DEPARTMENT OF MICROBIOLOGY
FACULTY OF ARTS, SCIENCE AND HUMANITIES (FASH)
KARPAGAM ACADEMY OF HIGHER EDUCATION
UG PROGRAM (CBCS) – Microbiology (2016–2017 Batch)

Course code	Name of the course	Objective & outcomes		Hrs / week	Marks			Exam (h)	Credit
		PEOs	POs		CIA	ESE	Total		
16LSU101	Language – I	VII	e	04	40	60	100	3	4
16ENU101	English	VII	e	04	40	60	100	3	4
16MBU101	Introduction to Microbiology and Microbial Diversity	I I	a	04	40	60	100	3	4
16MBU102	Bacteriology	I	g	04	40	60	100	3	4
16MBU103	Biochemistry	VI	g	04	40	60	100	3	4
16MBU111	Basic Microbiology- Practical	VI	b	03	40	60	100	3	2
16MBU112	Bacteriology - Practical	VI	b	03	40	60	100	3	2
16MBU113	Basic Biochemistry- Practical	VI	b	04	40	60	100	3	2
	Semester total			**30**	**320**	**480**	**800**	–	**26**
16LSU201	Language –II	VII	e	04	40	60	100	3	4
16MBU201	Virology	I	g	04	40	60	100	3	4
16MBU202	Microbial Physiology and Metabolism	II	g	04	40	60	100	3	4
16MBU203	Microbial genetics	IV	g	04	40	60	100	3	4
16MBU211	Virology - Practical	VI	b	03	40	60	100	6	2
16MBU212	Microbial Physiology and Metabolism - Practical	VI	b	03	40	60	100	6	2
16MBU213	Microbial Genetics - Practical	VI	b	04	40	60	100	6	2
16AEC201	Environmental Studies	IV	f	04	40	60	100	3	4
	Semester total			**30**	**320**	**480**	**800**	–	**26**
16MBU301	Environmental Microbiology	IV	h	04	40	60	100	3	4
16MBU302	Food and Dairy Microbiology	IV	h	04	40	60	100	3	4
16MBU303	Industrial Microbiology	IV	g	04	40	60	100	3	4
16MBU304A	Microbial Quality Control in Food and Pharmaceutical Industries	IV	h	03	40	60	100	3	3
16MBU304B	Microbial Diagnosis in Health Clinic								
16MBU311	Environmental Microbiology - Practical	IV	h	04	40	60	100	9	2
16MBU312	Food and Dairy Microbiology- Practical	VI	b	04	40	60	100	9	2
16MBU313	Industrial Microbiology - Practical	IV	g	04	40	60	100	9	2
16MBU314A	Microbial Quality Control in Food and Pharmaceutical Industries - Practical	III	b,h	03	40	60	100	3	1
16MBU314B	Microbial Diagnosis in Health Clinic - Practical								
	Semester total			**30**	**320**	**480**	**800**	–	**22**

16MBU401	Immunology	I	h	04	40	60	100	3	4
16MBU402	Medical Microbiology	IV	j	04	40	60	100	3	4
16MBU403	Recombinant DNA Technology	IV	h,g,i	04	40	60	100	3	4
16MBU404A	Biofertilizers and Biopesticides			03	40	60	100	3	3
16MBU404B	Personal Health Care	IV	j						
16MBU411	Immunology - Practical	I	h	04	40	60	100	6	2
16MBU412	Medical Microbiology - Practical	IV	j	04	40	60	100	9	2
16MBU413	Recombinant DNA Technology – Practical	IV	h,g,i	04	40	60	100	9	2
16MBU414A	Biofertilizers and Biopesticides - Practical			03	40	60	100	6	1
16MBU414B	Personal Health Care - Practical	IV	j						
	Semester total			**30**	**320**	**480**	**800**	**-**	**22**

16MBU501A	Management of Human Microbial Diseases	IV	B	04	40	60	100	3	4
16MBU501B	Microbiological Analysis of air and water	I	B						
16MBU502A	Biomathematics and Biostatistics	VII	D	04	40	60	100	3	4
16MBU502B	Bioinformatics	VII	C						
16MBU503A	Instrumentation and Biotechniques	VI	B	04	40	60	100	3	4
16MBU503B	Plant Pathology	II	B						
16MBU504A	Microbial Biotechnology	V	G	03	40	60	100	3	3
16MBU504B	Inheritance Biology	II	A						
16MBU511A	Management of Human Microbial Diseases - Practical	IV	B	04	40	60	100	9	2
16MBU511B	Microbiological Analysis of air and water - Practical	I	B						
16MBU512A	Biomathematics and Biostatistics - Practical	VII	D	04	40	60	100	3	2
16MBU512B	Bioinformatics - Practical	VII	C						
16MBU513A	Instrumentation and Biotechniques - Practical	VI	B	04	40	60	100	3	2
16MBU513B	Plant Pathology - Practical	II	B						
16MBU514A	Microbial Biotechnology - Practical	V	G	03	40	60	100	6	1

16MBU514B	Inheritance Biology - Practical	II	A						
	Semester total			**30**	**320**	**480**	**800**	**–**	**22**
16MBU601A	Mushroom Cultivation	III	G	04	40	60	100	3	4
16MBU601B	Food Fermentation Techniques	IV	H						
16MBU602A	Biosafety and Intellectual Property Rights	V	I	04	40	60	100	3	4
16MBU602B	Microbes in Sustainable Agriculture and Development	IV	G						
16MBU603A	Cell Biology	VI	B	03	40	60	100	3	3
16MBU603B	Molecular Biology	VI	B						
16MBU611A	Mushroom Cultivation - Practical	III	G	04	40	60	100	6	2
16MBU611B	Food Fermentation Techniques - Practical	IV	H						
16MBU612A	Biosafety and Intellectual Property Rights - Practical	V	I	04	40	60	100	6	2
16MBU612B	Microbes in Sustainable Agriculture and Development -Practical	IV	G						
16MBU613A	Cell Biology - Practical	VI	B	03	40	60	100	3	1
16MBU613B	Molecular Biology - Practical	VI	B						
16MBU691	Project	IV	D	08	40	60	100	3	6
	ECA / NCC / NSS / Sports / General interest etc							Good	
	Semester total			**30**	**280**	**420**	**700**	**–**	**22**
	COURSE TOTAL			**180**	**1880**	**2820**	**4700**	**–**	**140**

Elective Courses

Skill Enhancement Elective Courses			
Elective	**Semester**	**Course code**	**Name of the course**
SEC – 1	III	16MBU304A	Microbial Quality Control in Food and Pharmaceutical Industries
		16MBU314A	Microbial Quality Control in Food and Pharmaceutical Industries - Practical
	III	16MBU304B	Microbial Diagnosis in Health Clinic
		16MBU314B	Microbial Diagnosis in Health Clinic - Practical
SEC – 2	IV	16MBU404A	Biofertilizers and Biopesticides
		16MBU414A	Biofertilizers and Biopesticides-Practical
	IV	16MBU404B	Personal Health Care
		16MBU414B	Personal Health Care –Practical
SEC – 3	V	16MBU501A	Management of Human Microbial Diseases
		16MBU511A	Management of Human Microbial Diseases – Practical
	V	16MBU501B	Microbiological Analysis of air and water
		16MBU511B	Microbiological Analysis of air and water – Practical
SEC – 4	VI	16MBU601A	Mushroom Cultivation
		16MBU611A	Mushroom Cultivation –Practical
	VI	16MBU601B	Food Fermentation Techniques
		16MBU611B	Food Fermentation Techniques -Practical

Discipline Specific Elective Courses

Electives	**Semester**	**Course code**	**Name of the course**
DSE – 1	V	16MBU502A	Biomathematics and Biostatistics
		16MBU512A	Biomathematics and Biostatistics - Practical
	V	16MBU502B	Bioinformatics
		16MBU512B	Bioinformatics – Practical
DSE – 2	V	16MBU503A	Instrumentation and Biotechniques
		16MBU513A	Instrumentation and Biotechniques - Practical
	V	16MBU503B	Plant Pathology
		16MBU513B	Plant Pathology – Practical
DSE – 3	V	16MBU504A	Microbial Biotechnology
		16MBU514A	Microbial Biotechnology - Practical
	V	16MBU504B	Inheritance Biology
		16MBU514B	Inheritance Biology – Practical
DSE – 4	VI	16MBU602A	Biosafety and Intellectual Property Rights
		16MBU612A	Biosafety and Intellectual Property Rights - Practical
	VI	16MBU602B	Microbes in Sustainable Agriculture and Development

		16MBU612B	Microbes in Sustainable Agriculture and Development - Practical
DSE – 5	VI	16MBU603A	Cell Biology
		16MBU613A	Cell Biology – Practical
	VI	16MBU603B	Molecular Biology
		16MBU613B	Molecular Biology- Practical
DSE – 6	VI	16MBU691	Project

Undergraduate Programme – B.Sc Microbiology Programme Outcomes

Programme Outcomes of UG Microbiology: Students of all undergraduate microbiology degree Programmes at the time of graduation will be able to

a. Scientific Knowledge: Microbiology majors able to make observations, develop hypotheses, and design and execute experiments using advanced methods. Able to discuss science and scientific methodology. They will have a good knowledge of Intellectual Property Rights.

b. Laboratory Skills: Microbiology students will master the following laboratory skills: aseptic culture techniques, microscopy, use of appropriate methods to identify microorganisms and to use high laboratory equipments. They are able to practice safe microbiology, using appropriate protective and emergency procedures.

c. Data analysis skills: Systematically collect, record, and analyze data, identify sources of error, interpret the results, and reach logical conclusions.

d. Problem-Solving Skills: Microbiology students will be able to analyze and interpret results from a variety of microbiological methods, and apply these methods to analogous situations. Use mathematical and graphing skills and reasoning to solve problems in microbiology.

e. Communication Skills: Microbiology majors will demonstrate competence in written and oral communication.

f. Cooperation/Social Responsibility: Microbiology majors able to understand and appreciate the value of cooperating and working effectively with peers and be able to demonstrate a commitment to the process of developing such skills.

g. Able to understand the importance of microorganisms in various industries such as pharmaceuticals, food, biofertilizers and biopesticidesetc, Students will have a major knowledge on concepts of immunology, biotechnology, molecular biology, biochemistry, genetics. Able to explain the beneficial and harmful role of microorganisms in environment.

Programme Specific Outcomes (PSOs)

h. Students will have a major knowledge on concepts of immunology, biotechnology, molecular biology, biochemistry, genetics. Able to explain the beneficial and harmful role of microorganisms in environment. Able to understand the importance of microorganisms in various industries such as pharmaceuticals, food, biofertilizers and biopesticides etc,

i Describe how microorganisms are used as *model systems* to study basic biology, genetics, metabolism and ecology.

j. Identify ways microorganisms play an *integral role* in disease, and microbial and immunological methodologies are used in disease treatment and prevention.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

Programme Educational Objectives of UG Microbiology: The major objectives of the undergraduate course is

PEO-I: To impart knowledge on basic concepts of microbiology. To understand the beneficial and harmful role of microorganisms in the environment.

PEO-II: To understand the fundamentals of physiological reactions including metabolic pathways and biochemical reactions in microorganisms.

PEO-III: To develop human resource and entrepreneurs in Microbiology with the ability to independently start their own ventures or small biotech units in the field of biotechnology.

PEO-IV: Understand modern microbiology - practices and approaches with an emphasis in technology application in pharmaceutical, medical, industrial, environmental and agricultural areas.

PEO-V: Become familiar with public policy, bio-safety, and intellectual property rights issues related to microbiology applications nationally and globally

PEO-VI: Gain experience with standard bioinstrumentations and molecular tools and approaches utilized: manipulate genes, gene products and organisms.

PEO-VII: To demonstrate the written and oral communication skill. To develop the problem solving and data interpretation skills.

POs	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**
PEO I	X							X		X
PEO II	X							X	X	
PEO III				X			X	X		
PEO IV				X			X		X	
PEO V	X					X				X
PEO VI		X	X	X						
PEO VII	X		X	X	X					

Semester – I

16LSU101 **தமிழ்முதல்தாள்** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40**External: **60** Total: **100**

End Semester Exam: 3 Hours

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- கற்றல் வழி சிந்தனைத் திறனையும், கருத்து வெளிப்பாட்டுத் திறனையும், மேம்படுத்துத□□.
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- இலக்கியங்கள் உணர்த்தும் வாழ்வின் நுட்பமான பகுதிகளை உணர்த்துதல்.
- மனித மனத்தினைப் பக்குவப்படுத்துதலில் இலக்கியம் தரும் பங்கினை உணர்த்துதல்.
- வளர்ந்து வரும் சமூகத்தில் அறஉணர்வு, பண்பாடு போன்றவை குறித்து அறிவூட்டல்.
- அரசுத் தேர்வுகளுக்கு மாணவர்களை ஆயத்தமாக்குதல்.

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தாள்கள் வரிசையும் தேர்வுச் செயல்திட்டமும் பகுதி-I தமிழ்

அலகு – I :இக்காலஇலக்கியம்: **(10 மணிநேரம்)**

கல்வி: மகாகவிபாரதியார் – சுயசரிதை – ஆங்கிலக்கல்வி.

இன்றையநிலை: கவிமணிதேசிகவிநாயகம்பிள்ளை–ஒற்றுமையேஉயிர்நிலை.

மனிதநேயம்:கவிஞர்சிற்பிபாலசுப்பிரமணியன் –மலையாளக்காற்று.

சூழலியல்:கவிஞர்வைதீஸ்வரன் - விரல்மீட்டியமழை.

பெண்ணியம்:கவிஞர்சுகந்திசுப்பிரமணியம் – புதையுண்டவாழ்க்கை.

அலகு – II :அறஇலக்கியம்: (10 மணிநேரம்)

கொன்றைவேந்தன்: 1-50 பாடல்கள்

திருக்குறள்: பண்புடைமை, வினைத்திட்பம் – 20 குறள்கள்

பழமொழிநானூறு: 5 பாடல்கள்

அலகு - III :சிற்றிலக்கியம்: (10 மணிநேரம்)

மூவருலா: 1-26 கண்ணிகள்

திருச்செந்தூர்முருகன்பிள்ளைத்தமிழ்: 2 பாடல்கள்

கலிங்கத்துப்பரணி: போர்பாடியது - 9 பாடல்கள்

அலகு – IV :கட்டுரை: (10 மணிநேரம்)

1. **உயர்தனிச்செம்மொழி-பரிதிமாற்கலைஞர்**
2. **கட்டிடக்கலை**- அ. இராசமாணிக்கனார்
3. **வாழ்க்கை** - இளவழகனார்
4. ஆளுமைத்திறன்அறிவோம் - ஸ்ரீகண்ணன்
5. மணற்கேணி - நெ.து.சுந்தரவடிவேலு

அலகு- V :மொழிப்பயிற்சி: (8 மணிநேரம்)

1. படைப்பிலக்கியப்பயிற்சிகள் (கதை,கவிதை, கட்டுரை, உரைநடை)
2. மொழிபெயர்ப்பு
3. இலக்கணப்பயிற்சிகள்

பாடநூல்:கற்பகச்சோலை – தமிழ்ஏடு.கற்பகம்பல்கலைக்கழகத்தமிழ்த்துறைவெளியீடு.

16ENU101 **ENGLISH** **Semester – I**
4H – 4C

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40**External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives:

- To help students enhance their Language skills
- To introduce different kinds of literary works
- To familiarize different genres of Literature
- To instruct moral values through literature.
- To improvise their productive and receptive skills
- To strengthen the basic knowledge about grammar.

Course Outcome:

- Develop the four types of skills
- Reading and comprehending literary works
- Genres of literature to provide moral education
- Develop communication skills in business environment
- Interpersonal skills will be developed.
- Betterment of language competence

UNIT–I

Prose: Google Guys (Extract) – Richard L Brandt
Poetry: The Blind Pedlar – Osbert Sitwell
Short Story: A Garden So Rich – Christie Craig
Vocabulary: Prefix, Antonyms, Sentence Completion
Grammar: Article, Adverb, Pronoun

UNIT – II

Prose: Happiness 101 – Geeta Padmanabhan
Poetry: An Old Woman **–** Arun Kolatkar
Vocabulary: Suffix, Analogies
Grammar: Noun, Adjective

UNIT– III

Prose: Structured Procrastination – John Perry
Short Story: The Umbrella Man – Roald Dahl
One-Act Play: The Boy Who Stopped Smiling – Ramu Ramanathan
Vocabulary: Synonyms, Euphemisms, Word Definitions
Grammar: Verb, Conjunction and Interjection, Indirect/Reported Speech

UNIT – IV

Poetry: No Sentence – Anjum Hassan
One-Act Play: While the Auto Waits- O' Henry
Vocabulary: Words Often Confused, Anagrams
Grammar: Preposition, Voice- Active and Passive

UNIT–V

Short Story: The Bird – Amar Jalil
One-Act Play: The Cellphone Epidemic – Claudia I. Haas
Vocabulary: Portmanteau Words, One Word Substitution
Grammar: Question, Pronunciation

PRESCRIBED TEXT

- Rao, G. Chandralekha et al. *Spring* 2013**.** Emerald Publishers: Chennai.

SUGGESTED READINGS

- Shyamala, V. *English for Communication*. 2006. Emerald Publishers: Chennai

Semester – I

16MBU101 INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY 4H – 4C

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40**External: **60** Total: **100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES

- It gives brief description on the microbial metabolism and its energetic
- It deals with the various aerobic and an aerobic process through which the organisms obtain and utilize the energy for their growth and to produce industrially important products that helps the students to become better entrepreneurs
- Explains photosynthesis and photosynthetic bacteria
- To study the structure, function, energy metabolism, growth and regulatory mechanisms of microorganisms.
- The students will learn about the metabolic diversity exhibited by microorganisms
- The students will learn about regulatory networks that support their survival and growth of the microorganism.

COURSE OUTCOME (CO'S)

- The students will be able to understand and predict the various metabolic reactions in microbial cell.
- This will make them predict the intermediate products which can be employed in industrial production processes.
- Students will understand the growth, nutrition and environmental factors
- Students able to assess the prokaryotes by observing the biochemical reaction
- This course will support them to interpret the fermentation using microbes
- Able to summarize the nutrients uptake system in the prokaryotes

Unit I – History and Development of Microbiology

Development of microbiology as a discipline, spontaneous generation Vs biogenesis. Contribution of Anton von Leewenhoek, Golden era of Microbiology Louis Pasteur, Robert Koch, Joseph Lister, Alexander Flemming. Role of microorganism in fermentation, Germ theory of disease, Establishment of fields of medical microbiology and immunology through the work of Paul Ehrlich, Ellie Metchnikoff, Edward Jenner. Microscopy Application in industries, Application in medicine, Application in agriculture, Application in biotechnology, Application in biology.

Unit II – Diversity of Microbial world

Bergey's Manual, Binomial Nomenclature and Universal Phylogenetic tree. Classification system: Phenetic and Phylogenetic, Whittaker's Five Kingdom and Carl Woese's three kingdom classification system and their utility. Difference between prokaryotic and eukaryotic microorganism.Major diversity of microbial life. Bacteriology

Unit III– Algae

General characteristics of algae including algal cell ultra-structure.Chlamydomonas, Volvox, Diatoms, red algae and brown algae.Application of Algae in agriculture, industry, environment and food.

Unit IV – Fungi and Actinomycetes

General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultra-structure. Economic importance of fungi with examples in agriculture, environment, industry, medicines, food, biodeterioration and mycotoxins. Alexopoulos classification.

Unit V – Protozoa and virus

General characteristics with special references with *Entameoba histolytica*, *Trichomonas*, *Giardia* and *Plasmodium*. Classification of viruses.

SUGGESTED READINGS

1. Tortora, G.J., Funke, B.R., and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education.
2. Madigan, M.T., Martinko J.M., Dunlap, P.V., and Clark, D.P. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition.
3. Cappucino, J., and Sherman, N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited.
4. Wiley, J.M., Sherwood, L.M., and Woolverton, C.J. (2013) Prescott's Microbiology. 9th edition. McGraw Hill International.
5. Atlas, R.M. (1997). Principles of Microbiology. 2nd edition. WM.T.Brown Publishers.
6. Pelczar, M.J., Chan, E.C.S., and Krieg, N.R. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
7. Stanier, R.Y., Ingraham, J.L., Wheelis, M.L., and Painter, P.R. (2005). General Microbiology. 5th edition. McMillan.8
8. Duby, R.C. (2014)Textbookof Microbiology. 5th edition. S. Chand Publishing.

Semester – I

16MBU102 **BACTERIOLOGY** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40v**External: **60** Total: **100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES

- To provide a strong base in the fundamentals of bacteria that improves their chances in employability.
- To learn techniques and methods used in the cultivation and isolation of bacteria.
- To learn various physical and chemical means of sterilization
- To prepare the specimen and identify the morphology of the bacteria
- To know about the culture media
- To obtain with the knowledge about the habitat and characteristics of various physiological groups of bacteria and archaea in detail.

COURSE OUTCOME (CO'S)

After completion of this course candidate able to:

- Understand the basic microbial structure and function and this course provide an understanding of the concepts of bacteriology which is one of the basic requirements for their employability
- Understand the structural similarities and differences among various physiological groups of bacteria and archaea
- Demonstrate theory and practical skills in staining procedures
- Understand various Culture media and their applications
- Understand various physical and chemical means of sterilization
- Know General bacteriology and microbial techniques for isolation of pure culture of bacteria

Unit I – Cell organization

Cell shape and arrangement, glycocalyx, capsule, flagella, fimbriae and pili. Cell-wall: Composition and detailed structure of Gram-positive and Gram-negative cell walls, Archaebacterial cell wall, Gram and acid-fast staining mechanisms, sphaeroplasts, protoplasts, and L-forms. Effect of antibiotics and enzymes on the cell wall. Cell Membrane: Structure, function and chemical composition of bacterial and Archaeal cell membranes. Cytoplasm: Ribosomes, mesosomes, inclusion bodies, nucleoid, chromosome and plasmids. Endospore: Structure, formation, stages of sporulation.

Unit II – Bacteriological techniques

Observation of living microorganisms- Wet mount, motility. Stains and staining reactions - Simple and differential staining - Gram, Spore, Capsule, Acid fast and Hemocytometer. Pure culture isolation: Streaking, serial dilution and plating methods; cultivation, maintenance and preservation/stocking of pure cultures; cultivation of anaerobic bacteria, and methods to study non-culturable bacteria.

Unit III – Growth, nutrition and reproduction in bacteria

Culture media: components of media, natural and synthetic media, chemically defined media, complex media, selective, differential, indicator, enriched and enrichment media. Physical methods of microbial control: heat – below 100˚C, at 100˚C, above 100˚C, Autoclave, Tyndallization; filtration, desiccation, osmotic pressure, radiation. Chemical methods of microbial control: Antiseptics, disinfectants – types and mode of action. Asexual methods of reproduction, logarithmic representation of bacterial populations, phases of growth, calculation of generation time and specific growth rate

Unit IV – Bacterial Systematics

Aim and principles of classification, systematics and taxonomy, concept of species, taxa, strain; conventional, molecular and recent approaches to polyphasic bacterial taxonomy, evolutionary chronometers, rRNA oligonucleotide sequencing, signature sequences, and protein sequences. Differences between eubacteria and Archaebacteria.

Unit V – Important archaeal and eubacterial groups

Archaebacteria: General characteristics, phylogenetic overview, genera belonging to Nanoarchaeota (*Nanoarchaeum*), Crenarchaeota (*Sulfolobus*, *Thermoproteus*) and Euryarchaeota(*Methanobacterium*, *Methanocaldococcus*).Thermophiles (*Thermococcus*, *Pyrococcus*, *Thermoplasma*) and Halophiles (*Halobacterium*, *Halococcus*)]. Eubacteria: Morphology, metabolism, ecological significance and economic importance of following groups: Gram Negative:General characteristics with suitable examples of Alpha, Beta, Gamma, Delta, Epsilon, Zeta and Non-proteobacteria.Gram Positive:Low G+C (Firmicutes): General characteristics with suitable examples. High G+C (Actinobacteria): General characteristics with suitable examples. Cyanobacteria: An Introduction.

SUGGESTED READINGS

1. Pelczar, J.r M.J., Chan,ECS., and Krieg, N.R. (2004). Microbiology. 5th edition. Tata McGraw Hill.
2. Willey, J.M., Sherwood, L.M., and Woolverton, C.J. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.
3. Madigan, M.T., and Martinko, J.M. (2014). Brock Biology of Micro-organisms. 14th edition. Parker J. Prentice Hall International, Inc.
4. Tortora, G.J., Funke, B.R., and Case, C.L. (2008). Microbiology: An Introduction. 9th edition. Pearson Education.
5. Black, J.G. (2008). Microbiology: Principles and Explorations. 7th edition. Prentice Hall
6. Stanier, R.Y., Ingraham,J.L., Wheelis, M.L., and Painter, P.R. (2005). General Microbiology. 5th edition. McMillan.
7. Atlas, R.M. (1997). Principles of Microbiology. 2nd edition. WM.T.Brown Publishers.
8. Cappucino, J., and Sherman. N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited
9. Srivastava, S., and Srivastava, P.S. (2003). Understanding Bacteria. Kluwer Academic Publishers, Dordrecht.

