid waste disposal (composting and sanitary landfill),Hazardous solid waste and disposal, Utilization of solidwastes for mushroom production Liquid waste management: Composition and strength of sewage (BOD and COD), Primary, secondary (oxidation ponds, trickling filter, activated sludge process and septic tank) and tertiary sewage treatment. Xenobiotics – their recalcitrance and effects on microflora.

Total Lecture Hours -90

COURSE OUTCOME

After the completion of course, the students should be able to,

1. Understand the role of microbes in Agriculture.
2. Acquire Knowledge about Phytopathology and control measures.
3. Elucidate the concept of Aero Microbiology.
4. Summarize the Aquatic microbiology
5. Find Solution of Waste Management by using Microorganisms

TEXT BOOKS

1. ChatterjiA.K. 2005.Introduction to Environmental Biotechnology. Prentice-Hall of India Private Limited, New Delhi
2. Dubey R.C & Maheshwari D. K.2103.A Textbook of Microbiology,S.ChandPublising, New Delhi.
3. JogdandS.N. 2010.EnvironmentalBiotechnology,HimalayaPublishingHouse.NewDelhi.
4. Rangaswami, G, and Bagyaraj, D.J.2009. Agricultural Microbiology, 2nd Edi. Prentice-Hall of India Private Limited, New Delhi.
5. SambamurtyA. 2009.Textbook of Plant Pathology,I.K.International Publishing House,New Delhi.
6. SubbaRao, N.S. 1995 .Soil Micro organisms and plant growth, Oxford and IBH publishing Co. Pvt. Ltd.New Delhi
7. SubbaRao, N.S., 2000. Advances in Agricultural Microbiology, Oxford & IBH Publ. Co. Pvt. Ltd., New Delhi.
8. Vijayaramesh ,K.2004. Environmental Microbiology, MJPPublishers , Chennai.
9. Yogarajan, Pranay Kumar .2020. Essentials of Microbiology ,Innovative Publication private ltd., 1st Edition, India

REFERENCE BOOK(S)

1. Alexander. 1997. Introduction to soil Microbiology. John Wiley and Sons. New York.
2. Atlas, R. M. and Bartha. R. 1992. Microbial Ecology: Fundamentals and Applications. 3 rdEdition.Benjamin| Cummings. Redwood City. United States.
3. Burns.R. CandSlater J.H.1982.ExperimentalMicrobialEcology–Blackwell ScientificPublications, Oxford, London.
4. Christon.J.Hurst.2002.Manual of Environmental Microbiology, 2ndedition .American Society for Microbiology, Washington.
5. Deepa Kumar Verma 2021.Microbiology for Sustainable agriculture, Soil Health and Environmental protection, Apple Academic Press, United States.
6. GarethM.EvansandJudithC,Furlong. 2003.EnvironmentalBiotechnology-Theory and Application, JohnWiley and sonsLtd.United Kingdom.
7. Glick B.R. 2015. Beneficial Plant Bacterial Interactions, Springer.
8. Jan DirkvanElsar, Jack.T.Trevors,Alexandersoares Rosado, Pootonannniperi,2019. Modern Soil Microbiology, CRC press, United states.
9. Madigan M.T., Bender K.S., Buckley D.H., Sattley W.M. and Stahl D.A. 2017. Brock Biology of Microorganisms, 15thEdn. (Global Edn.) Pearson Education.United States
10. Mahendra K. Rai .2005. Hand book of Microbial biofertilizers, The Haworth Press, Inc. New York.
11. Paul E.A. 2015. Soil Microbiology, Ecology and Biochemistry, 4thEdn, Academic Press,London
12. Willey JM, Sherwood LM, and Woolverton CJ. 2013. Prescott's Microbiology. 9th edition. McGraw Hill Higher Education. United States

E-RESOURCES

1. https://www.slideshare.net/NavneetKaur337/biofertilizers-ppt-76285633
2. https://www.slideshare.net/ajuna1234/introduction-to-plant-pathology-88703653
3. https://www.slideshare.net/amjadkhanafridi4all/aeromicrobiology-185366127
4. https://www.slideshare.net/AnushkaPrasadJayasin/aquatic-microbiology-53786079
5. https://www.slideshare.net/GhassanHadi/waste-water-treatment-120127260
6. https://www.onlinelibrary.Wiley.com.

Semester: V- CC-VII: Molecular Biology and Microbial Genetics

Ins. Hours / Week: 6 **Course Credit: 6** **Course Code:R23MB511**

UNIT- I History of Genetics **(18 Hours)**

Milestones in history – Definition of nucleic acids - Experimental proofs of DNA as the genetic material (Griffith and Hershey Chase) – Experimental proofs of RNA as the genetic material - Chemistry and molecular structure of DNA double helix - Discovery of DNA structure –types and forms of DNA – Types of RNA - Plasmids: structure and types.

UNIT –II Replication in Prokaryotes **(18 Hours)**

DNA Replication in prokaryotes: Meselson and Stahl experiment – Mechanism, enzymes and proteins of replication – Theta replication and Rolling circle replication. Replication of RNA – reverse transcriptase.

UNIT –III Central Dogma **(18 Hours)**

Definition of gene. DNA Transcription: Definition – transcriptional machinery and mechanism of transcription – Genetic code – RNA Translation: Definition -– translational machinery and mechanisms of translation. Regulation of gene expression in prokaryotes – Operon concept – *lac*and *trp*operons.

UNIT- IV Gene Transfer Mechanisms **(18 Hours)**

Transformation - Discovery, mechanism of natural competence - Conjugation - Discovery, F+ *v/s* F-, Hfr+ *v/s* F- - Transduction – Generalized and Specialized transduction.

