BHARATHIDASAN UNIVERSITY  **TIRUCHIRAPPALLI - 620 024.**

B.Sc. MICROBIOLOGY

CHOICE BASED CREDIT SYSTEM –

LEARNING OUTCOMES BASED CURRICULUM FRAMEWORK (CBCS - LOCF)

(Applicable to the candidates admitted from the academic year 2022-23 onwards)

(NAAN MUDHALVAN SCHEME was implemented from 2nd to 6th Semester)

Sem.	Part	Course	Title	Ins. Hrs.	Credit	Exam Hours	Marks		Total
							Int.	Ext.	
I	I	Language Course – I (Tamil $ / Other Languages + #)		6	3	3	25	75	100
	II	English Course – I		6	3	3	25	75	100
	III	Core Course – I (CC)	Basics of Microbiology	5	5	3	25	75	100
		Core Practical – I (CP)	Basics of Microbiology	4	4	3	40	60	100
		First Allied Course – I (AC)	Fundamentals of Biological Sciences	4	4	3	25	75	100
		First Allied Practical (AP)	Fundamentals of Biological Sciences & General Biochemistry	3	-	-	-	-	-
	IV	Value Education		2	2	3	25	75	100
	TOTAL			**30**	**21**	**-**	**-**	**-**	**600**
II	I	Language Course – II (Tamil $ / Other Languages + #)		6	3	3	25	75	100
	II	English Course – II		4	3	3	25	75	100
	III	Core Course – II (CC)	Microbial Physiology	5	5	3	25	75	100
		Core Practical – II (CP)	Microbial Physiology	4	4	3	40	60	100
		First Allied Practical (AP)	Fundamentals of Biological Sciences & General Biochemistry	3	2	3	40	60	100
		First Allied Course – II (AC)	General Biochemistry	4	4	3	25	75	100
		Add on Course – I ##	Professional English – I	6*	4	3	25	75	100
	IV	Environmental Studies		2	2	3	25	75	100
	VI	Language Proficiency for Employability (NMS) @@	Language Proficiency for Employability -Effective English	2	2	3	25	75	100
	TOTAL			**30**	**29**	**-**	**-**	**-**	**900**

III	I	Language Course – III (Tamil $ / Other Languages + #)		6	3	3	25	75	100
	II	English Course – III		6	3	3	25	75	100
	III	Core Course – III (CC)	Introductory Virology	5	5	3	25	75	100
		Core Practical – III (CP)	Introductory Virology	4	4	3	40	60	100
		Second Allied Course – I (AC)	Biostatistics	4	4	3	25	75	100
		Second Allied Practical (AP)	Biostatistics & Bioinformatics and Computational Biology	3	-	-	-	-	-
		Add on Course – II ##	Professional English - II	6*	4	3	25	75	100
	IV	Non-Major Elective – I @ Those who choose Tamil in Part I can choose a non-major elective course offered by other departments. Those who do not choose Tamil in Part I must choose either a) Basic Tamil if Tamil language was not studied in school level or b) Special Tamil if Tamil language was studied upto 10th & 12th std.	Clinical Bacteriology	2	2	3	25	75	100
	VI	Naan Mudhalvan Scheme (NMS) @@	Digital Skills for Employability – Microsoft Digital Skills	-	2	3	25	75	100
	TOTAL			**30**	**27**	**-**	**-**	**-**	**800**
IV	I	Language Course –IV (Tamil $ / Other Languages + #)		6	3	3	25	75	100
	II	English Course – IV		6	3	3	25	75	100
	III	Core Course – IV (CC)	Immunology	5	5	3	25	75	100
		Core Practical – IV (CP)	Immunology	4	4	3	40	60	100
		Second Allied Practical (AP)	Biostatistics & Bioinformatics and Computational Biology	3	2	3	40	60	100
		Second Allied Course – II (AC)	Bioinformatics and Computational Biology	4	4	3	25	75	100
	IV	Non-Major Elective II @ - Those who choose Tamil in Part I can choose a non-major elective course offered by other departments. Those who do not choose Tamil in Part I must choose either a) Basic Tamil if Tamil language was not studied in school level or b) Special Tamil if Tamil language was studied upto 10th & 12th std.	Antimicrobial Agents	2	2	3	25	75	100
	VI	Naan Mudhalvan Scheme (NMS) @@	Employability Skills - Employability Skills	-	2	3	25	75	100
	TOTAL			**30**	**25**	**-**	**-**	**-**	**800**

V	III	Core Course –V (CC)	Medical Microbiology	5	5	3	25	75	100
		Core Course – VI(CC)	Environment and Agricultural Microbiology	5	5	3	25	75	100
		Core Course – VII(CC)	Molecular Biology and Microbial Genetics	5	5	3	25	75	100
		Core Practical –V (CP)	Medical Microbiology, Environment and Agricultural Microbiology & Molecular Biology and Microbial Genetics	4	4	3	40	60	100
		Major Based Elective – I (Any one)	1. Diagnostic Microbiology 2. Pharmaceutical Microbiology	5	4	3	25	75	100
	IV	Skill Based Elective I	Mushroom Technology	4	2	3	25	75	100
		Soft Skills Development		2	2	3	25	75	100
	VI	Naan Mudhalvan Scheme (NMS) @@	Advanced Technology for Employability in Life science – Medical Coding	-	2	3	25	75	100
	TOTAL			**30**	**29**	**-**	**-**	**-**	**800**
VI	III	Core Course – VIII (CC)	Food Microbiology	6	5	3	25	75	100
		Core Course – IX (CC)	Industrial Microbiology	6	5	3	25	75	100
		Core Practical – VI(CP)	Food Microbiology and Industrial Microbiology	4	4	3	40	60	100
		Major Based Elective – II (Any one)	1. Recombinant DNA Technology 2. Microbial Biotechnology & Bioethics	5	4	3	25	75	100
		Project	Group Project (3 to 5 candidates)	4	3	-	20	80	100
	IV	Skill Based Elective – II	Biofertilizer Technology	4	2	3	25	75	100
	V	Extension Activities **		-	1	-	-	-	-
		Gender Studies		1	1	3	25	75	100
	VI	Naan Mudhalvan Scheme (NMS) @@	Advanced Medical Coding	-	2	3	25	75	100
	TOTAL			**30**	**27**	**-**	**-**	**-**	**800**
GRAND TOTAL				**180**	**158**	**-**	**-**	**-**	**4700**

$ For those who studied Tamil upto 10th +2 (Regular Stream).

+ Syllabus for other Languages should be on par with Tamil at degree level.

Those who studied Tamil upto 10th +2 but opt for other languages in degree level under Part- I should study special Tamil in Part – IV.

The Professional English – Four Streams Course is offered in the 2nd and 3rd Semester (only for 2022-2023 Batch) in all UG Courses. It will be taught apart from the Existing hours of teaching / additional hours of teaching (1 hour /day) as a 4 credit paper as an add on course on par with Major Paper and completion of the paper is must to continue his / her studies further. (As per G.O. No. 76, Higher Education (K2) Department dated: 18.07.2020).

* The Extra 6 hrs / cycle as per the G.O. 76/2020 will be utilized for the Add on Professional English Course.

@ NCC Course is one of the Choices in Non-Major Elective Course. Only the NCC cadets are eligible to choose this course. However, NCC Course is not a Compulsory Course for the NCC Cadets.

** Extension Activities shall be outside instruction hours.
@@ Naan Mudhalvan Scheme.

SUMMARY OF CURRICULUM STRUCTURE OF UG PROGRAMMES

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	800
4.		Core Practical	6	24	700
5.		Allied Courses I & II	4	16	400
6.		Allied Practical	2	4	200
7.		Major Based Elective Courses	2	8	200
8.		Add on Courses	2	8	200
9.		Project	1	3	100
10.	IV	Non-Major Elective Courses (Practical)	2	4	200
11.		Skill Based Elective Courses	2	4	200
12.		Soft Skills Development	1	2	100
13.		Value Education	1	2	100
14.		Environmental Studies	1	2	100
15.	V	Gender Studies	1	1	100
16.		Extension Activities	1	1	0
17.	VI	Naan Mudhalvan Scheme	5	10	500
	Total		**48**	**158**	**4700**

PROGRAMME OUTCOMES

- Graduates would acquire both theoretical and practical knowledge of fundamental concepts in Microbiology.
- Graduates would knowledgeably be competent with characteristics, skills and cognizance established.
- A microbiologist could enter into higher studies for their passion of futuristic drive or could prefer academia for manifesting instructional capability.
- After graduation, the graduates can join public health sectors not only for career advancement but, for the betterment/welfare of the human society as well.
- Understand and appreciate the importance of microbes in different arena of novelty for day-to-day applications.

PROGRAMME SPECIFIC OUTCOMES

- Understanding of the fundamentals of Microbiology as applicable to wide ranging frameworks.
- Graduates would have appropriate aids of Microbiology and can perform their duties as a subject authority.
- The interdisciplinary subjects of Microbiology graduates would attribute them with skills of other arena and would assist in solving broader problems.
- Knowledge of the Microbiology curriculum and other allied subjects together would certainly guarantee promising career opportunities in academic, research and industrial sectors.
- The knowledge of microbes, understanding of microbial nature and benefits of their byproducts' for human society would ensure lifelong merit.

First year	CORE COURSE I BASICS OF MICROBIOLOGY	Semester I
Code	(Theory)	Credit 5

COURSE OBJECTIVES:

- To understand classification of microorganisms and basic concepts of Microscopes.
- To understand bacterial size, shape and their structure.
- To understand the general characteristics of prokaryotic and eukaryotic microorganisms.
- To understand the concept of microbial control.
- To understand the process of microbial growth and nature of culture media.

UNIT – I History, Taxonomy and Microscopy:

Introduction-Definition, scope of Microbiology, Concepts of Microbiology, Major contribution of microbiologists. Classification – Taxonomy, Taxonomic ranks – Three kingdom concept, five kingdom concept, three domain concepts. Microscopy: Principles and applications of microscopes: brightfield, dark field, phase contrast, fluorescent, SEM and TEM. Micrometry – measurement of bacterial size.

UNIT – II Classification and Ultrastructure:

Difference between prokaryotic and eukaryotic microorganisms. Outline classification of bacteria on the basis of Bergey's manual of systemic bacteriology. Structural organization of bacteria – Size, shape and arrangement of bacterial cells - Ultrastructure of a bacterial cell - cell wall, cell membrane, ribosomes, nucleoid, slime, capsule, flagella, fimbriae, spores, cysts, plasmid, mesosomes and cytoplasmic inclusions.

UNIT – III General Characters, Eucaryotic Classification and Staining:

General characteristics and nature of Archaeobacteria, Cyanobacteria, Mycoplasma, Rickettsiae, Chlamydia, Spirochaetes, Actinobacteria, Protozoa, Algae, Fungi, lichens and Viruses. Basic understanding of classification of algae-Fritch, fungi-Alexopoulos and protozoa. Principles and types of staining– Simple, gram, acid fast, spore and Capsule staining.

UNIT – IV Control of Microorganisms:

Physical methods of Sterilization - Moist heat, dry heat and filtration and radiation – Chemical methods of sterilization – phenolics, alcohols, heavy metals, aldehydes and gaseous chemicals. Antimicrobial chemotherapy – Mode of action of antibiotics. Factors affecting the growth of microorganisms.

UNIT – V Microbial Growth:

Culture media – Types of Medium, simple, enriched, enrichment, selective, differential and transport medium. Classification medium. Common ingredients

of culture media – peptone Sodium chloride, yeast extract beef extract and agar-agar. Pure culture techniques – Serial dilution, pour plate, spread plate and streak plate technique. Aerobic and Anaerobic culture techniques. Preservation of microorganisms.

Unit – VI Current Contours (For continuous internal assessment only):

Comment on recent trends in microbiology. How microbes relate to biotechnological innovations. Impart knowledge in ubiquitous nature of microorganisms. Identification features in relation to morphology and culture.

REFERENCES:

1. Alcamo IE. 2001. Fundamentals of Microbiology, sixth edition, Addison wesley Longman, Inc. California.
2. Dubey RC and Maheswari DK. 2010. A Text Book of Microbiology. S Chand, New Delhi.
3. Madigan MT, Martinko JM, and Parker J. 2009. Biology of Microorganisms, 12th Edition, MacMillan Press, England.
4. Pelczar MJ, Chan ECS and Kreig NR. 2009. Microbiology, 5th Edition. McGraw- Hill. Book Co.Singapore.
5. Prescott LM, Harley JP, and Klein DA. 2007. Microbiology (7th edition) McGraw Hill, Newyork.
6. Schlegel HG. 2008. General Microbiology, Cambridge University Press, U.K.
7. Tortora GJ, Funke BR and Case CL. 2009. Microbiology: An Introduction. 9th Edition, Pearson Education, Singapore.
8. Rajan S and Selvi Christy R. 2018. Essentials of Microbiology, CBS Publishers, NewDelhi, 2018.
9. Holt, J.S., Kreig, N.R., Sneath, P.H.A., Williams, S.T. 1994. Bergeys Manual of Determinative Bacteriology, 9th edition, William and Wilkins, Baltimore.
10. George Plopper, Diana Bebek Ivankovic. 2020. Principles of Cell Biology. 2020. 3rd Edition John willey.
11. https://www.basic-concept.com/c/basic-types-of-nutrition-with-explanations
12. https://www.labconco.com/articles/a-brief-introduction-to-kjeldahl-nitrogen-determ
13. https://microbenotes.com/light-microscope/

COURSE OUTCOMES:

Upon successful completion of this course, the students would be able to:

- Understand the historical Developments in Microbiology.
- Understand the usage of microscopes to know the size and shape of microorganisms.
- Understand eubacteria, archaebacteria and actinomycetes.
- Understand systemic classification of microorganisms.
- Understand the concept of microbial growth, culture media and the process of controlling microbial growth.

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First year	CORE PRACTICAL I BASICS OF MICROBIOLOGY	Semester I
Code	(Practical)	Credit 4

COURSE OBJECTIVES:

- To operation of all laboratory equipments,
- To isolation techniques of microorganisms
- To staining of microbial cells
- To enumeration methods of microorganisms
- To understand basic structure of microbes.