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16MBU103 **BIOCHEMISTRY** **Semester – I (4H – 4C)**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40**External: **60** Total: **100**
End Semester Exam: 3 Hours

COURSE OBJECTIVES

- To provide the knowledge on basics of biochemistry and its applications and to highlight the technical skill.
- To describe the classification and functions of lipids.
- To summarize the structure and classification of enzymes
- To state the Structure and types of DNA
- To analyse the functions and properties of phosphoglycerides
- To understand about storage and structural polysaccharides.

COURSE OUTCOME (CO'S)

- Understand the structures of enzymes, proteins, carbohydrates and fats
- Understand the functions of biomolecules
- Analyze the process of metabolism
- Understand of nucleic acids and their importance to combine and analyses information.
- Structure and classification of enzymes, specificity of enzymes
- Summarize the protein structure and enzyme activity, unit and specificity

Unit I–Basics of Biochemistry

Atoms and molecules, cell structure, cell organelles, developing membrane structure, transport of molecules, Beer and Lambert's Law, Calorimeter,Anabolism and catabolism and standard for energy change.

Unit II – Carbohydrates

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

Unit III – Lipids

Definition and major classes of storage and structural lipids.Storage lipids.Fatty acids structure and functions.Essential fatty acids. Triacyl glycerols structure, functions and properties. Saponification.Structural lipids. Phosphoglycerides: Building blocks, General structure, functions and properties. Structure of phosphatidylethanolamine and phosphatidylcholine, Sphingolipids: building blocks, structure of sphingosine, ceramide. Special mention of sphingomyelins, cerebrosides and gangliosides Lipid functions: cell signals, cofactors, prostaglandins, Introduction of lipid micelles, monolayers, bilayers

Unit IV – Proteins

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

Unit V – Enzymes and Vitamins

Structure of enzyme: Apoenzyme and cofactors, prosthetic group-TPP, coenzymeNAD,metal cofactors, Classification of enzymes, Mechanism of action of enzymes: active site, transition state complex and activation energy. Lock and key hypothesis, and Induced Fit hypothesis. Significance of hyperbolic, double reciprocal plots of enzyme activity, Km, and allosteric mechanism Definitions of terms – enzyme unit, specific activity and turnover number, Multienzyme complex : pyruvate dehydrogenase; isozyme: lactate dehydrogenase, Effect of pH and temperature on enzyme activity. Enzyme inhibition: competitive- sulfa drugs; non-competitive-heavy metal salts. Vitamins - Classification and characteristics with suitable examples, sources and importance.

SUGGESTED READINGS

1. Campbell, M.K. (2012) Biochemistry, 7th edition. Published by Cengage Learning.
2. Campbell, P.N., and Smith, A.D., (2011) Biochemistry Illustrated, 4th edition. Published by Churchill Livingstone.
3. Tymoczko, J.L., Berg, J.M., and Stryer, L. (2012) Biochemistry: A short course, 2nd edition. W.H.Freeman.
4. Berg, J.M., Tymoczko, J.L., and Stryer, L. (2011) Biochemistry, W.H.Freeman and Company.
5. Nelson, D.L and Cox, M.M. (2008) Lehninger Principles of Biochemistry, 5th edition. W.H. Freeman and Company.
6. Willey, M.J., Sherwood, L.M., & Woolverton, C. J. (2013) Prescott, Harley and Klein's Microbiology.9th edition. McGrawHill.

16MBU111 **BASIC MICROBIOLOGY -PRACTICAL** **Semester – I (3H – 2C)**

Instruction Hours / week: L: 0 T: 0 P: 3 **Marks:** Internal: **40**External: **60** Total: **100**
End Semester Exam: 3 Hours

COURSE OBJECTIVES

- To develop skills related to
- Isolation and culture techniques of bacteria
- The external feature of bacteria and colony characteristics. Various staining techniques
- Sterilization of heat sensitive materials
- Counting of microorganism in the environment
- Isolation of parasites from edible fruits.
- Good laboratory practice and Biosafety measures.

COURSE OUTCOME (CO'S)

- This practical paper will build the student to describe and distinguish the bacterial colonies.
- They also will create knowledge on preparing permanent temporary mounts for fungi, protozoan's and algae.
- Students will able to understand the parasites and its nature.
- They can able to handle the pathogens safely.
- Students able to describe the *Spirogyra, Chlamydomonas* and *Volvox*
- Students able to handle the instruments in the microbiology laboratory

EXPERIMENTS

1. Microbiology Good Laboratory Practices and Biosafety.
2. To study the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, microscope, pH meter) used in the microbiology laboratory.
3. Preparation of culture media for bacterial cultivation.
4. Sterilization of heat sensitive material by membrane filtration and assessment for sterility.
5. Demonstration of the presence of micro flora in the environment by exposing nutrient agar plates to air.
6. Temporary mounts Lacto phenol cotton blue mount – *Rhizopus*, *Penicillium*, *Aspergillus*.
7. Study of *Spirogyra* and *Chlamydomonas*, *Volvox* using temporary mounts.
8. Study of the following protozoans using permanent mounts/photographs: *Amoeba*,*Entamoeba*,*Paramecium* and *Plasmodium*

SUGGESTED READINGS

1. Tortora, G.J., Funke, B.R, and Case, C.L. (2008). Microbiology: An Introduction. 9th edition. Pearson Education.
2. Madigan, M.T., Martinko, J,M., Dunlap, P.V., and Clark,D.P. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International edition.
3. Cappucino, J., and Sherman,N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited.

4. Wiley, J.M., Sherwood, L.M., and Woolverton, C.J. (2013) Prescott's Microbiology. 9th edition. McGraw Hill International.
5. Atlas, R.M. (1997). Principles of Microbiology. 2nd edition. WM.T.Brown Publishers.
6. Pelczar, M.J., Chan,ECS., and Krieg, N.R. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
7. Stanier, R.Y., Ingraham, J.L., Wheelis, M.L., and Painter, P.R., (2005). General Microbiology.5th edition.McMillan.

Semester – I

16MBU112 **BACTERIOLOGY -PRACTICAL** **(3H – 2C)**

Instruction Hours / week: L: 0 T: 0 P: 3 **Marks:** Internal: **40**External: **60** Total: **100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES

- To provide a strong base in the fundamentals of bacteria.
- To learn techniques and methods used in the cultivation and isolation of bacteria.
- To develop skills related to preservation of bacterial cultures.
- To learn about bacterial specialized structure using staining methods
- To learn the bacterial special structure capsule and spore
- To measure the bacterial size

COURSE OUTCOME (CO'S)

Theory and practical skills in staining procedures

- Various Culture media and their applications
- Various microbial culture techniques to obtain isolation of pure cultures of bacteria
- Bacterial endospore and capsule
- Able to analyze the Bacterial size
- Able explain the bacterial motility and flagella
- To know the staining procedure

EXPERIMENTS

1. Preparation of different media: synthetic media BG-11, Complex media - Nutrient agar, McConkey agar, EMB agar.
2. Micrometry.
3. Motility by hanging drop method.
4. Simple staining
5. Negative staining
6. Gram's staining
7. Acid fast staining – demonstration permanent slide only.
8. Capsule staining
9. Endospore staining.
10. Isolation of pure cultures of bacteria by streaking method - Quadrant, Continuous and T-streaking.
11. Preservation of bacterial cultures by various techniques - Agar slants and deeps - Mineral Oil,Glycerol stocks
12. Estimation of Colony Forming Unit (CFU) count by spread plate method/pour plate method.

SUGGESTED READINGS

1. Pelczar Jr, M.J., Chan,ECS., and Krieg, N.R. (2004). Microbiology. 5th edition. Tata McGraw Hill.
2. Willey, J.M., Sherwood, L.M., and Woolverton, C.J. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.
3. Madigan, M.T., and Martinko, J.M. (2014). Brock Biology of Micro-organisms. 14th edition. Parker J. Prentice Hall International, Inc.

4. Tortora, G.J., Funke, B.R., and Case, C.L. (2008). Microbiology: An Introduction. 9th edition. Pearson Education.
5. Black, J.G. (2008). Microbiology: Principles and Explorations. 7th edition. Prentice Hall
6. Stanier, R.Y., Ingraham, J.L., Wheelis, M.L., and Painter, P.R. (2005). General Microbiology. 5th edition. McMillan.
7. Atlas, R.M. (1997). Principles of Microbiology. 2nd edition. WM.T.Brown Publishers.
8. Cappucino, J., and Sherman, N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited
9. Srivastava, S., and Srivastava, P.S. (2003). Understanding Bacteria. Kluwer Academic Publishers, Dordrecht.

Semester – I

16MBU113 **BASIC BIOCHEMISTRY- PRACTICAL** **(3H – 2C)**

Instruction Hours / week: L: 0 T: 0 P: 4 **Marks:** Internal: **40**External: **60** Total: **100**

End Semester Exam: 3 Hours

COURSE OBJECTIVE

- To familiarize the students with the basic cellular processes at molecular level
- To make students familiar with practical techniques used for studying biochemical structure and analysis of biochemical methods.
- To expertise in Qualitative/Quantitative tests of carbohydrates, reducing sugars, Protein and lipids
- To study the protein secondary and tertiary structures
- To study the effect of temperature, pH and heavy metals on enzyme activity.
- To gain the knowledge on vitamin estimation

COURSE OUTCOME

- The practical knowledge and the skills associated about various techniques used in Biochemistry.
- The skill in qualitative and quantity analysis of carbohydrates, protein and lipid
- An understanding in protein secondary and tertiary structures
- An insight in enzyme activity and its physical factors influence the activity
- Knowledge on vitamin estimation
- Cognitive skill and students able to solve the numerical problems

EXPERIMENTS

1. Properties of water, concept of pH and buffers, preparation of buffers and numerical problems to explain the concepts.
2. Numerical problems on calculations of standard free energy change and equilibrium constant.
3. Standard free energy change of coupled reactions.
4. Qualitative/Quantitative tests for carbohydrates, reducing sugars, and non-reducing sugars.
5. Qualitative/Quantitative tests for lipids and proteins.
6. Study of protein secondary and tertiary structures with the help of models.
7. Study of enzyme kinetics – calculation of Vmax, Km, Kcat values.
8. Study effect of temperature, pH and heavy metals on enzyme activity.
9. Estimation of any one vitamin.

SUGGESTED READING

1. Campbell., M.K. (2012) Biochemistry, 7th edition. Published by Cengage Learning.
2. Campbell, P.N., and Smith, A.D. (2011) Biochemistry Illustrated, 4th edition. Published by Churchill Livingstone.
3. Tymoczko, J.L., Berg, J.M., and Stryer, L. (2012) Biochemistry: A short course, 2nd edition. W.H.Freeman
4. Berg, J.M., Tymoczko, J.L., and Stryer, L. (2011) Biochemistry, W.H.Freeman and Company.
5. Nelson, D.L., and Cox, MM.. (2008) Lehninger Principles of Biochemistry, 5th Edition. W.H. Freeman and Company.
6. Willey, M.J. herwood, L.M.& Woolverton, C.J. (2013) Prescott, Harley and Klein's Microbiology 9th Edition. McGrawHill
7. Voet, D,.and Voet, J.G. (2004) Biochemistry 3rd edition, John Wiley and Sons.

Semester – II
(4H – 4C)

16LSU201 **தமிழ்இரண்டாம்தாள்**

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- கற்றல் வழி சிந்தனைத் திறனையும், கருத்து வெளிப்பாட்டுத் திறனையும், மேம்படுத்துத□□.
- □□□□□□□□□□□□ மேம்படுத்துத□□.
- இலக்கியங்கள் உணர்த்தும் வாழ்வின் நுட்பமான பகுதிகளை உணர்த்துதல்.
- மனித மனத்தினைப் பக்குவப்படுத்துதலில் இலக்கியம் தரும் பங்கினை உணர்த்துதல்.
- வளர்ந்து வரும் சமூகத்தில் அறஉணர்வு, பண்பாடு போன்றவை குறித்து அறிவூட்டல்.
- அரசுத் தேர்வுகளுக்கு மாணவர்களை ஆயத்தமாக்குதல்.

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அலகு – I :பக்திஇலக்கியம் **(10 மணிநேரம்)**

வைணவஇலக்கியங்கள் - தோற்றம் ,வளர்ச்சி, வரலாறு.

1. சைவம் -பெரியபுராணம் - திருமூலநாயனார்புராணம்.

2.வைணவம் - பெரியாழ்வார்திருமொழி: 10 பாடல்கள்.

அலகு – II :சங்கஇலக்கியம் : **(15 மணிநேரம்)**

சங்கஇலக்கியங்கள்அறிமுகம்

அ).எட்டுத்தொகை

நற்றிணை: பிரசம்கலந்த – பாலை -110

குறுந்தொகை : கருங்கட்டாக்கலை – குறிஞ்சி- 69

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முருகன்இருப்பிடங்கள் – 'சிறுதினைமலரொடு' என்பதிலிருந்துதொடங்கி, 'அறிந்தவாறே' என்பதுவரையிலானதொடர்கள்: 218-249.

முருகன்அருள்புரிதல் – 'தெய்வம்சான்ற' என்பதிலிருந்துதொடங்கி, 'நல்குமதி' என்பதுவரையிலானதொடர்கள்: 286-295.

அலகு - III :காப்பியம் (6 மணிநேரம்)

சிலப்பதிகாரம்:

மங்கலவாழ்த்துப்பாடல்: (21-29) – கண்ணகியின்சிறப்பு:

'நாகநீள்நகரொடு' என்பதிலிருந்துதொடங்கி,
'கண்ணகிஎன்பாண்மன்னோ' என்பதுவரையிலானதொடர்கள்.

நடுகற்காதை: (207-234)-

சேரன்செங்குட்டுவன்கண்ணகிக்குக்கோயில்எடுத்தல்:
'அருந்திறலரசர்' என்பதிலிருந்துதொடங்கி, 'மன்னவரேறென்' என்பதுவரையிலானதொடர்கள்.

வாழ்த்துக்காதை: (482-485)-

செங்குட்டுவனுக்குக்கண்ணகிகாட்சியளித்தல்: 'என்னே' என்பதிலிருந்துதொடங்கி, 'விசும்பில்தோன்றுமால்' என்பதுவரையிலானதொடர்கள்.

வழக்குரைகாதை:பத்தினிப்பெண்டிர்எழுவர்கதை: 'நீர்வார்கண்ணை' என்பதிலிருந்துதொடங்கி, 'புகாரென்பதியே' என்பதுவரையிலானதொடர்கள்.

வஞ்சினமாலை: 'வன்னிமரமும்' என்பதிலிருந்துதொடங்கி, 'பதிப்பிறந்தேன்' என்பதுவரையிலானதொடர்கள்.

அலகு – IV :சிறுகதை **(10 மணிநேரம்)**

1. **குளத்தங்கரைஅரசமரம் – வ.வே.சு.ஐயர்**
2. **காட்டில்ஒருமான் - அம்பை**
3. **நாற்காலி – கி.ராஜநாராயணன்**
4. **நகரம் – சுஜாதா**

அலகு- V :மொழிப்பயிற்சி **(7 மணிநேரம்)**

படைப்பிலக்கியப்பயிற்சிகள் (கதை, கவிதை, கட்டுரை, உரைநடை)

மொழிபெயர்ப்பு

பாடநூல்:கற்பகச்சோலை –

தமிழ்ஏடு.கற்பகம்பல்கலைக்கழகத்தமிழ்த்துறைவெளியீடு.

16MBU201 **VIROLOGY** **Semester – II (4H – 4C)**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40**External: **60** Total: **100**
End Semester Exam: 3 Hours

COURSE OBJECTIVES

- Describe the structure and replication strategies of the individual viruses discussed, including the processes of entry into cells, control of gene transcription.
- Define the process of virus latency and describe in molecular terms control of the process and activation of viral genomes during reactivation.
- Describe the growth behavior differences between normal cells and cells transformed by oncogenic DNA and RNA viruses.
- To study general aspects of viral morphology and classification.
- Cultivation of viruses and various methods of propagation.
- To discuss the application of various immunological and molecular diagnostic tools.

COURSE OUTCOME (CO'S)

- Upon paper completion, students will have skill-based knowledge on structure of plants, animal, bacteria and viruses.
- This paper also enables the student on isolation, propagation of various viruses.
- It will help the students to understand the plant and animal viruses.
- Students can distinguish the viruses According to their characteristic features.
- It will explain the research activities involved in virology studies.
- Skill based viral analysis can be performed in medical research.

Unit I – Nature and Properties of Viruses

Introduction: Discovery of viruses, nature and definition of viruses, general properties, concept of viroids, virusoids, satellite viruses and Prions. Structure of Viruses: Capsid symmetry, enveloped and non-enveloped viruses. Isolation, purification and cultivation of viruses. Viral assay, Viral taxonomy: Classification and nomenclature of different groups of viruses

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

Unit III – Viral Transmission, salient features of viral nucleic acids & replication
Modes of viral transmission: Persistent, non-persistent, vertical and horizontal. Salient features of viral Nucleic acid: Unusual bases (TMV,T4 phage), overlapping genes (φX174, Hepatitis B virus), alternate splicing (HIV), terminal redundancy (T4 phage), terminal cohesive ends (lambda phage), partial double stranded genomes (Hepatitis B), long terminal repeats (retrovirus), segmented (Influenza virus), and non-segmented genomes (picornavirus), capping and tailing (TMV).

Unit IV – Viruses and Cancer, Prevention & control of viral diseases
Viral multiplication and replication strategies: Interaction of viruses with cellular receptors and entry of viruses. Replication strategies of viruses as per Baltimore classification (phi X 174, Retroviridae, Vaccinia, Picorna), Assembly, maturation and release of virions

Unit V – Applications of Virology
Introduction to oncogenic viruses. Types of oncogenic DNA and RNA viruses: Concepts of oncogenes and proto-oncogenes. Antiviral compounds and their mode of action. Interferon and their mode of action.General principles of viral vaccination. Immunization schedule. Use of viral vectors in cloning and expression, gene therapy and phage display

SUGGESTED READINGS

1. Dimmock, N.J., Easton., A.L., Leppard, K.N. (2007). Introduction to Modern Virology. 6th edition, Blackwell Publishing Ltd.
2. Carte,r J., and Saunders, V. (2007). Virology: Principles and Applications. John Wiley and Sons.
3. Flint, S.J., Enquist, L.W., Krug, R.M., Racaniello, V.R., Skalka, A.M. (2004). Principles of Virology, Molecular biology, Pathogenesis and Control. 2nd edition. ASM press Washington DC.
4. Levy, J.A., Conrat, H.F., Owens, R.A. (2000). Virology. 3rd edition. Prentice Hall publication, New Jersey.
5. Wagner, E.K., Hewlett, M.J. (2004). Basic Virology. 2nd edition. Blackwell Publishing.
6. Mathews. (2004). Plant Virology. Hull R. Academic Press, New York.
7. Nayud, M.V. (2008). Plant Viruses. Tata McGraw Hill, India.
8. Bos, L. (1999) Plant viruses-A text book of plant virology by. Backhuys Publishers.
9. Versteeg J. (1985). A Color Atlas of Virology. Wolfe Medical Publication.

Semester – II

16MBU202 **MICROBIAL PHYSIOLOGY AND METABOLISM** **(4H – 4C)**

Instruction Hours / week:L: 4 T: 0 P: 0 **Marks:** Internal: **40**External: **60** Total: **100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES

- It gives brief description on the microbial metabolism and its energetic
- It deals with the various aerobic and an aerobic process through which the organisms obtain and utilize the energy for their growth and to produce industrially important products that helps the students to become better entrepreneurs
- Explains photosynthesis and photosynthetic bacteria
- To study the structure, function, energy metabolism, growth and regulatory mechanisms of microorganisms.
- The students will learn about the metabolic diversity exhibited by microorganisms
- The students will learn about regulatory networks that support their survival and growth of the microorganism.

COURSE OUTCOME (CO'S)

- The students will be able to understand and predict the various metabolic reactions in microbial cell.
- This will make them predict the intermediate products which can be employed in industrial production processes.
- Students will understand the growth, nutrition and environmental factors
- Students able to assess the prokaryotes by observing the biochemical reaction
- This course will support them to interpret the fermentation using microbes
- Able to summarize the nutrients uptake system in the prokaryotes

Unit I – Microbial Growth & Effect of Environment on Microbial Growth

Definitions of growth, measurement of microbial growth, Batch culture, Continuous culture, generation time and specific growth rate, synchronous growth, diauxic growth curve. Microbial growth in response to environment -Temperature (psychrophiles, mesophiles, thermophiles, extremophiles, thermodurics, psychrotrophs), pH (acidophiles, alkaliphiles), solute and water activity (halophiles, xerophiles, osmophilic), Oxygen (aerobic, anaerobic, microaerophilic, facultative aerobe, facultative anaerobe),barophilic..

Unit II– Nutrient uptake and Transport

Microbial growth in response to nutrition and energy – Autotroph/Phototroph, heterotrophy, Chemolithoautotroph, Chemolithoheterotroph, Chemoheterotroph, Chemolithotroph, photolithoautotroph, Photoorganoheterotroph. Passive and facilitated diffusion.Primary and secondary active transport, concept of uniport, symport and antiport.Group translocation. Iron uptake

Unit III – Chemoheterotrophic Metabolism-Aerobic Respiration

Concept of aerobic respiration, anaerobic respiration and fermentation Sugar degradation pathways i.e. EMP, ED, Pentose phosphate pathway TCA cycle, Electron transport chain: components of respiratory chain, comparison of mitochondrial and bacterial ETC, electron transport phosphorylation, uncouplers and inhibitors.

Unit IV – Chemoheterotrophic Metabolism-Anaerobic respiration&fermentation

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

Unit V– Chemolithotrophic, Phototrophic and nitrogen Metabolism

Introduction to aerobic and anaerobic chemolithotrophy with an example each.Hydrogen oxidation (definition and reaction) and methanogenesis (definition and reaction). Introduction to phototrophic metabolism - groups of phototrophic microorganisms, anoxygenic *vs.* oxygenic photosynthesis with reference to photosynthesis in green bacteria, purple bacteria and cyanobacteria. Nitrogen Metabolism: An overview. Introduction to biological nitrogen fixation Ammonia assimilation. Assimilatory nitrate reduction, dissimilatory nitrate reduction, denitrification

SUGGESTED READINGS

1. Madigan, M.T., and Martinko, J.M. (2014). Brock Biology of Microorganisms. 14th edition. PrenticeHall International Inc.
2. Moat, A.G., and Foster, J.W. (2002). Microbial Physiology. 4th edition. John Wiley & Sons.
3. Reddy, S.R., and Reddy, M. (2005). Microbial Physiology. Scientific Publishers India.
4. Gottschalk, G. (1986). Bacterial Metabolism. 2nd edition. Springer Verlag.
5. Stanier, R.Y., Ingrahm, J.I., Wheelis, M.L., and Painter, P.R. (1987). General Microbiology. 5th edition, McMillan Press.
6. Willey, J.M., Sherwood, L.M., and Woolverton, C.J. (2013). Prescott's Microbiology. 9th edition.McGraw Hill Higher Education.

16MBU203 **MICROBIAL GENETICS** **Semester – II (4H – 4C)**

Instruction Hours / week:L: 4 T: 0 P: 0 **Marks:** Internal: **40**External: **60** Total: **100**
End Semester Exam: 3 Hours

COURSE OBJECTIVES

- To focus on the basic principles of genetics incorporating the concepts of classical, molecular and population genetics.
- Compilation is required for recent advances in genetic principles for strong foundation in Biotechnology that improve their chances of employability in biotechnological industries
- To explain the mutagen and process of mutation
- To explain about DNA as a genetic material
- To paraphrase the genetic material structure and model
- To explain the concept of recombination, linkage mapping and elucidate the gene transfer mechanisms in prokaryotes and eukaryotes

COURSE OUTCOME (CO'S)

- This course provided candidates with basic knowledge and understanding of Molecular Biology with special reference to microbial genome.
- Students undertaking this course will be able to describe the nature of molecular world and its application in modern Microbiological sectors.
- Students able to understand the properties, structure and function of genes in microorganism at the molecular level
- Describe the importance of genetic code and operon concept
- Discuss the molecular mechanisms underlying mutations and repair mechanisms
- Able to summarize the concept of recombination, linkage mapping and elucidate the gene transfer mechanisms in prokaryotes and eukaryotes

Unit I – History of Genetics

Concept of Genetics, Mendel's model of genetics, proof of structure material, DNA structure, models of DNA, DNA replication, transcription, translation, RNA structure, types of RNA,

Unit II – Plasmids

Types of plasmids – F plasmid, R Plasmids, colicinogenic plasmids, Ti plasmids, linear plasmids, yeast- 2 μ plasmid, Plasmid replication and partitioning, Host range, plasmid-incompatibility, plasmid amplification, Regulation of copy number, curing of plasmids, Application of plasmids.