UNIT- V Mutation and its Repair **(18 Hours)**

Definitions of mutations, mutagenesis and mutants – types of mutations; Physical and chemical mutagens. Transposons – Applications of mutations, Carcinogenicity testing. DNA repair mechanisms.

Total Lecture Hours - 90

COURSE OUTCOMES

The students will be able to,

1. Learn about the history of nucleic acid discover and its basic structure.

2. Understand the mechanism of replication of nucleic acids in prokaryotes.
3. Explain about the central dogma of life and its regulation.
4. Gain knowledge on the gene transfer mechanisms.
5. Identify the types of mutations and DNA Repair mechanisms.

TEXT BOOKS

1. Channarayappa, A. 2010. Cell Biology, Universities Press, (India) Pvt. Ltd, Hyderabad, India.
2. David Frifelder, 1990. Microbial Genetics, Narosa Publishing House, New Delhi.
3. David Frifelder, 2008. Molecular Biology, 2nd edition. Narosa Publishing House, New Delhi.
4. Friedberg, E.C., Walker, C.C. and Siede, W.1995. DNA repair and mutagenesis, ASM Press.
5. Monroe, W., and Stickberger. 2003.Genetics, 3rd edition, Prentice Hall of India Pvt. Ltd., New Delhi.
6. Sambaurthy, A.V.S.S. 2008. Molecular biology. Narosa publishing house, New Delhi.

REFERENCE BOOK(S)

1. Cooper, G. M., and Hausman, R. E. 2013. The Cell: a Molecular Approach (6th Ed.). Washington: ASM ; Sunderland.
2. Daniel, L. Hartl and Elizabeth, W. Jones. 2001. Genetics - Analysis of Genes and Genomes, Jones and Bartlett publishers, UK.
3. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology, 8th edition. Lippincott Williams and WilkIns., Philadelphia.
4. Gardner, E.J., Simmons, M.J., and Snustad, D.P. 1991.Principles of Genetics. John Wiley and sons.
5. George, M. MalacIns.ki. 2008. Freifelder'sEssentials of Molecular Biology. 4th edition. Narosa Publishing House. New Delhi.
6. Hardin, J., Bertoni, G., KleIns.mith, L. J., and Becker, W. M. 2012. Becker's World of the Cell. Boston (8th Ed.). Benjamin Cummings, USA.
7. Jeremy M Dale. 1998.Molecular Genetics of Bacteria, 3rd edition, John Wiley and sons, New York,

8. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments, 6th edition, John Wiley and Sons. Inc.
9. Krebs, J. E., Lewin, B., Kilpatrick, S. T. and Goldstein, E. S. 2014. Lewin's Genes XI. Burlington, MA: Jones & Bartlett Learning.
10. Larry Synder and Wendy Champness. 2003. Molecular Genetics of Bacteria, 2nd edition, American Society for Microbiology,Washington.
11. Lodish, H., Baltimore, D., Berk, A., Zipsury, S.L., Matsudaira, P. and Darnell, J. 1995.Molecular Cell Biology. Scientific American Books.
12. Lodish, H. F. 2016. Molecular Cell Biology (8th Ed.). New York: W.H. Freeman.
13. Maxine Singer and Paul Berg. 1991. Genes and Genomes. University science books,California.
14. Old, R.S. and Primrose, S.B.1989. Principles of Gene Manipulation, 4th edition, Blackwell Scientific Publications, London.
15. Russell, P.J. 2009. Genetics- A Molecular Approach. 3rd edition, Benjamin Cummings. USA.
16. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. 2008. Molecular Biology of the Gene, 6th edition, Cold Spring Harbour Lab. Press, Pearson Publication.

E- RESOURCES

1. https://www.khanacademy.org/science/biology
2. https://www.imedpub.com/genetics-molecular-biology-research/
3. https://www.mdpi.com/journal/genes/sections/MGG
4. https://www.ncbi.nlm.nih.gov
5. https://library.au.dk/en/subject-areas/molecularbiologyandgenetics
6. https://www.libguides.gvsu.edu.in

Semester: V- CP-V: Medical Microbiology, Agricultural and Environmental Microbiology, Molecular Biology and Microbial Genetics

Ins. Hours / Week: 3 **Course Credit: 3** **Course Code:R23MB512P**

Medical Microbiology

- Collection, coding and transport of clinical specimen for microbiological examination
- Isolation of bacterial flora of skin by swab method.
- Isolation of bacteria from urine, stool and sputum
- Identification of Gram positive organisms (using laboratory strains.): *Streptococcus pneumoniae, Staphylococcus aureus*and *Bacillus* sp on the basis of microbiological, cultural and biochemical characteristics.
- Identification of Gram negative organisms (using laboratory strains.): *Escherichia coli, Proteus*sp and *Klebsiellapneumoniae*on the basis of microbiological, cultural and biochemical characteristics.
- Saline and iodine wet mount to demonstrate protozoan parasites
- Giemsa staining for the demonstration of blood parasites
- KOH and Lactophenol cotton blue mount to demonstrate fungi.
- Germ tube technique to identify *Candida albicans.*
- Antibacterial sensitivity test–Kirby-Bauer method.
- Observation of symptoms of diseases caused by bacterial, fungal, viral and protozoan pathogens using photographs.

Agricultural and Environmental Microbiology

- Water analysis by MPN technique – presumptive coliform test – confirmed coliform test and completed coliform test.
- Microbial assessments of air quality – open plate method and air sampler-technique.
- Isolation and counting of faecal bacteria from water.
- Soil Analysis -pH, chlorides, nitrate, calcium, magnesium and total phosphorus.
- Isolation of cyanobacteria from water(any two)
- Isolation of *Rhizobium* form legume nodule.
- Isolation of phosphorus bacteria from soil.
- Observation of VAM from plant roots.