EXPERIMENTS:

1. Laboratory rules and regulations.
2. Basic requirements of Microbiology laboratory.
3. Principles and operations – Autoclave, Hot Air Oven, Incubators, Laminar Air Flow, Filtration, colony counter, Centrifuge, pH meter, Colorimeter and Spectrophotometer
4. Cleaning and sterilization of glassware.
5. Preparation of culture media – solid, semi-solid and liquid.
6. Illustrate contributions of Antony Von Leuwenhoek Louis Pasteur, Sergi Winogradsky, Alexander Fleming, Robert Koch, Joseph Lister and Edward Jenner.
7. Measurement of size of microbes – micrometry.
8. Isolation of bacteria, actinobacteria, fungi and cyanobacteria from soil sample.
9. Pure culture techniques - Streak plate, Pour plate and Spread plate.
10. Test for motility of bacteria – Hanging drop method
11. Staining techniques – Simple staining, Gram's staining, Spore-staining, Capsular staining and LPCB.
12. Observation of permanent slides to study the structural characteristics of algae (*Anabena, Nostoc, Spirulina, Oscillatoria*), fungi (*Rhizopus, Saccharomyces, Penicillium, Aspergillus*, *Agaricus*) and protozoa (*Entamoeba histolytica, Giardia lamblia* and *Plasmodium* sp.).
13. Components and uses of Peptone, sodium chloride, Yeast extract, agar- agar, Nutrient agar, EMB agar, Mac Conkey agar, Mueller Hinton Agar and Potato Dextrose agar.

REFERENCES:

1. Monica Cheesbrough. 2006. District Laboratory Practice in Tropical Countries - Part I and II 2 nd edition. Cambridge University Press, New Delhi.
2. Rajan S. 2012. Manual for Medical Laboratory Technology. Anajanaa Book House, Chennai.
3. Betty A Forbes, Daniel F Sahm and Alice S Weissfeld. 2007. Bailey and Scott's Diagnostic Microbiology, 12th Edition. Mosby Elsevier.
4. Mackie and McCartney. 2006. Practical Medical Microbiology, 14th Edition. South Asia Edition.
5. Rajan S and Selvi Christy R.2018. Experimental Procedures in Life Sciences. CBS Publishers, New delhi.

COURSE OUTCOMES:

After the completion of this lab course, the students will be able to:

- Understand basics of laboratory rules and minimum requirements of a laboratory – equipments / instruments and their operations.
- Understand media preparation methods.
- Understand pure culture methods to isolate and enumerate microbes.
- Understand various staining techniques.
- Understand morphological features of micro-organisms.

First year	FIRST ALLIED COURSE I FUNDAMENTALS OF BIOLOGICAL SCIENCES	Semester I
Code	(Theory)	Credit 4

COURSE OBJECTIVES:

- To gain the basic knowledge about plants and animals.
- To study the biological concepts of plant and animal evolution and establishments.
- To understand the biological sciences' importance to human society.
- To enhance the student knowledge from current biological diversity to safe earth.
- To introduce the recent research topics as to stimulate the learners' interest towards higher studies.

UNIT – I Origin, Evolution, Diversity of Biological Sciences:

Origin of life theory, history and evolution of biology. Chemical basis of life and diversity of life forms. General characteristic features of living organisms: Plants, animals and microorganisms. Hierarchical levels of organization in living organisms; difference between prokaryotes and eukaryotes.

UNIT – II Plant Diversity and Taxonomy:

Introduction, plant nomenclature - Binomial system, International Code of Botanical Nomenclature (ICBN). Types of classification and plant taxonomy. Salient features and distribution of lichens, bryophytes, pteridophytes, gymnosperms and angiosperms.

UNIT – III Plant Functional Traits and Values:

Physiology and reproduction of plants: photosynthesis; anatomy and embryological features; pollination biology; micropropagations. Economic importance of plants and value-added products.

UNIT – IV Animal Diversity and Taxonomy:

Introduction to animal kingdom and evolutionary theories. International code of zoological nomenclature (ICZN). Types of classification and nomenclatures of animals. Salient features and distribution of invertebrates and vertebrates.

UNIT – V Animal Functional Traits and Values:

Introduction to animal physiology. Growth and homeostasis. Animal behaviour. Brief on comparative anatomy and physiology. Animal reproductive biology and endocrinology. Biological importance on presence of diverse animals.

Unit – VI Current Contour (For continuous internal assessment only):

Importance of biological sciences and their study with relevance to the existence of life on planet earth. Integration of biological sciences with various fields for human welfare. Stem cells and regenerations research.

REFERENCES:

1. Annie Regland and Kumaresan. Angiosperms, Saras publication, Nagercoil.2013.
2. Pandey BP. Taxonomy of Angiosperms, S. Chand and company ltd, New Delhi.1999.
3. Kumaresan V. Horticulture and plant breeding, Saras publication. 2009.
4. Balinsky B. An introduction to embryology, 3rd edition, W.B. Saunders, Philadelphia. 1981.
5. Pandey BP. Plant pathology, S. Chand and company ltd. 2009.
6. Douglas J Futyma. Evolutionary biology, 2nd edition, Sinauer Associates.1989.
7. Eli C Minkoff. Evolutionary biology, Addition- Wesley.1983.
8. Pandey BP. Taxonomy of Angiosperms, S. Chand, New Delhi.1999
9. Sharma PD. Microbiology and plant physiology Rastogi publications.2001.
10. Young E, Alper H. Synthetic biology: tools to design, build, and optimize cellular processes. J Biomed Biotechnol. 2010; 2010:130781.
11. Verma V. Text book of plant physiology, Ane Books India, New Delhi.2007.
12. Jain VK. Fundamentals of plant physiology, S. Chand and Co, New Delhi.2006.
13. Pandey SN and Sinha BK. Plant physiology, 4th edition, Vikas publishing, ND. 2006.

COURSE OUTCOMES:

Upon successful completion of this course, the students would be able to:

- Gain knowledge about plants and animals on a par with their higher education.
- Understand the biological concepts of plant and animal evolution and their establishments.
- Imbibe the biological sciences' importance to human society.
- Enhance their knowledge of existing biological diversity and of a safe earth.
- Know the current research topics that could stimulate them towards higher studies.

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First year **FIRST ALLIED PRACTICAL** **Semester I**

FUNDAMENTALS OF BIOLOGICAL SCIENCES & GENERAL BIOCHEMISTRY

Code **(Theory)** **Credit 2**

COURSE OBJECTIVES:

- To understand the plants' tissue anatomical structure.
- To learn the comparative characteristic features of vegetative natures.
- To study the morphological differences among microbes using microscopes.
- To isolate the endophytic microorganisms from medicinal plants.
- To study the microbes based on various staining techniques
- To be aware of laboratory safety methods and calibration procedures.
- To make well versed in molecular techniques.
- To motivate for innovative findings in microbial molecular mechanism.
- To train on the basic separation techniques.
- To understand the pigments' profiles using appropriate methods.

EXPERIMENTS:

1. Stem, leaf and root sections of a monocot and a dicot plant
2. Study through permanent slides and specimens (vegetative and reproductive structures) of Coleacheate, *Vaucheria, Polysiphonia, Fucus (*fucus permanent slides only*); Rhizopus, Penicillium* and *Agaricus; Riccia, Anthoceros, Funaria; Cycas, Pinus,*
3. Study of the characteristic features of any two flowers for each family: a. Malvaceae/Fabaceae/Cruciferae (any one family), (b) Compositae, c. Euphorbiaceae, (d) Poaceae/Liliaceae (any one family)
4. Extraction of compound from medicinal plant.
5. Determination of ABO Blood group
6. Enumeration of red blood cells and white blood cells using haemocytometer
7. Estimation of haemoglobin using Sahli's haemoglobinometer
8. Preparation of haemin and haemochromogen crystals
9. Safety measures in laboratories, use and calibration of pipettes.
10. Preparation of normal, molar and percent solutions.
11. Concept of pH and preparation of buffers.
12. Assay of enzyme activity of Alkanine Phosphatases, SGOT, SGPT.
13. Estimation of polysaccharide (starch or glycogen) from the biological material.
14. Separation of amino acids by paper chromatography and identification of amino acid.
15. Separation of proteins by PAGE, SDS – PAGE – Demonstration.
16. Pigments (Chlorophyll-Carotenoids–Phycobili Proteins)–Spectrophotometry.

REFERENCES:

1. Burran and DesRochers. 2021Principles of Biology I Lab Manual
2. Jerry G. Chmielewski and David Krayesky General Botany Laboratory Manual. 2013 Publisher: Author House ISBN: 978-1-4772-9653-0
3. Naveena Varghese and P.P. Joy Microbiology Laboratory Manual. 2014 Edition: 1 Publisher: Aromatic and Medicinal Plants Research Station
4. Pakpour & Horgan. 2021.General Microbiology Lab Manual
5. Josephine A. Morello Paul A. Granato Helen and Eckel Mizer. 2003Laboratory Manual and Workbook in Microbiology Applications to Patient Care. ISBN: 0-07-246354-6.
6. Pattabiraman, 2015. Laboratory manual in biochemistry fourth edition. All Indian

Publisher
7. Sattanathan, S.S. Padmapriya, B. Balamuralikrishnan. 2020. Practical Manual of Biochemistry. Skyfox Publishing Group Skyfox Press
8. DM Vasudevan and Subir Kumar Das. 2013. Practical Textbook of Biochemistry for Medical Students. Jaypee Brothers Medical Publishers (P) Ltd
9. Gyorgy H, Jozsef K, Mihaly, K. Introduction to Practical. 2013 Eötvös Loránd University

COURSE OUTCOMES:

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

- Acquire a knowledge on specimen preparation from plant samples
- Practice handling of microscopes.
- Get a clear practical knowledge on various staining techniques.
- Study the isolation methods of both aerobic and anaerobic bacteria.
- Know the compounds' extraction and purification methods from plant sources for value added products.
- Understand important laboratory safety and precautionary measures.
- Know the principles and calibration of basic analytical instruments.
- Learn the molecules' separation techniques
- Derive the pigmentation profiles of microbes/ plants
- Comprehend the biological materials and their polysaccharide level.

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First year **CORE COURSE II** **Semester II**

MICROBIAL PHYSIOLOGY

Code **(Theory)** **Credit 5**

COURSE OBJECTIVES:

- To impart among the learners the fundamental principles of microbial physiology.
- To provide the role / functions of various organelles of a cell.
- To understand the route of a cell to metabolize carbohydrate, protein and fatty acids.
- To highlight the microbial enzymes' profiles and their activity.
- To underscore the significance of each chemical component of a microbiological medium towards the growth of the organism through theory classes & self-demonstrations.

UNIT – I Microbial Growth and Growth Curve:

Microbial nutrition and growth: Nutritional requirements of microbes - Autotrophs, Heterotrophs, Photoautorophs, Chemoautotrophs, Copiotrophs, Oligotrophs, Factors influencing microbial growth – pH, temperature, substrate and osmotic condition. Bacterial growth curve & importance of the growth phases – Generation time - Growth measurements – batch, continuous and synchronous. Diauxic growth.

UNIT – II Microbial Enzymes:

Bacterial enzymes – classification & nomenclature, properties, kinetics of enzyme action – Michaelis-Menton equation for simple enzymes - coenzymes and cofactors, isozymes. Factors affecting enzyme activity.

UNIT – III Carbohydrates: Anabolism & Catabolism:

Carbohydrate metabolism: Anabolism – bacterial phototsynthesis – oxygenic – anoxygenic, synthesis of carbohydrate – catabolism of glucose – EMP – HMP – ED pathways, TCA cycle – electron transport system, Phosphorylation, oxidative and substrate level phosphorylations.

UNIT – IV Proteins: Anabolism & Catabolism:

Protein metabolism – synthesis and degradation of amino acids – glycine tyrosine, cysteine, serine, glutamine, synthesis of peptides and proteins – urea cycle

UNIT – V Fatty Acids Metabolism:

Lipids metabolism – biosynthesis of fatty acids and cholesterol – oxidation of fatty acids. Anaerobic Respiration – Nitrate, sulphate and methane respiration – Fermentations – alcoholic, propionic, mixed acid, lactic acid fermentation.

UNIT – VI Current Contours (For continuous internal assessment only):

Demonstration on the role of nutrients & individual components of nutrient agar, nutrient broth, Mac Conkey Agar, *Salmonella–Shigella* Agar, Mueller-Hinton Agar, Hektoen Enteric Agar, Mannitol Salt Agar, Robertson Cooked Meat Broth – assignments on types of microbial nutrients – bacterial growth curve - Diauxic growth – classification & nomenclature of enzymes – factors affecting enzyme activity - EMP – HMP – ED pathways, TCA cycle – ATP production – protein synthesis – fermentation – fatty acid

oxidation – short seminar classes – debates of selected topics of the course – discussion of previous year question papers.

REFERENCES:

1. Moat G, John W. Foster and Michael P. Spector (2002). Microbial physiology. Fourth edition, A John Wiley sons, Inc. publication. New Delhi.
2. Dubey RC and Maheswari DK (2022). A Text of Microbiology. Revised edition, S. Chand and Company Ltd., New Delhi
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4. Rajan S and Selvichristry (2019). Exam Oriented Biochemistry. CBS Publishers, New Delhi
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10. Mathews CK and Holde KEV. (2003) Biochemistry – The Benjamin/Cummings Publishing company, Inc., New York..
11. Murray RK, Granner MD, Mayes PA and Rodwell VW. (2000) Biochemistry – Prentice Hall International Inc., London.
12. Pelczar TR M J Chan ECS and Kreig N R (2006). Microbiology. Tata Mc GrawHill INC., New York.
13. https://www.elsevier.com/books/bacterial-physiology-and metabolism/ sokatch/ 978-1-4832-3137-2
14. 3.https://bio.libretexts.org/Bookshelves/Microbiology/Book%3A_Microbiology_(Bruslind)/11%3A_Microbial_Nutrition
15. https://microbiologynotes.org/introduction-to-the-microbial-nutrition/

COURSE OUTCOMES:

Upon successful completion of this course, the students would be able to:

- Understand the nature of nutrients required by microbes.
- Learn the macro molecules' classification based on their nutritional needs.
- Grasp various factors which effect & affect microbial growth as well as the functions of enzymes.
- Comprehend how energy is synthesized from carbohydrates, proteins and fatty acids
- Understand the synthesis of macro molecules through metabolism.