Unit III – Mechanisms of Genetic Exchange

Genetic code, Lac operon, Trp operon,Transformation - Discovery, mechanism of natural competence. Conjugation - Discovery, mechanism, Hfr and F' strains, Interrupted mating technique and time of entry mapping. Transduction - Generalized transduction, specialized transduction, LFT & HFT lysates, Mapping by recombination and co- transduction of markers Features of T4 genetics, Genetic basis of lytic *versus* lysogenic switch of phage lambda

Unit IV – Phage Genetics

Genome organization: *E. coli, Saccharomyces, Tetrahymena.* Mutations and mutagenesis: Definition and types of Mutations; Physical and chemical mutagens; Molecular basis of mutations; Functional mutants (loss and gain of function mutants); Uses of mutations. Reversion and suppression: True revertants; Intra- and inter-genic suppression; Ames test; Mutator genes.

Unit V – Transposable elements

Prokaryotic transposable elements – Insertion Sequences, composite and non-composite transposons, Replicative and Non replicative transposition, Mu transposon.Eukaryotic transposable elements - Yeast (Ty retrotransposon), Drosophila (P elements), Maize (Ac/Ds). Uses of transposons and transposition

SUGGESTED READINGS

1. Klug, W.S., Cummings, M.R., Spencer, C., Palladino, M. (2011). Concepts of Genetics, 10th edition, Benjamin Cummings.
2. Krebs, J., Goldstein, E., Kilpatrick, S. (2013). Lewin's Essential Genes, 3rd edition, Jones and Bartlett Learning.
3. Pierce, B.A. (2011) Genetics: A Conceptual Approach, 4th edition, Macmillan Higher Education Learning.
4. Watson, J,D., Baker, T.A., Bell, S.P., et al. (2008) Molecular Biology of the Gene, 6th edition, Benjamin Cummings.
5. Gardner, E.J., Simmons, M.J., Snustad, D,P. (2008). Principles of Genetics. 8th edition, Wiley-India.
6. Russell, P.J. (2009). *i*Genetics- A Molecular Approach. 3rdedition, Benjamin Cummings.
7. Sambrook, J., and Russell, D.W. (2001). Molecular Cloning: A Laboratory Manual. 4th edition, Cold Spring Harbour Laboratory press.
8. Maloy, S.R, Cronan, J.E., and Friefelder, D.(2004) Microbial Genetics 2nd edition, Jones andBarlettPublishers.

Semester – II

16MBU211 **VIROLOGY–PRACTICAL** **(3H – 2C)**

Instruction Hours / week:L: 0 T: 0 P: 3 **Marks:** Internal: **40**External: **60** Total: **100**

End Semester Exam: 6 Hours

COURSE OBJECTIVES

- Describe the structure and replication strategies of the individual viruses discussed, including the processes of entry into cells, control of gene transcription.
- Define the process of virus latency and describe in molecular terms control of the process and activation of viral genomes during reactivation.
- Describe the growth behavior differences between normal cells and cells transformed by oncogenic DNA and RNA viruses.
- To study general aspects of viral morphology and classification.
- Cultivation of viruses and various methods of propagation.
- To discuss the application of various immunological and molecular diagnostic tools.

COURSE OUTCOME (CO'S)

- Upon paper completion, students will have skill-based knowledge on structure of plants, animal, bacteria and viruses.
- This paper also enables the student on isolation, propagation of various viruses.
- It will help the students to understand the plant and animal viruses.
- Students can distinguish the viruses According to their characteristic features.
- It will explain the research activities involved in virology studies.
- Skill based viral analysis can be performed in medical research.

EXPERIMENTS

1. Study of the structure of important animal viruses (rhabdo, influenza, paramyxo hepatitis B and retroviruses) using electron micrographs – Demonstration.
2. Study of the structure of important plant viruses (caulimo, Gemini, tobacco ring spot, cucumber mosaic and alpha-alpha mosaic viruses) using electron micrographs – Demonstration.
3. Study of the structure of important bacterial viruses (φX174, T4, λ) using electron micrograph – Demonstration.
4. Isolation and enumeration of bacteriophages (PFU) from water/sewage sample using double agar layer technique
5. Studying isolation and propagation of animal viruses by chick embryo technique
6. Study of cytopathic effects of viruses using photographs
7. Perform local lesion technique for assaying plant viruses.

SUGGESTED READING

1. Dimmock, N.J., Easton, A.L., Leppard, K.N. (2007). Introduction to Modern Virology. 6th edition, Blackwell Publishing Ltd.

2. Carter, J., and Saunders, V. (2007). Virology: Principles and Applications. John Wiley and Sons.
3. Flint, S.J., Enquist, L.W., Krug, R.M., Racaniello, V.R., Skalka, A.M. (2004). Principles of Virology, Molecular biology, Pathogenesis and Control. 2nd edition. ASM pres.s Washington DC.
4. Levy, J.A., Conrat, H.F., Owens, R.A. (2000). Virology. 3rd edition. Prentice Hall publication, New Jersey.
5. Wagner, E.K., Hewlett, M.J. (2004). Basic Virology. 2nd edition. Blackwell Publishing.
6. Mathews. (2004). Plant Virology. Hull R. Academic Press, New York.
7. Nayudu, M.V. (2008). Plant Viruses. Tata McGraw Hill, India.
8. Bos, L. (1999) Plant viruses-A text book of plant virology by. Backhuys Publishers.
9. Versteeg, J. (1985). A Color Atlas of Virology. Wolfe Medical Publication.

Semester – II

16MBU212 MICROBIAL PHYSIOLOGY AND METABOLISM – PRACTICAL (3H – 2C)

Instruction Hours / week:L: 0 T: 0 P: 3 **Marks:** Internal: **40**External: **60** Total: **100**

End Semester Exam: 6 Hours

COURSE OBJECTIVES

- To enhance the student's knowledge on various aspects of microbial physiology like growth, extremophiles studies and chemical characterization of microbes.
- To improve their skills in handing microorganisms
- To analyze the growth condition of the bacteria.
- To facilitate the students to deal with the bacterial strain
- To demonstrate the fermentation technique
- To demonstrate the generation time and thermal death time of bacteria

COURSE OUTCOME

- The students will be able to analyze the bacteria growth and growth condition
- Able to identify the various factors for optimal growth of *E.coli.*
- Understand the basic microbial structure and functions of various physiological groups of prokaryotes.
- Able to utilize the various Culture media in the proper physical condition for fermentation
- Able to explain the microbial metabolism – Autotrophy and heterotrophy modes of nutrition
- Students able to understand the physical and chemical growth requirements of bacteria and thermal death time of bacteria.

EXPERIMENTS

1. Study and plot the growth curve of *E. coli* by turbidometric and standard plate count methods.
2. Calculations of generation time and specific growth rate of bacteria from the graph plotted with the given data
3. Effect of temperature on growth of *E. coli*
4. Effect of pH on growth of *E. coli*
5. Effect of carbon and nitrogen sources on growth of *E.coli*
6. Effect of salt on growth of *E. coli*
7. Demonstration of alcoholic fermentation
8. Demonstration of the thermal death time and decimal reduction time of *E. coli.*

SUGGESTED READINGS

1. Madigan, M.T., and Martinko, J.M. (2014). Brock Biology of Microorganisms. 14th edition. Prentice Hall International Inc.
2. Moat, A.G., and Foster,J.W. (2002). Microbial Physiology. 4th edition. John Wiley & Sons
3. Reddy, S.R., and Reddy, S.M. (2005). Microbial Physiology. Scientific Publishers India
4. Gottschalk, G. (1986). Bacterial Metabolism. 2nd edition. Springer Verlag

5. Stanier, R.Y, Ingrahm, J.I., Wheelis, M.L., and Painter, P.R. (1987). General Microbiology. 5th edition, McMillan Press.
6. Willey, J.M., Sherwood, L.M., and Woolverton, C.J. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.

Semester – II

16MBU213 MICROBIAL GENETICS - PRACTICAL (3H – 2C)

Instruction Hours / week: L: 0 T: 0 P: 4 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 6 Hours

COURSE OBJECTIVES

- To focus on the basic principles of genetics incorporating the concepts of classical, molecular and population genetics.
- Compilation is required for recent advances in genetic principles for strong foundation in Biotechnology that improve their chances of employability in biotechnological industries
- To study the effect of chemical and physical mutagens on prokaryotic cell
- To isolate the extra chromosomal from bacteria
- To Interpret the DNA quantity and purity
- To identify the mutant strains using appropriate techniques

COURSE OUTCOME (CO'S)

- Students undertaking this practical shall be able to describe the key concept in the basic Microbial Genetics
- Effectively understand the implication of mutation and its characteristics.
- Further, the experiments would allow students to recall and relate the information gained from Microbial Genetics theory paper and skills associated with it
- Students able demonstrate the gene transfer techniques
- Students can estimate the genetic materials
- Able to distinguish the plasmid and Genomic DNA

EXPERIMENTS

1. Preparation of Master and Replica Plates.
2. Study the effect of chemical (HNO2) and physical (UV) mutagens on bacterial cells.
3. Study survival curve of bacteria after exposure to ultraviolet (UV) light.
4. Isolation of Plasmid DNA from *E.coli.*
5. Study different conformations of plasmid DNA through Agarose gel electrophoresis.
6. Demonstration of Bacterial Conjugation.
7. Demonstration of bacterial transformation and transduction.
8. Demonstration of AMES test.

SUGGESTED READINGS

1. Klug, W.S., Cummings, M.R., Spencer, C., Palladino, M. (2011). Concepts of Genetics, 10th edition, Benjamin Cummings
2. Krebs, J., Goldstein, E., Kilpatrick, S. (2013). Lewin's Essential Genes, 3rd edition, Jones and Bartlett Learning.
3. Pierce, B.A. (2011) Genetics: A Conceptual Approach, 4thedition, Macmillan Higher Education Learning.
4. Watson, J.D., Baker, T.A., Bell, S.P., et al. (2008) Molecular Biology of the Gene, 6thedition, Benjamin Cummings.
5. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). Principles of Genetics. 8thedition, Wiley-India.

6. Russell, P.J. (2009). *I* Genetics- A Molecular Approach. 3rd edition, Benjamin Cummings.
7. Sambrook, J., and Russell, D.W. (2001). Molecular Cloning: A Laboratory Manual. 4th edition, Cold Spring Harbour Laboratory press.

Semester – II

16AEC201 **ENVIRONMENTAL STUDIES** **(4H – 4C)**

Instruction Hours / week:L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES

- To create the awareness about environmental problems among people.
- To develop an attitude of concern for the environment.
- To motivate public to participate in environment protection and improvement.
- To Demonstrate proficiency in quantitative methods, qualitative analysis, critical thinking, and written and oral communication needed to conduct high-level work as interdisciplinary scholars and/or practitioners.
- To create awareness among the students to know about various renewable and nonrenewable resources of the region, enables environmentally literate citizens (by knowing the environmental acts, rights, rules, legislation, etc.)
- To make appropriate judgments and decisions for the protection and skills associated with improvement of the earth.

COURSE OUTCOME

- Master core concepts and methods from ecological and physical sciences and their application in environmental problem solving.
- Master core concepts and methods from economic, political, and social analysis as they pertain to the design and evaluation of environmental policies and institutions.
- Appreciate the ethical, cross-cultural, and historical context of environmental issues and the links between human and natural systems.
- Understand the transnational character of environmental problems and ways of addressing them, including interactions across local to global scales.
- Apply systems concepts and methodologies to analyze and understand interactions between social and environmental processes.
- Reflect critically about their roles and identities as citizens, consumers and environmental actors in a complex, interconnected world.

Unit I–Environment Definition, scope and importance, components, Ecosystem Definition, Concept, Scope, importance, Structure and functions of ecosystem. Energy flow, Ecological succession Food chains and food webs. Classification of ecosystem.

Unit II – Natural Resources - Renewable and Non-renewable Resources: Natural resources and associated problems. Forest resources, Water resources, Mineral resources, Food resources, Energy resources, Land resources : Use and over-utilization, exploitation. Role of an individual in conservation of natural resources.Equitable use of resources for sustainable lifestyles.Ill-effects of fireworks.

Unit III – Biodiversity and Its Conservation: Introduction, definition: genetic, species and ecosystem diversity. Bio-geographical classification of India. Value of biodiversity: consumptive use, productive use, social, ethical,

aesthetic and option values. Biodiversity at global, National and local levels.India as a mega-diversity nation.Hot-spots of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemic species of India. Conservation of biodiversity: in-situ and ex-situ conservation of biodiversity.

Unit IV– Environmental Pollution - Definition, Causes, effects and control measures of Air pollution, Water pollution, Soil pollution , Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards, Solid waste management: Causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution.Pollution case studies. Disaster management: Foods, earthquake, cyclone and landslides.

Unit V – Social Issues and the Environment: From unsustainable to sustainable development. Urban problems related to energy. Water conservation, rain water harvesting, watershed management. Resettlement and rehabilitation of people; its problems and concerns. Environmental ethics: Issues and possible solutions. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case studies.Wasteland reclamation.Consumerism and waste products.Environment Protection Act.Air (Prevention and Control of Pollution) Act.
Water (Prevention and Control of Pollution) Act.Wildlife Protection Act.Forest Conservation Act. Issues involved in enforcement of environmental legislation. Public awareness.Population growth, variation among nations. Population explosion—Family Welfare Programme. Environment and human health.Human rights.Value education.HIV/AIDS.Women and Child Welfare.Role of Information Technology in environment and human health.

SUGGESTED READINGS

1. Tripathy.S.N. and Sunakar Panda. 2004. Fundamentals of Environmental Studies; 2nd Edition, Vrianda Publications Private Ltd., New Delhi.
2. Arvind Kumar, 2004. A Textbook of Environmental Science; APH Publishing Corporation, New Delhi.
3. P.S.Verma, V.K.Agarwal. 2001. Environmental Biology (Principles of Ecology); S.Chand and Company Ltd., New Delhi.
4. Anubha Kaushik, C.P.Kaushik, 2004. Perspectives in Environmental Studies, New Age International Pvt. Ltd. Publications, New Delhi.
5. Singh, M.P., B.S. Singh and Soma S. Dey, 2004. Conservation of Biodiversity and Natural Resources. Daya Publishing House, Delhi.
6. Daniel B.Botkin and Edward A. Keller. 1995. Environmental Science, John Wiley and Sons, Inc., New York.
7. Uberoi, N.K., 2005. Environmental Studies, Excel Books Publications, New Delhi, India.

Semester – III

16MBU301 **ENVIRONMENTAL MICROBIOLOGY** **(4H – 4C)**

Instruction Hours / week:L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES

- To educate students about Environmental monitoring and environmental aspects of microbes.
- To impart a skilled knowledge on Microbes and environment and ecological importance.
- The main goal is to know and understand the role of microbes in biogeochemical processes in different ecosystems.
- The students will learn the basic microbiological principles, the methods in microbial ecology and their theoretical and practical use.
- The knowledge can give the base for understanding processes and changes in the environment.
- The students can get some skills to recognise the ecological problems and critical evaluation of the human impacts on pollution, climate changes and as well as environmental protection.

COURSE OUTCOME

- It provides a comprehensive overview of biogeochemical processes relevant to environmental scientists and engineers mediated by microorganisms.
- It will impart the student to develop their entrepreneurial knowledge on ecological behavior of microorganism.
- It will distinguish biogeochemical cycles
- This course will determine microbial role in nutrient cycling
- This course can able to determine water quality,
- It will explain the degradation of natural organic compounds and selected pollutants in the environment.

UnitI – Microorganism and their Habitats

Structure and function of ecosystems.Terrestrial Environment: Soil profile and soil microflora. Aquatic Environment: Microflora of fresh water and marine habitats. Atmosphere: Aeromicroflora and dispersal of microbes. Animal Environment: Microbes in/on human body (Microbiomics) & animal (ruminants) body. Extreme Habitats: Extremophiles: Microbes thriving at high & low temperatures, pH, high hydrostatic & osmotic pressures, salinity, & low nutrient levels. Microbial succession in decomposition of plant organic matter.

Unit II – Microbial Interactions

Microbe interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism, predation. Microbe-Plant interaction: Symbiotic and non-symbiotic interactions. Microbe-animal interaction: Microbes in ruminants, nematophagus fungi and symbiotic luminescent bacteria

Unit III – Biogeochemical Cycling

Carbon cycle: Microbial degradation of cellulose, hemicelluloses, lignin and chitin. Nitrogen cycle: Nitrogen fixation, ammonification, nitrification, denitrification and nitrate reduction. Phosphorus cycle: Phosphate immobilization and solubilisation. Sulphur cycle:Microbes involved in sulphur cycle. Other elemental cycles: Iron and manganese

Unit IV – Waste Management

Solid Waste management:Sources and types of solid waste, Methods of solid waste disposal (composting and sanitary landfill). Liquid waste management: Composition and strength of sewage (BOD and COD), Primary, secondary (oxidation ponds, trickling filter, activated sludge process and septic tank) and tertiary sewage treatment.

Unit V – Microbial Bioremediation and Water Potability

Principles and biodegradation of common pesticides, organic (hydrocarbons, oil spills) and inorganic (metals) matter, biosurfactants. Treatment and safety of drinking (potable) water, methods to detect potability of water samples: (a) MPN test (b) Membrane filter technique.GMO and their impact.

SUGGESTED READINGS

1. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press
2. Okafor, N (2011). Environmental Microbiology of Aquatic & Waste systems. 1st edition, Springer, New York
3. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA
4. Subba Rao NS. (1999). Soil Microbiology. 4th edition. Oxford & IBH Publishing Co. New Delhi.
5. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.
6. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.
7. Lynch JM & Hobbie JE. (1988). Microorganisms in Action: Concepts & Application in Microbial Ecology. Blackwell Scientific Publication, U.K.
8. Martin A. (1977). An Introduction to Soil Microbiology. 2nd edition. John Wiley & Sons Inc. New York & London.
9. Stolp H. (1988). Microbial Ecology: Organisms Habitats Activities. Cambridge University Press, Cambridge, England.
10. Madigan MT, Martinko JM and Parker J. (2014). Brock Biology of Microorganisms. 14th edition. Pearson/ Benjamin Cummings.

Semester – III

16MBU302 FOOD AND DAIRY MICROBIOLOGY(4H – 4C)

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES

- To encode the employability importance of the role of microorganisms in food industries both in beneficial and harmful ways.
- This course aims to provide instruction in the general principles of food microbiology.
- Hands on practical complimented with an industry-based project, give a real-world perspective to microbiological challenges faced by the food industry.
- The course covers the microbiology of food preservation and food commodities; principles and methods for the microbiological examination of foods and microbiological quality control.
- To develop an understanding of the major principles of and current issues in the several topical areas that collectively constitute Food Microbiology
- It will helps the students to understand the dairy Technology.

COURSE OUTCOME

- Provides job-oriented information about the role of microorganisms in many food, and beverage industries both in production and spoilage processes.
- Develop job based output on industrial based technologies on Food microbiology.
- It will explain the interactions between microorganisms and the food environment, and factors influencing their growth and survival.
- Discuss the microbiology of different types of food commodities.
- Explain why microbiological quality control programmes are necessary in food production.
- It helps to start business.

Unit I – Foods as a substrate for microorganisms

Natural flora and source of contamination of foods in general. Intrinsic and extrinsic factors that affect growth and survival of microbes in foods. Microbial spoilage of various foods – Spoilage of vegetables, fruits, meat, eggs, milk and butter, bread, canned Foods

Unit II – Principles and methods of food preservation and sterilization

Principles of food preservation. Physical methods of food preservation: temperature (low, high, canning, and drying), irradiation, hydrostatic pressure, high voltage pulse, microwave processing and aseptic packaging. Chemical methods

of food preservation: salt, sugar, organic acids, SO_2, nitrite and nitrates, antibiotics and bacteriocins, sterilization of dry heat, moist heat, chemical, physical and radiation.

Unit III – Fermented foods

Fermented dairy products: yogurt, acidophilus milk, kumiss, kefir, dahi and cheese. Other fermented foods: dosa, sauerkraut, soy sauce and tampeh. Probiotics: Health benefits, types of microorganisms used, probiotic foods available in market.

Unit IV– Food borne diseases

Causative agents, foods involved, symptoms and preventive measures of the following diseases

Food intoxications:*Staphylococcus aureus*, *Clostridium botulinum* and mycotoxins. Food infections:*Bacillus cereus*, *Vibrio parahaemolyticus*, *Escherichia coli*, Salmonellosis, Shigellosis, *Yersinia enterocolitica*, *Listeria monocytogenes* and *Campylobacter jejuni*, fungal diseases, toxins

Unit V– Detection of food borne pathogens, food sanitation and control Cultural and rapid detection methods of food borne pathogens in foods and introduction to predictive microbiology. HACCP, FSSAI Indices of food sanitary quality and sanitizers.

SUGGESTED READINGS

1. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7th edition, CBS Publishers and Distributors, Delhi, India.
2. Frazier WC and Westhoff DC. (1992). Food Microbiology. 3rd edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.
3. Adams MR and Moss MO. (1995). Food Microbiology. 4th edition, New Age International (P) Limited Publishers, New Delhi, India.
4. Gould GW. (1995). New Methods of Food Preservation. Blackie Academic and Professional, London.
5. Banwart JM. (1987). Basic Food Microbiology. 1st edition. CBS Publishers and Distributors, Delhi, India.
6. Davidson PM and Brannen AL. (1993). Antimicrobials in Foods. Marcel Dekker, New York.
7. Dillion VM and Board RG. (1996). Natural Antimicrobial Systems and Food Preservation. CAB International, Wallingford, Oxon.
8. Lund BM, Baird Parker AC, and Gould GW. (2000). The Microbiological Safety and Quality of Foods. Vol. 1-2, ASPEN Publication, Gaithersberg, MD.

Semester – III

16MBU303 INDUSTRIAL MICROBIOLOGY (4H – 4C)

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES

- To encompasses the employability use of microorganisms in the manufacture of food or industrial products.
- The aim of the course is to give the students broad theoretical and practical skills in industrial microbiology.
- This course covers the principles of various processes associated with the production and recovery of different bio-products derived from microorganisms.
- The students will be able to discuss the role of microorganisms in industry, as well as to carry out experiments to produce microbial metabolites.
- It will make the students to explore their practical skills in entrepreneurial activities.
- It will deliver the large-scale production of microbial products techniques in advanced level.

COURSE OUTCOME

- Provides knowledge in the large scale production of industrial product, providing the trends to cater the needs of industry.
- This will help the students to enhance their employment knowledge on microbiology based commercial products.
- The aim of the course is to give the students broad theoretical and practical skills in industrial microbiology.
- This course covers the principles of various processes associated with the production and recovery of different bio-products derived from microorganisms.
- The students will be able to discuss the role of microorganisms in industry, as well as to carry out experiments to produce microbial metabolites.
- Students will differentiate the types of fermentation processes

Unit I – Introduction to industrial microbiology

Brief history and developments in industrial microbiology. Sources of industrially important microbes and methods for their isolation, primary and secondary strain improvement.

Unit II – Isolation of industrially important microbes and fermentation media

Preservation and maintenance of industrial strains. Crude and synthetic media - molasses, corn- steep liquor, sulphite waste liquor, whey, yeast extract and protein hydrolysates.

Unit III – Types of fermentation processes, bio-reactors and measurement of fermentation parameters

Types of fermentation processes – Solid-state and liquid-state (stationary and submerged) fermentations; batch, fed-batch and continuous fermentations. Components of a typical bio-reactor, Types of bioreactors – Laboratory, pilot- scale and production fermenters, constantly stirred tank and air-lift fermenters. Measurement and control of fermentation parameters - pH, temperature, dissolved oxygen, foaming and aeration.

Unit IV – Down-stream processing and Enzyme immobilization

Separation of cells – filtration and centrifugation.Cell disruption – physical, chemical and enzymatic methods.Product separation – solvent extraction and precipitation.Lyophilization and spray drying. Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes (glucose isomerase and penicillin acylase).

Unit V –Microbial production of industrial products (micro-organisms involved, media, fermentation conditions, downstream processing and uses)

Citric acid, Ethanol, Penicillin, Glutamic acid, Vitamin B_{12}, Enzymes (amylase, protease, lipase) Wine, Beer.