Molecular biology and Microbial genetics

- Isolation of chromosomal DNA from bacteria
- Isolation of plasmid DNA from bacteria
- Isolation of Auxotrophic mutants.
- Demonstration of bacterial transformation technique.
- Demonstration of Agarose gel electrophoresis (to study DNA/RNA) and SDS–PAGE (to study proteins.).

TEXT BOOKS

1. Rajan S. 2012. Manual for Medical Laboratory Technology. Anajanaa Book House, Chennai.
2. Rajan S and Selvi Christy R. 2011. Experimental Procedures in Life Sciences. Anjanaa Book House, Chennai
3. Monica Cheesbrough.2011. District Laboratory Practice in Tropical Countries-Part I and II, 2nd edition, Cambridge University Press, New Delhi.

REFERENCE BOOK(S)

1. Betty A Forbes, Daniel F Sahm and Alice S Weissfeld. Bailey and Scott's, 2007. Diagnostic Microbiology, Mosby Elsevier. 12thEdition.
2. Mackie and McCartney 2006. Practical Medical Microbiology, South AsiaEdition.14thedition.
3. James G Cappuccino and Natalie Sherman. 1996. Microbiology-A Laboratory Mannual (4thedition).The Benjamin publishing company, New York.
4. Jeanne Dijkstra and CeesP.deJager. 1998. Practical Plant Virology. Springer-Verlag Berlin Heidelberg, Germany.
5. Paul I A and Clark FE. 2000. Soil Microbiology and Biochemistry,2nd Ed. Academic press. United States.
6. RussellF Bey. 2001. Microbiology Laboratory Manual, Brooks/Cole, Australia.
7. Schaechter M, Medoff G and Eisenstein BC.1993. MechanismofMicrobialdiseases.2ndedition.Williams and WilkIns., Baltimore.

E - RESOURCES

1. https://www.slideshare.net/amanullah9803150/biochemical-tests-for-gram-positive-cocci
2. https://www.slideshare.net/AshwiniGowda6/haemoparasites-in-blood-smear
3. https://www.slideshare.net/MariyaRaju/bacteriological-analysis-of-drinking-water
4. https://www.slideshare.net/AsmaAshraf7/dna-isolation-73144905
5. https://www.slideshare.net/TapeshwarYadav1/gel-electrophoresis-53828963

Semester: V- MBE-I: Research Methodology

Ins. Hours / Week: 3 **Course Credit: 3** **Course Code:R23MBEMB1**

UNIT- I: Basics of Research **(9 Hours)**

Methodology Objectives – principles – types of research approaches – Research process – Criteria of good research – Research and Scientific method – Defining the Research problem – Selecting the problem – Techniques in defining the problem.

UNIT- II: Formulation of hypothesis **(9 Hours)**

Importance and need for research ethics and scientific research - Formulation of hypothesis – Types and characteristics – Hypothesis testing – Procedures.

UNIT- III: Designing of research work **(9 Hours)**

Designing a research work – Need of research design – Features of a good design – Concepts and different research design – Basic principles of experimental design.

UNIT- IV: Interpretation and report writing **(9 Hours)**

Techniques and significance of report writing – Steps - Types of report. Presentation of Result: Selection of Appropriate Statistical Techniques – Software tools- SPSS (IBM), R (R Foundation for statistical computing. Report Writing.Application of computer in research.

UNIT- V: Scientific writing **(9 Hours)**

Logical format for writing thesis and papers – Essential features of abstract, introduction, review of literature, materials and methods, results and discussion. Effective illustration – Tables and figures – Plates – Conclusion and Bibliography. Plagiarism-Software tools to check the Plagiarism.

Total Lecture Hours - 45

COURSE OUTCOME

The students will be able to,

1. Understand the research process and techniques

2. Formulate and testing the hypothesis for research problem
3. Design the different type of research
4. Analyse and interpret data, writing of thesis, and preparation of manuscript for publication.
5. Identify the research ethics for publication

TEXT BOOKS

1. Anderson J.B. and Poole M. 2011. Assignment and Thesis Writing. Wiley India Private Limited. Noida.
2. Gupta, S.P. 2014. Statistical Methods -S. Chand publication, New Delhi
3. Gurumani, N. 2006. Research methodology for biological sciences. MJP Publishers. A unit of Tamil nadu Book House, Chennai.
4. Kothari C.R. and Garg , G. 2004. Research Methodology: Methods and Techniques. 2nd edn. New Age International Publishers, New Delhi.
5. Stanton A. Glantz., 2001. Primer of Biostatistics. McGraw-Hill, New York.
6. Wayne W. Daniel, 2006. Biostatistics- A foundation for analysis in the Health Sciences. 7th edition. Wiley India publication, Karnataka.
7. Shanti Bhushan Mishra and ShashiAlokEducreation, 2017. Hand Book of Research methodology, Publishing Rz 94, Sector - 6, Dwarka, New Delhi.

REFERENCE BOOK(S)

1. Anderson J.B. and Poole M. 2011. Assignment and Thesis Writing. 4th edn. Wiley India Private Ltd., Karnataka.
2. Attwood, T.K. and Parry-Smith, D.J. 2001. Introduction to Bioinformatics, Pearson Education Asia.
3. Beth Dawson Robert, G. and Trapp Beth Dawson Robert Trapp. 2004. Basic and Clinical Biostatistics (LANGE Basic Science), McGraw-Hill, Uttar Pradesh.
4. Claverie, J.M. and Notredame, C. 2003.Bioinformatics for Dummies, Wiley Publishing, Inc., Karnataka.
5. David W. M., 2001. Sequence and Genome Analysis, Bioinformatics. Cold Spring Harbor Laboratory Press.