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First year	CORE PRACTICAL II MICROBIAL PHYSIOLOGY	Semester II
Code	(Practical)	Credit 4

COURSE OBJECTIVES:

- To provide the students hands-on practice on the first-line microbial physiology experiments.
- To train the learners to independently test various carbohydrate fermenting abilities of microbes.
- To make the students to understand the principles of significant biochemical tests done to identify bacterial isolates.
- To educate microbial growth experiments and their impacting factors.
- To provide hands- on experience of microbial cultivations by different methods.

EXPERIMENTS:

1. Bacteria & carbohydrate fermentation tests: Glucose, Lactose, Sucrose and Mannitol.
2. Biochemical tests to identify bacterial isolates - IMViC test, Oxidase test, Catalase test, Urease test, TSI test
3. Enzymatic Hydrolysis of Starch & Casein by selective bacterial isolates.
4. Bacterial (*Escherichia coli)* Growth curve: Cell count
5. Measurement of Microbial growth –Turbidity methods.
6. Studying the influence of temperature & pH on the growth of test bacteria.
7. Anaerobic bacterial cultivation - candle jar method.

REFERENCES:

1. Aneja KR (2017). Experiments in Microbiology, Plant pathology and Biotechnology. 4th Edition, NewAge International Publishers, Chennai.
2. J. Mudili (2020), Introductory Practical Microbiology, Narosa publishers
3. Amita Jain, Jyotsna Agarwal, Vimala Venkatesh (2018). Microbiology Practical Manual, 1st Edition
4. James G. Cappuccino, (2014). Microbiology: A Laboratory Manual, 10th Edition, Pearson
5. Dubey RC and Maheswari DK (2004). Practical Microbiology 1st Edition, S. Chand & Company Ltd., New Delhi.
6. Kannan N (2003). Handbook of Laboratory Culture Media, Reagents, Stains and Buffers. Panima Publishing Corporation, NewDelhi.
7. Rajan S and Selvi Christy R. (2018). Experimental Procedures in Life Sciences. CBS Publishers, New delhi.
8. Sundararaj T. Microbiology laboratory manual. Revised and published by Aswathy Sundararaj.No.5 First Cross Street, Thirumalai Nagar, Perungudi, Chennai.
9. https://www.frontiersin.org/books/Microbial_Physiology_and_Metabolism
   https://onlinelibrary.wiley.com/doi/book/10.1002/0471223867

COURSE OUTCOMES:

Upon successful completion of this course, the students would be able to:

- Test & determine sugar fermenting/ utilizing abilities of different bacterial species.
- Understand the principles behind important biochemical tests done to identify/characterize bacterial species.
- Determine growth stages of a test bacterial species.
- Evaluate the impact of various external components on the microbial growth.
- Grow anaerobic bacteria in a conventional microbiology laboratory.

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First year	FIRST ALLIED COURSE II GENERAL BIOCHEMISTRY	Semester II
Code	(Theory)	Credit 4

COURSE OBJECTIVES:

- To provide basic understandings of cell structural compositions.
- To teach biochemical nature and functions of microbes.
- To study the basics of bio-molecules' synthesizing mechanisms and regulations.
- To know the biological energy sources and transferring molecules.
- To understand the molecules involved in metabolic functional systems.

UNIT – I Cell and Its Function:

Composition of living matter. Biochemistry of microbial, plant and animal cells. Specialized components of microorganisms and their structure and function.

UNIT – II Enzymes:

Enzymes as biocatalysts, enzyme classification, specificity, active site, unit activity, isozymes. Enzyme kinetics: Michaelis Menton equation for simple enzymes. Enzyme inhibition.

UNIT – III Types of Macromolecules and Properties:

Structural features and chemistry of macromolecules. Nucleic acid –Structure of DNA and RNA; functional properties. Proteins – classification – Amino acids - primary-secondary-tertiary – quaternary and three-dimensional structure of proteins. Carbohydrates - mono, di, oligo and polysaccharides. Lipids and biomolecules: Fatty acids, properties, -oxidation and reduction reactions.

UNIT – IV Biosynthesis of Macromolecules:

Nucleic acids: biosynthesis of purines and pyrimidines. Proteins – biosynthesis from DNA. Fatty acid biosynthetic pathways. Biosynthesis of cholesterol. Assembly of carbohydrate from monomeric structures and the enzyme involved in the synthesis.

UNIT – V Bioenergetics:

Bioenergetics and strategy of metabolism - flow of energy through biosphere, strategy of energy production in the cell. Oxidation – reduction reactions, coupled reactions and group transfer. ATP production, structural features of biomembranes, transport, free energy and spontaneity of reaction, G, G°, G' and equilibrium. Basic concepts of acids, base, pH and buffers.

UNIT – VI Current Contour (For continuous internal assessment only):

Different biochemical pathways. Types Diabetics mellitus. Promotion and inhibition of drug functioning mechanisms. Biochemical limitation and solutions in disease diagnostic practices.

REFERENCES:

1. Christopher K Mathews and Van Holde KE. Biochemistry. 2nd edition. The Benjamin/Cummings publishing company, Inc.1996.
2. David E Metzler and Carol M Metzler. Biochemistry -The chemical reactions of living cells- Vol1and2.2nd edition. Harcourt/Academic press, Newyork. 2001.
3. Donald Voet and Judith G. Voet. Biochemistry – Second Edition. John Willey and Sons, Inc.1995.
4. Freifelder D. Molecular Biology, II Edition, Narosa Publishing House, New Delhi.1996.
5. Geofferey L and Zubay. Biochemsitry. Fourth Edition. Wm. C. Brown Publishers.1998.
6. Jeremy M Berg, John L Tymoczko and Lubert stryer. Biochemistry.5th edition. W.H. Freeman and company, Newyork.2002.
7. Stryer L Berg JM and Tymoczko JL. Biochemistry. 5th edition. New York: W. H. Freeman. 2002.
8. Reginald H Garret and Charles M Grishm. Biochemistry (Second Edition) Saundars College Publishing.1998.
9. Thomas M Devlin. Textbook of Biochemistry with clinical correlations. 5th edition. A John Wiley and sons, Inc., publication, Newyork.2002.
10. Trudy McKee and James R McKee. Biochemistry-An Introduction.2nd edition. WCB McGraw- Hill, U.S.A. 1999.
11. Lehninger, Albert L, David L Nelson and Michael M Cox. Lehninger Principles of Biochemistry. New York: Worth Publishers. 2000.
12. Rafi MD. Textbook of Biochemistry for medical students, 2nd edition, Universities Press, (India) Pvt. Ltd, Hyderabad, India. 2014.

COURSE OUTCOMES:

Upon successful completion of the course, the students would be able to:

- Assimilate the basic knowledge of cell structural compositions.
- Understand the biological & chemical nature and functions of cells.
- Describe the basics of bio-molecules synthesizing mechanisms and their regulations.
- Explain about biological energy sources and transferring molecules.
- Understand the molecules associated with metabolic functional systems.

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Second year **CORE COURSE III** **Semester III**

INTRODUCTORY VIROLOGY

Code **(Theory)** **Credit 5**

COURSE OBJECTIVE:

- To facilitate in understanding basics of viruses and their discovery.
- To impart the structure and classification of viruses.
- To teach about virus assay and diagnostics.
- To provide the fundamentals of bacteriophages.
- To understand the important features of plant viruses and common properties of human viruses.

UNIT – I General Virology:

Virus – History of Virology - General properties of Viruses – Classification of Viruses (LHT, Baltimore and ICTV) - Ultra structure of Viruses – Sub viral agents- viroids, prions, virusoids and satellite viruses – Replication of Viruses.

UNIT – II Diagnostic Virology and Control of Viruses:

Cultivation of viruses- Embryonated eggs and Primary and secondary cell cultures. Serological methods- hemagglutination, hemagglutination inhibition, complement fixation, immunofluorescence, ELISA, RIA and assay of viruses. Purification, Characterization, Separation and Assay of Viruses. Viral Vaccines antiviral drugs, Interferons.

UNIT – III Phages:

Bacteriophages - Classification - Structure and life cycle of T4 Phage, Lambda Phage and M13 Phage-lytic and lysogenic Life cycles - Bacteriophage typing - Cyanophages, Microphages and cultivation strategies of phages from sewage.

UNIT – IV Human Viruses:

Classification - Structure, Multiplication, Pathogenesis, Diagnosis, Prevention and Treatment of following animal viruses – Polyomaviridae (Simian Virus – 40), Herpesviridae (HSV 1), Pox viridae (Small Pox), Hepadnaviridae (HBV), Picornaviridae (HAV), Rhabdoviridae (Rabies virus), Orthomyxoviridae (Influenza Virus), Retroviridae (Human Immuno Deficiency virus), Filoviridae (Ebola virus), Flaviviridae (Dengue Virus) and Coronaviridae (SARS-CoV2).

UNIT – V Plant Viruses:

Classification– Transmission of plant viruses – Symptoms of Viral infection in plants - Control of plant viral diseases. Detailed study of TMV and CaMV- Common viral diseases in paddy, cotton, tomato and sugar cane - Name of diseases, pathogens and symptoms. Cultivation of Plant Viruses. Vector control.

UNIT – VI Current Contours (For continuous internal assessment only):

Method of analyzing viral infection in a community. How to control viral spread in a community. Infection control system in a community.

REFERENCES:

1. Martinez J. Hewlett, David Camerini, David C. Bloom. 2021. Basic Virology, Fourth Edition, Wiley Blackwel.
2. Flint, S. J., Enquist, L. W., Racaniello, V. R., and Skalka, A. M. 2015. Principles of Virology: Molecular Biology, Pathogenesis, and Control of Animal Viruses, 4th ed. 944 pp. ASM Press, Washington, DC.
3. Dimmock. N.J and Eatson, A.J., Leppard, K.N. 2016. Introduction to Modern Virology. VII edition. Blackwell Scientific Publications, Oxford.7th Edition.
4. Kenneth M Smith. 1972. A text book of plant viral diseases, 3rd edition, Elsevier Inc, New York.
5. Maureen A Harrison and Ian F Rae. 2010. General techniques of cell cultures, Cambridge University Press, England.
6. Nicklin J, Greame Cook and Killington, R. 2003. Instant notes in Microbiology, 2nd Edition, Viva Books private Limited, New Delhi.
7. Rajan S and Kumaresan. S. 2007. Virology. Saras Publications.
8. Rajan S and Selvichristy J. 2018. Essentials of Microbiology, CBS Publishers, New Delhi.
9. Saravanan. P. 2006. Virology. MJP Publishers.
10. Robert I Krasner. 2002. The Microbial challenge: Human Microbe Interaction, American Society for Microbiology, 2nd edition, Washington.
11. https://www.sciencedirect.com/science/article/pii/S0160412019305410.
12. https://journal.hep.com.cn/fese/EN/article/downloadArticleFile.do?attachType=PDF&id=28677.
13. https://www.nature.com/scitable/topicpage/the-origins-of-viruses-14398218/
14. https://www.sciencedirect.com/journal/virology
15. https://www.news-medical.net/health/What-is-Virology.aspx
16. Topley and Wilson's. 1990. Principles of Bacteriology, Virology and Immunity. VIII edition Vol. IV Virology, Edward Arnold, London.

Course Outcomes

Upon successful completion of the course, the students would be:

- Able to describe the classification of viruses
- Able to explain virus structure, process of virus attachment and entry, virus assembly and release.
- Able to state the steps of viral replication .
- Able to understand the methods of preparing virus vaccines and anti-viral drugs.
- Able to illustrate animal, plant and bacterial viruses.

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Second year **CORE PRACTICAL III** **Semester III**

INTRODUCTORY VIROLOGY

Code **(Practical)** **Credit 4**

COURSE OBJECTIVES:

- To teach the methods of isolation, concentration and titration of phages.
- To impart the knowledge of plant virus infection.
- To provide a knowledge of human viral diseases and the role of advanced techniques in viral diagnosis.
- To expose the learners to the methods of animal viral cultivation.
- To describe the symptoms of human viral diseases.

EXPERIMENTS:

1. Isolation and characterization of bacteriophage from natural sources.
2. Determination of Phage Titre.
3. Study of virus infected plant samples – Study any 5 Plant virus symptoms.
4. Cultivation of Animal Viruses – Embryonated Egg.
5. Study on the symptoms of human viral disease Small pox, Chicken Pox, Monkeypox, Mumps and Measles.

REFERENCES:

1. Dharmalingam K. 1986. Experiments with M13 gene cloning and DNA sequencing. Published by Wasani for Macmillan India Limited.
2. Brown W.M.C. 1994. Microbiological Applications. 6th edition, Publishers, a division of W.M.C. Brown Communications, Inc.
3. Dejkstra J, Ces P. de Jager. 1998. Practical Plant Virology (protocols and exercises) Springer Lab Manual, Berlin, Heidelberg, New York.
4. Cappucino, James G. 2016. Microbiology - A laboratory Manual. 11th Edition. Addison -Wesley Publishin Company Inc.
5. Gunasekaran P. 2008. Laboratory Manual in Microbiology, New Age International Pvt. Ltd. Publishers, New Delhi.
6. Kanika Sharma. 2009. Manual of Microbiology – Tools and Techniques. 2nd Edition, Ane Books Pvt. Ltd., New Delhi.
7. Rajan S and Selvi Christy R. 2018. Experimental Procedures in Life Sciences, CBS Publishers.
8. Shawn O' Farrell and Ryan T Ranallo. 2000. Experiments in Biochemistry: A Hands on Approach-A manual for the undergraduate laboratory, Thomson Learning, Inc., Australia.
9. Wilson K and Walker J. 2000. Practical biochemistry, 5th edition, Cambridge University Press, London.
10. http://eprints.usm.my/29021/1/isolation_and_characterization_ofbacteriophage_from_raw_sewage_specific_for_escherichia_coli_0157-h7.pdf

COURSE OUTCOMES:

After the completion of the course, students would be able to:

- Isolate and characterize bacteriophage from natural sources.
- Gain knowledge in preparing bacteriophage stock - Lambda & T4.
- Understand the T4 Phage Titration and plant virus transmission methods.
- Explain animal virus propagation - egg inoculation and cellculture methods.
- Describe viral diagnostic methods in animals and plants.

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Second year	SECOND ALLIED COURSE I BIOSTATISTICS	Semester III
Code	(Theory)	Credit 4

COURSE OBJECTIVES:

- To find numerical solutions to scientific data.
- To analyses and interpret scientific data using numerical and mathematical equations.
- To recognize the definition of statistics, the subject's relation with the other sciences.
- To know how to collect data relating to variable/variables.
- To calculate descriptive statistics for an appropriate data.