SUGGESTED READINGS

1. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.
2. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
3. Okafor N. (2007). Modern Industrial Microbiology and Biotechnology. 1st edition. Bios Scientific Publishers Limited. USA
4. Glaze A.N. and Nikaido H. (1995). Microbial Biotechnology: Fundamentals of Applied Microbiology. 1st edition. W.H. Freeman and Company
5. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
6. Patel A.H. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
7. Waites M.J., Morgan N.L., Rockey J.S. and Higton G. (2001). Industrial Microbiology: An Introduction. 1st edition. Wiley – Blackwell.

Semester – III

16MBU304A **(3H – 3C)**

MICROBIALQUALITY CONTROL IN FOOD AND PHARMACEUTICAL INDUSTRIES

Instruction Hours / week:L: 3 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES

- To make the students better to understand the aspects of skilled manufacturing practices, kinds of pathogenic microorganisms in food and quality control in food and pharmaceutical industries.
- Develop industry-oriented skills on developing drugs and food.
- To make the students to understand the food quality systems and advancement universally.
- It will explain the students about all kinds of bio safety levels in laboratories.
- To train the students to be competent working professionals in the food industry and pharmaceutical industry.
- To help the students to explain the production of quality food by imparting better nutritional, sanitation & hygiene concepts.

COURSE OUTCOME

- Imparts skilled knowledge on good manufacturing practices and food spoilage of different types of foods.
- Develop skills on Food and drug based microbiological analysis.
- To encourage students to the entrepreneurs and develop the capacity for setting up small scale enterprises with respect to food and pharmaceuticals within the country.
- To organize functions for creating awareness about the importance of safe processed nutritious food.
- To provide diagnostic analysis of food and pharmaceutical products.
- The students will be able to discuss the role of microorganisms in industry, as well as to carry out experiments to produce microbial metabolites.

Unit I – Microbiological Laboratory and Safe Practices

Good laboratory practices – Good microbiological practices. Biosafety cabinets – Working of biosafety cabinets, using protective clothing, specification for BSL-1, BSL-2, BSL-3.Discarding biohazardous waste – Methodology of Disinfection, Autoclaving & Incineration.

Unit II – Determining Microbes in Food / Pharmaceutical Samples

Sampling procedures for food, water, and air. Culture and microscopic methods – Standard plate count, membrane filtration,most probable numbers, direct microscopic counts, Biochemical and immunological methods: Limulus lysate test for endotoxin, gel, lot agglutination precipitation, sterility testing for pharmaceutical products. Molecular methods – Nucleic acid probes, PCR based detection, biosensors.

Unit III – Enrichment culture technique

Enrichment culture technique, Detection of specific microorganisms – on XLD agar, Salmonella Shigella Agar, Mannitol salt agar, EMB agar, MacConkey Agar, Saboraud Agar.

Unit IV – Pathogenic Microorganisms of Importance in Food & Water

Ascertaining microbial quality of milk by MBRT, Rapid detection methods of microbiological quality of milk at milk collection centres (COB, 10 min Resazurin assay).

Unit V – HACCP for Food Safety and Microbial Standards

Hazard analysis of critical control point (HACCP) - Principles, flow diagrams, limitations.Microbial Standards for Different Foods and Water – BIS specifications for common foods and drinking water.

SUGGESTED READINGS

1. Harrigan WF (1998) Laboratory Methods in Food Microbiology, 3rd edition, Academic Press
2. Garg N, Garg KL and Mukerji KG (2010). Laboratory Manual of Food Microbiology I K International Publishing House Pvt. Ltd.
3. Jay JM, Loessner MJ, Golden DA (2005) Modern Food Microbiology, 7th edition. Springer.
4. Baird RM, Hodges NA and Denyer SP (2005). Handbook of Microbiological Quality control in Pharmaceutical and Medical Devices, Taylor and Francis Inc.

Semester – III

16MBU304B MICROBIAL DIAGNOSIS IN HEALTH CLINIC (3H – 3C)

Instruction Hours / week: L: 3 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES

- To provide an employment understanding of the natural history of infectious diseases in order to deal with the etiology, laboratory diagnosis, treatment and control of infections in the community.
- This course is aimed to Identify the species of pathogenic bacteria and fungi
- Determine the modes of transmission of infectious diseases and pathogenesis
- Know of the theoretical foundations for the differentiation of the major pathogenic groups
- To Determine the antimicrobials to be used in the sensitivity testing of different types of pathogens.
- Analyze and solve case studies involving bacterial and fungal agents

COURSE OUTCOME

- Provides employment knowledge to identify the common infectious agents with the help of laboratory procedures and use antimicrobial sensitivity tests to select suitable antimicrobial agents.
- It describes the basic mechanisms of pathogenesis of infectious diseases.
- It explains the basic principles of diagnosis, antimicrobial treatment, prevention and control of infectious diseases in the hospital and community.
- It helps the students to understand the host immune system and explain the host response to infection
- Understand and interpret basic laboratory tests for the diagnosis of infectious diseases.
- Apply the principles of molecular and immunological techniques for the diagnosis of infectious diseases.

Unit I– Importance of Diagnosis of Diseases

Bacterial, Viral, Fungal and Protozoan Diseases of various human body systems, Disease associated clinical samples for diagnosis.

Unit II – Collection of Clinical Samples

How to collect clinical samples (oral cavity, throat, skin, Blood, CSF, urine and faeces) and precautions required. Method of transport of clinical samples to laboratory and storage.

Unit III – Direct Microscopic Examination and Culture

Examination of sample by staining – Gram stain, Ziehl-Neelson staining for tuberculosis, Giemsa-stained thin blood film for malaria.Preparation and use of culture media - Blood agar, Chocolate agar, Lowenstein-Jensen medium, MacConkey agar, distinct colony properties of various bacterial pathogens.

Unit IV – Serological and Molecular Methods

Serological Methods - Agglutination, ELISA, immune fluorescence, Nucleic acid based methods – PCR, Nucleic acid probes, Typhoid, and HIV

Unit V – Testing for Antibiotic Sensitivity in Bacteria

Importance, Determination of resistance/sensitivity of bacteria using disc diffusion method (Kirby Bauer Method) Determination of minimal inhibitory concentration (MIC) of an antibiotic by broth dilution method.

SUGGESTED READINGS

1. Ananthanarayan R and Paniker CKJ (2009). Textbook of Microbiology, 8th edition, Universities Press Private Ltd.
2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013). Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication.
3. Randhawa, VS, Mehta G and Sharma KB (2009) Practicals and Viva in Medical Microbiology. 2nd edition, Elsevier India Pvt Ltd.
4. Tille P (2013) Bailey's and Scott's Diagnostic Microbiology, 13th edition, Mosby
5. Collee JG, Fraser, AG, Marmion, BP, Simmons A (2007) Mackie and Mccartney Practical Medical Microbiology, 14th edition, Elsevier.

16MBU311 ENVIRONMENTAL MICROBIOLOGY –PRACTICAL **Semester – III (3H – 2C)**

Instruction Hours / week:L: 0 T: 0 P: 4Marks: Internal: **40** External: **60** Total: **100**
End Semester Exam: 9 Hours

COURSE OBJECTIVES

- To educate students about skill oriented Environmental monitoring and environmental aspects of microbes.
- To impart a knowledge on Microbes and environment and ecological importance.
- To study the diversity of microorganism and microbial communities inhabiting a multitude of habitats and occupying a wide range of ecological habitats.
- Learn the occurrence, abundance and distribution of microorganism in the environment and their role in the environment and also learn different methods for their detection and characterization
- Competently explain various aspects of environmental microbiology and microbial ecology and to become familiar with current research in environmental microbiology.
- Understand various biogeochemical cycles – Carbon, Nitrogen, Phosphorus cycles etc. and microbes involved

COURSE OUTCOME

- Provides a comprehensive skilled overview of biogeochemical processes relevant to environmental scientists and engineers mediated by microorganisms.
- Understand various plant microbes interactions especially rhizosphere and their applications especially the biofertilizers and their production techniques
- Understand the basic principles of environment microbiology and be able to apply these principles to understanding and solving environmental problems – waste water treatment and bioremediation
- Know the Microorganisms responsible for water pollution especially Water-borne pathogenic microorganisms and their transmission
- Comprehend the various methods to determine the Sanitary quality of water and sewage treatment methods employed in waste water treatment
- Provide learning opportunities to critically evaluate research methodology and findings.

EXPERIMENTS

1. Analysisofsoil-pH,moisturecontent,waterholdingcapacity,percolation,capillaryaction.
2. Isolationofmicrobes(bacteria&fungi)fromsoil(28ºC&45ºC).
3. Isolationofmicrobes(bacteria&fungi)fromrhizosphereandrhizoplane.
4. Assessmentofmicrobiologicalqualityofwater.
5. DeterminationofBODofwastewatersample.
6. Studythepresenceofmicrobialactivitybydetecting(qualitatively)enzymes(dehydrogenase, amylaseand urease)insoil.
7. Isolationof*Rhizobium*fromrootnodules.

SUGGESTEDREADINGS

1. MaierRM,PepperILandGerbaCP.(2009).EnvironmentalMicrobiology.2nd edition,Academic Press.
2. Okafor,N(2011).EnvironmentalMicrobiologyofAquatic&Wastesystems.1st edition,Springer, NewYork.
3. AtlasRMandBarthaR.(2000).MicrobialEcology:Fundamentals&Applications. 4thedition. Benjamin/Cummings SciencePublishing,USA
4. SubbaRaoNS.(1999).SoilMicrobiology.4th edition.Oxford&IBHPublishingCo. NewDelhi.
5. BartonLL&NorthupDE(2011).MicrobialEcology.1st edition,WileyBlackwell,USA Campbell RE.(1983).MicrobialEcology.BlackwellScientificPublication,Oxford,England.
6. CoyneMS.(2001).SoilMicrobiology:AnExploratoryApproach.DelmarThomsonLearning.
7. LynchJM&HobbieJE.(1988).MicroorganismsinAction:Concepts&ApplicationinMicrobial Ecology.BlackwellScientificPublication,U.K.
8. MartinA.(1977).AnIntroductiontoSoilMicrobiology.2ndedition.JohnWiley&SonsInc.New York&London.
9. StolpH.(1988).MicrobialEcology:OrganismsHabitatsActivities.CambridgeUniversityPress, Cambridge,England.
10. MadiganMT,MartinkoJMandParkerJ.(2014).BrockBiologyofMicroorganisms.14thedition. Pearson/BenjaminCummings.
11. WilleyJM,SherwoodLM,andWoolvertonCJ.(2013).Prescott'sMicrobiology.9thedition. McGrawHillHigherEducation.
12. SinghA,Kuhad,RC&WardOP(2009).AdvancesinAppliedBioremediation.Volume17, Springer-Verlag,BerlinHedeilberg.

Semester – III

16MBU312 FOOD AND DAIRY MICROBIOLOGY– PRACTICAL (3H – 2C)

Instruction Hours / week: L: 0 T: 0 P: 4Marks: Internal: **40** External: **60** Total: **100**
End Semester Exam: 9 Hours

COURSE OBJECTIVES

- To encode the importance of the role of microorganisms in food industries both in beneficial and harmful ways.
- To obtain a good entrepreneurial understanding of food and dairy products and become qualified as microbiologist in food and dairy industries.
- Understand the significance and activities of microorganisms in food and role of intrinsic and extrinsic factors on growth and survival of microorganisms in foods
- To know the spoilage mechanisms in foods and thus identify methods to control deterioration and spoilage
- Recognize and describe the characteristics of important pathogens and spoilage microorganisms in foods.
- To Learn various methods for their isolation, detection and identification of microorganisms in food and employ in industries.

COURSE OUTCOME

- Provides necessary entrepreneurial information on the food, dairy Microbiology in safety and quality perspective.
- It will help to study the importance in the prevention of contamination that might be caused by the microorganisms.
- To Learn various methods for their isolation, detection and identification of microorganisms in food and employ in industries
- Identify ways to control microorganisms in foods and thus know the principles involving various methods of food preservation
- Students can able to understand of the basis of food safety regulations and Discuss the rationale for the use of standard methods and procedures for the microbiological analysis of food
- Acquire, discover, and apply the theories and principles of food microbiology in practical, real-world situations and problems.

EXPERIMENTS

1. MBRT of milk samples

2. Standard plate count of milk sample.
3. Alkaline phosphatase test to check the efficiency of pasteurization of milk.
4. Isolation of food borne bacteria from food products.
5. Isolation of spoilage microorganisms from spoiled vegetables/fruits.
6. Isolation of spoilage microorganisms from bread.
7. Preparation of yogurt.

SUGGESTED READINGS

1. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7th edition, CBS Publishers and Distributors, Delhi, India.
2. Frazier WC and Westhoff DC. (1992). Food Microbiology. 3rd edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.
3. Adams MR and Moss MO. (1995). Food Microbiology. 4th edition, New Age International (P) Limited Publishers, New Delhi, India.
4. Gould GW. (1995). New Methods of Food Preservation. Blackie Academic and Professional, London.
5. Banwart JM. (1987). Basic Food Microbiology. 1st edition. CBS Publishers and Distributors, Delhi, India.
6. Davidson PM and Brannen AL. (1993). Antimicrobials in Foods. Marcel Dekker, New York.
7. Dillion VM and Board RG. (1996). Natural Antimicrobial Systems and Food Preservation. CAB International, Wallingford, Oxon.
8. Lund BM, Baird Parker AC, and Gould GW. (2000). The Microbiological Safety and Quality of Foods. Vol. 1-2, ASPEN Publication, Gaithersberg, MD.
9. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education.

Semester – III

16MBU313 INDUSTRIAL MICROBIOLOGY– PRACTICAL (3H – 2C)

Instruction Hours / week: L: 0 T: 0 P: 4 Marks: Internal: **40** External: **60** Total: **100**

End Semester Exam: 9 Hours

COURSE OBJECTIVES

- To encompasses the use of microorganisms in the manufacture of food or industrial products on the basis of employment.
- Get equipped with a theoretical and practical understanding of industrial microbiology
- Appreciate how microbiology is applied in manufacture of industrial products
- Know how to source for microorganisms of industrial importance from the environment
- Know about design of bioreactors, factors affecting growth and production, heat transfer, oxygen transfer
- Understand the rationale in medium formulation & design for microbial fermentation, sterilization of medium and air.

COURSE OUTCOME

- Provides knowledge in the large-scale production of industrial product, and teaches the modern employment trends to cater the needs of industry.
- Students will differentiate the types of fermentation processes
- Understand the biochemistry of various fermentations
- Identify techniques applicable for Improvement of microorganisms based on known biochemical pathways and regulatory mechanisms
- Comprehend the techniques and the underlying principles in downstream processing
- Students can able to explore the practical skills in research activities.

EXPERIMENTS

1. Study of different parts of fermenter
2. Microbial fermentation – Production and estimation (qualitative and quantitative) of
    a) Enzymes : Amylase and Protease
    b) Amino acid : Glutamic acid
    c) Organic acid : Citric acid
    d) Alcohol : Ethanol
3. A visit to any educational institute/industry to see an industrial fermenter, and other downstream processing operations.

SUGGESTED READINGS

1. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.
2. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
3. Okafor N. (2007). Modern Industrial Microbiology and Biotechnology. 1st edition. Bios Scientific Publishers Limited. USA.
4. Glaze A.N. and Nikaido H. (1995). Microbial Biotechnology: Fundamentals of Applied Microbiology. 1st edition. W.H. Freeman and Company.
5. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
6. Patel A.H. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
7. Waites M.J., Morgan N.L., Rockey J.S. and Higton G. (2001). Industrial Microbiology: An Introduction. 1st edition. Wiley – Blackwell.

Semester – III

16MBU314A **(3H – 1C)**

MICROBIAL QUALITY CONTROL IN FOOD AND PHARMACEUTICAL INDUSTRIES– PRACTICAL

Instruction Hours / week:L: 0 T: 0 P: 3 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

COURSE OBJECTIVE

- To make the students better to understand the aspects of skilled manufacturing practices, kinds of pathogenic microorganisms in food and quality control in food and pharmaceutical industries.

- Quality systems such as investigations, document management systems, Standard Operating Procedures (SOP), change management system, recall management and inspection management
- Food safety systems including hazard analysis critical control points and preventative control plans
- Principles of enumeration and identification of micro-organisms, using both traditional and rapid methods as well as the pharmacopoeial methods for the detection of specified organisms.
- To gain theoretical and practical knowledge on food and pharma industries.
- To encourage students to the entrepreneurs and develop the capacity for setting up small scale enterprises with respect to food within the country.

COURSE OUTCOME

- This paper imparts skilled knowledge on good manufacturing practices and food spoilage of different types of foods.
- Students can develop their entrepreneurial skills in food and pharma sectors.
- Good Manufacturing Practices (GMP) and associated guidelines for drugs, natural health products, cannabis and food
- Good documentation Practices (GDP) and Data Integrity (DI)
- Validation for equipment, methods, cleaning and process
- Quality systems such as investigations, document management systems, Standard Operating Procedures (SOP), change management system, recall management and inspection management.

EXPERIMENTS

1. Good manufacturing practices.
2. Most probable number test.

3. Isolation of pathogens from food samples.
4. Methylene blue reduction test.
5. Enumeration of microbial population from pharmaceutical samples.

SUGGESTED READINGS

1. Harrigan WF (1998) Laboratory Methods in Food Microbiology, 3rd edition, Academic Press.
2. Garg N, Garg KL and Mukerji KG (2010). Laboratory Manual of Food Microbiology I K International Publishing House Pvt. Ltd.
3. Jay JM, Loessner MJ, Golden DA (2005) Modern Food Microbiology, 7th edition. Springer.
4. Baird RM, Hodges NA and Denyer SP (2005). Handbook of Microbiological Quality control in Pharmaceutical and Medical Devices, Taylor and Francis Inc.

Semester – III

16MBU314B **(3H – 1C)**

MICROBIAL DIAGNOSIS IN HEALTH CLINICS- PRACTICAL

Instruction Hours / week:L: 0 T: 0 P: 3 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES

- To provide employment-oriented understanding of the natural history of infectious diseases in order to deal with the etiology, laboratory diagnosis, treatment and control of infections in the community.
- This course provides learning opportunities in the basic principles of medical microbiology and infectious disease.
- It covers mechanisms of infectious disease transmission, principles of aseptic practice, and the role of the human body's normal microflora.
- The course provides the conceptual basis for understanding pathogenic microorganisms and the mechanisms by which they cause disease in the human body.
- It also provides opportunities to develop informatics and diagnostic skills, including the use and interpretation of laboratory tests in the diagnosis of infectious diseases.
- To understand the importance of pathogenic bacteria in human disease with respect to infections of the respiratory tract, gastrointestinal tract, urinary tract, skin and soft tissue.

COURSE OUTCOME

- Acquire knowledge to identify the common infectious agents with the help of laboratory procedures and use antimicrobial sensitivity tests to select suitable antimicrobial agents on the basis of employment.
- Helps to understand the use of lab animals in medical field.
- Recall the relationship of this infection to symptoms, relapse and the accompanying pathology.
- Explain the methods of microorganism's control, e.g. chemotherapy & vaccines. Solve problems in the context of this understanding.
- Demonstrate theory and practical skills in microscopy and their handling techniques and staining procedures.
- It will help the students to understand the general bacteriology and microbial techniques for isolation of pure cultures of Microorganisms.

EXPERIMENTS

1. Collection and processing of clinical specimen – Sputum.

2. Collection and processing of clinical specimen – Urine.
3. Collection and processing of clinical specimen – Blood.
4. Collection and processing of clinical specimen – Stool.
5. Antibiotic sensitivity testing by Kirby-Bauer method
6. Determination of minimal inhibitory concentration.

SUGGESTED READINGS

1. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013). Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication.
2. Collee JG, Fraser, AG, Marmion, BP, Simmons A (2007) Mackie and Mccartney Practical Medical Microbiology, 14th edition, Elsevier.
3. Greenwood D, Slack R, Barer M, and Irving W. (2012). Medical Microbiology, 18th Edition. Churchill Livingstone.
4. Ryan KJ and Ray CG. (2014). Sherris Medical Microbiology, 6th Edition. McGraw-Hill Professional.

Semester – IV

16MBU401 **IMMUNOLOGY** **(4H – 4C)**

Instruction Hours / week: L: 4 T: 0 P: 0Marks: Internal: **40**External: **60** Total: **100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES

- To strengthen the knowledge of students in immunodiagnostics.
- To learn the latest trends in immunology.
- Rapid diagnosis and Immune reaction.
- To provide overview of immune system, antigen antibody structure and interactions.
- To develop understanding of innate and adaptive immunity along with major cells and molecules involved.
- To integrate immunology with health and enrich the knowledge for autoimmune disorders, hypersensitivity reaction

COURSE OUTCOME

- Introducing the employment aspect of immunology and to study various types of immune systems their classification structure and mechanism of immune activation.
- Upon completion students will gain knowledge of immune system, cells involved along with complement system and autoimmunity
- Develop understanding about immune system, antigen antibody interactions.
- Gain theoretical knowledge of various diseased conditions generated due to interplay of immune system components.
- Students can able to perform basic immunological assays.
- It will distinguish fundamental knowledge on immunology and its advancement.

Unit I – Introduction, Immune Cells and Organs

Concept of Innate and Adaptive immunity; Contributions of following scientists to the development of field of immunology – Edward Jenner, Karl Landsteiner, Robert Koch, Paul Ehrlich, Elie Metchnikoff, Peter Medawar, MacFarlane Burnet, Neils K Jerne, Rodney Porter and Susumu Tonegawa. Structure, Functions and Properties of: Immune Cells – Stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell, dendritic cell; and Immune Organs – Bone Marrow, Thymus, Lymph Node, Spleen, GALT, MALT, CALT.

Unit II – Antigens and Antibodies

Antigens – Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity); Haptens; Epitopes (T & B cell epitopes); T-dependent and T-independent antigens; Adjuvants. Antibodies – Structure, Types, Functions and Properties of antibodies; Antigenic determinants

on antibodies (Isotypic, allotypic, idiotypic); VDJ rearrangements; Monoclonal and Chimeric antibodies.

Unit III – Major Histocompatibility Complex, Complement System

MHC – Organization of MHC locus; Structure and Functions of MHC I & II molecules; Antigen processing and presentation (Cytosolic and Endocytic pathways). Complement system – Components of the Complement system; Activation pathways (Classical, Alternative and Lectin pathways); Biological consequences of complement Activation

Unit IV – Generation of Immune Response, Immunological Disorders and Tumor Immunity

Primary and Secondary Immune Response; Generation of Humoral Immune Response (Plasma and Memory cells); Generation of Cell Mediated Immune Response (Self MHC restriction, T cell activation, Co-stimulatory signals); Killing Mechanisms by CTL and NK cells, Introduction to tolerance. Types of Autoimmunity and Hypersensitivity with examples; Immunodeficiencies – Animal models (Nude and SCID mice), DiGeorge syndrome, Chediak-Higashi syndrome, Leukocyte adhesion deficiency, CGD; Transplation immunology, Graft versus host reaction Types of tumors, tumor Antigens, causes and therapy for cancers.

Unit V – Immunological Techniques

Principlesof precipitation, agglutination, complement fixation, Immunodiffusion, Immunoelectrophoresis, ELISA, ELISPOT, Western blotting, Immunofluoresence, Flow cytometry, Immunoelectron microscopy.

SUGGESTED READINGS

1. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition. W.H. Freeman and Company, New York.
2. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 11th edition Wiley- Blackwell Scientific Publication, Oxford.
3. Murphy K, Travers P, Walport M. (2008). Janeway's Immunobiology. 7th edition Garland Science Publishers, New York.
4. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6th edition, Saunders Publication, Philadelphia.
5. Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition ChurchillLivingstone Publishers, Edinberg.

Semester – IV

16MBU402 MEDICAL MICROBIOLOGY (4H – 4C)

Instruction Hours / week:L: 4 T: 0 P: 0 **Marks:** Internal: **40 External**: **60** Total: **100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES

- To strengthen the knowledge of students in immunodiagnostics.
- To learn the latest trends in immunology.
- Rapid diagnosis and Immune reaction.
- To provide overview of immune system, antigen antibody structure and interactions.
- To develop understanding of innate and adaptive immunity along with major cells and molecules involved.
- To integrate immunology with health and enrich the knowledge for autoimmune disorders, hypersensitivity reaction

COURSE OUTCOME

- Introducing the employment aspect of immunology and to study various types of immune systems their classification structure and mechanism of immune activation.
- Upon completion students will gain knowledge of immune system, cells involved along with complement system and autoimmunity
- Develop understanding about immune system, antigen antibody interactions.
- Gain theoretical knowledge of various diseased conditions generated due to interplay of immune system components.
- Students can able to perform basic immunological assays.
- It will distinguish fundamental knowledge on immunology and its advancement.