6. David, W. Mount,. 2001. Cold Bioinformatics, Sequence and Genome Analysis, Spring Harbor Laboratory Press.
7. Jeffrey A. Witmer and Myra L. Samuels, 2002. Statistics for the Life Sciences (3rd Edition). Prentice Hall.
8. Kothari, C.R., 2013. Research methodology Methods and Techniques, New Age International Pvt Ltd Publishers., New Delhi
9. Ramadass, P. and Wilson Aruni, A. 2009. Research and Writing - Across the Disciplines. MJP Publishers, Chennai.
10. Willie Tan, 2017.Research Methods: A Practical Guide For Students And Researchers 1st Edition, World Scientific Publishers, London.

E -RESOURCES

1. http://www.math.yorku.ca/scs/statResource.html# General
2. http://www.anest.ufl.edu/computer/index.html
3. http://www.jegsworks.com/Lessons/index.html
4. http://www.bettycjung.net/statsites.html
5. http://www.biostat.harvard.edu/links/
6. http://www.ped.mod.utah.edu/genpedscrr/Epibio.html/

Semester: V- SBE-II: Medical Laboratory Techniques

Ins. Hours / Week: 2 **Course Credit: 2** **Course Code:R23SBEMB2**

UNIT–I Identification of Bacterial pathogens (5 Hours)

Microscopic examination of specimen – simple, differential staining and motility. Biochemical reaction – Sugar fermentation test

UNIT–II Antimicrobial susceptibility testing (6 Hours)

Disc diffusion – Kirby Bauer method.MIC, E test – reporting of results & interpretation.

UNIT–III Serology (7 Hours)

Antigen – Antibody reactions – Agglutination (blood grouping, WIDAL) RPR and Hemaaglutination Precipitation (VDRL), Immunodiffusion – (Mono and Double), Immunoelectorophoresis (Rocket and Counter current). Advanced techniques – ELISA, Radio immuno assay (RIA) Quantitative study of Antigen – Antibody reactions. Immunosensors. CD4, CD8 cell counting, Western blot analysis for HIV, RT-PCR forCovid 19.

UNIT–IV Laboratory methods in basic Mycology (7 Hours)

Direct Microscopic examination of clinical specimens, culture media and incubation, Serological tests for fungi – Antifungal susceptibility testing. Superficial infections – Dermatophytes – Microsporum.Opportunistic fungal infections – *Aspergillus* and Mucor.

UNIT–V Laboratory methods for parasitic infections (5 Hours)

Diagnostic techniques for faecal, gastrointestinal and uro-genital specimen.Identification of Protozoa – Amoebiasis and Malaria.Identification of Helminths – Filariasis and Ascariasis.

Total Lecturer Hours: 30

COURSE OUTCOME:

After completion of the course the students should able to,

1. Identify the bacterial pathogen by microscopic observation and biochemical tests from clinical samples.

2. Evaluate and interpret the antibiotic susceptibility test.
3. Apply various Immunological and rapid diagnostic tests to detect the pathogens
4. Choose the appropriate diagnostic method to identify fungal pathogens.
5. Interpret the parasitic infections by suitable diagnostic method

TEXT BOOKS

1. P.B. Godkar, Text Book of Medical Laboratory Technology, 2ndEd. (2003). Bhalani Publication.
2. Balasubramanian, A. and Senthilkumar, P.K, 2017. Medical Microbiology. Darshan Publication, Rasipuram
3. Chakraborty, P., 2003. A Text Book of Microbiology. 2nd edition, Published by New Central Agency (P) Ltd., Kolkatta.

REFERENCE BOOKS

1. Bailey and Scott‟s, (2013). Diagnostic Microbiology 13thEd. The Mosby Company.
2. Abdul Khader, (2003), Medical laboratory techniques 1stEd. Frontline Publications.
3. Goering R., Dockrell H., Zuckerman M. and Wakelin D. 2007 Mims' Medical Microbiology. 4th edition. Elsevier, Academic Presss, USA.
4. Jawetz E Melnic JL and Adelberg EA, (1998). Review of Medical Microbiology Lange Medical Publications, USA.
5. Joanne Willey and Kathleen Sandman and Dorothy Wood, (2020). Prescott‟s Microbiology 11thEd. McGraw Hill Book, New York.
6. Madigan MT, Martinko JM, Dunlap PV and Clark DP. 2014. Brock Biology of Microorganisms. 14th edition. Pearson International Edition, UK
7. Rajesh Karyakarte, AjitDamla, 2004. Medical Parasitology. Books and Allied publishers, Kolkata
8. Subash O. Parija, (2013). Textbook of Medical Parasitology 1stEd. All India Publishers and Distributors, Chennai
9. Joanne Willey and Kathleen Sandman and Dorothy Wood, (2020). Prescott‟s Microbiology 11thEd. McGraw Hill Book, New York.

E LEARNING RESOURCES:

1. https://www.youtube.com/watch?v=uAmTgVvTUNk
2. https://www.youtube.com/watch?v=KrpooZv5juo

3. https://www.youtube.com/watch?v=Oy5uixdzJ_c
4. https://sites.google.com/view/frejltsgqy/medical-mycology-lecture-notes-ppt
5. https://www.dailymotion.com/video/x3eoujz

Semester: V- SBE-III: Medical Coding

Ins. Hours / Week: 2 **Course Credit: 2** **Course Code: R23SBEMB3**

UNIT–I Industry and the Codes **(5 Hours)**

The Coder – ICD Coding – CPT Coding – Specialty Coding – Liability and Legal Issues.

UNIT–II – Introduction to Medical Terminology **(6 Hours)**

The World of Health Care – Medical Terminology: Dividing and Combining Terms – Abbreviations, Symbols and Special Terms – Documenting Medical Records – Medical Ethics

UNIT–III Diagnostic Coding **(6 Hours)**

ICD-10-CM Coding Manual Introduction – ICD-10-CM Diagnosis Coding: Guidelines and Rules – Infections to Blood Diseases – Mental Disorders to the Respiratory System – the Digestive System to Pregnancy – Skin to condition of the – Perinatal Period- symptoms to complication.