UNIT – I Introduction to Biostatistics:

Biostatistics - Definition, statistical methods, biological measurement, kinds of biological data, functions of statistics and limitation of statistics – Application of statistics in various field, biology, medicine, etc...

UNIT – II Data Collection and Representation:

Collection of data, sampling and sampling design, classification and tabulation, Variables vs. Attributes – Primary vs. secondary data - types of representations, Different types of chart and diagrams, graphic–bar diagrams, pie diagrams and curves.

UNIT – III Central Tendency:

Measures of central tendency, mean, median, mode, geometric mean, harmonic mean, Quartile, Deciles, percentiles. (Concept formulae and their calculations)

UNIT – IV Dispersion & Deviation:

Measures of dispersion and variability-changes. Deviations–Mean Deviation, Standard Deviation, Coefficient of variation, Loren Zen's curve – Gini.

UNIT – V Skewness and ANOVA:

Skewness, Kurtosis, Moments, Meaning, test of skewness, characteristics of dispersion and skewness. Measures of skewness, objectives. Karl Pearson's Coefficient of skewness, Bocoley's coefficient of skewness. Software's -ANOVA, SPSS, Sigma plot.

Unit – VI Current Contour (For continuous internal assessment only):

Literature seminar on Biostatistics and its detailed application for all students. Group discussion on How Biostatistics play an important Role on recent day science. – Give a work to the students to know about best statistical research centres and institutes in India. Demonstration of Statistical tools available with the institute.

REFERENCES:

1. Bernard Rosner. Fundamentals of Biostatistics, 7th edition, Cengage Learning, 2010.
2. Maicello Pagano and Kimberlee Gauvreau, 2nd edition Principles of Biostatistics, Duxbury Press.2000.
3. Roland Ennos. Statistical and Data Handling Skills in Biology, Pearson. 2011.
4. Jerrold H Zar. Bio statistical Analysis, 5th Ed, Prentice Hall. 2010.
5. Sundar Rao and Richard. Introduction to Biostatistics and Research Methods, 5th edition, PHI Learning Pvt. Ltd. 2012.
6. Arora PN and Malhan PK. Bio statistics, Himalaya Publishing house.2008.
7. Pranab Kumar Banerjee. Introduction to Bio statistics. 4th edition, S. Chand and company Ltd. 2014.
8. Introductory Statistics (10th Edition) – ISBN 9780321989178, by Neil A, Weiss published by Pearson.
9. Introductory statistics (4th Edition) – Sheldon M. Ross.
10. https://academic.oup.com/biostatistics.

COURSE OUTCOMES:

After completing this course the students would be able to:

- Create graphs using scientific data and to communicate important information about data, and interpret these in the form of graphs.
- Familiarize with widely used statistical databases.
- Know basic concepts of probability and statistics.
- Know the application and limitations of different statistical methods.
- Get conceptual understanding of modern statistical tools and software's available.

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Second year **SECOND ALLIED PRACTICAL** **Semester III**

BIOSTATISTICS & BIOINFORMATICS AND COMPUTATIONAL BIOLOGY

Code **(Practical)** **Credit 4**

COURSE OBJECTIVES:

- To provide foundational skills and knowledge in biostatistics as to gain a deeper understanding
- to introduce probability and sampling distributions
- To analyse quantitative and qualitative data using biostatistics
- To interpret results of data analysis
- To appraise how quantitative and qualitative data can be integrated into mixed methods
- To gain an understanding of the computational challenges in the analysis of large biological data sets.
- To provide a hands- on understanding of how some of the commonly used bioinformatics tools work.
- To teach the learners on the effective usage of the tools as well as the methods to read and evaluate research articles in a field.
- To practise about structural protein using software.
- To train sequence alignment methods.

EXPERIMENTS:

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. Tests of significance 't' test, 'chi' square, standard error and standard deviation.
4. 't' Test, chi square, statistical error, standard deviation also, to be practically done through SPSS programme [Statistical Package for Social Sciences].
5. F – test
6. ANOVA
7. Study of Nucleic acid sequence databanks – GenBank, EMBL nucleotide sequence databank, DDBJ.
8. Study of Protein Structure and Classification databases – PDB, SCOP and CATH.
9. Multiple sequence alignment - ClustalW.
10. Evaluation of protein structure by Swiss PDB viewer and RASMOL
11. Sequence alignment - Local and global, pair wise and multiple, BLAST.

REFERENCES:

1. Maicello Pagano, Kimberlee Gauvreau. Principles of Biostatistics, 2nd edition, Duxbury Press. 2000.
2. Roland Ennos. Statistical and Data Handling Skills in Biology, 3rd edition. Pearson. 2011.
3. http://en.m.wikipedia.org/wiki/Nucleotide sequence database4
4. https://www.statsref.com/StatsRefSample.pdf
5. http://www.ru.ac.bd/wp-content/uploads/sites/25/2019/03/102_10_ Longnecker_An-Introduction-to-Statistical-Methods-and-Data-Analysis-6th-Ed.pdf
6. https://www.spss-tutorials.com/tools/
7. Maicello Pagano, Kimberlee Gauvreau. Principles of Biostatistics, 2nd edition, Duxbury Press. 2000.

8. Roland Ennos. Statistical and Data Handling Skills in Biology, 3rd edition. Pearson. 2011.
9. http://en.m.wikipedia.org/wiki/Nucleotide sequence database
10. http://en.m.wikipedia.org/wiki/Multiple sequence alignment
11. http://en.m.wikipedia.org>wiki>Swiss PDB viewer
12. Reece, J. B., Taylor, M. R., Simon, E. J., & Dickey, J. (2009). Biology: concepts & connections (Vol. 3, p. 2). Pearson/Benjamin Cummings
13. Fall, C.P., Marland, E.S., Wagner, J.M., Tyson, J.J.(2002). Computational Cell Biology. Springer

COURSE OUTCOMES:

After successful completion of this course, students are expected to:

- Analyse statistical data using MS-Excel.
- Organize, manage and present data.
- Present statistical data graphically using frequency distributions and cumulative frequency distributions.
- Evaluate statistical data using measures of central tendency, dispersion and location.
- Acquire knowledge of statistics and its scope and importance.
- Get introduced to the basic concepts of Bioinformatics and its significance in biological data analysis.
- Gain knowledge about various biological databases that provide information about nucleic acids and protein.
- Secure knowledge on primary and secondary structures of proteins.
- Be knowledgeable on the tertiary and quaternary structures of proteins.
- Be trained on the basics of sequence alignment.

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Second year **NON MAJOR ELECTIVE I** **Semester III**

CLINICAL BACTERIOLOGY

Code **(Theory)** **Credit 2**

COURSE OBJECTIVES:

- To provide information on common pathogenic bacteria.
- To understand pathogenicity of bacterial agents
- To understand disease causing process and identification of intracellular and extracellular pathogens
- To describe sterilization and antibiotic sensitivity methods
- To know the basic concept of water quality assessmemt.

UNIT – I

Historical development in Bacteriology, Classification of Pathogenic bacteria, General methods of isolation and identification of pathogenic bacteria.

UNIT - II

Infections associated with following Gram-positive bacteria – *Bacillus anthracis. Clostridium tetani, Pneumococcus, Corynebacterium diphtheriae,* Streptococcal pyogenes, Staphylococcal aureus

UNIT – III

Infections associated with following Gram-negative bacteria – Enterobacteriaceae – *Salmonella typhi, Shigella sonnei, Klebsiella pneumoniae, Proteus vulgaris, Yersinia pestis and Escheichia coli, Vibrio cholerae, Pseudomonas aeruginosa, Neisseria gonorrhoea, Haemophilus influenzae, C Bordetella, Brucella.*

UNIT – IV

Infections associated with *Mycoplasma, Mycobacterium tuberculosis and Mycobacterium leprae. Spirochetes – Treponema, Borrelia and Leptospira.* Actinomycetes. *Rickettsiae, Chlamydiae, Bordetella and Brucella.*

UNIT V

Nosocomial infections and Zoonotic diseases, Sterilization, disinfection and antimicrobial chemotherapy, culturing Techniques and sensitivity Testing; MPN count for water Quality.

Unit – VI Current Contour (For continuous internal assessment only):

Review on recent bacterial infections in a community. Methods to control infection in a community.

REFERENCES:

1. Moselio Schaechter, Cary Engleberg, N.Barry I. Eisenstein, Gerald medoff. Mechanisms of microbial disease, 3rd ed, Lippincott Williams & Wilkins, 1999.
2. Ananthanarayan and Jayaram Paniker. Textbook of Microbiology, 4th ed. Orient Longman, 2000.
3. Mandel, G.L. Bennet, J.E. and Dolin, R. 1995. Principles and practice of infectious disease. 4th edi. Churchil Living stone. New York.
4. Rajan S and Selvichristy J. 2018. Essentials of Microbiology, CBS Publishers, New Delhi.
5. Rajan S. Medical Microbiology, MJP Publishers Chennai. 2007.

COURSE OUTCOMES:

Upon successful completion of the course, the students can:

- Understand the fundamental bases of classification of pathogenic microorganisms.
- Gather information about the nature of bacterial pathogens. understand the phenomena of pathogenesis of bacterial diseases.

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Second year	**CORE COURSE IV IMMUNOLOGY**	**Semester IV**
Code	**(Theory)**	**Credit 5**

COURSE OBJECTIVES:

- To provide the various components of the host immune system.
- To understand structural organization and functions of immune organs and cells.
- To present the activities of T and B cells.
- To impart the process and properties of antigens and antibodies' reactions.
- To describe the immune reaction with reference to transplantation and autoimmunity.

UNIT – I Immune System:

History of Immunology, Immunity - innate and acquired. Inflammation. Haematopoiesis – Blood Group System, Cells of the immune system- lymphocytes, macrophages, mononuclear phagocytes- dendritic cells, granulocytes, NK cells and mast cells Central and peripheral lymphoid organs- Thymus, bone marrow, spleen, lymph nodes, MALT and GALT.

UNIT – II T and B cell:

Detailed structure and development of B cell and T cell – receptors - Activation of T and B cells- Maturation of T cell and B cell. Cytokines and Plasma cells. Organization of the genes for B and T cell receptors. Genetic organization of MHC-I and MHC-II complex (both HLA and H-2).

UNIT – III Antigen Antibody:

Antigen – Types, Toxoid-vaccines – Antibody – types of antibody. Cell mediated immunity – Humoral mediated immunity – Theories of antibody formation. Antibody biodiversity.

UNIT – IV Ag-Ab Interactions:

Antigen antibody reactions - Precipitation, agglutination, complement fixation, RIA, ELISA, Western blotting and immunofluorescence. Production of polyclonal and monoclonal antibodies.

UNIT – V Immune Mechanisms:

Complement system: Basics of complement protein - different pathways of complement activation - classical and alternative. Hypersensitivity reaction and their types. Auto immune disorders, transplantation and cancer immunology. Deficiencies / defects of T cells, B cells, and phagocytic cells. Immunity to tuberculosis, malaria and HIV.

Unit – VI Current Contours (For continuous internal assessment only):

Review and debate on latest discovery on immunology; Seminar on immune responses against SARS-CoV2 and vaccination for COVID19.

REFERENCES:

1. David Male, R. Stokes Peebles and Victoria Male. 2020. Immunology. 9th Edition, Elsevier.
2. Rajan S and Selvichristy J. 2018. Essentials of Microbiology, CBS Publishers, New Delhi.
3. Charlene Sand. A reference guide to immune disorder including hypersensitivity and auto immune disease, Webster's digital service, ebook. 2013.
4. Goldsby RA, Kindt TK, Osborne BA and Kuby J. Immunology, 5th Edition, W.H. Freeman and Company, New York. 2007.
5. Ivan Roitt, Jonathan Brostoff and David Male. Immunology, 8th edition, Elsevier science Ltd., New York. 2012.
6. Kuby J. Immunology, 7th edition, W.H. Freeman and company, New York. 2008.
7. Tak W Mak and Mary Saunders. The immune response basic and clinical practices. Elsevier Academic press, New York. 2012.
8. Tak W Mak and Mary Saunders. Primer to the Immune Response. 2nd edition from *Tak Mak*, *Mary Saunders*, Bradley Jett. New York. 2014.
9. Thomas J Kindt, Barbara A Osborne, and Richard A Golds. Immunology online, University of South Carolina. 2006.
10. William E Paul. Fundamental Immunology. 7th revised edition, Raven press, New York. 2012.
11. Sudha Gangal and Shubhangi Sontakke. Textbook of Basic and clinical Immunology, Universities Press, (India) Pvt. Ltd, Hyderabad, India. 2013.
12. https://doi.org/10.1016/j.immuni.2020.05.002
13. https://doi.org/10.3389/fimmu.2020.02037
14. https://www.immunopaedia.org.za/immunology/
15. http://cshprotocols.cshlp.org/site/Taxonomy/immunology_l1.xhtml

COURSE OUTCOMES:

Upon successful completion of the course, the students can:

- Understand the fundamental bases of immune system and immune response
- Gather information about the structure and organization of various components of the immune system
- Assimilate the operation and the mechanisms which underlie the immune response.
- Apply the knowledge gained to understand the phenomena like host defense and hypersensitivity (allergy).
- Comprehend the organ transplantation and certain immunological diseases.

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Second year **CORE PRACTICAL IV IMMUNOLOGY (Practical)** **Semester IV**

Code **Credit 4**

COURSE OBJECTIVES:

- To provide hands- on training on the basics to advanced techniques in immunology.
- To teach about blood and to train in blood collection, serum separation.
- To explain blood cell count and its differentiation
- To describe about agglutination and precipitation methods.
- To make the learners understand immune electrophoresis.

EXPERIMENTS:

1. Collection of venous blood from human.
2. Preparation of serum and plasma.
3. Total count (RBC and WBC).
4. Differential Count (WBC).
5. Dissection of primary and secondary lymphoid organs in a selected animal.
6. Haemagglutination - ABO Blood grouping.
7. Agglutination reactions – WIDAL, RPR, CRP.
8. Precipitation reactions: Single and Double immune diffusion.
9. Immuno-electrophoresis: Counter current and Rocket immuno electrophoresis.

