M. Sc. DEGREE

PROGRAMME: M. Sc. MICROBIOLOGY

ELIGIBILITY:

A pass in any one of the following Degree Course of B.Sc. Microbiology / Biotechnology / Biology / Botany / Zoology /Plant Science/ Animal Sciences / Biochemistry / Bioinformatics / Environmental Science / Food and Nutrition/ Clinical Lab Technology of any University in Tamil Nadu or an Examination accepted as equivalent thereto by the Academic Council, Course to such conditions as may be prescribed thereto are permitted to appear and qualify for the **M.Sc., Microbiology Examination** of this College after a course study of two academic years.

PROGRAMME OBJECTIVES:

The Curriculum is designed to attain the following learning goals which students shall accomplish by the time of their graduation to:

- Present intense knowledge in areas of organization and functioning of micro-organisms.
- Familiarize with the operations of bio instruments and related techniques.
- Enable students to understand the applications of microbiology in healthcare, agriculture, food technology & environmental protection.
- Provide opportunities to develop skills and participate in Research projects.

Programme Outcomes

On the successful completion of the programme, the following are the expected outcomes.

PO Number	PO Statement
PO1	To impart knowledge of various branches of Microbiology and to understand the role of microorganisms in human welfare and sustainable development.
PO2	To acquire skills in the techniques used to observe and study the nature of microorganisms and the techniques, skills, and modern tools necessary for biological practice.
PO3	To appreciate the complexities of microbiological processes for industrial and other purposes, especially the genetic manipulation of microorganisms for the production of antibiotics, hormones, etc.
PO4	To inculcate broad education necessary to understand the impact of microbiological solutions in a global and societal context; an ability to function in multi-disciplinary teams; To develop the ability to identify, formulate, and solve biological problems and to design and conduct experiments, as well as to analyze and interpret data.
PO5	To create awareness of contemporary issue and to appreciate the applications of Microbiology to become an entrepreneur.

M.Sc., MICROBIOLOGY PROGRAMME

Course Code	Course Category	Course Name	L	T	P	Exam (h)	Max Marks			Credits
							CIA	ESE	Total	
First Semester										
193MB2A1CA	Core	Principles of Microbiology	4	-	-	3	25	75	100	4
193MB2A1CB	Core	Bacterial Diversity and Metabolism	4	-	-	3	25	75	100	4
193MB2A1CC	Core	Bioinstrumentation	4	-	-	3	25	75	100	4
193MB2A1CD	Core	Mycology and Phycology	3	1	-	3	25	75	100	3
193MB2A1CE	Core	Comprehensive Biology	3	1	-	3	25	75	100	3
193MB2A1CP	Core Practical	Principles of Microbiology, Microbial Diversity and Bioinstrumentation	-	-	6	9	40	60	100	3
	Elective		3	1	-	3	25	75	100	3
Total			**21**	**3**	**6**				**700**	**24**
Second Semester										
193MB2A2CA	Core	Microbial Genetics And Molecular Biology	4	-	-	3	25	75	100	4
193MB2A2CB	Core	Food Microbiology And Food Quality Control	4	-	-	3	25	75	100	4
193MB2A2CC	Core	Environmental and Agricultural Microbiology	4	-	-	3	25	75	100	4

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193MB2A2CD	Core	Virology	3	1	-	3	25	75	100	3
193MB2A2CE	Core	Pharmaceutical Microbiology and Quality Assurance	3	1	-	3	25	75	100	3
193MB2A2CP	Core Practical	Applied Microbiology, Virology and Genetics	-	-	6	9	40	60	100	3
	Elective		3	1	-	3	25	75	100	3
Total			**22**	**2**	**6**	**-**	**-**		**700**	**24**
Third Semester										
193MB2A3CA	Core	Immunology and Immuno-Technology	4	-	-	3	25	75	100	4
193MB2A3CB	Core	Medical Microbiology I -Bacteriology And Virology	4	-	-	3	25	75	100	4
193MB2A3CC	Core	Medical Microbiology II -Mycology And Parasitology	4	-	-	3	25	75	100	4
193MB2A3CD	Core	Genetic Engineering	4	-	-	3	25	75	100	4
193MB2A3CE	Core	Research Methodology, Biostatistics and Bioinformatics	3	1	-	3	25	75	100	3
193MB2A3CP	Core Practical	Immunology, Medical Microbiology and Genetic Engineering	-	-	6	9	40	60	100	3
	Elective		3	1		3	25	75	100	3
193MB2A3CT	Internship Training	A to C								
Total			**22**	**2**	**6**	**-**	**-**	**-**	**700**	**25**

Fourth Semester										
193MB2A4CV	Core	Project and Viva - voce	-	-	16	-	80	120	200	8
193MB2A4CA	Core	Bioprocess Technology	4	1	-	3	25	75	100	3
193MB2A4CB	Core	Bioethics, Biosafety and IPR	4	1	-	3	25	75	100	3
	Elective		3	1		3	25	75	100	3
		Total	**11**	**3**	**16**				**500**	**17**
Grand Total									**2600**	**90**

ELECTIVE – I

(Student shall select any one of the following Course as Elective – I in first semester)

S.No	Course Code	Name of the Course
1.	193MB2A1DA	Microbial Nanotechnology
2.	193BC2A1DA	Cancer Biology, Diagnosis and Therapy
3.	193BT2A1DA	Protein Engineering

ELECTIVE – II

(Student shall select any one of the following Course as Elective-II in Second semester)