Unit I – Normal micro flora of the human body and host pathogen interaction

Normal microflora of the human body: Importance of normal microflora, normal microflora of skin, throat, gastrointestinal tract, urogenital tract. Host pathogen interaction: Definitions – Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Carriers and their types, Opportunistic infections, Nosocomial infections. Transmission of infection, Pathophysiologic effects of LPS. Collection, transport and culturing of clinical samples – Sputum, Stool and Urine.

Unit II – Bacterial diseases

List of diseases of various organ systems and their causative agents.The following diseases in detail with symptoms, mode of transmission, prophylaxis and control.Respiratory

Diseases:*Streptococcus pyogenes, Haemophilus influenzae, Mycobacterium tuberculosis*. Gastrointestinal Diseases: *Escherichia coli, Salmonella typhi, Vibrio cholerae, Helicobacter pylori.* Others: *Staphylococcus aureus, Bacillus anthracis, Clostridium tetani, Treponema pallidum, Clostridium difficle.*

Unit III – Viral diseases

The detailed study of following diseases – Causative agents, Mode of transmissions, Pathogenicity, Symptoms and prophylaxis of Polio, Herpes, Hepatitis, Rabies, Dengue, AIDS, Influenza with brief description of swine flu, Ebola, Chikungunya, Japanese Encephalitis

Unit IV – Fungal and Protozoan diseases

Brief description of each of the following types of mycoses and one representative disease to be studied with respect to transmission, symptoms and prevention. Cutaneous mycoses: Tinea pedis (Athlete's foot). Systemic mycoses: Histoplasmosis. Opportunistic mycoses: Candidiasis. The detailed study of following diseases – Causative agents, Mode of transmissions, Pathogenicity, Symptoms and prophylaxis of Amoebiasis, Giardiasis, Elephanttiasis, Taeniasis, Malaria, Kala-azar.

Unit V – Antimicrobial agents: General characteristics and mode of action

Antibacterial agents: Five modes of action with one example each: Inhibitor of nucleic acid synthesis; Inhibitor of cell wall synthesis; Inhibitor of cell membrane function; Inhibitor of protein synthesis; Antibiotic resistance - MDR, XDR, MRSA, NDM-1 – resistance mechanisms. Antifungal agents: Mechanism of action of Amphotericin B, Griseofulvin. Antiviral agents:Mechanism of action of Amantadine, Acyclovir, Azidothymidine.

SUGGESTED READINGS

1. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013). Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication.
2. Greenwood D, Slack R, Barer M, and Irving W. (2012). Medical Microbiology, 18th Edition. Churchill Livingstone.
3. Ryan KJ and Ray CG. (2014). Sherris Medical Microbiology, 6th Edition. McGraw-Hill Professional.
4. Ananthanarayan R. and Paniker C.K.J. (2009) Textbook of Microbiology. 8th edition, University Press Publication.
5. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition.
6. Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2007). Mims' Medical Microbiology. 4th edition. Elsevier.

7. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott, Harley and Klein's Microbiology. 9th edition. McGraw Hill Higher Education.

Semester – IV

16MBU403 RECOMBINANT DNA TECHNOLOGY (4H – 4C)

Instruction Hours / week:L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES

- To learn the basic tools in recombinant technology
- To understand the various concepts of cloning vectors and cloning strategies
- To emphasize the knowledge in biotechnology and techniques.
- To familiarize the students to versatile tools and techniques employed in genetic engineering and recombinant DNA technology.
- A sound knowledge on procedural repertoire allows students to innovatively apply these in basic and applied fields of biological research.
- This course offers theoretical bases to properties and applications of versatile DNA modifying enzymes, cloning strategies, vector types, host genotype specificities for selection and screening of recombinants and/or recombinant transformants.

COURSE OUTCOME

- Imparts the entrepreneurial concepts of rDNA technology and their applications and Acquire knowledge on the applications of genetic engineering.
- Understand the difference between old biotechnology and modern biotechnology.
- Provide examples of current applications of biotechnology and advances in the different areas like medical, microbial, environmental, bioremediation, agricultural, plant, animal, and forensic sciences.
- Explain the general principles of generating transgenic plants, animals and microbes.
- Technical know-how on versatile techniques in recombinant DNA technology.
- An understanding on application of genetic engineering techniques in basic and applied experimental biology.

Unit I – Introduction to Genetic Engineering

Milestones in genetic engineering and Biotechnology cloning Tools; Restriction modification systems: Types I, II and III. Mode of action, nomenclature, applications of Type II restriction enzymes in genetic engineering. DNA modifying enzymes and their applications: DNA polymerases. Terminal deoxynucleotidyl transferase, kinases and phosphatases, and DNA ligases

Unit II – Molecular Cloning- Tools and Strategies

Cloning Vectors: Definition and Properties Plasmid vectors: pBR and pUC series Bacteriophage lambda and M13 based vectors Cosmids, BACs, YACs. Use of linkers and adaptors. Expression vectors: *E.coli* lac and T7 promoter-based vectors, yeast YIp, YEp and YCp vectors, Baculovirus based vectors, mammalian SV40-based expression vectors

Unit III– Methods in Molecular Cloning

Transformation of DNA: Chemical method, Electroporation. Gene delivery: Microinjection, electroporation, biolistic method (gene gun), liposome and viral- mediated delivery, *Agrobacterium* - mediated delivery DNA, RNA and Protein analysis: Agarose gel electrophoresis, Southern - and Northern - blotting techniques, dot blot, DNA microarray analysis, SDS-PAGE and Western blotting.

UnitIV – DNA Amplification and DNA sequencing

PCR: Basics of PCR, RT-PCR, Real-Time PCR. Sanger's method of DNA Sequencing: traditional and automated sequencing. Primer walking and shotgun sequencing

UnitV – Construction and Screening of Genomic and cDNA libraries. Applications of Recombinant DNA Technology

Genomic and cDNA libraries: Preparation and uses, Screening of libraries: Colony hybridization and colony PCR, Chromosome walking and chromosome jumping. Products of recombinant DNA technology: Products of human therapeutic interest - insulin, hGH, antisense molecules. Bt transgenic - cotton, brinjal, Gene therapy, recombinant vaccines, protein engineering and site directed mutagenesis.

SUGGESTED READINGS

1. Brown TA. (2010). Gene Cloning and DNA Analysis. 6th edition. Blackwell Publishing, Oxford, U.K.
2. Clark DP and Pazdernik NJ. (2009). Biotechnology: Applying the Genetic Revolution. Elsevier Academic Press, USA.
3. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
4. Sambrook J and Russell D. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.
5. Wiley JM, Sherwood LM and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. McGraw Hill Higher Education.
6. Brown TA. (2007). Genomes-3. Garland Science Publishers
7. Primrose SB and Twyman RM. (2008). Genomics: Applications in human biology. Blackwell Publishing, Oxford, U.K.

Semester – IV

16MBU404A **BIOFERTILIZERS AND BIOPESTICIDES** **(3H – 3C)**

Instruction Hours / week:L: 3 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES

- To demonstrate the techno-economic viability of the biofertilizers / biopesticides to farmers through field demonstration at farmer's field & by know-how training.
- To study about the biofertilizers in increasing soil fertility and usage of Biopesticides for plant disease.
- To prepare literature and promulgate in local language through booklets / documents etc. about; the benefits of biofertilizers for farming in villages through trained beneficiaries/ cultivators as multiplier impact.
- To demonstrate the effectiveness of biofertilizer cultural practices in the farmers fieldsfor enhanced crop productivity through bioreclamation of waste/ marginal land
- To raise the rural/tribal economy & living standard of the lowly of the lowest backward farming community especially SC & ST and marginal farmers.
- To create self employment opportunities to weaker underprivileged SC & ST and marginal farmers.

COURSE OUTCOME

- This course has been designed to provide the student knowledge about ecofriendly product which play a crucial role in determining its future use and applications in environmental management.
- Provides detailed entrepreneurial idea about biofertilizer production and plant disease.
- To produce and impart training of ecofriendly agricultural inputs so as to nullify the ill effects of chemical fertilizers.
- To demonstrate the know-how technology pertinent to microbiological and physico-chemical analyses of soil samples and their assessment.
- To demonstrate the low-cost media preparation and cultural practices in biofertilizer / biopesticide production.
- Students can able to develop fundamental aspects of to seed/seed material/seedlings/soil/waste matter/crop residues in order to increase the population

Unit I– Biofertilizers

General account of the microbes used as biofertilizers for various crop plants and their advantages over chemical fertilizers. Symbiotic N2 fixers:*Rhizobium* – Isolation, characteristics, types, inoculum production and field application, legume/pulses plants. *Frankia* – Isolation and characteristics, Alder, Casurina plants, non-leguminous crop symbiosis. Cyanobacteria, *Azolla* – Isolation, characterization, mass multiplication, their role in rice cultivation, crop response and field application.

Unit II – Non-Symbiotic Nitrogen Fixers

Free living *Azospirillum, Azotobacter* – isolation, characteristics, mass production and field application.

Unit III – Phosphate Solubilizers

Phosphate solubilizing microbes – Isolation, characterization, mass production, field application.

Unit IV – Mycorrhizal Biofertilizers

Importance of mycorrizal inoculum, types of mycorrhizae and associated plants, Mass production of VAM, field applications of Ectomycorrhizae and VAM.

Unit V– Biopesticides

General account of microbes used as bio-insecticides and their advantages over synthetic pesticides, *Bacillus thuringiensis*, production, Field applications, Viruses – cultivation and field applications.

SUGGESTED READINGS

1. Kannaiyan, S. (2003). Bioetchnology of Biofertilizers, CHIPS, Texas.
2. Mahendra K. Rai (2005). Hand book of Microbial biofertilizers, The Haworth Press, Inc. New York.
3. Reddy, S.M. *et. al.* (2002). Bioinoculants for sustainable agriculture and forestry, Scientific Publishers.
4. Subba Rao N.S (1995) Soil microorganisms and plant growth Oxford and IBH publishing co. Pvt. Ltd. NewDelhi.
5. Saleem F and Shakoori AR (2012) Development of Bioinsecticide, Lap Lambert Academic Publishing GmbH KG.
6. Aggarwal SK (2005) Advanced Environmental Biotechnology, APH publication.

Semester – IV

16MBU404B **PERSONAL HEALTH CARE** **(3H – 3C)**

Instruction Hours / week:L: 3 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES

- To strengthen the knowledge of personal health care to students through a detailed study on vaccine and its schedule throughout the life time for all age group.
- Increase the focus on health promotion and prevention, screening and early intervention; and
- Improve quality, safety, performance and accountability.
- To provide health care services aimed at preventing health problems.
- To work with health care professionals
- To counsel and educate the patients and their families

COURSE OUTCOME

- Introducing the skilled basics about the health care and to study various types of vaccines to control the life time infectious disease.
- Demonstrate understanding of the role of health in the practice of health promotion
- Discuss the concepts of health, health education, health promotion and some related terms
- To develop Personal Health Knowledge to achieve societal benefits on health care system.
- Upon completion students will gain knowledge personal health care system.
- Gain theoretical knowledge of various diseased conditions generated due to interplay of immune system components.

Unit I

Vaccination: History –Types of vaccines –conventional and modern vaccines, Route of administrations – mechanisms of inducing immunity.

UnitII

Vaccination schedule for adults - Hepatitis B vaccines, MMR – Tetanus - Varicella vaccines.Vaccines for travelers.

UnitIII

Vaccines for 50 - year-old adult - types and routes.Vaccines for 65 – year - old adult - types and routes.Vaccines for healthcare workers.

UnitIV

Child health management - General health - Types of infection in child - Growth and development – Nutrition and fitness - Positive parenting.

UnitV

Vaccination schedule in children – New born - Child below 5yrs - Child below 10years Vaccines at adolescent age. Vaccine risks and safety.

SUGGESTED READINGS

1. Gary S. Marshall, M.D. 2015. The Vaccine Handbook: A Practical Guide for Clinicians. 5th Edition. Professional Communications Publishers.
2. International Travel and Health. WHO Guide. 2012.
3. Centers for Disease Control and Prevention. Epidemiology and Prevention of Vaccine-Preventable Diseases. 2012. 12th edition.
4. Vaccine Administration, Recommendations and Guidelines. CDC. 2012.
5. Chaudhri, A.K., (Editor) 1998. Tripathy, G.C. and D. Sharma - Common sense rules for wellbeing. Naval Printing Press, New Delhi.
6. Dunne, J., (Editor) 1997. Webb, M., R. Scott and P. Beale - First aid manual. 7th Edition. Dorling Kindersley Ltd., London.
7. Nadkarni, S.S., 1995. Anatomy and Physiology. Syndicate Pvt. Ltd, Chennai.
8. Prasada Rao, J.V.R., 1999. Manual for Control of Hospital Associated Infections National AIDS Control Organization. Ministry of Health and Family Welfare, Government of India. New Delhi.
9. Reed, G. (Editor), 1998. Prescott and Dunn's Industrial Microbiology. 4th Edition, CBS Publishers and Distributors, New Delhi.

Semester – IV

16MBU411 IMMUNOLOGY– PRACTICAL (3H – 2C)

Instruction Hours / week:L: 0 T: 0 P: 4 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 6 Hours

COURSE OBJECTIVES

- To strengthen the knowledge of students in immunodiagnostics on skill basis.
- To learn the latest trends in immunology.
- Rapid diagnosis and Immune reaction.
- To provide overview of immune system, antigen antibody structure and interactions.
- To develop understanding of innate and adaptive immunity along with major cells and molecules involved.
- To integrate immunology with health and enrich the knowledge for autoimmune disorders, hypersensitivity reaction.

COURSE OUTCOME

- Introducing the science of immunology and to study various types of immune systems their classification structure and mechanism of immune activation.
- Upon completion students will gain knowledge of immune system, cells involved along with complement system and autoimmunity
- Develop understanding about immune system, antigen antibody interactions.
- Gain theoretical knowledge of various diseased conditions generated due to interplay of immune system components.
- After course completion, students can apply the knowledge in further studies and higher education.
- Knows the concepts of advanced immunological assays.

EXPERIMENTS

1. Identification of human blood groups.
2. Perform Total Leukocyte Count of the given blood sample.
3. Perform Differential Leukocyte Count of the given blood sample.
4. Separate serum and plasma from the blood sample (demonstration).
5. Perform immunodiffusion by Ouchterlony method.
6. Perform DOT ELISA.
7. Perform immunoelectrophoresis.

SUGGESTED READINGS

1. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition, W.H. Freeman and Company, New York.
2. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 11th edition, Wiley- Blackwell Scientific Publication, Oxford.

3. Murphy K, Travers P, Walport M. (2008). Janeway's Immunobiology. 7th edition, Garland Science Publishers, New York.
4. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6th edition, Saunders Publication, Philadelphia.
5. Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinberg.
6. Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.

Semester – IV

16MBU412 MEDICAL MICROBIOLOGY - PRACTICAL (3H – 2C)

Instruction Hours / week:L: 0 T: 0 P: 4 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 9 Hours

COURSE OBJECTIVES

- To introduce the knowledge of the medically important microganisms, microbial morphology with the main focuses being the characterization, isolation and identification of different microorganism.
- The aim of Medical Microbiology course is to introduce basic principles and application relevance of clinical disease for students who are in preparation for physicians.
- The content of rigorous course includes many etiological agents responsible for global infectious diseases.
- It covers all biology of bacteria, viruses and other pathogens related with infectious diseases in humans.
- The course will provide the conceptual basis for understanding pathogenic microorganisms and particularly address the fundamental mechanisms of their pathogenicity.
- It will develops the basic skills on handling clinical pathogens.

COURSE OUTCOME

- It provides the entrepreneurial ability to characterize, isolate and identify different microbes.
- It includes a detailed study of characterization, etiology, pathogenicity, clinical systems, and laboratory diagnosis of disease-causing Microorganisms.
- It will also provide opportunities for a student to develop diagnostic skills in microbiology, including the practical application and interpretation of laboratory tests for the diagnosis of infectious diseases.
- Comprehend the various methods for identification of unknown microorganisms.
- Recall the relationship of this infection to symptoms, relapse and the accompanying pathology.
- Demonstrate practical skills in fundamental microbiological techniques.

EXPERIMENTS

1. Identify bacteria (any three of *E. coli, Salmonella, Pseudomonas, Staphylococcus, Bacillus*) using laboratory strains on the basis of cultural, morphological and biochemical characteristics: IMViC, TSI, nitrate reduction, urease production and catalase tests.
2. Study of composition and use of important differential media for identification of bacteria: EMB Agar, MacConkey agar, Mannitol salt agar, Deoxycholate citrate agar, TCBS, Salmonella Shigella/BSA Agar.
3. Study of bacterial flora of skin by swab method.
4. Antibacterial sensitivity assay by Kirby-Bauer method.
5. Determination of minimal inhibitory concentration (MIC) of an antibiotic.

6. Study symptoms of the diseases with the help of photographs: Polio, anthrax, herpes, chicken pox, HPV warts, AIDS (candidiasis), dermatomycoses (ring worms).
7. Study of various stages of malarial parasite in RBCs using permanent mounts.

SUGGESTED READINGS

1. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013). Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication
2. Greenwood D, Slack R, Barer M, and Irving W. (2012). Medical Microbiology, 18th Edition. Churchill Livingstone.
3. Ryan KJ and Ray CG. (2014). Sherris Medical Microbiology, 6th Edition. McGraw-Hill Professional.
4. Ananthanarayan R. and Paniker C.K.J. (2009) Textbook of Microbiology. 8th edition, University Press Publication.
5. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition.
6. Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2007). Mims' Medical Microbiology. 4th edition. Elsevier
7. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott, Harley and Klein's Microbiology. 9th edition. McGraw Hill Higher Education.

Semester – IV

16MBU413 RECOMBINANT DNA TECHNOLOGY – PRACTICAL (3H – 2C)

Instruction Hours / week:L: 0 T: 0 P: 4 Marks: Internal: **40** External: **60** Total: **100**

End Semester Exam: 9 Hours

COURSE OBJECTIVES

- To learn the entrepreneurial basic tools in recombinant technology
- To understand the various concepts of cloning vectors and cloning strategies
- To emphasize the knowledge in biotechnology and techniques.
- Provide idea about DNA, protein purification from samples and quantification.
- To learn the techniques pertaining to amplification of biological molecules.
- To impart knowledge on basic microbial isolation and identification approaches

COURSE OUTCOME

- Imparts the concepts of rDNA technology and their applications and Acquire knowledge on the applications of genetic engineering.
- Students will develop understanding about isolation and enumeration of microorganisms from various samples.
- Microbial identification and characterization using a number of approaches will be well understood.
- Acquainted with molecular modification approaches that encompass extraction, purification, quantification and augmentation.
- To give basic understanding of microbial genetic manipulations
- To understand working of different laboratory equipments used in microbiological laboratories

EXPERIMENTS

1. Preparation of competent cells for transformation.
2. Demonstration of Bacterial Transformation and calculation of transformation efficiency.
3. Digestion of DNA using restriction enzymes and analysis by agarose gel electrophoresis
4. Ligation of DNA fragments.
5. Cloning of DNA insert and Blue white screening of recombinants.
6. Interpretation of sequencing gel electropherograms.
7. Designing of primers for DNA amplification.
8. Amplification of DNA by PCR.
9. Demonstration of Southern blotting.

Suggestedreading

1. Brown TA. (2010). Gene Cloning and DNA Analysis. 6th edition. Blackwell Publishing, Oxford, U.K.
2. Clark DP and Pazdernik NJ. (2009). Biotechnology: Applying the Genetic Revolution. ElsevierAcademic Press, USA.

3. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
4. Sambrook J and Russell D. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. ColdSpring Harbor Laboratory Press
5. Wiley JM, Sherwood LM and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. McGraw Hill Higher Education
6. Brown TA. (2007). Genomes-3. Garland Science Publishers
7. Primrose SB and Twyman RM. (2008). Genomics: Applications in human biology. Blackwell Publishing, Oxford, U.K.

Semester – IV

16MBU414A BIOFERTILIZERS AND BIOPESTICIDES- PRACTICAL (3H – 1C)

Instruction Hours / week:L: 0 T: 0 P: 3 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES

- To study about the biofertilizers in increasing soil fertility and usage of Biopesticides for plant disease on the entrepreneurial basis.
- Appreciate the diversity of microorganism and microbial communities inhabiting a multitude of habitats and occupying a wide range of ecological habitats.
- Learn the occurrence, abundance and distribution of microorganism in the environment and their role in the environment and also learn different methods for their detection and characterization
- Competently explain various aspects of environmental microbiology and microbial ecology and to become familiar with current research in environmental microbiology.
- Understand various biogeochemical cycles – Carbon, Nitrogen, Phosphorus cycles etc. and microbes involved
- Understand various plant microbes interactions especially rhizosphere, phyllosphere and mycorrhizae and their applications especially the biofertilizers and their production techniques

COURSE OUTCOME

- Provide the student knowledge about eco friendly product which play a crucial role in determining its future use and applications in environmental management.
- Provides detailed idea about biofertilizer production and plant disease.
- Understand the basic principles of environment microbiology and be able to apply these principles to understanding and solving environmental problems
- waste water treatment and bioremediation
- Know the Microorganisms responsible for water pollution especially Water-borne pathogenic microorganisms and their transmission
- Comprehend the various methods to determine the Sanitary quality of water and sewage treatment methods employed in waste water treatment

EXPERIMENTS

1. Isolation and identification of *Rhizobium* spp. from root nodules – mass production and application.
2. Isolation and identification of *Azotobacter* spp. – mass production and application.
3. Isolation and identification of *Azospirillum* spp. – mass production and application.
4. Isolation and identification of phosphate solubilizing bacteria – mass production and application.
5. Isolation and identification of mycorrhizae.
6. Isolation and maintenance of *Azolla*.
7. Isolation and identification of *Anabena* and *Nostoc* – its mass cultivation.
8. Isolation, identification and maintenance of *Bacillus thuringiensis*.
9. Isolation and identification of *Trichoderma viridae* – its mass cultivation.
10. Isolation and identification of *Beauveria bassiana* – its mass cultivation.

SUGGESTED READINGS

1. Kannaiyan, S. (2003). Biotechnology of Biofertilizers, CHIPS, Texas.
2. Mahendra K. Rai (2005). Hand book of Microbial biofertilizers, The Haworth Press, Inc. New York.
3. Reddy, S.M. *et. al.* (2002). Bioinoculants for sustainable agriculture and forestry, Scientific Publishers.
4. Subba Rao N.S (1995) Soil microorganisms and plant growth Oxford and IBH publishing co. Pvt. Ltd. NewDelhi.
5. Saleem F and Shakoori AR (2012) Development of Bioinsecticide, Lap Lambert Academic Publishing GmbH KG.

Semester – IV

16MBU414B PERSONAL HEALTH CARE – PRACTICAL (3H – 1C)

Instruction Hours / week:L: 0 T: 0 P: 3 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES

- To strengthen the skilled knowledge of personal health care to students through a detailed study on vaccine and its schedule throughout the life time for all age group.
- Demonstrate understanding of the role of health in the practice of health promotion
- Discuss the concepts of health, health education, health promotion and some related terms
- Identify social determinants of health
- List the levels of disease prevention
- To distinguish microbial concept on normal micro flora and pathogens.

COURSE OUTCOME

- Introducing the skilled basics about the health care and to study various types of vaccines to control the life time infectious disease.
- Personal Health and disease, influence of family and community
- Culture, beliefs, attitudes, and stigmatized illnesses
- To make the understanding on Leading causes of death, risk factors, and prevention
- To distinguish three levels of health promotion/disease prevention
- To build a consumer-focused integrated primary health care system.

EXPERIMENTS

1. Effect of hand-wash on microbial load.
2. Isolation of Various kinds of skin microflora.
3. Effectiveness of antimicrobial clothes
4. Normal flora and pathogen of mouth.
5. Evaluation of disinfectants and antiseptics.

SUGGESTED READINGS

1. Chaudhri, A.K., (Editor) 1998. Tripathy, G.C. and D. Sharma - Common sense rules for wellbeing. Naval Printing Press, New Delhi.
2. Dunne, J., (Editor) 1997. Webb, M., R. Scott and P. Beale - First aid manual. 7th Edition. Dorling Kindersley Ltd., London.
3. Nadkarni, S.S., 1995. Anatomy and Physiology. Syndicate Pvt. Ltd, Chennai.

4. Prasada Rao, J.V.R., 1999. Manual for Control of Hospital Associated Infections National AIDS Control Organisation. Ministry of Health and Family Welfare, Government of India. New Delhi.
5. Reed, G. (Editor), 1998. Prescott and Dunn's Industrial Microbiology. 4th Edition, CBS Publishers and Distributors, New Delhi.