REFERENCES:

1. Abbas AK, Lichtman AH, Shiv Pillai. 2021. *Cellular and Molecular Immunology*, 10th Edition. Elsevier.
2. Benjamin E, Coico R and Sunskise. 2000. Immunology: a short course. Edition IV, Wiley – Liss publication, NY.
3. Barbara Detrick, Robert G. Hamilton, James D. Folds. 2006. Manual of Molecular and Clinical Laboratory Immunology 7th Edition. ASM press.
4. Talwar GP and Gupta SK. 2012. A Handbook of Practical & Clinical Immunology. CBS Publishers
5. Frank C. Hay and Olwyn M.R. Westwood. 2008. Practical Immunology, 4th Edition, Wiley-Blackwell.
6. Rajan S and Selvi Christy R. 2018. Experimental Procedures in Life Sciences, CBS Publishers.
7. Hilary Warren. 2003.Practical Immunology. Wiley-Blackwell
8. https://www.urmc.rochester.edu/MediaLibraries/URMCMedia/labs/frelingerlab/documents/Immunology-Lab-Manual.pdf
9. https://www.urmc.rochester.edu/MediaLibraries/URMCMedia/labs/fr
10. Rajan S. Manual for Medical Laboratory Technology. Anajanaa Book House, Chennai. 2012.
11. Monica Cheesbrough. District Laboratory Practice in Tropical Countries - Part I and II (Second Edition). Cambridge University Press, New Delhi.

Course Outcomes:

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

- Understand blood collection, serum & plasma separation methods.
- Perform blood grouping technique and other immunological tests
- Obtain hands- on training on immune-electrophoresis technique
- Understand cells and organs of immune system.
- Perform complete blood count.

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Second year	**SECOND ALLIED COURSE II BIOINFORMATICS AND COMPUTATIONAL BIOLOGY**	**Semester IV**
Code	**(Theory)**	**Credit 4**

COURSE OBJECTIVES:

- To introduce the rapidly evolving field of Bioinformatics.
- To transfer basic knowledge of computers and internet.
- To teach the computational methods as to utilize expression data of cellular biology.
- To study of the inherent structure of biological information.
- To analyse the gene and protein sequences as to reveal protein evolution.

UNIT – I Basics of Computer:

Computers – Characteristics of Computers – Areas of computer applications- I-P-O Cycle. Components of Computers – Memory and control units-Input devices and output devices- Hardware and Software -Operating Systems. Languages – Basics, Windows, Unix and Linux.

UNIT – II Web and Browsers:

Internet-History of Internet-Uses of internet. Connection to Internet-Getting connection-Web page- www, websites, URL, browsers, search engines, Modem-Internet Service Providers-E-mail and Voice Mail, Creating E-mail Address, IoT-Internet of Things.

UNIT – III Basics of Bioinformatics:

Introduction to bioinformatics – history and its development – Scope and applications of bioinformatics. Computer aided drug design, docking, screening. Bacterial identification system. Applications of computational biology.

UNIT – IV Databases and Phylogeny:

Biological database – NCBI-GenBank, EMBL, DDBJ. DNA Sequence analysis, Sequence Alignment-Pairwise (BLAST and FASTA and its features) and Multiple sequence alignment (ClustalW) – PAM matrix - Conservation score, Phylogenetic trees

UNIT – V Proteomics:

Structure of Protein, Classification –PDB, Swiss-PROT, SCOP, CATH. Protein visualization tools-RASMOL, Swiss PDB viewer. – three kinds of protein structures, protein sequence analysis, hydrophophobicity profiles – Ramachandran plot.

UNIT – VI Current Contours (For continuous internal assessment only):

Give a Literature seminar on Computational biology and its importance in the field of Microbiology for all students. – Group discussion on biological software's – to learn about computational research centres and Institutes all around the world. Demonstrate the students with basics of protein structure visualization tools and the different models of proteins. Experience them with the updated versions of Nucleotide databases.

REFERENCES:

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2. Ruchi Singh and Richa Sharma. Bioinformatics: Basics, algorithms and applications, Universities Press, (India) Pvt. Ltd, Hyderabad, India. 2010.
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4. M. Michael Gromiha, Protein Bioinformatics: From sequence to function, Academic Press, 2010.
5. D.E. Krane M.L. Raymer, Fundamental concepts of bioinformatics, Pearson education Inc. 2006.
6. Computational Biology: A Hyper text book (ASM Books) 1st Edition by Scott T. Kelley (Author), Dennis Didulo. Jan - 2018.
7. https://link.springer.com/book/10.1007/978-981-16-4241-8
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COURSE OUTCOMES:

After completing this course, students will gain knowledge:

- In understanding the biological challenges and the computational solutions.
- Of computer basics and usage of biological software.
- To analyse the biological data using computer.
- Required for sequence submission and retrieval.
- Of protein sequencing, nucleic acid sequencing techniques and their analysis.

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Second year	NON MAJOR ELECTIVE II ANTIMICROBIAL AGENTS	Semester IV
Code	(Theory)	Credit 4

COURSE OBJECTIVES:

- To educate clinically significant antimicrobial agents and their mechanisms of drug resistance.
- To isolate and identify the novel antimicrobial resistant organisms.
- To learn about antimicrobial drugs and their mechanisms.
- To produce new antimicrobial drug against various diseases.
- To create an awareness on the studies of antimicrobial resistance among the students.

UNIT – I Introduction of Antimicrobial Agents:

Definition – disinfection – antiseptics – antibiotics – chemical agents (antibacterial, antifungal, antiviral and antiparasitic) – non pharmaceutical agents (essential oils) –physical agent (Ozone, heat, radiation).

UNIT – II Antibacterial Agents:

Antibacterial agent - mechanism of action- cell wall synthesis inhibitor (penicillin, arabinoglycan), protein synthesis inhibitor (Tetracycline, Chloramphenicol), nucleic acid synthesis inhibitor (metronidazole, rifampin), alteration of cell membranes (gramicidin, polymyxin, antimetabolite (sulfanilamide).

UNIT – III Antiviral Agents:

Antiviral agents - interferon – types- mechanism of action - amantadine, rimantadine, zanamivir, and oseltamivir - viral vaccines.

UNIT – IV Antifungal Agents:

t-mode of action- amphotericin, nystatin and fluorocytosine. Antiprotozoal agents – mechanism of action – (Metronidazole – chloroquine, Paromomycin sulfate,– quinolines).

UNIT – V Drug Resistance:

Emergence of drug resistance – bacteria, fungi and viruses. Alternative drugs- antimicrobial peptides.

UNIT – VI Current Contours (For internal assessment only):

The Demand for Antibiotics: Antimicrobial Peptides, Nanoparticles, and Combinatorial Therapies as Future Strategies in Antibacterial Agent Design. Novel Antimicrobial Agents: Discovery, Design and New Therapeutic Strategies

REFERENCES:

1. Alan R Hauser. Antibiotics basics for clinicians: choosing the right antibacterial agent. Wolter Kluwer / Lipponcott Williams and Wilkins Publisher, New York. 2018, 3rd edition.
2. Anthony J Trevor, Bertram G Katzung, Susan B Masters. Katzung and Trevor's. Pharmacology: examination and board review. McGraw-Hill Professional, New York. 2021, 13th edition.
3. Cohen MR. Medication errors, American pharmaceutical association, Washington, DC. 2007.
4. Erika J Ernst. Antifungal agent (methods in molecular medicine). Humana Press, New York. 2015, 2005th edition.
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6. Hellen Geiband, Molly Miller, Petrie, Suraj Pant, Sumanth Gandra, Jordan lewinson, Devra Barter, Andrea White and Ramanan Laxminarayanan. The state of the Worlds antibiotic. CDDEP publisher, Washington, DC. 2021.
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9. Waxman DJ and Strominger JL. Beta-lactam antibiotics: biochemical modes of action. In: (Morin RB, Gorman M): Chemistry and Biology of Beta-Lactam Antibiotics. Academic Press, San Diego. 1982.
10. Wolfson JS and Hooper DC. Quinolone Antimicrobial Agents. 2nd edition. American Society for Microbiology, Washington.1993.
11. https://www.mdpi.com/topics/anti_agent
12. https://www.frontiersin.org/articles/10.3389/fmicb.2020.01669/full

COURSE OUTCOMES

Upon successful completion of this course, the students would be able to:

- Explain the mechanism of antimicrobial agent.
- Understand the production of antimicrobial drug from various sources.
- Investigate interesting biological problems.
- Have an insight of current topics in microbial genetics and related fields.
- Relate pharamaceutical microbiology to biotechnology.

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Third year	CORE COURSE V MEDICAL MICROBIOLOGY	Semester V
Code	(Theory)	Credit 5

COURSE OBJECTIVES:

- To make the students understand normal flora, host parasite interactions and epidemiology of infectious diseases.
- To acquire a basic understanding of the common infections
- To understand the diseases of medical importance, their microbial causes, pathogenic action.
- To diagnose infection associated with microbial infection.
- To understand the fungal and protozoan diseases and preventive measures.

UNIT – I Introduction to Medical Microbiology:

History of Medical Microbiology - Classification of medically important microbes - Normal microbial flora of the human body-Host bacterial interactions – Nosocomial and community acquired infections – Epidemiology of infectious diseases.

UNIT – II Medical Bacteriology:

Morphological, cultural and biochemical characteristics of and epidemiology, mechanism of bacterial pathogenesis, lab diagnosis, prophylaxis and control of medically important diseases caused by*: Staphylococcus aureus,* Group A Streptococci, *Corynebacterium diphtheriae, Clostridium tetani, Treponema pallidum, Mycobacterium tuberculosis, Escherichia coli, Vibrio cholerae, Niesserriae gonorrhoea, Haemophilus influenza,* Zoonotic bacterial diseases.

UNIT – III Medical Mycology:

Morphological and cultural characteristics of and epidemiology, mechanism of fungal pathogenesis, lab diagnosis and treatment of medically important diseases caused by*:* Superficial mycosis – *Tinea versicolor*. Cutaneous mycoses: *Microsporum*, *Trichophyton*, *Epidermophyton*. Subcutaneous mycoses: Sporotrichosis, Chromoblastomycosis. Systemic Mycoses – *Histoplasma capsulatum* and *Cryptococcus neoformans*,

UNIT – IV Medical Virology:

General properties of and epidemiology, pathogenesis, lab diagnosis and treatment of medically important viral diseases - Measles, Mumps, Rubella, Chicken Pox, Hepatitis A, B,C, D and E, Poliomyelitis, HIV, Rabies, Yellow fever, Dengue and Covid 19. Brief note on oncogenic viruses. Antiviral drugs, antiviral vaccines.

UNIT – V Medical Parasitology and Diagnostic Microbiology:

Morphology of, and pathogenesis, laboratory diagnosis and treatment of medically important protozoan diseases amoebiasis, giardiasis, malaria, Kala-azar, filariasis, Ascariasis and Fascioliasis. Diagnosis of protozoal and helminthic disease of Human.

UNIT – VI Current Contours (For continuous internal assessment only) :

Making awareness and celebration of world AIDS day, World TB, cancer Day, Pulse polio immunization day etc., awareness programme on personal hygiene and vaccination.

REFERENCES:

1. Aejaz Iqbal and Zafar Nowshad. 2020. MEDICAL MICROBIOLOGY: Millennium Edition. Notion Press.
2. Jawetz, Melnick, &Adelberg's Medical Microbiology by Carroll KC, Hobdon JA, Miller S, Morse SA, Mietzner TA. 27th edition. Lange Publication, 2016.
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5. Rajan S and Selvichristy J. Essentials of Microbiology, CBS Publishers, New Delhi. 2018.
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8. Rajan S. Medical Microbiology, MJP Publishers Chennai. 2007.
9. Topley and Wilsons. Principles of Bacteriology, Virology and Immunology. Edward Arnold, London. 1995.
10. https://www.mooc-list.com/tags/bacteriology
11. https://mycology.adelaide.edu.au/
12. http://nvbdcp.gov.in/
13. https://www.mooc-list.com/tags/human-parasitology
14. https://www.mooc-list.com/tags/tropical-parasitology

COURSE OUTCOMES:

Upon successful completion of the course, the student will be able to:

- Understand of normal flora and host parasite interaction.
- Describe the characteristics of disease-causing bacteria and viruses
- Assess fungal infections in human beings.
- Understand the problems of parasitic diseases.
- Know the diagnostic features of infectious diseases.

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Third year **CORE COURSE VI** **Semester V**

ENVIRONMENT AND AGRICULTURAL MICROBIOLOGY

Code **(Theory)** **Credit 5**

COURSE OBJECTIVES:

- To communicate the students with basic principles of microbiology and their applications to environment and agriculture.
- Students will be able to know extremophilic microorganisms and their significant role.
- To know the type of waste disposing mechanisms using microbial sources.
- To provide the fundamental knowledge pertaining to the various scopes of agricultural and environmental microbiology.
- Students will learn the course concepts of plant diseases, aeromicrobiology, aquatic microbiology, disposal of wastes and commercial aspects of soil microbiology.

UNIT I Microbiology of Air and Extremphiles:

Distribution and sources. Droplet nuclei, aerosol, assessment of air quality. Brief account of air borne transmission of harmful microbes. Concepts of microbial ecology - Relationship between microorganism and different environments land, water and air. Extremophiles – Thermophiles, mesophiles, psychrophiles, Deep-sea, Desert, Acidophilic, Alkalophilic and Halophilic microorganisms.

UNIT II Microbiology of Water:

Different kinds of water. Physico-chemical properties of water, brief account of water borne diseases, microbial assessment of water quality, water purification, brief account of water borne diseases. Aquatic micro flora and fauna of lake, ponds, river, estuary, mangrove and sea.

UNIT III Wastes and Its Management:

Types of wastes – characterization of solid and liquid wastes. Solid waste treatment – saccharification – gasification – composting, Utilization of solid wastes for mushroom production. Liquid waste treatment - Treatment methods– primary and secondary (anaerobic – methanogenesis) aerobic: trickling, activated sludge, oxidation pond – tertiary treatment.

UNIT IV Microorganisms in Agriculture:

Microorganisms in the rhizosphere, root surfaces and phylloplane –Biofertilizer- Advantages over chemical fertilizers, types, production and - quality control of biofertilizers - Isolation, mass inoculum production, field application. Types of biofertilizers - Rhizobium, Azotobacter, Azospirillum, Cyanobacteria, Azolla, Mycorrhizae, Frankia. Biological nitrogen fixation.