UNIT–IV CPT Coding **(7 Hours)**

Integumentary System – Reproductive Systems – Radiology, Pathology, Medicine and Anesthesia – Evaluation and Management Services – Comprehensive Surgery Coding – Comprehensive Musculoskeletal coding – Comprehensive Digestive System Coding – Comprehensive Urology and Reproductive system coding – Comprehensive Pulmonology and Cardiovascular coding.

UNIT–V History of HCPCS Coding **(6 Hours)**

Levels of HCPCS – Procedure and series codes for outpatient care -Medical Coding – Medical Billing – Auditing – Medical Documentation – Compliance – Medical coding tools.

Total Lecture Hours: 30

COURSE OUTCOME:

After completion of the course the students should able to,

1. Understand about basics of Medical coding.

2. Impart the knowledge about different types of Coding.
3. Explore ICT & CPC coding.
4. Insist different types of procedure codes.
5. Predict codes based on anatomy &its ICD guidelines.

TEXT BOOKS

1. AlokGha, PriyankaArora- Medical Transcription Made easy.
2. Mike Macgrath 2017.Coding For Beginners In Easy Steps. Kindle Edition
3. Karen Smiley 2019.Medical coding and Billing Wiley publication. UK

REFERENCES BOOKS

1. Terry Tropin M Shai, RHIA, CCS-P, AHIMAICD-10-CM- Coding guidelines made easy2017.
2. Besty J Shiland- Medical terminology and anatomy for ICD-10.
3. Karen Smiley- Medical Billing and coding for dummies, 2nd edition.
4. ICD-10-CM Official Guidelines for Coding & Reporting.

E LEARNING RESOURCES:

1. https://www.aapc.com/medical-coding/medicalcoding.aspx#WhyIsMedicalCodingNeeded
2. https://www.medicalbillingandcoding.org/coding-training/ 3https://www.rasmussen.edu/degrees/health-sciences/blog/what-is-medical-coder/
3. https://revcycleintelligence.com/features/exploring-the-fundamentals-of-medical-billingand-coding
4. https://www.ultimatemedical.edu/blog/what-is-a-medical-coding-and-billing-specialist/

Semester: VI- CC-XIII: Food and Fermentation Technology

Ins. Hours / Week: 6 **Course Credit: 6** **Course Code:R23MB613**

UNIT –I: Microbes in Food (18 Hours)

Preservation: principles of high temperature, low temperature, radiation, chemical preservatives and bio preservatives. Spoilage and methods of preservation.Production of byproducts after processing waste and their utilization.

UNIT – II: Microbes for Industrial Exploitation (18 Hours)

Fermented plant products: Bread, Sauerkraut, Vinegar- Fermented milk products-cheese, Butter milk, Yogurt, Kumis, Kefir and Acidophilus milk. Fermented foods in India and its importance-Prebiotics, Probiotics, Synbiotics.

UNIT – III: Microbial Examination (18 Hours)

Methods for the microbiological examination of foods.Food borne illness and diseases. Microbial cultures for food fermentation. Indian Factories Act on safety, HACCP, Safety from adulteration of food.

UNIT –IV: Fermentation (18 Hours)

Basic principles of fermentation technology.Culture systems- batch, fed- batch, continous.Growth and fermentation kinetics.Design of chemostat and turbidostat.Production and preservation of starter culture.Development of inoculum, assay of fermentation products. Types of fermentation- surfaces, submerge and solid state fermentation. Hygiene and sanitation requirement in food processing and fermentation industries.

UNIT – V: Fermented Foods (18 Hours)

Lactic acid fermentation of cabbage, cucumber, olives.Production of sauerkraut,Preparation of pickles. Fermentation of dill pickles.Oriental fermented foods-Soy sauce, Masco,Tempe,

Ontjons, Hamanatto, Tofu, Natto Traditional fermented foods – Idli, Dosa,Fermented meat and milk Products

Total Lecture Hours - 90

COURSE OUTCOMES

The students will be able to,

1. Assess the fundamental concepts of food preservation.
2. Understand the industrial processes carrying out in the food and dairy sector.
3. Implement knowledge of food safety aspects
4. Evaluate the significance of fermenter and its uses
5. Formulate the various fermented foods

TEXT BOOKS

1. James M Jay.2004. Modern Food Microbiology.4th Edition, CBS Publishers and Distributors, New Delhi. Adams MR and Moss MO. Food microbiology, New Age international (P) Ltd., New Delhi.
2. Patel. A.H. 2015. Industrial Microbiology. Trinity Publications New Delhi.
3. Choudhary NL. 2012. Food Processing and Biotechnology Applications, Oxford Press, New Delhi.
4. Singh K. 2012. Dairy Technology, Oxford Book Company, New Delhi.
5. Avantina Sharma. 2006. Text Book of Food Science and Technology, International Book Distributing Co, Lucknow, UP.
6. Vijaya Ramesh, K. 2007. Food Microbiology,MJP Publishers, Chennai.
7. Varun Mehta. 2006. Food Biotechnology, Campus Books International, New Delhi.
8. Sivasankar. 2005. Food Processing and Preservation, 3rd Edition.,Prentice hall of India Pvt Ltd, NewDelhi.
9. Adams M.R. and M.O. MOSS. 2005. Food Microbiology.1st edition. Reprinted, Published by New Age International (P) Limited. Publishers - New Delhi.
10. Jay, J.M. 2005. Modern Food Microbiology 4thedn, CBS Publishers and Distributors, New Delhi
11. KhetarpaulNeelam. 2005. Food Processing and Preservation, Daya Publishing House, Delhi.
12. Bamforth C.W. 2005. Food, Fermentation and Microorganisms, Blackwell Science.