16MBU501A MANAGEMENT OF HUMAN MICROBIAL DISEA SES (4H – 4C) Semester – V

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES

- To provide a strong base in the fundamentals of pathogens.
- To learn techniques and methods used in the cultivation and isolation of pathogens.
- To obtain with the knowledge about the habitat and characteristics of pathogens in detail.
- Develop understanding about immune system, antigen antibody interactions.
- Gain theoretical knowledge of various diseased conditions generated due to interplay of immune system components.
- Theoretical knowledge on techniques employed for culturing and detection of plant and animal viruses.

COURSE OUTCOME

- Develop employability skills for identification, classification, and characterization of various pathogens.
- To describe and practice the basic principles of chemotherapy and disinfection through laboratory exercises accompanied by case studies.
- Upon completion, students gained the knowledge of most common medically important organism and the infections they cause.
- Different approaches, techniques and tools used to identify pathogens and control them.
- Diagnostic approaches for microbial pathogens
- Developing efficient vaccines and new drugs

Unit I – Human Diseases

Infectious and non-infectious diseases, microbial and non-microbial diseases, Deficiency diseases, occupational diseases, Incubation period, mortality rate, nosocomial infections

Unit II – Microbial diseases

Respiratory microbial diseases, gastrointestinal microbial diseases, Nervous system diseases, skin diseases, eye diseases, urinary tract diseases, Sexually transmitted diseases: Types, route of infection, clinical systems and general prevention methods, study of recent outbreaks of human diseases (SARS/ Swine flu/Ebola) – causes, spread and control, Mosquito borne disease – Types and prevention.

Unit III – Therapeutics of microbial diseases

Treatment using antibiotics: beta lactam antibiotics (penicillin, cephalosporins), quinolones, polypeptides and aminoglycosides**.** Judicious use of antibiotics, importance of completing antibiotic regimen, Concept of DOTS, emergence of antibiotic resistance, current issues of MDR/XDR microbial strains. Treatment using antiviral agents: Amantadine, Acyclovir, Azidothymidine. Concept of HAART.

Unit IV – Prevention of microbial Diseases

General preventive measures, Importance of personal hygiene, environmental sanitation and methods to prevent the spread of infectious agents transmitted by direct contact, food, water and insect vectors.

Unit V – Vaccines and immune prophylaxis

Importance, types, vaccines available against microbial diseases, vaccination schedule (compulsory and preventive) in the Indian context.

SUGGESTED READINGS

1. Ananthanarayan R. and Paniker C.K.J. (2009) Textbook of Microbiology. 8th edition, University Press Publication
2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication.
3. Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2007) Mims' Medical Microbiology. 4th edition. Elsevier.
4. Willey JM, Sherwood LM, and Woolverton CJ. (2013) Prescott, Harley and Klein's Microbiology. 9th edition. McGraw Hill Higher Education.
5. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition.

Semester – V

16MBU501B MICROBIOLOGICAL ANALYSIS OF AIR AND WATER (4H – 4C)

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

COURSE OBJECTIVE

- To impart knowledge microflora of air and water, sample collection, analysis and control of diseases.
- This paper is designed with the objective to impart hand-on experience and laboratory skills to students in area of bioprocess.
- Learning the basic principles of environment microbiology and be able to apply these principles to understanding and solving problems in current environmental, air and water issues.
- The students will develop set of skills to recognize the ecological problems and critical evaluation of the human impacts on pollution, climate changes and as well as environmental protection.
- To reduce volume of sludge, to stabilize organic solids, and to recover resources. Typical Methods of Treatment: Thickening, chemical addition, centrifugation, filtration, digestion, incineration.
- Quality systems such as investigations, document management systems, Standard Operating Procedures (SOP), change management system, recall management and inspection management

COURSE OUTCOME

- Provides employability skills involved in the air and water analysis
- Characterization of microorganisms from water and air samples
- Students will get the basic knowledge how to prepare and perform sampling and microbial analyses to determine the abundance, growth rate and microbial community composition together with the basic environmental parameters.
- Validation for equipment, methods, cleaning and process
- Students can develop their entrepreneurial skills in analysis of air and water sample.
- Learning the basic principles of microbiological analysis of environmental sector.

Unit I – Aero microbiology

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

Unit II – Air Sample Collection and Analysis

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

Unit III – Control Measures

Fate of bioaerosols, inactivation mechanisms – UV light, HEPA filters, desiccation, Incineration. Precipitation, chemical disinfection, filtration, high temperature, UV light

Unit IV – Water Microbiology

Water borne pathogens and water borne diseases

Unit V – Microbiological Analysis of Water

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

SUGGESTED READINGS

1. Da Silva N, Taniwaki MH, Junqueira VC, Silveira N, Nascimento MS, Gomes RAR (2012) Microbiological Examination Methods of Food and Water. A Laboratory Manual, CRC Press.
2. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA.
3. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press.
4. Hurst CJ, Crawford RL, Garland JL, Lipson DA (2007). Manual of Environmental Microbiology, 3rd edition, ASM press.

16MBU502A **BIOMATHEMATICS AND BIOSTATISTICS** **Semester – V (4H – 4C)**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

SCOPE

- This course has been intended to provide the learner insights into helpful areas of Statistics which plays an essential role in present, future use and applications of Biology.
- This course provides an introduction to a variety of statistical methods of use in describing and analyzing biological data.
- It includes a laboratory component in which biological data are analyzed using statistical software. No prior knowledge of the software will be assumed.
- Statisticians help to design data collection plans, analyze data appropriately and interpret and draw conclusions from those analyses.
- To develop students' skills in algebraic manipulation, the calculus of linear and non-linear differential equations, mathematical modelling, matrix algebra and statistical methods.
- To introduce students to the application of mathematical modeling in the analysis of biological systems including populations of molecules, cells and organisms.
- To show how mathematics, statistics and computing can be used in an integrated way to analyse biological systems.

OBJECTIVE

- Students get an idea about collection, interpretation and presentation of statistical data.
- Statistics, a branch of applied Mathematics, is regarded as mathematics applied to observational data.
- Conceivably everything dealing with the collection, processing, analysis and interpretation of numerical data belongs to the domain of statistics.
- To introduce students to the use of R for the analysis of biological processes and data, including simple computer programming.
- have an enhanced knowledge and understanding of mathematical modeling and statistical methods in the analysis of biological systems;
- be able to analyse data from experiments and draw sound conclusions about the underlying processes using their understanding of mathematics and statistics be better able to assess biological inferences that rest on mathematical and statistical arguments.

Unit I

Sets. Functions and their graphs : polynomial, sine, cosine, exponential and logarithmic functions. Motivation and illustration for these functions through projectile motion, simple pendulum, biological rhythms, cell division, muscular fibres etc. Simple observations about these functions like increasing, decreasing and, periodicity. Sequences to be introduced through the examples arising in Science beginning with finite sequences, followed by concepts of recursion and difference equations. For instance, the Fibonacci sequence arising from branching habit of trees and breeding habit of rabbits.

Unit II

Intuitive idea of algebraic relationships and convergence. Infinite Geometric Series. Series formulas for ex, log (1+x), sin x, cos x. Step function. Intuitive idea of discontinuity, continuity and limits. Differentiation. Conception to be motivated through simple concrete examples as given above from Biological and Physical Sciences. Use of methods of differentiation like Chain rule, Product rule and Quotient rule. Second order derivatives of above functions. Integration as reverse process of differentiation.Integrals of the functions introduced above. Differential Equations of first order, Linear Differential Equations. Points in plane and space and coordinate form. Examples of matrices arising in Biological Sciences and Biological networks. Sum and Produce of matrices upto order3.

Unit III

Measures of central tendency, Measures of dispersion; skewness, kurtosis; Elementary Probability and basic laws; Discrete and Continuous Random variable, Mathematical Expectation; Curve Fitting; Correlation and Regression. Emphasis on examples from Biological Sciences.

Unit IV

Mean and Variance of Discrete and Continuous Distributions namely Binomial, Poisson, Geometric, Weibull, Logistic and Normal distribution. Fitting of Distributions; Statistical methods: Scope of statistics: utility and misuse. Principles of statistical analysis of biological data.

Unit V

Sampling parameters. Difference between sample and Population, Sampling Errors, Censoring, difference between parametric and non-parametric statistics. Sampling Distributions, Standard Error, Testing of Hypothesis, Level of Significance and Degree ofFreedom; Large Sample Test based on Normal Distribution, Small sample test based on t-test, Z- test and F test; Confidence Interval; Distribution-free test - Chi-square test; Basic Introduction to Multivariate statistics, etc.

SUGGESTED READINGS

1. H. S. Bear: Understanding Calculus, John Wiley and Sons (Second Edition); (2003).
2. E. Batschelet : Introduction to Mathematics for Life Scientists,Springer Verlag, InternationalStudent Edition, Narosa Publishing House, New Delhi; (1975)
3. Edmondson and D. Druce : Advanced Biology Statistics, Oxford University Press; (1996).
4. W. Danial:Biostatistics: A foundation for Analysis in Health Sciences, John Wiley and Sons Inc; (2004).

16MBU502B **BIOINFORMATICS** **Semester – V (4H – 4C)**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

COURSE OBJECTIVES

- To detail the importance of computer in field of life sciences.
- To obtain good understanding about the interpretation of biological data base.
- To uptake knowledge in latest tools and technology.
- Aimed to provide an overview of various bioinformatics tools, databases available and sequence analysis
- Provide knowledge on database concept, management, retrieval along with utilization in gene and protein analysis.
- To get introduced to the basic concepts of Bioinformatics and its significance in Biological data analysis.

COURSE OUTCOME

- Provides computational skill on search engines and various software tools involved in bioinformatics
- It will impart computational based techniques which includes genomics and proteomics in Bioinformatics.
- Retrieve information from available databases and use them for microbial identifications and drug designing
- Gain ability to modify gene and protein structures in simulated systems.
- Introduction to the basics of sequence alignment and analysis.
- Describe about the different types of Biological databases.

Unit I– Introduction to Computer Fundamentals
RDBMS - Definition of relational database. Mode of data transfer (FTP, SFTP, SCP), advantage of encrypted data transfer.

Unit II– Introduction to Bioinformatics and Biological Databases
Biological databases– nucleic acid, genome, protein sequence and structure, geneexpression databases, Database of metabolic pathways, Mode of data storage - File formats - FASTA, Genbank and Uniprot, Data submission & retrieval from NCBI, EMBL, DDBJ, Uniprot, PDB.

Unit III– Sequence Alignments, Phylogeny and Phylogenetic trees
Local and Global Sequence alignment, pairwise and multiple sequence alignment. Scoring an alignment, scoring matrices, PAM & BLOSUM series of matrices. Types of phylogenetic trees, Different approaches of phylogenetic tree construction - UPGMA,Neighbour joining, Maximum Parsomony, Maximum likelihood.

Unit IV– Genome organization and analysis
Diversity of Genomes: Viral, prokaryotic & eukaryotic genomesGenome, transcriptome, proteome, 2-D gel electrophoresis, Maldi Tof spectroscopy. Major features of completed genomes: *E.coli, S.cerevisiae, Arabidopsis*, Human.

Unit V – Protein Structure Predictions

Hierarchy of protein structure - primary, secondary and tertiary structures, modeling. Structural Classes, Motifs, Folds and Domains. Protein structure prediction in presenceand absence of structure template Energy minimizations and evaluation by Ramachandran plot Protein structure and rational drug design.

SUGGESTED READINGS

1.Saxena Sanjay (2003) A First Course in Computers, Vikas Publishing.

2.Pradeep and Sinha Preeti (2007) Foundations of Computing, 4th ed., BPB Publications.

3.Lesk M.A.(2008) Introduction to Bioinformatics . Oxford Publication, 3rd International Student Edition.

4. Rastogi S.C., Mendiratta N. and Rastogi P. (2007) Bioinformatics: methods and applications, genomics, proteomics and drug discovery, 2nd ed. Prentice Hall India Publication.

5.Primrose and Twyman (2003) Principles of Genome Analysis & Genomics. Blackwell.

Semester – V

16MBU503A INSTRUMENTATION AND BIOTECHNIQUES (4H – 4C)

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES

To develop skills related to

- Understand the principles of various instruments used in the life sciences
- Ability to operate the instruments
- Data analysis and interpretations
- Introduce the basic concept of qualitative and quantitative analysis of a given sample
- Study various spectroscopic techniques and its instrumentation.
- Study the concept of separation science and its applications.
- To learn the fundamentals of research methodology, working principles and applications of instruments used in biology.

COURSE OUTCOME

- offers the students with an opportunity to develop skill on the bioinstrumentation and concepts of principles and applications.
- Define and explain various fundamentals of spectroscopy, qualitative and quantitative analysis
- and characterize functionalities of biomolecules by using spectroscopic techniques.
- Explain the various separation techniques and its instrumentation.
- Describe the principle and working of various radiation detectors.
- Evaluate the various types & applications of chromatography and electrophoresis.
- Appreciate the working principles and applications of Microscopy.

Unit I– Microscopy

Brightfield and darkfield microscopy, Fluorescence Microscopy, Phase contrast Microscopy, Confocal Microscopy, Electron Microscopy (Scanning and Transmission Electron Microscopy).

Unit II – Chromatography

Principles and applications of paper chromatography (including Descending and 2-D), Thin layer chromatography. Column Chromatography - packing types (IEC, AC, SEC), fraction collection. GLC and HPLC.

Unit III – Electrophoresis

Principle and applications of native polyacrylamide gel electrophoresis, SDS- polyacrylamide gel electrophoresis, 2D gel electrophoresis, Isoelectric focusing, Zymogram preparation and Agarose gel electrophoresis.

Unit IV – Spectrophotometry

Principle, Instrumentation and application of spectrophotometer, colorimeter and turdibometer.

Unit V – Centrifugation

Principles of centrifugations – RCF and sedimentation coefficient. Types of centrifuges – rotors - fixed angle and swinging bucket rotors. Types of Centrifugation – differential, density gradient and ultracentrifugation. Analytical centrifugation.

SUGGESTED READINGS

1. Wilson K and Walker J. (2010). Principles and Techniques of Biochemistry and Molecular Biology. 7th Ed., Cambridge University Press.
2. Nelson DL and Cox MM. (2008). Lehninger Principles of Biochemistry, 5th Ed., W.H. Freeman and Company.
3. Willey MJ, Sherwood LM & Woolverton CJ. (2013). Prescott, Harley and Klein's Microbiology. 9th Ed., McGraw Hill.
4. Karp G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley & Sons. Inc.
5. De Robertis EDP and De Robertis EMF. (2006). Cell and Molecular Biology. 8th edition. Lipincott Williams and Wilkins, Philadelphia.
6. Cooper G.M. and Hausman R.E. (2009). The Cell: A Molecular Approach. 5th Edition. ASM Press & Sunderland, Washington D.C., Sinauer Associates, MA.
7. Nigam A and Ayyagari A. 2007. Lab Manual in Biochemistry, Immunology and Biotechnology. Tata McGraw Hill.

Semester – V

16MBU503B PLANT PATHOLOGY (4H – 4C)

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

COURSE OBJECTIVES

- This paper aims at introducing students to the basic and applied aspects of plant biotechnology.
- Introduce students to the basic principles and concepts of plant pathology.
- Introduce and illustrate the major groups of organisms that cause plant diseases.
- Enhance student's understanding of scientific research, especially as it applies to the science of plant pathology and the study of microorganisms.
- Provide a framework that students can use in their profession to best approach plant disease management.
- Prepare students for additional classes in Plant Pathology and related disciplines.

COURSE OUTCOME

- This will enable for learning the techniques to save endangered species which will be useful for mankind
- Describe the concepts of what constitutes disease in plants.
- Identify major principles of plant pathology.
- Recognize the etiological agents of disease.
- Employ methods to diagnose and manage a wide range of plant diseases.
- Describe aspects of integrated pest management.

Unit I – Introduction and History of plant pathology

Concept of plant disease- definitions of disease, disease cycle and pathogenicity, symptoms associated with microbial plant diseases, types of plant pathogens, economic losses and social impact of plant diseases. Significant landmarks in the field of plant pathology- Contributions of Anton DeBary, Millardet, Burrill, E. Smith, Adolph Mayer, Ivanowski, Diener, Stakman, H.H. Flor, Van Der Plank, molecular Koch's postulates. Contributions of eminent Indian plant pathologists.

Unit II – Stages in development of a disease

Infection, invasion, colonization, dissemination of pathogens and perennation. Concepts of monocyclic, polycyclic and polyetic diseases, disease triangle & disease pyramid, forecasting of plant diseases and its relevance in Indian context.

Unit III – Specific plant diseases

Study of some important plant diseases giving emphasis on its etiological agent, symptoms, epidemiology and control.

a. Important diseases caused by phytopathogenic bacteria: Angular leaf spot of cotton, bacterial leaf blight of rice, crown galls, bacterial cankers of citrus.

b. Important diseases caused by fungi: White rust of crucifers - *Albugo candida,* Downy mildew of onion – *Peronospora,* Powdery mildew of wheat - *Erysiphe graminis.*

c. Important diseases caused by viruses: Papaya ring spot, tomato yellow leaf curl, banana bunchy top, rice tungro.

Unit IV– Host Pathogen Interaction

a. Microbial Pathogenicity

Virulence factors of pathogens: enzymes, toxins (host specific and non specific) growth regulators, virulence factors in viruses (replicase, coat protein, silencing suppressors) in disease development. Effects of pathogens on host physiological processes (photosynthesis, respiration, cell membrane permeability, translocation of water and nutrients, plant growth and reproduction).

b. Genetics of Plant Diseases

Concept of resistance (R) gene and avirulence (avr) gene; gene for gene hypothesis, types of plant resistance: true resistance– horizontal & vertical, apparent resistance.

c. Defense Mechanisms in Plants

Concepts of constitutive defense mechanisms in plants, inducible structural defenses (histological- cork layer, abscission layer, tyloses, gums), inducible biochemical defenses [hypersensitive response (HR), systemic acquired resistance (SAR), phytoalexins, pathogenesis related (PR) proteins, plantibodies, phenolics, quinones, oxidative bursts].

Unit V– Control of Plant Diseases

Principles and practices involved in the management of plant diseases by different methods, *viz.* regulatory - quarantine, crop certification, avoidance of pathogen, use of pathogen free propagative material cultural - host eradication, crop rotation, sanitation, polyethylene traps and mulcheschemical - protectants and systemic fungicides, antibiotics, resistance of pathogens to chemicals. biological - suppressive soils, antagonistic microbes- bacteria and fungi, trap plantsgenetic engineering of disease resistant plants- with plant derived genes and pathogen derived genes.

SUGGESTED READINGS

1. Agrios GN. (2006). Plant Pathology. 5th edition. Academic press, San Diego.
2. Lucas JA. (1998). Plant Pathology and Plant Pathogens. 3rd edition. Blackwell Science, Oxford.

Semester – V

16MBU504A **MICROBIAL BIOTECHNOLOGY** **(3H – 3C)**

Instruction Hours / week: L: 3 T: 0 P: 0 **Marks:** Internal: **40** External:**60**Total: **100**

End Semester Exam: 3 Hours

COURSE OBJECTIVE

- To make students understand the aspects of industrial, soil, environmental, agricultural microbiology.
- Gain knowledge about the Industrially important microorganisms &uritional requirements.
- Know about the Commercialization methods of Microbial products.
- To understand the industrially important microorganisms' commercial value and importance of patent and IPR.
- Describe about different sewage treatment methods employed in waste water treatment.
- know the microorganisms responsible for water pollution.

COURSE OUTCOME

- This paper imparts knowledge on applications of microorganisms in various fields and helps to gain employability in pharmaceutical industries
- Describe about different sewage treatment methods employed in waste water treatment.
- Learn about the global environmental problems.
- To provide a fundamental knowledge about the various scopes in environmental and industrial studies.
- Learn about the applications of microbes in biotransformations, therapeutic and industrial biotechnology
- Describe aspects of genetically engineered microbes for industrial application.

Unit I – Microbial Biotechnology and its Applications

Microbial biotechnology: Scope and its applications in human therapeutics, agriculture (Biofertilizers, PGPR, Mycorrhizae), environmental, and food technology. Use of prokaryotic and eukaryotic microorganisms in biotechnological applications. Genetically engineered microbes for industrial application: Bacteria and yeast

Unit II – Therapeutic and Industrial Biotechnology

Recombinant microbial production processes in pharmaceutical industries - Streptokinase, recombinant vaccines (Hepatitis B vaccine). Microbial polysaccharides and polyesters, Microbial production of bio-pesticides, bioplastics, Microbial biosensors

Unit III – Applications of Microbes in Biotransformations

Microbial based transformation of steroids and sterols. Bio-catalytic processes and their industrial applications: Production of high fructose syrup and production of cocoa butter substitute

Unit IV – Microbial Products and their Recovery and RNAi

Microbial product purification: filtration, ion exchange & affinity chromatography techniques Immobilization methods and their application: Whole cell immobilization. RNAi and its applications in silencing genes, drug resistance, therapeutics and host pathogen interactions.

Unit V – Microbes for Bio-energy and Environment, Intellectual Property Rights

Bio-ethanol and bio-diesel production: commercial production from lignocellulosic waste and algal biomass, Biogas production: Methane and hydrogen production using microbial culture. Microorganisms in bioremediation: Degradation of xenobiotics, mineral recovery, removal of heavy metals from aqueous effluents. Patents, patenting fundamental requirements- patent multicellular organisms, IPR, Copyrights, Trademarks

SUGGESTED READINGS

1. Ratledge, C and Kristiansen, B. (2001). Basic Biotechnology, 2nd edition, Cambridge University Press.
2. Demain, A. L and Davies, J. E. (1999). Manual of Industrial Microbiology and Biotechnology, 2nd edition, ASM Press.
3. Swartz, J. R. (2001). Advances in Escherichia coli production of therapeutic proteins. Current Opinion in Biotechnology, 12, 195–201.
4. Prescott, Harley and Klein's Microbiology by Willey JM, Sherwood LM, Woolverton CJ (2014), 9th edition, Mc Graw Hill Publishers.
5. Gupta PK (2009) Elements of Biotechnology 2nd edition, Rastogi Publications.
6. Glazer AN and Nikaido H (2007) Microbial Biotechnology, 2nd edition, Cambridge University Press
7. Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology 4th edition, ASM Press.
8. Stanbury PF, Whitaker A, Hall SJ (1995) Principles of Fermentation Technology 2nd edition, Elsevier Science.
9. Crueger W, Crueger A (1990) Biotechnology: A text Book of Industrial Microbiology 2nd edition. Sinauer associates, Inc.

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16MBU504B **INHERITANCE BIOLOGY** **Semester – V (3H – 3C)**

Instruction Hours / week: L: 3 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

COURSE OBJECTIVE

- To make students understand the principles of Genetics and inheritance biology.
- understand that genes are the units of inheritance for individual characteristics and also may contribute to susceptibility to certain diseases
- understand the number of chromosomes that make up the human genome and where they are located within the cell
- understand the role of the X and Y chromosomes in determining sex and how they are inherited.
- understand how gametes are produced by the process of meiosis and how the full complement of 46 chromosomes is restored at fertilisation
- To identify and describe the process and purposes of the cell cycle, meiosis, and mitosis, as well as predict the outcomes of these processes.

COURSE OUTCOME

- This paper imparts knowledge on the different aspects of genetics and pedigree analysis.
- Understand the central dogma of molecular biology and the genome of prokaryotic and eukaryotic microorganisms.
- To gain knowledge about the microbial genetics and central dogma of molecular biology
- Students will understand the cellular components underlying mitotic cell division.
- Students will apply their knowledge of cell biology to selected examples of changes or losses in cell function. These can include responses to environmental or physiological changes, or alterations of cell function brought about by mutation.
- To describe applications and techniques of modern genetic technology, as well as select the correct techniques to solve practical genetic problems.

Unit I – Introduction to Genetics

Historical developments: Model organisms in genetic analyses and experimentation: *Escherichia coli, Saccharomyces cerevisiae, Neurospora crassa, Caenorhabditis elegans Drosophila melanogaster, Arabidopsis thaliana.*

Unit II – Mendelian Principles

Mendel's Laws: Dominance, segregation, independent assortment, deviation from Mendelian inheritance, Rediscovery of Mendel's principles, Chromosome theory of inheritance: Allele, multiple alleles, pseudoallele, complementation tests, Extensions of Mendelian genetics: Allelic interactions, concept of dominance, recessiveness, Incomplete dominance and co-dominance, Multiple alleles, Epistasis, penetrance and expressivity.

Unit III – Linkage and Crossing over & Recombination

Linkage and recombination of genes, Cytological basis of crossing over, Crossing over at four-strand stage, Molecular mechanism of crossing over, mapping Homologous and non-homologous recombination, including transposition, site-specific recombination.