UNIT V Plant Diseases:

Mode of entry of pathogens, Symptoms, Disease cycle and control measures. Different types of plant diseases - Tobacco mosaic, Bacterial blight of paddy, Downy

mildew of bajra, Powdery mildew of cucurbits, Head smut of sorghum, Red rot of sugar cane, Citrus cancer, Downy mildew of bajra, Powdery mildew of cucurbits. Microbial Pesticides – types and applications. Integrated Pest and Disease Management (IDPM).

UNIT – VI Current Contours (For continuous internal assessment only):

Assignment shall be given based on the syllabus and seminar was subjected to students related to their assignment topics individually. A group project shall be assigned in the topic of assessment of microorganisms in air. Mini project in various recent research topics related to the course shall be given.

REFERENCES:

1. Chatterji, A.K., 2005. Introduction to Environmental Biotechnology. Prentice-Hall of India Private Limited.
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3. Duncan Mara, Nigel Horen, 2003. The Handbook of water and waste water Microbiology. Academic press-An imprint of Elsevier.
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11. https://www.kobo.com/us/en/ebook/microbial-ecology-2
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COURSE OUTCOMES:

By the end of the course, the students will be able to:

- Know the significance of the microbes in atmosphere and water.
- Get in-depth information about the harmful effects and beneficial role of microbes in each sector.
- Acquire deeper knowledge on water and waste water treatment to tackle the current environmental problems.
- Elicit meticulous thoughts on the task of microbes in waste water treatment and solid waste management.
- Understand methods to exploiting natural wastes by producing bioorganic fertilizers.

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Third year **CORE COURSE VII** **Semester V**

MOLECULAR BIOLOGY AND MICROBIAL GENETICS

Code **(Theory)** **Credit 5**

Course Objectives:

- To provide the students with the fundamental principles and concepts of prokaryotic genes and genomes.
- To study about the molecular organization, replication and functions of gene and genome.
- To understand the genetic transfer mechanisms in microbes.
- To learn about the mutation and mutagenesis.
- To know about the mechanisms of DNA replications and it's Repairing.

UNIT - I Genetic Material and Its Structure:

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 – Brief account on types and forms of DNA – Types of RNA - Definition of a gene. Organization of DNA in prokaryotes (E. coli) and viruses. Brief note on plasmids: Extra chromosomal elements – Plasmid and transposons, Brief note's structure and types.

UNIT - II DNA Replication and Its Mechanisms:

DNA Replication in prokaryotes: Meselson and Stahl experiment – Mechanism, enzymes and proteins of replication – Theta replication and Rolling circle replication. Replication of DNA – semi conservative mechanisms, enzyme involved in replication – Replication of RNA – reverse transcriptase - cloning and its mechanisms-hybridization.

UNIT - III Transcription and Translation:

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

UNIT – IV Transformation:

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

UNIT – V Mutation and Mutagenesis:

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

UNIT – VI Current Contours (For continuous internal assessment only):

Group discussion on Molecular Biology related recent invention and research, give a seminar on each student from Microbial genetics related topics. Demonstrate them the importance of Horizontal Gene Transfer in Natural Selection and Evolution.

REFERENCES:

1. David Frifelder Molecular Biology, Narosa publishing house, New Delhi. 2nd edition. 2008.
2. George M Malacinski. Freifelder's Essentials of Molecular Biology. 4th edition. Narosa Publishing House. 2008.
3. Stanly R Maloy, John E Cronan Jr. and David Freifelder, Microbial Genetics, 2nd edition, Narosa publishing house, New Delhi. 2006.
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7. Sambaurthy AVSS. Molecular biology. Narosa publishing house, New Delhi.2008.
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10. Watson JD, Tania AB, Stephen PB, Alexander G, Michael L, Richard L (2017) Molecular Biology of the Gene. 7th Edition. Pearson Education.
11. Wilson K, Walker J (2010) Principles and Techniques of Biochemistry and Molecular Biology. Cambridge University Press, Cambridge.
12. http://cshprotocols.cshlp.org/site/Taxonomy/molecular_biology_l1.xhtml

COURSE OUTCOMES;

After Completion of the course, the students will learn:

- Processes behind mutations and other genetic changes
- The genetic regulatory mechanisms at different levels
- The common methods in microbial genetics
- About DNA replication and repairing mechanisms
- About microbial genetics to biotechnology

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Third year **CORE PRACTICAL V** **Semester V**

MEDICAL MICROBIOLOGY, ENVIRONMENT AND AGRICULTURAL MICROBIOLOGY AND MOLECULAR BIOLOGY & MICROBIAL GENETICS

Code **(Practical)** **Credit 4**

COURSE OBJECTIVES:

- To provide hands- on training in identifying bacteria using culture media
- To handle clinical specimen for fungal infection diagnosis
- To handle microscopic methods to diagnose protozoa and helminth infections.
- To impart hands- on training in conventional methods of microbial identification.
- To perform antibiotic sensitivity assay.
- This course is designed to prepare the students for a sensible knowledge in a wide range of profession.
- This paper provides the scientific discipline that deals with the application of microorganisms and a knowledge about them.
- Applications of microorganisms for sustainable agriculture and Environment.
- It also covers important experiments linked with this course.
- To exhibit practical knowledge in the research laboratories and industries.
- To provide fundamental knowledge and techniques in microbial genetics.
- To know about the isolation of bacterial chromosomal and plasmid DNA
- To analyse the quality and to estimate the quantity of DNA
- To isolate the genomic RNA and auxotrophic mutants
- To experience the Agarose gel electrophoresis technique

EXPERIMENTS:

1. Isolation and identification of *Staphylococcus aureus* from pus.
2. Isolation and identification of *Salmonella* from stool.
3. Isolation and identification of *E. coli* from urine.
4. Antibiotic susceptibility test – Disc diffusion method (Kirby –Bauer).
5. Identification of *Candida albicans*
6. Saline and Iodine wet mount to detect cysts, trophozoites and eggs.
7. Giemsa staining to detect blood parasites
8. Enumeration of microorganisms from air by open plat technique.
9. Isolation and identification of air-borne microbes using Andersen sampler.
10. Isolation of phosphate solubilizing bacteria from soil
11. Assessment of water quality by MPN technique
12. Screening of antagonistic bacteria in soil by agar block overlay method.
13. Enumeration of microbial population from rhizosphere and non-rhizosphere soil
14. Isolation of *Azospirillum* and *Azotobacter* from soil
15. Isolation of *Rhizobium* sp. from root nodules of legumes
16. Evaluation of root nodule by cross section of legume roots.
17. Isolation of Cyanobacteria from agricultural soil and water
18. Isolation of bacterial and fungal pathogens from plants.
19. Prevalence of Arbuscular Mycorrhizae (AM) in infected plants.
20. Demonstration of the plant diseases: a) Bacterial blight of paddy; b) Powdery mildew of cucurbits; c) Red rot of sugar cane; d) Citrus cancer;
21. Isolation of chromosomal DNA from bacteria
22. Isolation of plasmid DNA from bacteria
23. Isolation of microbial Genomic RNA
24. Quantification of DNA and RNA by Spectrophotometric method

25. Isolation of Auxotrophic mutants.
26. Demonstration of bacterial transformation technique.
27. Demonstration of Agarose gel electrophoresis (to study DNA/ RNA) and SDS – PAGE (to study proteins).

NOTE: Identification of bacteria should be done using microscopic methods, culturing on selective cum differential media and biochemical tests (Indole, Methyl Red, Voges Proskauer, Citrate utilization, TSI, Urease, Nitrate, Catalase, Oxidase Carbohydrate fermentation tests, Sensitivity test for gram positive organisms, Hippurate hydrolysis, Coagulase test, Salt tolerance test, Bile solubility etc.,

REFERENCES:

1. Monica Cheesbrough. 2006. District Laboratory Practice in Tropical Countries - Part I and II 2nd edition. Cambridge University Press, New Delhi.
2. Rajan S. 2012. Manual for Medical Laboratory Technology. Anajanaa Book House, Chennai.
3. Betty A Forbes, Daniel F Sahm and Alice S Weissfeld. Bailey and Scott's Diagnostic Microbiology, Mosby Elsevier. 12th edition. 2007.
4. Mackie and McCartney. 2006. Practical Medical Microbiology, South Asia Edition. 14th edition.
5. Rajan S and Selvi Christy R. 2018. Experimental Procedures in Life Sciences. CBS Publishers, New Delhi, 2018.
6. Aneja, K.R., 1993. Experiments in Microbiology: Plant Pathology and Tissue Culture, Wishwa Prakashan, New Delhi.
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13. http://www.unido.org/fileadmin/media/documents/pdf/Agro/MacroLab.pdf
14. http://samples.sainsburysebooks.co.uk/9780470757482_sample_385283.pdf
15. https://jascoinc.com/wp-content/uploads/2017/09/APP-Note-UV0004-Chromium-Quantitative-Determination.pdf
16. Atlas RM and Bartha R. Microbial Ecology: Fundamentals and Applications, 3rd Ed., Benjamin and Cummings Pub. Co. New York. 1993.
17. Rajan S and Selvi Christy R. Experimental Procedures in Life Sciences. Anajanaa Book House, Chennai
18. Monica Cheesbrough. District Laboratory Practice in Tropical Countries - Part I and II, 2nd edition, Cambridge University Press, New Delhi. 2011.
19. Betty A Forbes, Daniel F Sahm and Alice S Weissfeld. Bailey and Scott's Diagnostic Microbiology, Mosby Elsevier. 12th Edition. 2007.
20. Current protocols in molecular biology (2007). John Wiley & Sons Inc. Vol. 1 & 2.
21. Sambrook J and Russell DW (2001). Molecular cloning - A laboratory manual, Cold Spring Laboratory Press, New York, 3rd Edition. Vol. 1, 2, 3.
22. Surzyeki S (2000). Basic Techniques in Molecular Biology, Springer.
23. http://www.ncbi.nlm.nih.gov/
24. www.yeastgenome.org
25. http://sequence-ww.stanford.edu/group/yeast_deletion_project /deletions3.html

COURSE OUTCOMES:

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

- Practice handling the clinical samples
- Get a clear practical knowledge on molecular techniques.
- Understand the transformation mechanisms.
- Learn the quantification of macromolecules in industrial point of view.
- Know the applications of various instruments to analyses the quality of macromolecules in a solution.
- Know about the techniques to isolate and assess the harmful microorganisms in environmental samples.
- Provide meticulous ideas for the enumeration of air and water borne microorganisms.
- Get an idea to isolate and characterize the microbes in extreme environmental conditions.
- Gain several practical knowledge & opportunities.
- Understand the common plant diseases and their symptoms.
- Learn all the identification methods of bacterial pathogens.
- Learn the diagnostic techniques of fungal and parasitic diseases.
- Become familiar with all microscopic methods of microbial identification.
- Understand all methods of cultivation and familiarize with all biochemical tests.
- Understand the principles of antibiotic sensitivity assay.

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Third year **MAJOR BASED ELECTIVE I** **Semester V**

1. DIAGNOSTIC MICROBIOLOGY

Code **(Theory)** **Credit 4**

COURSE OBJECTIVES:

- To impart the students with the knowledge of various clinical specimen collection from human cases.
- To provide the basics of clinical pathology and hematology.
- To expose the students to microbiological, biochemical, immunological and molecular scrutinization so as to diagnose specific clinical abnormalities among human patients.
- To provide methods of handling instruments, principle and advantages of diagnostics.
- To know the diagnostic challenges of the mycological diseases.

UNIT – I Clinical Specimen Collection and Investigation:

Human clinical specimens – methods of collection, processing, transport and their storage – Throat swab, Blood, Urine, Stool, Sputum, pus & body fluids (CSF, ascetic fluids). Microscopic identification of bacterial pathogens – urine & pus specimens – differential staining and motility.

UNIT – II General Clinical Pathology and Haematology:

Preparation, staining & examination of human blood smear and morphological abnormalities. RBC count & Differential WBC count – Reticulocyte count- absolute eosinophil count – E.S.R, P.C.V, Blood indices - Platelet count: BT, CT - Prothrombin time, APTT, FDP estimation.

UNIT - III: Urine Specimen and Molecular Diagnosis

Human urine examination: physical and chemical tests, microscopic examination – crystals, casts, sediments, pregnancy tests – Diagnostic protocol of urinary tract infection. Advanced diagnostic techniques (outline of the protocol) – ELISA, Western blot analysis for HIV, RT-PCR for Covid 19. Antimicrobial susceptibility testing-– Kirby Bauer Disc diffusion method - reporting of results and their interpretation.

UNIT – IV Stool Specimen and Mycology Lab:

Human stool examination – Physical, Chemical and Microscopic examination and their significance. Laboratory methods in basic Mycology-Direct Microscopic examination of clinical specimens and culture media. Serological tests for fungi - Antifungal susceptibility testing.

UNIT – V Sputum Specimen and Parasitological Lab:

Sputum examination: Microscopic examination – Diagnostic protocol of Respiratory tract infections (Upper and Lower). Laboratory methods for parasitic infections – Diagnostic technique from faecal specimen. Identification of Protozoa – Amoebiasis and Malaria.

UNIT – VI Current Contours (For continuous internal assessment only):

A visit to a diagnostic laboratory/ hospital/ primary health care centre – Internship at a diagnostic lab for 'one day' - assignments on clinical specimens' collection & processing – viral infections - Detection of viral antigen (flourescent antibody and solid phase immunoassays) - viral serology – antimicrobial susceptibility testing and results interpretation – Throat swab, Blood, Urine microbiological examination steps/ stages for each – ELISA – western blot – RT- PCR – Literature seminar topics representing each unit – Debate on PCR & disease diagnosis.

REFERENCES:

1. Ananthanarayanan R and CK Jayaram Panicker (2017), Textbook of Microbiology, 10thEd.. OrientLongman.
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6. Talib. V.H, (2008). Handbook of Medical Microbiology, 2 ndEd. CBS Publishers.
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9. Rajan S. (2012) Manual for Medical Laboratory Technology. Anajanaa Book House, Chennai.
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13. https://www.academia.edu/10296941/diagnostic_microbiology
14. https://www.youtube.com/watch?v=uAmTgVvTUNk
15. https://www.youtube.com/watch?v=Oy5uixdzJ_c

Course Outcomes

After a successful completion of the course, the students who undergo the course will be able to:

- Collect, transport, store and microbiologically process a variety of routine human clinical specimens.
- Prepare and investigate blood smears as well as to interpret various common blood clinical parameters.
- Investigate urine, stool & sputum specimens as well as to interpret various common urine clinical parameters.
- Realize the need of molecular methods and their importance in disease diagnosis.
- Understand the health care sectors and laboratories' role in microbial disease diagnostic procedure.