13. Marwaha S.S. and Arora, J.K. 2000. Food Processing: Biotechnological applications, Asia tech Publishers Inc., New Delhi.

REFERENCE BOOK(S)

1. Chris Bell, Paul Neaves, Anthony P. Williams. 2006. Food Microbiology and Laboratory Practicals 2nd edition, Blackwell Scientific Publishers, UK.
2. Hobbs, B.C. and Roberts, D, 1968. Food Poisoning and Food Hygiene 7 thedn. Edward Arnold: London.
3. Lund BM, Baird Parker AC and Gould GW. 2000. The Microbiological Safety and Quality of foods. Vol. 1-2, ASPEN Publication, Gaithersberg, MD.
4. Doyle M.P. and Buchanan R.L. (Ed.) 2013. Food Microbiology: Fundamentals and Frontiers, 4th Edn. ASM press, USA.
5. Jay J.M.,Loessner M.J. and Golden D.A. 2005. Modern Food Microbiology, 7th Edn. Springer Publishers.
6. Prescott and Dunn, 1982. Industrial Microbiology 4thedn, CBS Publishers and Distributors, New Delhi.
7. Robinson R.K. 2002. Dairy Microbiology: Milk and Milk Products, 3rd Edn. Wiley Publishers, UK.
8. Didier Montet, Ramesh C. Ray. 2016. Fermented Foods, Part I Biochemistry and Biotechnology,CRC Press, Florida, US.

E-RESOURCES

1. https://guides.library.iit.edu/c.php?g=474742&p=3248297
2. https://www.classcentral.com/course/swayam-food-microbiology-14063
3. https://libguides.reading.ac.uk/food/e-resources
4. https://alison.com/course/introduction-to-food-microbiology
5. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6723656/

Semester: VI- CC-IX: Microbial Biotechnology and Bioethics

Ins. Hours / Week: 6 **Course Credit: 6** **Course Code:R23MB614**

UNIT-I: Microbial Products **(18 Hours)**

Biotechnology: Definition – Milestones in History - Scope of microbial biotechnology and its applications - Microbial production of pharmaceuticals – antibiotics, hormones (Insulin), enzymes (streptokinase), recombinant vaccines (Hepatitis B vaccine) - Edible vaccine, Monoclonal antibodies

UNIT- II: Environmental Biotechnology and Bio Enterpreneurship (18 Hours)

Waste Water management: Need for water management, Conventional and advanced treatment technology: Solid waste management,Types of Solid Waste ; Disposal of organic and medical waste; Recovery and recycling of metallic waste; Disposal of plastic waste and hazardous wastes: source management and safety,Enterpreneurship Opportunity in Biotechnology. Government Schemes and funding

UNIT- III:Biotechnology For Environmental Production and Biomass Production(16 Hours)

Biodegradation and bioremediation of pollutants, Biomineralization, degradative plasmids.Production of Biodiesel, Single cell protein (algae and yeast).Microalgal technology – Industrial cultivation methods of *Spirulina* – bio-ethanol Production.Bio Electricity.Pharmaceutically valuable compounds from microalgae.

UNIT- IV: Transgenic Animals and Plants **(18 Hours)**

Transgenic animals: Production and applications of transgenic mice. Agrobacterium mediated transformation: Crown gall disease, Ti plasmids, T-DNA transfer, Ti plasmid derivatives- co-integrate vectors, binary vectors. Gene transfer to plants-development of pesticide, Insecticide and stress resistant plants .Plant tissue culture and its types.

UNIT -V: Intellectual Property Rights and Bioethics **(20 Hours)**

Intellectual Property Rights (IPR) - different types of IPRs. Introduction of Patents and patent application process (national and International), Patent applications- national and international,

Patent infringement, Patent Claims and Legal decision-making process. Principles of Bioethics– Good Laboratory Practices (GLP), Good Manufacturing Practices (GMP) **-** Definition of Ethics and Bioethics. - Ethics committee - Brief account on risks and ethics of modern biotechnology.

Total Lecture Hours- 90

COURSE OUTCOME

After the completion of the course, the students will be able to,

1. Understand potentiality of microbes in product development and pharmaceutically valuable compounds from microbial biomass
2. Utilize the Microbes for Environmental Management
3. Formulate pharmaceutically valuable compounds from microalgae
4. Develop transgenic plants and animals
5. Acquire knowledge about IPR and ethical issues in biotechnology

TEXT BOOKS

1. Crueger W and Crueger A. 1990. Biotechnology: A text Book of Industrial Microbiology 2nd edition Sinauer associates, Inc., United States.
2. Dubey RC. 2013.A textbook of Biotechnology. S. Chand and Company Ltd. New Delhi.
3. Hiren K. Das .2017. Text Book of Biotechnology Wiley India Pvt ltd, New Delhi.
4. Satyanarayana, U., Chakrapani, U 2020. 5th Edition , Biotechnology, Books & Allied Ltd, Kolkata.
5. Naidu, NVR. 2013. Management and Entrepreneurship,I. K. International Pvt Ltd, Karnataka.
6. Tilak, K.V.B.R., 1990. Bacterial Biofertilizers.IARI Publications, New Delhi.
7. Naidu, NVR. 2013. Management and Entrepreneurship,I. K. International Pvt Ltd, Karnataka.
8. Reed,G. 2004. Prescott and Dunn's Industrial Microbiology, (4th edn), CBS publication and distributors. New Delhi.

REFERENCE BOOK(S)

1. Desmond ST Nicholl.2002. An Introduction to Genetic Engineering, 2nd edition, Cambridge university press.
2. Erics Grace. 1997. Biotechnology unzipped-promises and realities. Joseph Henry press, Washington.