Unit IV – Extra-Chromosomal Inheritance & Human genetics

Rules of extra nuclear inheritance, Organelle heredity - Chloroplast mutations in *Chlamydomonas*, mitochondrial, mutations in *Saccharomyces*, Maternal effects – Shell coiling in *Limnaea peregra* Infectious heredity - Kappa particles in *Paramecium*.Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders.Polygenic inheritance, heritability and its measurements, QTL mapping.

Unit V – Characteristics of Chromosomes

Structural organization of chromosomes - centromeres, telomeres and repetitive DNA, Packaging DNA molecules into chromosomes, Concept of euchromatin and heterochromatin, Normal and abnormal karyotypes of human chromosomes, Chromosome banding, Giant chromosomes: Polytene and lampbrush chromosomes, Variations in chromosome structure: Deletion, duplication, inversion and translocation, Variation in chromosomal number and structural abnormalities -

Klinefelter syndrome, Turner syndrome, Down syndrome

SUGGESTED READINGS

1. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India.
2. Snustad DP, Simmons MJ (2011). Principles of Genetics. 6th Ed. John Wiley and Sons Inc.
3. Weaver RF, Hedrick PW (1997). Genetics. 3rd Ed. McGraw-Hill Education.
4. Klug WS, Cummings MR, Spencer CA, Palladino M (2012). Concepts of Genetics. 10th Ed. Benjamin Cummings.
5. Griffith AJF, Wessler SR, Lewontin RC, Carroll SB. (2007). Introduction to Genetic Analysis. 9th Ed. W.H.Freeman and Co., New York.
6. Hartl DL, Jones EW (2009). Genetics: Analysis of Genes and Genomes. 7th Ed, Jones and Bartlett Publishers.
7. Russell PJ. (2009). *i* Genetics - A Molecular Approach. 3rd Ed, Benjamin Cummings.

Semester – V

16MBU511A MANAGEMENT OF HUMAN MICROBIAL DISEASES- PRACTICAL (4H – 2C)

Instruction Hours / week: L: 0 T: 0 P: 4Marks: Internal: **40**External: **60** Total: **100**

End Semester Exam: 9 Hours

COURSE OBJECTIVES

- To provide a strong base in the fundamentals of pathogens.
- To learn techniques and methods used in the cultivation and isolation of pathogens.
- To obtain with the knowledge about the habitat and characteristics of pathogens.
- Program aims to develop students' understanding of medical microbiology with hand on experience in the isolation of the bacteria from different sources.
- It gives the knowledge about the pathogenicity, understanding the biofilm formation in bacteria, role of biofilm in pathogenicity and their antibiotics resistance pattern of pathogenic bacteria which is useful for public awareness.
- The objective of this course is to instill awareness on basics of immune system where students will learn the components of immunity and various immune responses that work together to protect the host.

COURSE OUTCOME

- Involves the identification, classification, and characterization of pathogenic species.
- This paper imparts employability in hospital laboratories.
- Properly use aseptic techniques, including sterilization. Know General bacteriology and microbial techniques for isolation of pure cultures of bacteria.
- Basics in microbiology course is designed as an interdisciplinary course to acquaint the students of different streams with a very basic knowledge and understanding of
- microbes, pathogens and their control Learning methods for antimicrobial susceptibility testing
- In this course the students will observe and perform experiments related to clinical microbiology and virology which will enhance their laboratory skills, and scientific knowledge.

EXPERIMENTS

1. Diagnosis of respiratory tract disease.
2. Diagnosis of urinary tract disease.
3. Diagnosis of gastrointestinal tract disease.
4. Identification of dermatophytes

SUGGESTED READINGS

1. Ananthanarayan R. and Paniker C.K.J. (2009) Textbook of Microbiology. 8th edition, University Press Publication
2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication.
3. Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2007) Mims' Medical Microbiology. 4th edition. Elsevier.

4. Willey JM, Sherwood LM, and Woolverton CJ. (2013) Prescott, Harley and Klein's Microbiology. 9th edition. McGraw Hill Higher Education.
5. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition.

Semester – V

16MBU511B **(3H – 1C)**

MICROBIOLOGICAL ANALYSIS OF AIR AND WATER –PRACTICAL

Instruction Hours / week: L: 0 T: 0 P: 3 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 9 Hours

COURSE OBJECTIVES

- Impart knowledge microflora of air and water, sample collection, analysis and control of diseases.
- Explain the significance of air Microflora and airborne diseases
- Gain knowledge about water pollution and waste water treatments.
- Learning the basic principles of environment microbiology and be able to apply these principles to understanding and solving problems in current environmental, air and water issues.
- Validation for equipment, methods, cleaning and process
- Students can develop their entrepreneurial skills in analysis of air and water sample.

COURSE OUTCOME

- This paper teaches different laboratory skills of analyzing air and water.
- Hand on training of the general equipment used in microbiology laboratory
- Develop capability to perform different gene transfer methods in microbes
- Characterization of microorganisms from water and air samples
- Enumeration of bacteria and fungi from air by membrane filtration technique
- Gain knowledge about water pollution and waste water treatments.

EXPERIMENTS

1. Enumeration of indoor and outdoor microflora of air (bacteria and fungi) by settle plate method.
2. Enumeration of bacteria and fungi from air by membrane filtration technique.
3. Microbicidal effect of UV light.
4. Evaluation of disinfectants – Phenol coefficient method.
5. MPN test.
6. Enumeration of bacteria and fungi from water by membrane filtration technique.

SUGGESTED READINGS

1. Da Silva N, Taniwaki MH, Junqueira VC, Silveira N, Nascimento MS, Gomes RAR (2012) Microbiological Examination Methods of Food and Water. A Laboratory Manual, CRC Press.
2. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA.
3. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press.
4. Hurst CJ, Crawford RL, Garland JL, Lipson DA (2007). Manual of Environmental Microbiology, 3rd edition, ASM press.

Semester – V

16MBU512A BIOMATHEMATICS AND BIOSTASTICS - PRACTICAL (4H – 2C)

Instruction Hours / week: L: 0 T: 0 P: 4 Marks: Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

SCOPE

- This course has been intended to provide the learner insights into helpful areas of Statistics which plays an essential role in present, future use and applications of Biology.
- Statisticians help to design data collection plans, analyze data appropriately and interpret and draw conclusions from those analyses.
- Statistics helps in the proper and efficient planning of a statistical inquiry in any field of study.
- Statistics helps in providing a better understanding and exact description of a phenomenon of nature.
- To develop students' skills in algebraic manipulation, the calculus of linear and non-linear differential equations, mathematical modelling, matrix algebra and statistical methods.
- To introduce students to the application of mathematical modeling in the analysis of biological systems including populations of molecules, cells and organisms.

OBJECTIVES

- Students get an idea about collection, interpretation and presentation of statistical data.
- Statistics help in providing data as well as tools to analyze the data.
- Some powerful techniques are index numbers, time series analysis, and also forecasting.
- Statistical knowledge helps you use the proper methods to collect the data, employ the correct analyses, and effectively present the results.
- To show how mathematics, statistics and computing can be used in an integrated way to analyse biological systems.
- Conceivably everything dealing with the collection, processing, analysis and interpretation of numerical data belongs to the domain of statistics.

Statistics helps in collecting appropriate quantitative data.

EXPERIMENTS

1. Word Problems based on Differential Equations
2. Mean, Median, Mode from grouped and ungrouped Data set
3. Standard Deviation and Coefficient of Variation
4. Skewness and Kurtosis
5. Curve fitting
6. Correlation
7. Regression
8. Finding area under the curve using normal probability
9. Testing of Hypothesis- Normal Distribution, t-test and Chi-Square-test
10. Confidence Interval

SUGGESTED READINGS

1. H. S. Bear: Understanding Calculus, John Wiley and Sons (Second Edition); (2003).

2. E. Batschelet : Introduction to Mathematics for Life Scientists,Springer Verlag, International Student Edition, Narosa Publishing House, New Delhi; (1975)
3. Edmondson and D. Druce : Advanced Biology Statistics, Oxford University Press; (1996).
4. W. Danial: Biostatistics: A foundation for Analysis in Health Sciences, John Wiley and Sons Inc; (2004).

Semester – V

16MBU512B BIOINFORMATICS - PRACTICAL (4H – 2C)

Instruction Hours / week: L: 0 T: 0 P: 3 **Marks:** Internal: **40** External:**60** Total: **100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES

- Students get an idea about collection, interpretation and presentation of bioinformatics data.
- Develop competence to integrate biological information with computational softwares
- Impart basic understanding of bioinformatics approaches for bacterial/viral/fungal identifications and drug design
- Bioinformatics is the application of computer technology to get the information that's stored in certain types of biological data.
- Bioinformatics provides central, globally accessible databases that enable scientists to submit, search and analyse information.
- A sound knowledge on procedural repertoire allows students to innovatively apply these in basic
- and applied fields of biological research.

COURSE OUTCOME

- This course has been intended to provide the learner insights into helpful areas of Bioinformatics which plays an essential role in application-oriented biology.
- Provides computational skill on search engines and various software tools involved in bioinformatics
- Learning methods for designing primers and in-silico PCR
- Develop competence to retrieve information from biological databases and integrate this biological information with computational softwares.
- Design an experiment with step-by-step instructions to address a research problem
- Technical know-how on versatile techniques in bioinformatics techniques

EXPERIMENTS

1. Introduction to different operating systems - UNIX, LINUX and Windows
2. Introduction to bioinformatics databases (any three): NCBI/PDB/DDBJ, Uniprot, PDB
3. Sequence retrieval using BLAST
4. Sequence alignment & phylogenetic analysis using clustalW & phylip
5. Picking out a given gene from genomes using Genscan or other softwares (promoter region identification, repeat in genome, ORF prediction). Gene finding tools (Glimmer, GENSCAN), Primer designing, Genscan/Genetool
6. Protein structure prediction: primary structure analysis, secondary structure prediction using psi- pred, homology modeling using Swissmodel. Molecular visualization using jmol, Protein structure model evaluation (PROCHECK)
7. Prediction of different features of a functional gene.

SUGGESTED READINGDS

1. Saxena Sanjay (2003) A First Course in Computers, Vikas Publishing House

2. Pradeep and Sinha Preeti (2007) Foundations of Computing, 4th ed., BPB Publications
3. Lesk M.A.(2008) Introduction to Bioinformatics . Oxford Publication, 3rd International Student Edition.
4. Rastogi S.C., Mendiratta N. and Rastogi P. (2007) Bioinformatics: methods and applications, genomics, proteomics and drug discovery, 2nd ed. Prentice Hall India Publication
5. Primrose and Twyman (2003) Principles of Genome Analysis & Genomics. Blackwell.

Semester – V

16MBU513A **INSTRUMENTATION AND BIOTECHNIQUES –PRACTICAL** **(4H – 2C)**

Instruction Hours / week: L: 0 T: 0 P: 4 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES

To develop skills related to

- Understand the principles of various instruments used in the life sciences.
- Ability to operate the instruments.
- Data analysis and interpretations.
- Appreciate the working principles and applications of Microscopy.
- Understand the mechanics of thesis writing
- To understand working of different laboratory equipment used in microbiological laboratories

COURSE OUTCOME

- Offers the students with an opportunity to gain practical skills on the bioinstrumentation and concepts of principles and applications.
- Evaluate the various types & applications of chromatography and electrophoresis.
- Evaluate the various types & phase contrast microscopy and Electron microscopy
- Explain the various separation techniques and its instrumentation.
- Hand on training of the general equipment used in microbiology laboratory
- Comprehend the major spectrophotometric and titrimetric approaches of quantification in biological and environmental samples.

EXPERIMENTS

1. Study of fluorescent micrographs to visualize bacterial cells – Demonstration
2. Ray diagrams of phase contrast microscopy and Electron microscopy – Demonstration
3. Separation of mixtures by paper / thin layer chromatography.
4. Demonstration of column packing in any form of column chromatography.
5. Separation of protein mixtures by any form of chromatography.
6. Separation of protein mixtures by Polyacrylamide Gel Electrophoresis (PAGE).
7. Determination of λ max for an unknown sample and calculation of extinction coefficient.
8. Separation of components of a given mixture using a laboratory scale centrifuge.
9. Understanding density gradient centrifugation with the help of pictures.

SUGGESTED READINGS

1. Wilson K and Walker J. (2010). Principles and Techniques of Biochemistry and Molecular Biology. 7th edition, Cambridge University Press.
2. Nelson DL and Cox MM. (2008). Lehninger Principles of Biochemistry, 5th edition, W.H. Freeman and Company.

3. Willey MJ, Sherwood LM & Woolverton CJ. (2013). Prescott, Harley and Klein's Microbiology. 9th edition, McGraw Hill.
4. Karp G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th edition. JohnWiley & Sons. Inc.
5. De Robertis EDP and De Robertis EMF. (2006). Cell and Molecular Biology. 8th edition. Lipincott Williams and Wilkins, Philadelphia.
6. Cooper G.M. and Hausman R.E. (2009). The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington D.C., Sinauer Associates, MA.
7. Nigam A and Ayyagari A. (2007). Lab Manual in Biochemistry, Immunology and Biotechnology. Tata McGraw Hill.

Semester – V

16MBU513B **PLANT PATHOLOGY – PRACTICAL** **(4H – 2C)**

Instruction Hours / week: L: 0 T: 0 P: 4 **Marks:** Internal: **40**External:**60** Total: **100**

End Semester Exam: 3 Hours

COURSE OBJECTIVE

- This paper aims at introducing students to the basic and applied aspects of plant biotechnology.
- Introduce students to the basic principles and concepts of plant pathology.
- Introduce and illustrate the major groups of organisms that cause plant diseases
- Provide a framework that students can use in their profession to best approach plant disease management.
- To study the importance of plant diseases and cutting sections of infected plant material
- To acquaint with different strategies for management of plant diseases

COURSE OUTCOME

- This will enable for learning the techniques to save endangered species which will be useful for mankind.
- Identify major principles of plant pathology.
- Demonstration of fungal, bacterial and viral plant pathogens.
- Recognize the etiological agents of disease.
- Employ methods to diagnose and manage a wide range of plant diseases.
- To teach the students about the different groups of insects that vector plant pathogens, vector-plant pathogen interaction, management of vectors for controlling diseases

EXPERIMENTS

1. Demonstration of Koch's postulates in fungal, bacterial and viral plant pathogens.
2. Study of important diseases of crop plants by cutting sections of infected plant material - *Albugo, Puccinia, Ustilago, Fusarium, Colletotrichum.*

SUGGESTED READINGS

1. Agrios GN. (2006). Plant Pathology. 5th edition. Academic press, San Diego,
2. Lucas JA. (1998). Plant Pathology and Plant Pathogens. 3rd edition. Blackwell Science, Oxford.
3. Mehrotra RS. (1994). Plant Pathology. Tata McGraw-Hill Limited.
4. Rangaswami G. (2005). Diseases of Crop Plants in India. 4th edition. Prentice Hall of India Pvt. Ltd., New Delhi.
5. Singh RS. (1998). Plant Diseases Management. 7th edition. Oxford & IBH,Delhi.

Semester – V

16MBU514A **MICROBIAL BIOTECHNOLOGY- PRACTICAL** **(3H – 1C)**

Instruction Hours / week: L: 0 T: 0 P: 3 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 6 Hours

COURSE OBJECTIVE

- To make students understand the aspects of industrial, soil, environmental, agricultural microbiology.
- To understand the methods for Production of industrially important compounds from fungal source.
- This paper is designed to provide an exposure to the students about the potential of fungi as food and in field of biotechnology as source of different enzymes, secondary metabolites, vitamins, polysaccharides, polyhydric alcohols, pigments and lipids.
- Develop an understanding of various aspects of bioprocess technology.
- Evaluate nanotechnology and microbial production of therapeutic compounds
- The laboratory training in addition to theory is included so that the students will acquire the skills to qualify for a broad range of positions in research, industry, consultancy, education and public administration, or for further education in a doctoral program.

COURSE OUTCOME

- Impart knowledge on applications of microorganisms in various fields
- Provides skill development on microbial products.
- To study the immobilization techniques and fungal pigment production.
- Develop a xylanase and lipase production technology.
- Demonstration of algal single cell proteins.
- State of art knowledge about various methodological and analytic approaches that are used within the specialization.

EXPERIMENTS

1. Study yeast cell immobilization in calcium alginate gels.
2. Study enzyme immobilization by sodium alginate method.
3. Pigment production from fungi (*Trichoderma* / *Aspergillus* / *Penicillium*).
4. Isolation of xylanase or lipase producing bacteria.
5. Study of algal Single Cell Proteins.

SUGGESTED READINGS

1. Ratledge, C and Kristiansen, B. (2001). Basic Biotechnology, 2nd edition, Cambridge University Press.
2. Demain, A. L and Davies, J. E. (1999). Manual of Industrial Microbiology and Biotechnology, 2nd edition, ASM Press.
3. Swartz, J. R. (2001). Advances in Escherichia coli production of therapeutic proteins. Current
4. Opinion in Biotechnology, 12, 195–201.
5. Prescott, Harley and Klein's Microbiology by Willey JM, Sherwood LM, Woolverton CJ (2014), 9th edition, Mc Graw Hill Publishers.
6. Gupta PK (2009) Elements of Biotechnology 2nd edition, Rastogi Publications.
7. Glazer AN and Nikaido H (2007) Microbial Biotechnology, 2nd edition, Cambridge University Press.
8. Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology 4th edition, ASM Press.

9. Stanbury PF, Whitaker A, Hall SJ (1995) Principles of Fermentation Technology 2nd edition, Elsevier Science.
10. Crueger W, Crueger A (1990) Biotechnology: A text Book of Industrial Microbiology 2nd edition Sinauer assciates, Inc.

Semester – V

16MBU514B **INHERITANCE BIOLOGY - PRACTICAL** **(3H – 1C)**

Instruction Hours / week: L: 0 T: 0 P: 3 **Marks:** Internal: **40** External:**60** Total: **100**

End Semester Exam: 6 Hours

COURSE OBJECTIVE

- To make students understand the principles of Genetics and inheritance biology.
- Students will learn the basic principles of inheritance at the molecular, cellular and organismal levels
- Students will test and deepen their mastery of genetics by applying this knowledge in a variety of problem-solving situations.
- Describe the principal cell types comprising each tissue system
- Identify location and function of apical meristems, and describe their general structure
- Explain DNA repair and recombination in terms of mutation and evolution
- The objective of the course is to make student understand about the structure and function of biologically important molecules.

COURSE OUTCOME

- Imparts knowledge on the different aspects of genetics and pedigree analysis.
- Students will understand the cellular components underlying mitotic cell division
- Students will apply their knowledge of cell biology to selected examples of changes or losses in cell function.
- Identify the organs and tissue systems of plants, and explain their respective function
- Understand how molecular cell biology forms the foundation of biotechnology
- Students will learn about DNA, RNA and the molecular events that govern cell functions

EXPERIMENTS

1. Mendelian deviations in dihybrid crosses
2. Studying Barr Body with the temporary mount of human cheek cells
3. Studying *Rhoeo* translocation with the help of photographs
4. Karyotyping with the help of photographs
5. Chi-Square Analysis
6. Study of polytene chromosomes using temporary mounts of salivary glands of *Chiromonas / Drosophila* larvae
7. Study of pedigree analysis
8. Analysis of a representative quantitative trait

SUGGESTED READINGS

1. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India.
2. Snustad DP, Simmons MJ (2011). Principles of Genetics. 6th Ed. John Wiley and Sons Inc.
3. Weaver RF, Hedrick PW (1997). Genetics. 3rd Ed. McGraw-Hill Education.
4. Klug WS, Cummings MR, Spencer CA, Palladino M (2012). Concepts of Genetics. 10th Ed. Benjamin Cummings.
5. Griffith AJF, Wessler SR, Lewontin RC, Carroll SB. (2007). Introduction to Genetic Analysis. 9th Ed. W.H.Freeman and Co., New York
6. Hartl DL, Jones EW (2009). Genetics: Analysis of Genes and Genomes. 7th Ed, Jones and Bartlett Publish.

Semester – VI

16MBU601A **MUSHROOM CULTIVATION** **(4H – 4C)**

Instruction Hours / week: L: 0 T: 0 P: 4 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES

- To evaluate the biology and health benefits of mushrooms.
- To encode the importance of the role of microorganisms in food industries
- To obtain a good understanding of production and multiplication of spawn by different composting techniques.
- To obtain knowledge in harvest, storage, marketing and economic impacts on mushroom cultivation.
- To gain knowledge about nutritional profile and medicinal properties of mushroom.
- To obtain knowledge in depth the problem in mushroom cultivation.

COURSE OUTCOME

- Able to Know the architecture of mushrooms
- To know the methods used to cultivate mushroom.
- Students are able to predict where the mushroom placed in vegetable kingdom
- Able to cultivate mushrooms from agricultural waste.
- Have an idea about packaging and storing.
- Have understand nutritional value of mushrooms.

Unit I – Mushroom morphology and classification

Mushroom morphology: Different parts of a typical mushroom and variations in mushroom morphology. Key to differentiate edible from poisonous mushrooms. Mushroom Classification: Based on occurrence – Epigenous and hypogenous, Natural habitats – Humicolous, Lignicolous & Coprophilous, Color of spores – white, yellow, pink, purple brown and black. Ainsworth et al classification (8^{th} edition) and Bisby's 'Dictionary of Fungi'.

Unit II – Biology of mushrooms

Biology of Mushrooms: Vegetative characters, general morphology, spore germination and life cycle of button mushroom (*Agaricus bisporus*), milky mushroom (*Calocybe indica*), oyster mushroom (*Pleurotus sajorcaju*) and paddy straw mushroom (*Volvariella volvcea*).

Unit III – Mushroom technology

Equipment and sterilization techniques. Isolation and culture of spores, culture media preparation. Production of mother spawn, multiplication of spawn – Inoculation technique – Cultivation technology – Substrates, composting technology, bed, polythene bag preparation, spawning – casing – cropping – Mushroom production – harvest – packing, storage and marketing.

Unit IV – Health benefits of mushrooms

Nutritional profile of Mushrooms: protein, amino acids, calorific values, carbohydrates, fats, vitamins & minerals. Medicinal Properties of Mushrooms: Antibacterial, antifungal, antiviral, anti-tumour effect and hematological value. Cardiovascular and renal effect, in therapeutic diets, adolescence, for aged persons and diabetes mellitus. Mushroom nutriceuticals.

Unit V – Diseases of mushroom and mushroom economics

Problems in cultivation – diseases, pests and nematodes, weed moulds and their management strategies. Mushroom economics: economics of spawn and mushroom, cultivation, postharvest technologies. Processing and preservation of mushrooms. Mushroom research centres in India.

SUGGESTED READINGS

1. Alice, D., Muthusamy and Yesuraja, M. (1999). Mushroom Culture. Agricultural College, Research Institute Publications, Madurai.
2. Marimuthu, T. et al. (1991). Oyster Mushroom. Department of Plant Pathology. Tamil Nadu Agricultural University, Coimbatore.
3. Nita Bhal. (2000). Handbook on Mushrooms. 2nd ed. Vol. I and II. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
4. Pathak, V. N. and Yadav, N. (1998). Mushroom Production and Processing Technology. Agrobios, Jodhpur.
5. Tewari Pankaj Kapoor, S. C. (1988). Mushroom Cultivation. Mittal Publication, New Delhi.
6. Tripathi, D. P. (2005). Mushroom Cultivation. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

Semester – VI

16MBU601B **FOOD FERMENTATION TECHNIQUES** **(4H – 4C)**

Instruction Hours / week:L: 4 T: 0 P: 0 **Marks:** Internal: **40**External: **60** Total: **100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES

- To encode the importance of the role of microorganisms in food industries in beneficial ways.
- To Understand the significance and activities of microorganisms in food and role of intrinsic and extrinsic factors on growth and survival of microorganisms in foods
- To Know the spoilage mechanisms in foods and thus identify methods to control deterioration and spoilage
- To Recognize and describe the characteristics of important pathogens and spoilage microorganisms in foods.
- To Learn various methods for their isolation, detection and identification of microorganisms in food and employ in industries
- To Identify ways to control microorganisms in foods and thus know the principles involving various methods of food preservation

COURSE OUTCOME

- Students Imparts knowledge on various microorganisms involved in food fermentation and develops the skills on Fermented Foods and production process.
- Students able to Identify ways to control microorganisms in foods and thus know the principles involving various methods of food preservation
- Understand of the basis of food safety regulations and Discuss the rationale for the use of standard methods and procedures for the microbiological analysis of food
- Acquire, discover, and apply the theories and principles of food microbiology in practical, real-world situations and problems.
- Have knowledge in fermented products and the role of microorganisms.
- Able to discriminate pathogens and legatee.