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Third year **MAJOR BASED ELECTIVE I** **Semester V**

2. PHARMACEUTICAL MICROBIOLOGY

Code **(Theory)** **Credit 4**

COURSE OBJECTIVES:

- To provide the basics of antimicrobials' assessment procedures & mode of action of antibiotics
- To instruct the learners with the methods of sterilization and sterility testing of various pharmaceutical articles/products.
- To impart proficiency on the production and quality control of prophylactic compounds
- To transfer skills required to control pharma products' microbial contamination and role of cell culture in pharmacy.
- To study the food and drug administration regulations to create awareness.

UNIT – I Antimicrobials:

Natural and synthetic antibiotics - Laboratory assessment of a new antibiotic - Testing of antimicrobial activity of a new substance - Mechanism of action of antibiotics - Methods for standardization of antibiotics, vitamins and amino acids.

UNIT – II Sterilization & Sterility:

Sterility testing of pharmaceutical products – Injectables – IV fluids – Solids – Ophthalmic – Pyrogen testing. Antiseptics, disinfectants and their standardisation. Evaluation of the efficiency of sterilization methods - Equipments employed in large scale sterilization - Sterility indicators.

UNIT – III Immunologicals:

Preparation and quality control of products representing various categories - Toxoids: Diphtheria and Tetanus, Live Bacterial Vaccines: BCG, Killed Bacterial Vaccines: Cholera & DPT. Viral Vaccines: Polio, Rabies and small pox, Antitoxins – Diphtheria. Preparation of Antisera and their standardization

UNIT – IV Antimicrobials – Bioassay, Contamination & Testing:

Bioassay of antibacterial agents in liquid media and in agar media based on standard CLSI guidelines - Microbial contamination and spoilage of pharmaceutical products – infection risk and contamination control - and their sterilization – *In vitro* methodologies for testing of antibacterial, antifungal and antiviral drugs

UNIT – V FDA, Cell Culture & Applications:

Food and Drug Administration (FDA) guidelines for drugs - Validation: GMP & GLP - Preservation of pharmaceutical products using antimicrobial agents, evaluation of microbial stability of formulations. Growth of animal cells in culture, Primary, established and transformed cell cultures. Application of cell cultures in pharmaceutical industry and research.

UNIT – VI Current Contours (For continuous internal assessment only):

A visit to a pharmaceutical industry / pharmacy institution - Assignments on highly significant topics across the five units & any latest developments in pharmaceutical microbiology (new vaccine technology after COVID 19) - Discussion on redressing antimicrobial resistance through industry- Quiz classes - short seminar classes – debates of selected topics of the course – discussion of previous year question papers.

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2. W.B. Hugo and A.D. Russel (2004): Pharmaceutical Microbiology, Blackwell Scientific publications, Oxford London
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4. Frederick Kavanagh (2014). Analytical Microbiology, Elsevier.
5. Stephen P Denyer, Norman A Hodges, Sean P Gorman, Brendan F Gilmore (2011). Laboratory evaluation of antimicrobial agents, Wiley-Blackwell
6. Vyas SP and Dixit VK (2010). Pharmaceutical Biotechnology, CBS Publishers & Distributors, New Delhi.
7. Joseph D Nally (2016). Good Manufacturing Practices for Pharmaceuticals, CRC Press, 6thedn.
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9. Tille P (2015). Bailey & Scott's Diagnostic Microbiology-E-Book, Elsevier Health Sciences.
10. Kim SK (2012). Marine pharmacognosy: Trends and applications, CRC Press.
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13. Zhang R *et al.*, (2018). Mxra8 is a receptor for multiple arthritogenic alphaviruses, *Nature* DOI: 10.1038/s41586-018-0121-3
14. https://medicine.wustl.edu/news/why-chikungunya-other-arthritis-causing-viruses-target-the-joints/
15. https://www.news-medical.net/news/20180511/Addressing-Antimicrobial-Resistance-Through-Industry.aspx

COURSE OUTCOMES:

Students who undergo the course, will be able to:

- Know how to evaluate a new drug for its property in the laboratory
- Carryout standard sterility testing procedures of pharmaceutical products.
- Control quality of pharmaceutical products representing various categories.
- Understand the contaminants & spoilage of pharmaceutical products.
- Recognize the importance of good manufacturing and laboratory practices as well as the role of animal cell culture in pharmacy industries.

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Third year	**SKILL BASED ELECTIVE I MUSHROOM TECHNOLOGY**	**Semester V**
Code	**(Theory)**	**Credit 2**

COURSE OBJECTIVES:

- The course contents are designed as to gain basic science knowledge of mushroom cultivation.
- The learners will understand the nutritional benefits of the microbes concerned and also related drawbacks.
- Learners can acquire knowledge about the prevailing market demands and scope of these technologies.
- They will learn to apply the gained knowledge for strain improvement to support their entrepreneurship talents.
- Students can develop their knowledge to start an industry as an entrepreneur.

UNIT – I Applied Mushroom Biology :

Introduction and Definition of a Mushroom, Mushroom Hunting, Ecological Classification of Mushrooms, Magnitude of Mushroom Species. Mushroom Science -Food Supply through Mushroom Themselves, Mushroom technology. Mushroom spoilages and mushroom borne diseases.

UNIT – II History of Mushroom Cultivation:

Biology of mushrooms; Nutritional value: (Proteins, amino acids, mineral elements, carbohydrates, fibers, vitamins); Medicinal value of mushrooms; Poisonous mushrooms and mushroom poisoning; edible mushrooms and cultivation in India and world; Mycorrhizal mushrooms and their role in plant growth.

UNIT – III Cultivation Technology:

Infrastructure, equipment and substrates required for mushroom cultivation: Polythene bags, vessels, inoculation hook, inoculation loop, love cost stove, sieves, culture racks, mushroom unit or mushroom house, water sprayer, tray, boilers, driers, pure culture, Spawns - types of spawn, preparation of spawn, mushroom bed preparation and factors affecting mushroom bed preparation. Compost - materials used for compost preparation, compost technology in mushroom production.

UNIT – IV Casing and Mass Cultivation :

Casing - raw material used for casing, preparation of casing material; important sanitation during various stages of mushroom cultivation. Cultivation of important mushrooms - General process for the cultivation of *Agaricus bisporus*, *Pleurotus ostreatus* and *Volvariella volvaceae*. Pests and Pathogens of mushrooms and their management with reference to *Agaricus bisporus*.

UNIT – V Storage and Food Preparation from Mushrooms:

Methods of storage of mushroom cultivation, Long term and short term storage of mushrooms Foods/recipes from mushrooms. Mushroom research centers or farms - National level and regional level. Marketing of mushrooms in India and world.

UNIT – VI Current Contours (For continuous internal assessment only):

Field trip to mushroom farms and research Institutes. Analysis of biological properties in the mushroom products. Awareness to the industrialists about the prevention of microbial contamination in the mushroom farms and products.

REFERENCES:

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2. Kaul, T.N. and B. L. Dhar, 2007. Biology and Cultivation of Edible Mushrooms. Westville Publishing House. New Delhi, 240pp
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5. Dewhurst, M., 2002. Phase III –the future? The Mushroom J. 626, 17-18.
6. Bhalla, T.C., Sharma, N.N., Sharma, M., 2007. Production of Metabolites, Industrial Enzymes, Amino Acids, Organic Acids, Antibiotics, Vitamins and Single Cell Proteins. National Science Digital Library, India.
7. https://www.mushroomoffice.com/mushroom-cultivation/
8. https://vikaspedia.in/agriculture/farm-based-enterprises/mushroom-production/button-mushroom-production
9. https://krishijagran.com/agripedia/a-complete-guide-to-profitable-mushroom-farming-in-india-read-composting-harvesting-techniques/
10. https://cropbag.in/mushroom-cultivation-complete-guide/

COURSE OUTCOMES:

At the end of the course, learners will be able to:

- Draw out the importance of mushrooms and their applications in health and neutraceuticals.
- Work out the production process for optimum mushroom yield.
- Explain their beneficial and erratic role during human consumption.
- List out the substrates employed in mushroom cultivation and sketch out the methods for improvement.
- Gain well-rounded knowledge and get fully prepared for employment, marketing and entrepreneur activities related to mushroom industries.

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Third year	CORE COURSE VIII FOOD MICROBIOLOGY	Semester VI
Code	(Theory)	Credit 5

COURSE OBJECTIVES:

- To learn the fundamental association between food and microbes.
- To acquire knowledge about the key concept of food fermentations
- To analyze the mechanism of food spoilage
- To understand the principles of food preservation.
- To enrich the knowledge of food quality control.

UNIT – I Food and Microbial Contamination:

Concepts of food and nutrients - Physicochemical properties of foods - Food and microorganisms – Importance and types of microorganisms in food (Bacteria, Mould and Yeasts) - Sources of contamination- Factors influencing microbial growth in food – pH, moisture, Oxidation-reduction potential, nutrient contents and inhibitory substances.

UNIT – II Food Fermentations:

Food Fermentations – Manufacture of fermented foods - Fermented dairy products (yoghurt and Cheese) - plant products- Bread, Sauerkraut and Pickles - Fermented beverages- Beer. Brief account on the sources and applications of microbial enzymes – Terminologies - Prebiotics Probiotics and synbiotics. Advantages of probiotics.

UNIT – III Fermented Food Products:

Contamination, spoilage and preservation of cereals and cereal products - sugar and sugar products -Vegetables and fruits- meat and meat products- Spoilage of canned food.

UNIT – IV Food Borne Diseases:

Food borne diseases and food poisoning – *Staphylococcus*, *Clostridium*, *Vibrio parahaemolyticus* and *Campylobacter jejuni. Escherichia coli* and *Salmonella* infections, Hepatitis, Amoebiosis. Algal toxins and Mycotoxins.

UNIT - V Food Preservation:

Food preservations: principles- methods of preservations-Physical and chemical methods- food sanitations- Quality assurance: Microbiological quality standards of food. Government regulatory practices and policies. FDA, EPA, HACCP, ISI. Food safety- control of hazards.

UNIT – VI Current Contours (for continuous internal assessment only):

Students may have a field visit to a food industry. Assignment, seminar and group discussion may be encouraged on Grain based fermented food - Koozhu, Pazhaiya soru, idli, dosa, Adai dosa, kallappam, dhokla etc.

REFERENCES:

1. Adams, M.R., Moss, M.O. 2018. Food microbiology, 1st edition, New Age international (P) Ltd, New Delhi.
2. Chris Bell., Paul Neaves., Anthony P.W. 2006. Food Microbiology and Laboratory Practicals, 2nd edition, Blackwell Scientific Publishers, UK.
3. Choudhary, N.L. 2012. Food Processing and Biotechnology Applications, Oxford Press, New Delhi.
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11. Subbulakshmi, G., Shobha, A. U., Padmini, S. G. 2022. Food Processing and preservation, 2nd edtion, New Age international (P) Ltd.
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15. https://microbenotes.com/factors-affecting-the-growth-of-microorganisms-in-food/

COURSE OUTCOMES:

Upon successful completion of this course, students will be able to:

- Comprehend the functions of Microorganisms in food.
- Acquire knowledge about the fermented food products.
- Build awareness about microbial spoilage of food.
- Gain acquaintance with food borne diseases and their significance.
- Carry a knowledge on food sanitations, quality assurance and food safety.

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Third year	CORE COURSE IX INDUSTRIAL MICROBIOLOGY	Semester VI
Code	(Theory)	Credit 5

COURSE OBJECTIVES:

- To impart the knowledge of current technology as to produce microbial products from cheap sources.
- To present the nature of the industrially important microorganisms, up and down stream process, functions of the fermentors, primary and secondary metabolites as the products.
- To provide the students broad theoretical and practical skills in industrial microbiology.
- To explain the nature of the bio-resources, industrially important microorganisms, up and down stream process.
- To describe the functions of the fermentors, primary and secondary metabolites and production of recombinant products.

UNIT – I Origin of Fermentation Industry:

Historical development of Industrial Microbiology. Industrially important microorganisms - the range of fermentation process, chronological development, component parts of a fermentation process, fermentation economics. Isolation, screening, improvement, preservation and handling the microbial strains.

UNIT – II Industrial Fermentation Media:

Formulation strategies, economical means of providing energy, carbon, nitrogen, vitamin and mineral sources. Role of additional ingredients - buffers, precursors, chelators, inhibitors, inducers and antifoams. Sterilization of industrial fermentation media.

UNIT – III Fermentor Design and Types:

Body construction, mass transfer, heat transfer, oxygen transfer, stirring and mixing. Sterilization of a Fermentor vessels. Scale up and scale down fermentation process. Control of temperature, pH, form pressure Computer application in fermentation technology. Fermentation types- Submerged and solid state.

UNIT – IV Downstream Processing:

Intracellular and extracellular fermentations products. Recovery and purification of the products - removal of solid matters and biomass, cell disruption by physical and chemical methods, extraction of the products, chromatographic techniques, reverse osmosis, ultrafiltration, drying and crystallization of the products.

UNIT – V Production of Varying Microbial Products:

Organic acids - Amino acids, Antibiotics, Enzymes, Vitamins, Alcoholic beverages - wine and beer, Fermented foods - bread, cheese and soy sauce. Recombinant products-insulin. Fermentation products from molasses, starch wastes and cellulosic wastes. Recycling and disposal of industrial wastes through microbes.

UNIT – VI Current Contours (For continuous internal assessment only):

Field trip to dairy, beverage Industry and food processing research Institutes. Analysis of microbiological quality in industrial products. Fermented food preparation. Awareness to the industrialists about the prevention of microbial contamination in industrial products.