3. Glick BR. and Pasternak JJ. 2001. Molecular Biotechnology, ASM press, Washington DC.
4. Glazer AN andNikaido H. 2007. Microbial Biotechnology, 2nd edition, Cambridge University Press.
5. Stanbury PF, Whitaker A and Hall SJ. 1995. Principles of Fermentation Technology 2nd edition, Elsevier Science.
6. Glick BR, Pasternak JJ and Patten CL. 2010 Molecular Biotechnology 4th edition, ASM Press.
7. Gupta PK. 2009. Elements of Biotechnology 2nd edition, Rastogi Publications.
8. Helen Kreuzer and Adrianne Massey. 1996. Recombinant DNA and Biotechnology, American Society for Microbiology, Washington.
9. MukeshPasupuleti. 2006. Molecular Biotechnology. MJP Publishers, Chennai.
10. Old RW and Primrose SB. 1994. Principles of Gene Manipulation, 4th edition, Blackwell Scientific Publications, London.
11. Ramawat K G and ShailyGoyal. 2009. Comprehensive Biotechnology. S. Chand and Company Ltd. 4th edition.
12. Ratledge C and Kristiansen B. 2001. Basic Biotechnology, 2nd Edition, Cambridge University Press.
13. Demain AL and Davies JE. 1999. Manual of Industrial Microbiology and Biotechnology, 2nd Edition, ASM Press. United States.
14. Singh, J., Vyas, A., Wang, S., Prasad, R. (Eds). 2020. Microbial Biotechnology: Basic Research and Applications,Springer, Nature,SingaporePvt Ltd. Singapore.
15. Willey JM, Sherwood LM, Woolverton CJ. Prescott, Harley and Klein's, 2014. Microbiology, 9th edition, McGraw Hill Publishers. New Delhi.
16. FarshadDarvishi, 2014. Microbial Biotechnology: Progress and Trend Publisher: CRC Press/Taylor & Francis Group, Editor: FarshadDarvishiHarzevili and HongzhangChen ISBN: 978-1-4822-4520-2.

E-RESOURCES

1. https://www.microscopemaster.com/tissue-culture.html
2. https://www.nap.edu/read/10418/chapter/3

3. http://www.biologydiscussion.com/essay/enzymes-essay/role-of-enzymes-in-geneticengineering-essay-genetic-engineering/84627
4. https://www.slideshare.net/drashutoshtiwari/monoclonal-antibody-36962354
5. https://openstax.org/books/principles-management/pages/7-4-start-your-own-business DOI:10.13140/2.1.3187.6804
6. https://study.com/academy/lesson/Ins.titutional-entrepreneurship-theory-examples.html
7. https://study.com/articles/Fermentation_Microbiologist_Job_Description_Salary_and_Career Outlook.html
8. http://agritech.tnau.ac.in/org_farm/orgfarm_vermicompost.html

Semester: VI- CP-VI: Food and Fermentation Technology, Microbial Biotechnology and Bioethics

Ins. Hours / Week: 6 **Course Credit: 5** **Course Code:R23MB615P**

Food and Fermentation Technology

- Assessment of milk quality by methylene blue reduction test
- Performance of phosphatase test for pasteurized milk.
- Isolation of bacteria from food by Standard Plate Count
- Isolation of Yeast from grapes.
- Wet mount preparation of spoiled bread, tomato, grapes, potato.
- Observation of food samples to study *Leuconsostoc*, *Lactobacillus,Streptococcuslactis*and *Saccharomyces*.
- Production of Citric acid using *Aspergillusniger*
- Starch (Amylase),casein (Protease) and lipid (Lipase) hydrolyses tests

Microbial Biotechnology and Bioethics

- Immobilization of yeast cell using sodium alginate
- Alcohol fermentation by *Saccharomyces cerevisiae* using Grapes
- Estimation of alcohol using Potassium Di-chromate method.
- Commercial production of bioethanol and biogas
- Production of SCP using *Spirullina*
- Production of Mushroom – Polythene bag method

Demonstration

- Preparation of fermented food –Yoghurt and cheese
- Screening of bacteria and actinobacteria for antibiotic and Enzyme production

TEXT BOOKS

1. Aneja KR. 2005. Experiments in Microbiology, Plant pathology and Biotechnology.4thedition,NewAgeInternational Publishers, Chennai.
2. James G Cappuccino and Natalie Sherman 2004. Microbiology: A laboratorymanual.6thedition, Publishedby Pearson Education.
3. Jay JM. 2000. Modern Food Microbiology, 4th edition, CBS Publishers and distributors, New Delhi.
4. Mathur N, 2007. Industrial Microbiology: A Laboratory Manual. 1st Edition, Aavishkar Publishers, Distributor, Rajasthan.
5. NeelimaGarg, Garg K.L, Mukerji K.L., 2020. Laboratory Manual of Food Microbiology, Dreamtech Press, Kerala

6. Ponmurugan P, Nithya R and Fredinose M, 2012. Experimental Procedure in Bioprocess Technology and Downstream Processing. Anjana Book House. Chennai.

REFERENCE BOOK(S)

1. Benson HJ. 1994. Microbiological Applications, WM. C. Brown Publishers, Oxford.
2. Collina CH and Lyne PM. 1985. Microbiological methods – Butter worths, London.
3. Horold J Benson, 1998. Microbiological Applications - Laboratory Manual in General Microbiology. Seventh International edition, Mc Grew-Hill, Boston.
4. Kannan N, 2003. Handbook of laboratory culture media, Reagents, StaIns.and buffers. Panima Publishing Corporation, New Delhi.
5. Kulanthaivel S and. Janarthanan S.2012. Practical Manual on FermentationTechnology.I.K.Internationalpublishinghouse.NewDelhi.