Unit I – Fermented Foods and Probiotic Foods

Definition, types, advantages and health benefits

Unit II– Milk Based Fermented Foods

Curd, Yogurt, Buttermilk and cheese: Preparation of inoculums, types of microorganisms and production process

Unit III – Grain Based Fermented Foods

Soy sauce, Bread, Idli and Dosa: Microorganisms and production process

Unit IV – Vegetable Based Fermented Foods

Pickels, Saeurkraut: Microorganisms and production process

Unit V – Fermented Meat and Fish

Pickles, Fermented Meat and Fish, Types, microorganisms involved fermentation process.

SUGGESTED READINGS

1. Hui YH, Meunier-Goddik L, Josephsen J, Nip WK, Stanfield PS (2004) Handbook of food and fermentation technology, CRC Press.
2. Holzapfel W (2014) Advances in Fermented Foods and Beverages, Woodhead Publishing.
3. Yadav JS, Grover, S and Batish VK (1993) A comprehensive dairy microbiology, Metropolitan.
4. Jay JM, Loessner MJ, Golden DA (2005) Modern Food Microbiology, 7th edition. Springer.

Semester – VI

16MBU602A BIOSAFETY AND INTELLECTUAL PROPERTY RIGHTS (4H – 4C)

Instruction Hours / week:L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES

- To learn the basic handling of microorganisms.
- To understand the various biological containments.
- To emphasize on IPR issues and need for knowledge in patents in biotechnology.
- The ethical and philosophical issues associated with international agreements.
- Various modes of presenting and disseminating patent licensing and agreements.
- Enable students to acquire expertise in the use and application of the methods of data collection and analysis.

COURSE OUTCOME

- Provides knowledge on safety aspects in biological laboratory and to create awareness on the Intellectual property rights and patenting of biotechnological processes.
- To gain knowledge on steps of a patenting process and the role of biosafety committee.
- To emphasize the components and design of laboratory.
- Provide learning opportunities to critically evaluate research methodology and findings
- Enable students to acquire expertise in the use and application of the methods of data collection and analysis.
- Enable students to be reflexive about their role and others' roles as researchers.

Unit I

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

Unit II

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

Unit III

AERB/RSD/RES guidelines for using radioisotopes in laboratories and precautions. Agreements and Treaties: GATT, TRIPS Agreements; Role of Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty on international recognition of the deposit of microorganisms; UPOV & Brene conventions; Patent Co-operation Treaty (PCT); Indian Patent Act 1970 & recent amendments.

Unit IV

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

Unit V

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

SUGGESTED READINGS

1. Bare Act, (2007).Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., New Delhi.
2. Kankanala C (2007). Genetic Patent Law & Strategy, 1st Edition, Manupatra Information Solution Pvt. Ltd. New Delhi.
3. Mittal, D.P. (1999). Indian Patents Law, Taxmann, Allied Services (p) Ltd.
4. Singh K K (2015). Biotechnology and Intelectual Property Rights: Legal and SocialImpliications, Springer India.
5. Goel D & Prashar S (2013). IPR, Biosafety and Bioethics. Pearson.
6. Senthil Kumar Sadhasivam and Mohammed Jaabir, M. S. (2008). IPR, Biosafety and biotechnology Management. Jasen Publications, Tiruchirappalli, India.

Semester – VI

16MBU602B MICROBES IN SUSTAINABLE AGRICULTURE AND DEVELOPMENT (4H – 4C)

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

COURSE OBJECTIVE

- The goal of sustainable agriculture is to meet society's food and textile needs in the present without compromising the ability of future generations to meet their own needs**.**
- Able to evaluate the application of ecological principles and concepts in sustainable agriculture system.
- To know the role of microbes which make crop output more and increase the fertility of crops.
- To know the basics and concepts of various biotechnological related terms
- To know the physiological processes that occur during plant growth and development of methodology involved in plant growth
- To make them to understand issues related to plant nutrition, quality improvement, environmental adaptation, transgenic crops and their use in agriculture.

COURSE OUTCOME

- Develops the programmatic activities in sustainable agriculture and food systems
- Able to relate their knowledge about ecology to its relevance in sustainable agriculture
- Provides detailed idea about biofertilizer production and develop entrepreneur skill related to agriculture field**.**
- Understand on soil characteristics and biogeochemical cycling.
- Students able to the uses of microorganisms as bio control agents.
- Understand transgenic crops and their use in agriculture.

Unit I– Soil Microbiology

Soil as Microbial Habitat, Soil profile and properties, Soil formation, Diversity and distribution of microorganisms in soil, Mineralization of cellulose, hemicelluloses, lignocelluloses, lignin and humus, phosphate, nitrate, silica, potassium

Unit II– Microbial Activity in Soil and Green House Gases

Carbon dioxide, methane, nitrous oxide, nitric oxide – production and control

Unit III– Microbial Control of Soil Borne Plant Pathogens

Biocontrol mechanisms and ways, Microorganisms used as biocontrol agents against Microbial plant pathogens, Insects, Weeds.

Unit IV– Biofertilization, Phytostimulation, Bioinsecticides

Plant growth promoting bateria, biofertilizers – symbiotic (*Bradyrhizobium, Rhizobium, Frankia*), Non Symbiotic (*Azospirillum*, *Azotobacter*, Mycorrhizae, MHBs, Phosphate solubilizers, algae), Novel combination of microbes as biofertilizers, PGPRs.

Unit V– Secondary Agriculture Biotechnology

Biotech feed, Silage, Biomanure, biogas, biofuels – advantages and processing parameters, Advantages, social and environmental aspects, Bt crops, golden rice, transgenic animals.

SUGGESTED READINGS

1. Agrios GN. (2006). Plant Pathology. 5th edition. Academic press, San Diego.
2. Singh RS. (1998). Plant Diseases Management. 7th edition. Oxford & IBH,New Delhi.
3. Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology 4th edition, ASM Press,
4. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA.
5. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press.
6. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, WileyBlackwell, USA.
7. Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.
8. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. DelmarThomson Learning.
9. Altman A (1998). Agriculture Biotechnology, Ist edition, Marcel decker Inc.
10. Mahendra K. Rai (2005). Hand Book of Microbial Biofertilizers, The Haworth Press, Inc. New York.
11. Reddy, S.M. et. al. (2002). Bioinoculants for Sustainable Agriculture and Forestry, Scientific Publishers.
12. Saleem F and Shakoori AR (2012) Development of Bioinsecticide, Lap Lambert Academic Publishing GmbH KG

Semester – VI

16MBU603A **CELL BIOLOGY** **(3H – 3C)**

Instruction Hours / week: L: 3 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES

- To study cell structure and functions of organelle.
- Exposure on transportations through cell membrane.
- To focus on different receptors and model of signaling.
- To introduce the concept of cell signaling.
- To obtain knowledge in cell death and cell renewal.
- To gain knowledge in structural aspects of cells.

COURSE OUTCOME

- Basic concept of cell structure, membrane, cellular functions of different types of cell, modes of cellular signaling and signal amplification.
- Students able to annotating cell organization of prokaryotic and Eukaryotic.
- Students able to paraphrase cell death and cell renewal.
- Able to bullet pointing protein sorting and transport
- Expertise in interpreting cell internal organelles.
- Knowledge in induced pleuripotent stem cells.

Unit I – Structure and organization of Cell

Cell Organization – Eukaryotic (Plant and animal cells) and prokaryotic. Plasma membrane: Structure and transport of small molecules. Cell Wall: Eukaryotic cell wall, Extra cellular matrix and cell matrix interactions, Cell-Cell Interactions - adhesion junctions, tight junctions, gap junctions, and plasmodesmata (only structural aspects). Mitochondria, chloroplasts and peroxisomes. Cytoskeleton: Structure and organization of actin filaments, association of actin filaments with plasma membrane, cell surface protrusions, intermediate filaments, microtubules.

Unit II – Nucleus

Nuclear envelope, nuclear pore complex and nuclear lamina. Chromatin – Molecular organization. Nucleolus.

Unit III – Protein Sorting and Transport

Ribosomes, Endoplasmic Reticulum – Structure, targeting and insertion of proteins in the ER, protein folding, processing and quality control in ER, smooth ER and lipid synthesis, export of proteins and lipids. Golgi Apparatus – Organization, protein glycosylation, protein sorting and export from Golgi Apparatus Lysosomes.

Unit IV– Cell Signalling

Signalling molecules and their receptors. Function of cell surface receptors. Pathways of intra-cellular receptors – Cyclic AMP pathway, cyclic GMP and MAP kinase pathway.

Unit V– Cell Cycle, Cell Death and Cell Renewal

Eukaryotic cell cycle and its regulation, Mitosis and Meiosis, Development of cancer, causes and types, Programmed cell death, Stem cells, Embryonic stem cell, induced pleuripotent stem cells.

SUGGESTED READING

1. Hardin J, Bertoni G and Kleinsmith LJ. (2010). Becker's World of the Cell. 8th edition. Pearson.

2. Karp G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley & Sons. Inc.

3. De Robertis, EDP and De Robertis EMF. (2006). Cell and Molecular Biology. 8th edition. Lipincott Williams and Wilkins, Philadelphia.

4. Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. 5th Edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.

Semester – VI

16MBU603B **MOLECULAR BIOLOGY** **(3H – 3C)**

Instruction Hours / week: L: 3 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

COURSE OBJECTIVE

- To provide an experience for the students in an interdisciplinary research program connecting animal genomics with animal reproduction and biotechnology.
- To impart information on the historical developments in Molecular Biology
- An in-depth study on structure and organization of chromosome and mutagenesis.
- To expose the students on the basic understanding of various techniques used in molecular studies.
- To gather information to know mechanism of DNA replication.
- To gain the knowledge of translational machinery in prokaryotes and eukaryotes.

COURSE OUTCOME

- Explores technologies using molecular biology, embryo manipulation, cell and tissue culture.
- Manipulate the genomes of animals for ways to improve the live stock for food production and biomedical purpose.
- Develop the skills in molecular biology.
- Executing concept of RNA splicing and mRNA and its significance.
- Students able to inferring various model of DNA replication
- Students able to contrast translational machinery.

Unit I – Structures of DNA and RNA / Genetic Material

DNA Structure: Miescher to Watson and Crick- historic perspective, DNAStructure, Salient features of double helix, Types of DNA, Types of genetic material, denaturation and renaturation, cot curves. DNA topology - linking number, topoisomerases; Organization of DNA Prokaryotes,Viruses, Eukaryotes.RNA Structure, Organelle DNA -- mitochondria and chloroplast DNA.

Unit II – Replication of DNA (Prokaryotes and Eukaryotes)

Bidirectional and unidirectional replication, semi- conservative, semi- discontinuous replication Mechanism of DNA replication: Enzymes and proteins involved in DNA replication –DNA polymerases, DNA ligase, primase, telomerase – for replication of linear ends. Various models of DNA replication including rolling circle, D- loop (mitochondrial), (theta) mode of replication and other accessory protein, Mismatch and excision repair.

Unit III – Transcription in Prokaryotes and Eukaryotes & Post-Transcriptional Processing

Transcription: Definition, difference from replication, promoter - concept and strength of promoter RNA Polymerase and the transcription unit, Transcription in Eukaryotes: RNA polymerases, general Transcription factors. Split genes, concept of introns and exons, RNA splicing, spliceosome machinery**,** concept of alternative splicing, Polyadenylation and capping, Processing of rRNA, RNA interference: si RNA, miRNA and its significance

Unit IV – Translation (Prokaryotes and Eukaryotes)

Translational machinery, Charging of tRNA, aminoacyl tRNA synthetases, Mechanisms of initiation, elongation and termination of polypeptides in both prokaryotes and eukaryotes, Fidelity of translation, Inhibitors of protein synthesis in prokaryotes and eukaryote

Unit V – Regulation of gene Expression in Prokaryotes and Eukaryotes

Principles of transcriptional regulation, regulation at initiation with examples from *lac* and *trp* operons, Sporulation in *Bacillus*,Yeast mating type switching , Changes in Chromatin Structure - DNA methylation and Histone Acetylation mechanisms.

SUGGESTED READINGS

1. Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008) Molecular Biology of the Gene, 6th edition, Cold Spring Harbour Lab. Press, Pearson Publication.
2. Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP (2009) The World of the Cell, 7th edition, Pearson Benjamin Cummings Publishing, San Francisco.
3. De Robertis EDP and De Robertis EMF (2006) Cell and Molecular Biology, 8th edition. LippincottWilliams and Wilkins, Philadelphia.
4. Karp G (2010) Cell and Molecular Biology: Concepts and Experiments, 6th edition, John Wiley & Sons. Inc.
5. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, ColdSpring Harbour Laboratory press.
6. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning.
7. Gardner EJ, Simmons MJ, Snustad DP (2008).). Principles of Genetics. 8th Ed. Wiley-India.

Semester – VI

16MBU611A **MUSHROOM CULTIVATION - PRACTICAL** **(4H – 2C)**

Instruction Hours / week:L: 0 T: 0 P: 4 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 6 Hours

COURSE OBJECTIVES

- To teach on cultivation, diseases and health benefits of mushrooms.
- To provide practical knowledge of different sterilization procedures and learn handling of mushrooms.
- To enhance the student's knowledge and impress upon them the important aspects of mushroom.
- To understand to know pure culture techniques and methods of culturing preservation and maintenance of mushrooms.
- To make the students more knowledge on mushroom cultivation.
- To make the students to know the classification.

COURSE OUTCOME

- To impart knowledge on various mushrooms and its cultivation techniques to became an entrepreneur.
- Students able to predict classification of edible mushroom.
- Able to cultivate spawn from waste materials.
- Have a knowledge in sterilization and handling of mushroom.
- Students understand the application of mushroom biotechnology.
- Students understand the characteristics and importance of mushrooms.

EXPERIMENTS

1. Oyster cultivation and demonstration of Button mushroom cultivation
2. Tissue isolation and sub culturing
3. Spawn making using sorghum
4. Fruiting bags production – preparing beds (chopping and sterilization of straw)
5. Field trip to commercial mushroom farms and scientific institutions.

SUGGESTED READINGS

1. Alice, D., Muthusamy and Yesuraja, M. (1999). Mushroom Culture. Agricultural College, Research Institute Publications, Madurai.
2. Marimuthu, T. et al. (1991). Oyster Mushroom. Department of Plant Pathology. Tamil Nadu Agricultural University, Coimbatore.
3. Nita Bhal. (2000). Handbook on Mushrooms. 2nd ed. Vol. I and II. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
4. Pathak, V. N. and Yadav, N. (1998). Mushroom Production and Processing Technology. Agrobios, Jodhpur.
5. Tewari Pankaj Kapoor, S. C. (1988). Mushroom Cultivation. Mittal Publication, New Delhi.
6. Tripathi, D. P. (2005). Mushroom Cultivation. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi
7.

Semester – VI

16MBU611B FOOD FERMENTATION TECHNIQUES – PRACTICAL (4H – 2C)

Instruction Hours / week:L: 0 T: 0 P: 4 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 6 Hours

COURSE OBJECTIVES

- To encode the importance of the role of microorganisms in food industries in beneficial ways.
- Understand the significance and activities of microorganisms in food and role of intrinsic and extrinsic factors on growth and survival of microorganisms in foods
- To learn various methods for their isolation, detection and identification of microorganisms in food and employ in industries
- To Identify ways to control microorganisms in foods and thus know the principles involving various methods of food preservation
- To Understand the use of standard methods and procedures for the microbiological analysis of food
- Acquire, discover, and apply the theories and principles of food microbiology in practical, real-world situations and problems.

COURSE OUTCOME

- To impart knowledge on various microorganisms involved in food fermentation.
- To nurture the student to gain employability in industrial area.
- Recognize and describe the characteristics of important pathogens and spoilage microorganisms in foods.
- Understand the beneficial role of microorganisms in fermented foods and in food processing and the microbiology of different types of fermented food products – dairy, pickles, Legume and cereal based food products
- Have an idea to isolate beneficial microorganisms from spoiled food.
- Identify methods to control deterioration and spoilage

EXPERIMENTS

1. Preparation of Yogurt.
2. Preparation of Sauerkraut.
3. Beer production.
4. Wine production.
5. Isolation of Microbes from spoiled Meet and Fish.

SUGGESTED READINGS

1. Hui YH, Meunier-Goddik L, Josephsen J, Nip WK, Stanfield PS (2004) Handbook of food and fermentation technology, CRC Press.
2. Holzapfel W (2014) Advances in Fermented Foods and Beverages, Woodhead Publishing.
3. Yadav JS, Grover, S and Batish VK (1993) A comprehensive dairy microbiology, Metropolitan.
4. Jay JM, Loessner MJ, Golden DA (2005) Modern Food Microbiology, 7th edition. Springer.

Semester – VI

16MBU612A BIOSAFETY AND INTELLECTUAL PROPERTY RIGHTS –PRACTICAL

(4H-2C)

Instruction Hours / week:L: 0 T: 0 P: 4 **Marks:** Internal: **40**External: **60** Total: **100**

End Semester Exam: 6 Hours

COURSE OBJECTIVES

- To learn the basic handling of microorganisms.
- To understand the various biological containments.
- To emphasize on IPR issues and need for knowledge in patents in biotechnology.
- To gain knowledge on steps of a patenting process and the role of biosafety committee.
- To emphasize the components and design of laboratory.
- Provide learning opportunities to critically evaluate research methodology and findings

COURSE OUTCOME

- Able to understand safety aspects in biological laboratory.
- To create awareness on the Intellectual property rights and patenting of biotechnological processes.
- To equip students with a basic understanding of the underlying principles of quantitative and qualitative patenting methods.
- Provide students with in-depth training on the conduct and management of patent filing from inception
- Enable students to acquire expertise in the use and application of the methods of data collection and analysis.
- Enable students to be reflexive about their role and others' roles as researchers.

EXPERIMENTS

1. Study of components and design of a BSL-III laboratory
2. Filing applications for approval from biosafety committee
3. Filing primary applications for patents
4. Study on steps of a patenting process

SUGGESTED READINGS

1. Bare Act, 2007.Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., New Delhi.
2. Kankanala C (2007). Genetic Patent Law & Strategy, 1st Edition, Manupatra Information Solution Pvt. Ltd. New Delhi.
3. Mittal, D.P. (1999). Indian Patents Law, Taxmann, Allied Services (p) Ltd.
4. Singh K K (2015). Biotechnology and Intelectual Property Rights: Legal and Social Implications, Springer India.
5. Goel D & Prashar S (2013). IPR, Biosafety and Bioethics. Pearson.

Semester – VI

(4H – 2C)

16MBU612B MICROBES IN SUSTAINABLE AGRICULTURE AND DEVELOPMENT - PRACTICAL

Instruction Hours / week: L: 0 T: 0 P: 4 **Marks:** Internal: **40** External:**60** Total: **100**

End Semester Exam: 6 Hours

COURSE OBJECTIVES

- Able to relate their knowledge about ecology to its relevance in sustainable agriculture
- Able to evaluate the application of ecological principles and concepts in sustainable agriculture system.
- To know the role of microbes which make crop output more and increase the fertility of crops**.**
- To analyses the degrading microorganisms by various techniques.
- Able to design biogas plant.
- To obtain knowledge in entrepreneur in agricultural area.

COURSE OUTCOME

- Able to relate their knowledge about ecology to its relevance in sustainable agriculture
- Provides detailed idea about biofertilizer production and develop entrepreneur skill related to agriculture field**.**
- Able to device biogas plant
- Students will be annotate various zone in soil profile
- Students will be isolate various degrading microorganisms for agricultural use.
- Criticize the role of soil microbes in crop production.

EXPERIMENTS

1. Study soil profile
2. Study microflora of different types of soils
3. *Rhizobium* as soil inoculants characteristics and field application
4. *Azotobacter* as soil inoculants characteristics and field application
5. Design and functioning of a biogas plant
6. Isolation of cellulose degrading organisms

SUGGESTED READINGS

1. Agrios GN. (2006). Plant Pathology. 5th edition. Academic press, San Diego,
2. Singh RS. (1998). Plant Diseases Management. 7th edition. Oxford & IBH, New Delhi.
3. Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology 4th edition, ASM Press.
4. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications.4th edition. Benjamin/Cummings Science Publishing, USA.
5. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press.
6. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA.
7. Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.

8. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.
9. Altman A (1998). Agriculture Biotechnology, Ist edition, Marcel decker Inc.
10. Mahendra K. Rai (2005). Hand Book of Microbial Biofertilizers, The Haworth Press, Inc. New York.
11. Reddy, S.M. et. al. (2002). Bioinoculants for Sustainable Agriculture and Forestry, Scientific Publishers.
12. Saleem F and Shakoori AR (2012). Development of Bioinsecticide, Lap Lambert Academic Publishing GmbH KG

Semester – VI

16MBU613A **CELL BIOLOGY - PRACTICAL** **(3H – 1C)**

Instruction Hours / week: L: 0 T: 0 P: 3 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 6 Hours

COURSE OBJECTIVES

- To study cell structure and functions of organelle.
- Exposure on transportations through cell membrane.
- To focus on different receptors and model of signaling.
- To introduce the concept of cell signaling.
- The course will facilitate in understanding of cell biology by examining common processes and principles in cells.
- Knowledge about detailed structure of cell organelles and electron micro graphs.

COURSE OUTCOME

- To understand the basic concept of cell structure, membrane, cellular functions of different types of cell
- Able to analyses modes of cellular signaling and signal amplification.
- Able to categorize cell internal organs.
- Able to retrieve polypoid stage in vegetables
- Able to predict cancer cells through photomicrograph
- Knowledge about detailed structure of cell organelles and electron micro graphs.

EXPERIMENTS

1. Study a representative plant and animal cell by microscopy.
2. Study of the structure of cell organelles through electron micrographs.
3. Cytochemical staining of DNA – Feulgen.
4. Demonstration of the presence of mitochondria in striated muscle cells/ cheek epithelial cell using vital stain Janus Green B.
5. Study of polyploidy in Onion root tip by colchicine treatment.
6. Identification and study of cancer cells by photomicrographs.
7. Study of different stages of Mitosis.
8. Study of different stages of Meiosis.

SUGGESTED READINGS

1. Hardin J, Bertoni G and Kleinsmith LJ. (2010). Becker's World of the Cell. 8th edition. Pearson.

2. Karp G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley & Sons. Inc.

3. De Robertis, EDP and De Robertis EMF. (2006). Cell and Molecular Biology. 8th edition. Lipincott Williams and Wilkins, Philadelphia.

4. Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. 5th Edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.

Semester – VI

16MBU613B **MOLECULAR BIOLOGY - PRACTICAL** **(3H – 1C)**

Instruction Hours / week: L: 0 T: 0 P: 3 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 6 Hours

COURSE OBJECTIVE

- To provide an experience for the students in an interdisciplinary research program connecting animal genomics with animal reproduction and biotechnology.
- The course will facilitate in understanding of molecular biology by examining common processes and principles in genes to illustrate complexity.
- To obtain knowledge in resolution and visualization of proteins
- To evaluate genetic material in different samples.
- The student will receive hands-on training in various culturing and molecular techniques for studying microbial diversity and microbial activity.
- To introduce the student to the advanced concepts in molecular biology.

COURSE OUTCOME

- Explores technologies using molecular biology, cell and tissue culture to manipulate the genomes of animals for ways.
- Develop the skills in molecular biology.
- Student capable of explaining process involved in genetic changes and mutations
- The identification of genetic regulatory mechanism and distinguishing different mechanism of gene regulation
- The design of different techniques based on utilizing the genetic mechanism of microbes.
- Hand on experience of different microbial genetic modification strategies.

EXPERIMENTS

1. Study of different types of DNA and RNA using micrographs and model / schematic representations.
2. Study of semi-conservative replication of DNA through micrographs / schematic representations.
3. Isolation of genomic DNA from *E. coli.*
4. Estimation of salmon sperm / calf thymus DNA using colorimeter (diphenylaminereagent) or UV spectrophotometer (A260 measurement).
5. Estimation of RNA using colorimeter (orcinol reagent) or UV spectrophotometer (A260 measurement).
6. Resolution and visualization of DNA by Agarose Gel Electrophoresis.
7. Resolution and visualization of proteins by Polyacrylamide Gel Electrophoresis (SDS-PAGE).

SUGGESTED READINGS

1. Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008) Molecular Biology of the Gene, 6th edition, Cold Spring Harbour Lab. Press, Pearson Publication

2. Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP (2009) The World of the Cell, 7th edition, Pearson Benjamin Cummings Publishing, San Francisco

3. De Robertis EDP and De Robertis EMF (2006) Cell and Molecular Biology, 8th edition. Lippincott Williams and Wilkins, Philadelphia
4. Karp G (2010) Cell and Molecular Biology: Concepts and Experiments, 6th edition, John Wiley & Sons. Inc.
5. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press.
6. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning.

Semester – VI

16MBU691	**PROJECT**	**(6C)**

Instruction Hours / week: L: 8 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**