REFERENCES:

1. Crueger, W., Crueger, A., 2000. Biotechnology: A Test Book of Industrial Microbiology, 2nd edition. Panima Publishing corporation, New Delhi.
2. Glazer, N.A., Nikaido, H., 2007. Microbial Biotechnology: Fundamentals of Applied Microbiology 2nd edition, Cambridge University Press.
3. Pandey, A., Soccol, R.C., Larroche, C., 2008. Current Developments in Solid-state Fermentation. Springer Verlag.
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5. Peppler, H.J., Pearlman, D., 2004. Microbial Technology – Fermentation Technology. Vol.1 and 2, 2nd edition, Academic Press, London.
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7. Purohit, S.S., Saluja, A.K., Kakrani, H.N., 2004. Pharmaceutical Microbiology. 1st edition, Agrobios India.
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9. Waites, M.J., Morgan, N.L., Rockey, J.S., Higton, G., 2001. Industrial Microbiology: An Introduction, Blackwell Science, London.
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12. https://www.omicsonline.org/enzyme-production-by-fermentation-technology-scholarly-open-access-journals.php
13. https://www.biologydiscussion.com/industrial-microbiology-2/fermentor-bioreactor-history-design-and-its-construction/55756
14. https://thebiologynotes.com/design-of-a-fermenter/
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COURSE OUTCOMES:

The students will be able to know

- The nature and current status of the microorganisms in producing industrial fermentation products.
- About utilization of natural resources on the production of microbial products like enzymes, organic acids, antibiotic, vitamins and alcoholic beverages.
- The methods of transforming natural resources in to products.
- Imbibe ideas on different types of fermentors and their functions.
- The opportunities to develop as a bio-entrepreneur by producing microbial products using the natural wastes.

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Third year **CORE PRACTICAL VI** **Semester VI**

FOOD MICROBIOLOGY AND INDUSTRIAL MICROBIOLOGY

Code **(Practical)** **Credit 4**

COURSE OBJECTIVES:

- To study the basics of food microbiology processes.
- To know the food quality assessment testing procedures.
- To learn about the different types of fermentation processes, equipments used and microbiological processes involved.
- To provide the food contaminants possibility and causing agents.
- To realize significance and activities of microorganisms in food.
- The aim of this course is to know various methods adopting to isolate, screen the industrially important microorganism.
- The course topic explored its production of microbial products like enzyme, antibiotic, alcohol and biosurfactants.
- It also covers purification and characterization of the products by appropriate methods.
- To study the microbial by products immobilization techniques.
- It promotes the students for employability in varying industries.

EXPERIMENTS:

1. Assessment of milk quality by methylene blue reduction test
2. Performance of phosphatase test for pasteurized milk.
3. Isolation of bacteria from food by Standard Plate Count method
4. Isolation of Yeast from grapes.
5. Wet mount preparation of spoiled bread, tomato, grapes, potato.
6. Observation of food samples to study *Leuconsostoc*, *Lactobacillus, Streptococcus lactis* and *Saccharomyes*.
7. Preparation of fermented food – Yoghurt and cheese (demonstration).
8. Screening of antibiotic producing microorganisms from soil.
9. Screening of enzyme producing organisms (e.g. Amylase and Cellulase).
10. Production of industrially important enzymes by solid state fermentation (Any one enzyme).
11. Production of wine from grapes.
12. Production of alcohol from agricultural wastes (sugarcane molasses and beetroot).
13. Characterization of alcohol: Nutritive value, Colour, Haze, Viscosity, foam Characteristics, gurting flavor
14. Microbial production of citric acid by using *Aspergillus*.
15. Production, extraction and characterization of biosurfactant of biosurfactant (emulsification index, foaming index, oil spread nature and ionic charecters).
16. Separation of bioactive compounds - TLC or Column Chromatography.
17. Immobilization of cells and enzymes.
18. Antibiotic sensitivity test: a) Kirby Bauer's method and b) MIC determination by filter paper assay and broth dilution assay.

REFERENCES:

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16. https://cevre.erciyes.edu.tr/upload/M6Z30UUmicrobiology-laboratory-manual.pdf
17. https://www.ikbooks.com/openPdf/9789381141809
18. https://app.knovel.com/web/toc.v/cid:kpMIMBE006/viewerType:toc/
19. http://www.cuteri.eu/microbiologia/manuale_microbiologia_pratica.pdf

COURSE OUTCOMES:

After completion of the lab course, learners will able to:

- Assess the quality of milk by microbiological analysis.
- Acquire a knowledge on food samples and their analysis.
- Evaluate the microorganisms involved in food spoilage.
- Learn about the preparation of fermented food.
- Understand the microbial roles in food preparations.
- Know about the techniques to isolate and screen the significant microorganisms capable to produce products.
- Generate ideas for the production of ethanol from natural and industrial wastes.
- Carry in-depth knowledge and ideas for the production of biosurfactant and its characterization.
- Isolate and characterize microbial products for further applications.
- Understand the opportunities to emerge as a bio-entrepreneur by producing microbial products from natural wastes.

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Third year **MAJOR BASED ELECTIVE II** **Semester VI**

1. RECOMBINANT DNA TECHNOLOGY

Code **(Theory)** **Credit 4**

COURSE OBJECTIVES:

- To educate the learners with the fundamental knowledge and importance of recombinant DNA (rDNA) technology.
- To learn gene isolation techniques.
- To describe the jargons of genetic engineering/ rDNA technology.
- To learn the basic tools, techniques and methods employed in gene cloning and gene expression strategies.
- To study the genetically engineered products in our daily life.

UNIT – I Milestones in rDNA Technology:

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

UNIT – II Enzymes of rDNA Technology:

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

UNIT – III Cloning Vectors:

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

UNIT – IV Gene/ DNA Transfer Techniques:

Gene/ DNA transfer techniques: Physical – Biolistic Method (Gene gun), Electroporation, Microinjection. Chemical- Calcium chloride and DEAE Methods, Biological *in vitro* packaging method in viruses - Selection and Screening of recombinants: Direct Method: Selection by Complementation, Marker inactivation methods - Indirect methods: Immunological and Genetic methods.

UNIT – V Nucleic Acid and Protein Hybridization Techniques:

Blotting (Southern, Western, Northern and North- eastern) techniques – PCR - basic steps in DNA amplification, RAPD, RFLP and their applications – DNA finger printing - DNA microarray analysis – Applications of recombinant DNA technology.

UNIT – VI Current Contours (for continuous internal assessment only):

Students may source recent advancements of recombinant DNA technology medicine and agriculture - human recombinant insulin, growth hormone, blood clotting factors, recombinant COVID-19 Vaccines, golden rice, herbicide-resistant crops, and insect-resistant crops from internet, social media and others.

REFERENCES:

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2. Primrose, S.B., Twyman, R.M. 2006. Principles of Gene Manipulation and Genomics, Wiley Blackwell, 7th edition.
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12. https://microbenotes.com/restriction-enzyme-restriction-endonuclease/
13. https://www.mlsu.ac.in/econtents/65_Enzymes%20used%20in%20GE.pdf
14. https://microbenotes.com/polymerase-chain-reaction-pcr-principle-steps-applications/
15. https://microbenotes.com/western-blotting-introduction-principle-and-applications/

COURSE OUTCOMES:

Upon successful completion of the course, the student will be able to:

- Explain the basic techniques, and milestones of Genetic Engineering.
- Understand the role of Enzymes in Gene manipulation.
- Recognize the relevance of the different kinds of vectors in rDNA technology.
- Acquire basic knowledge about isolation and purification of nucleic acids.
- Describe Gene transfer and other recent techniques of PCR, RAPD and RFLP.

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Third year **MAJOR BASED ELECTIVE II** **Semester VI**

2. MICROBIAL BIOTECHNOLOGY AND BIOETHICS

Code **(Theory)** **Credit 4**

COURSE OBJECTIVES:

- To introduce the role of micro-organisms in biotechnology.
- To understand various metabolic processes involved**.**
- To provide the first- line knowledge of utilizing microbes for the industrial production.
- To create awareness on the roles of microbes in the biotechnology field.
- To gather a sound knowledge of genetic manipulation as to attribute desirable characteristics.

UNIT – I Microbial Production of Therapeutic Agents and Vaccines:

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 Production of Biofertilizer, Biopesticides, Bioplastics and Bioremediation:

Microbial production of biofertilizers – (Rhizobia, Azospirillum, Frankia and VAM). Microbial production of bio-pesticides (*Bacillus thuriengiensis*). Microbial production of bioplastics. Microorganisms in bioremediation: Degradation of xenobiotics.

UNIT – III Algal Biotechnology:

Single cell protein (algae and yeast). Microalgal technology – Industrial cultivation methods of Spirulina – biotechnological potentials of Spirulina as: food and feed – fuel production from microalgae – pharmaceutically valuable compounds from microalgae. Commercial production of bio-ethanol and bio-diesel using lignocellulosic waste.

UNIT – IV Genetic Engineering of Plants and Animals:

Genetic engineering of plants: Ti plasmid vectors and gene transfer in plants – Development of insect, virus and herbicide resistant plants. Transgenic animals: methods of creating transgenic mice and sheep. Human gene therapy – in vivo and ex vivo gene therapy.

UNIT – V IPR and Bioethics:

Intellectual Property Rights (IPR) - different types of IPRs - Principles of Bioethics (IB) - Definition of Ethics and Bioethics. - Ethics committee - Brief account on risks and ethics of modern biotechnology - Ethical concerns in human gene therapy - Ethical limits of animal use. Ethical issues at the beginning of life (abortion) – Ethical issues at the end of life (withholding and withdrawing medical treatment and euthanasia).

UNIT – VI Current Contours (for continuous internal assessment only):

Learners can visit nearby agricultural field (Rice, onion, cotton or any other) to enrich knowledge on the application of biofertilizers. Students may prepare posters and models on Biogas, biofuel, Organic farming, Panchagavya, dolly, knockout mice, double transgenic mouse.

REFERENCES:

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COURSE OUTCOMES:

After successful completion of this course, the learners will be able to:

- Gather the basics of producing pharmaceutically valuable products from microbiota.
- Enrich themselves with knowledge of producing biofertilizers and biocontrol agents.
- Attain the knowledge on the exploitation and applications of microalgae.
- Posses the concepts of genetic engineering in plants and animals.
- Get a comprehensive idea about IPR and Bioethics.

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Third Year **PROJECT** **Semester-VI**

Code: **Credit: 3**

The candidate shall be required to take up a Project Work by group and submit it at the end of the final year. The Head of the Department shall assign the Guide who, in turn, will suggest the Project Work to the students in the beginning of the final year. A copy of the Project Report will be submitted to the University through the Head of the Department on or before the date fixed by the University.

The Project will be evaluated by an internal and an external examiner nominated by the University. The candidate concerned will have to defend his/her Project through a Viva-voce.

ASSESSMENT/EVALUATION/VIVA VOCE:

1. PROJECT REPORT EVALUATION (Both Internal & External)

   I. Plan of the Project - 20 marks

   II. Execution of the Plan/collection of Data / Organisation of Materials / Hypothesis, Testing etc. and presentation of the report. - 45 marks

   III. Individual initiative - 15 marks

2. Viva-Voce / Internal & External - 20 marks

TOTAL **- 100 marks**

PASSING MINIMUM:

	Vivo-Voce 20 Marks	**Dissertation 80 Marks**
Project	40% out of 20 Marks (i.e. 8 Marks)	40% out of 80 marks (i.e. 32 marks)

A candidate who gets less than 40% in the Project must resubmit the Project Report. Such candidates need to defend the resubmitted Project at the Viva-voce within a month. A maximum of 2 chances will be given to the candidate.

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Third year **SKILL BASED ELECTIVE II** **Semester VI**

BIOFERTILIZER TECHNOLOGY

Code **(Theory)** **Credit 4**

COURSE OBJECTIVES:

- To introduce the necessity and application relevance of biofertilizers.
- To initiate the students towards the development of sustainable agriculture.
- To learn how biofertilizers can be produced in large scale level.
- To signify the microbial biofertilizers namely, bacteria, fungi, cyanobacteria and actinorhiza.
- To present various methods of applying biomanures in the current agriculture.

UNIT - I Origin of Fertilizers and Natural Cycle:

Introduction - History, importance and present status of different types of fertilizers and their application to crop plants. Importance of macro and micro nutrients. Biological fixation of nitrogen; Natural cycles associated with microorganisms - carbon, nitrogen, phosphorous and sulphur.

UNIT – II Cyanobacterial and Bacterial Biofertilizers:

Cyanobacterial Biofertilizers - Nostoc, *Anabaena*, *Gloeocapsa* and *Scytonema* as biofertilizers; Symbiotic association with *Azolla*; Multiplication of blue green algae and its effect on rice yields. Bacterial biofertilizers - Free living forms: *Azotobacter*, *Azospirillum*; Symbiotic forms: *Rhizobium* - Legume Association; *Pseudomonas*, Non-legume association.

UNIT – III Fungal and Actinobacterial Biofertilizers:

Fungal biofertilizers – Types of fungal biofertilizers, ectomycorrhizal association with pines; arbuscular mycorrhizal association - *Glomus* sp., actinomycetes as Biofertilizers – Actinorhiza, Actinorhizal associations - *Frankia* sp.

UNIT - IV Biomanure Production:

Biomanures - A general account of manures – Moulds; Composts Farm Yard Manure- Oil seed cakes - Castor and neem; Green leaf manures - *Gyricidia*, *Sesbania* and *Crotalaria*; Agro-industrial wastes - Poultry manure and saw-dust; Vermi Compost; Microbial compost - pure culture techniques, consortium - types of compost pits. Biodegradation of organic components.

UNIT – V Mass Production of Biofertilizers:

Production of *Rhizobium*, mycorrhiza. Synthesis of micro and macro nutrients. Application of biofertilizers and manures - A combination of biofertilizer and manure applications with reference to soil, seed and leaf sprays. Laboratory and field application; Cost analysis of biofertilizer and biomanure production.

UNIT – VI Current Contours (For continuous internal assessment only):

Field trip to the institutes related to biofertilizers and biomanure production. Analysis of microbiological quality in fertile and infertile soil. An awareness to the farmers about the importance of the biofertilizers.

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COURSE OUTCOMES:

After successful completion of the course, the students will learn about:

- The importance and applications of the biofertilizers for a sustainable agriculture.
- To foster biofertilizers to overcome the applications of chemical fertilizers in the modern farmings.
- The opportunities for the students to develop as a bio-entrepreneur through the production of biofertilizers.
- Exploitation of natural wastes by producing bioorganic fertilizers.
- The concept of biofertilizers' applications in lab and field levels.

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