E-RESOURCES

1. https://www.slideshare.net/amjadkhanafridi4all/methylene-blue-reductase-test
2. https://www.slideshare.net/martyynyyte/bacteria-enumeration-37491510
3. https://www.slideshare.net/sukritisingh125/immobilisation-cell-culture
4. https://www.slideshare.net/pillaiaswathy/mushroom-cultivation-75321912
5. https://www.slideshare.net/DhSani1/bioethanol-86295213

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Semester: VI- MBE-II: Recombinant DNA Technology

Ins. Hours / Week: 5 **Course Credit: 3** **Course Code:R23MBEMB2**

UNIT-I: Introduction to rDNA technology (15 Hours)

Milestones in rDNA technology - Definition of gene manipulation - Major steps involved in gene cloning-Isolation and Purification of Chromosomal DNA, Plasmid DNA and RNA, - Chemical Synthesis of DNA, Genomic Library and cDNA Library -applications.

UNIT-II: DNA modifying enzymes (15 Hours)

Discovery, Mode of action and applications of Restriction endonucleases: Type I, II and III, Ligases, DNA polymerases, topoisomerases and DNA modifying enzymes.

UNIT-III: Natural and artificial cloning vectors (15 Hours)

Cloning vectors: Definition and properties – Plasmid based vectors- Natural vectors: pSC101, pSF2124 and pMB1. Artificial vectors: pBR322 and pUC. Phage based vectors: Lamda phage. Hybrid Vectors, Phagemid and Cosmid, BAC, YAC, PAC, MAC and HAC–Expression systems– *E.coli*.

UNIT-IV: Selection and screening of Recombinant (15 Hours)

Selection and screening of Recombinant by Physical– Blue-White Screening, Biolistic Method (Gene gun); Chemical- Calcium chloride and DEAE Methods; Biological-Colony Hybridization Method-Direct Method: Selection by Complementation, Marker in activation methods- Indirect methods: Immunological and Genetic methods.

UNIT-V: Blotting Techniques (15 Hours)

Blotting (Southern, Western, Northern, North- eastern, garden blot, dot and zoo blot) techniques – Types and basic steps in PCR -DNA amplification, RAPD, RFLP and their applications – DNA finger printing - DNA microarray analysis – Applications of rDNA technology in industry, medicine, agriculture and pharmacy.

Total Lecture Hours -75

COURSE OUTCOME

After the completion of the course, the students will be able to,

1. Understand the concepts of rDNA Technology and Gene Manipulation Techniques.
2. Comprehend the Various types of DNA Modifying Enzymes
3. Discuss the various cloning vector and their applications
4. Assess the usage and advantages of molecular tools
5. Acquire knowledge about selection and screening of Recombinant
6. Expertise on Blotting Techniques involved in rDNA Technology

TEXT BOOKS

1. Brown TA. 1995. An introduction to Gene Cloning, 3rd edition, Champman and Hall. Haryana
2. Brown TA. 2008. Genomes. 3rd Edition. New York: Garland Publishing Co. New York: Garland Science.
3. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter. 2002. Molecular Biology of the Cell, 4th Edition. Garland Sciences.

REFERENCE BOOK(S)

1. Brown TA. 2015. Gene Cloning and DNA Analysis, 7th edition, Wiley Blackwell.
2. Glick B.R. and Patten C.L. 2017. Molecular Biotechnology. Principles and Applications of Recombinant DNA, 5th Edn. ASM Press, Washington.
3. Glick BR and Pasternak JJ. 1994. Molecular Biotechnology. Principles and Application of recombinant DNA, ASM Press, Washington.
4. Innis, M.A., D.H. Gelfand and J.J. SnIns.key. 1995. PCR Strategies. Academic Press, San Diego.
5. Julia Lodge, Peter Lund and Steve Minchin 2006. Gene Cloning – Principles and Applications. Taylor and Francis, UK.
6. Keya Chaudhuri. 2012. Recombinant DNA Technology. The Energy and Resources Ins.titute, TERI.
7. Nicholl D.S.T. 2008. An Introduction to Genetic Engineering, 3rdEdn. Cambridge University Press. United Kingdom.
8. Old RW and Primrose SB. 1995.Principle of Gene Manipulation, 5th edition. Blackwell Scientific Publication, Boston.

9. Primrose S.B. and TwymanR.M , 2006. Principle of Gene Manipulation and Genomics, 7thEdn. Blackwell Publishing, United States.
10. Sandy B. Primrose, Richard M. Twyman, Robert W. Old. 2008. Principles of Gene Manipulation. 6th Edition. Blackwell Science.
11. Stanley Maloy 1994. Microbial genetics. 2nd Edition. Jones and Bartlett publisher, Burlington.
12. Tvan R.S. 1997. Recombinant Gene Expression Protocols. Humana Press Inc., Tokowa.
13. Uldis N. Streips and Ronalad E. Yasbin. 2002. Modern Microbial Genetics. 2nd Edition. Wiley-Blackwell, United States
14. Watson J.D. Gann A., Baker T.A., Levine M., Bell S.P and Losick R. 2014. Molecular Biology of Gene, 7thEdn. Pearson Publishers.
15. Watson J.D., Gilman M., Witkowski, J. and Zoller M. 1992. Recombinant DNA. 2nd Edition. Scientific American Books, New York.
16. Winnecker ED. 1987. From gene to clones, Introduction to Gene Technology, VCH Publication, FRG.

E-RESOURCES

1. https://youtu.be/3YRjpiBqSU4
2. https://youtu.be/hqs57VsSk7s
3. https://youtu.be/VXkw_U6mJpc
4. https://ocw.mit.edu/courses/biology/7-014-introductory-biology-spring-2005/video-Lecture/24-recombinant-dna-i/
5. https://ocw.mit.edu/courses/biology/7-014-introductory-biology-spring-2005/video-Lecture/8-biochemistry-vi-cont.-dna-as-genetic-material