S.No	Course Code	Name of the Course
1.	193MB2A2DA	Medical Laboratory Techniques
2.	193BC2A2DA	Biochemistry of Toxicology
3.	193BT2A2DA	Forensic Biotechnology

ELECTIVE – III

(Student shall select any one of the following Course as Elective-III in Third semester)

S.No	Course Code	Name of the Course
1.	193MB2A3DA	Molecular Diagnostics in Microbiology
2.	193BC2A3DA	System Biology
3.	193BT2A3DA	Molecular Therapeutics

ELECTIVE – IV

(Student shall select any one of the following Course as Elective - IV in Fourth semester)

S.No	Course Code	Name of the Course
1.	193MB2A4DA	Microbial Technology
2.	193BC2A4DA	Neurobiology
3.	193BT2A4DA	Stem Cell Technology

Self study paper offered by the Department of Microbiology

S. No.	Semester	Course Code	Course Title
1.	sem III	17PMBSS1	Developmental Biology
2.		17PMBSS2	Inheritance Biology

Regulation
(2019-2020)

PG Programme

Effective from the academic year 2019-20 and applicable to the students admitted to the Degree of Master of Arts/Commerce/Management/Science.

1. NOMENCLATURE

1.1 Faculty: Refers to a group of programmes concerned with a major division of knowledge. Eg. Faculty of Computer Science consists of Programmes like Computer Science, Information Technology, Computer Technology, Computer Applications etc.

1.2 Programme: Refers to the Master of Arts/Management/Commerce/Science Stream that a student has chosen for study.

1.3 Batch: Refers to the starting and completion year of a programme of study. Eg. Batch of 2015–2017 refers to students belonging to a 2-year Degree programme admitted in 2015 and completing in 2017.

1.4 Course: Refers to a component (a paper) of a programme. A course may be designed to involve lectures / tutorials / laboratory work / seminar / project work/ practical training / report writing / Viva voce, etc or a combination of these, to effectively meet the teaching and learning needs and the credits may be assigned suitably.

a) **Core Courses**

A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course.

b) **Extra Departmental Course (EDC)**

A course chosen generally from a related discipline/subject, with an intention to seek exposure in the discipline relating to the core domain of the student.

c) **Discipline Specific Elective Course (DSE)**: DSE courses are the courses offered by the respective disciplinary/ interdisciplinary programme.

d) Project Work:

It is considered as a special course involving application of knowledge in problem solving/analyzing/exploring a real-life situation. The Project work will be given in lieu of a Core paper.

e) Extra credits

Extra credits will be awarded to a student for achievements in co-curricular activities carried out outside the regular class hours. The guidelines for the award of extra credits are given in section two, these credits are not mandatory for completing the programme.

e) Advanced Learner Course (ALC):

ALC is doing work of a higher standard than usual for students at that stage in their education. Research work carried out in University/ Research Institutions/ Industries of repute in India or abroad for a period of 15 to 30 days.

2. EXTRA CREDITS

- Earning extra credit is mandatory. However, it is not essential for programme completion.
- Extra Credits will be awarded to a student for achievement in co-curricular/ extracurricular activities carried other than the regular class-hours.
- A student is permitted to earn a maximum of 10 extra Credits during the programme duration of PG from I to IV Semester.
- Candidate can claim a maximum of 1 credit under each category listed.

The following are the guidelines for the award of Extra credits:

2.1 Proficiency in Foreign Language

Qualification	Credit
A pass in any foreign language in the examination conducted by an authorized agency	1

2.2 Proficiency in Hindi

Qualification	Credit
A pass in the Hindi examination conducted by Dakshin Bharat Hindi Prachar Sabha	1

Examination passed during the programme period only will be considered for extra credit

2.3 Self-study Course

Qualification	Credit
A pass in the self-study courses offered by the department	1

The candidate should register in the self-study course offered by the department only in the III semester

2.4 Typewriting/Short hand

A Pass in shorthand /typewriting examination conducted by Tamil Nadu Department of Technical Education (TNDTE) and the credit will be awarded.

Qualification	Credit
A pass in the type writing /short hand examination offered by TNDTE	1

2.5 Diploma / Certificate

Courses offered by any recognized University / NCVRT

Qualification	Credit
A pass in any Certificate /Diploma/PG Diploma Course	1

2.6 CA /ICSI/ CMA

Qualification	Credit
Qualifying foundation/Inter level/Final in CA/ICSI/CMA etc.	1

2.7 Sports and Games

The Student can earn extra credit based on their achievement in sports as given below:

Qualification	Credits
Achievement in University/State /National/ International	1

2.8 Online Courses

Pass in any one of the online courses

Qualification	Credit
SWAYAM/NPTEL/Spoken Tutorial etc.,	1

2.9 Publications / Conference Presentations (Oral/ Poster) /Awards

Qualification	Credit
Research Publications in Journals/oral/poster presentation in Conference	1

2.10 Innovation / Incubation / Patent / Sponsored Projects / Consultancy

Qualification	Credit
Development of model/ Products/ Prototype/ Process/App/Registration of Patents/ Copyrights/ Trademarks/Sponsored Projects/Consultancy	1

2.11 Representation

Qualification	Credit
Participation in State / National level celebrations such as Independence day, Republic day Parade, National Integration camp etc.,	1

3. EXAMINATIONS

The following are the distribution of marks for External and Internal i.e., Comprehensive examination and Continuous Internal Assessment and passing minimum marks for theory papers of PG programmes.

TOTAL MARKS	EXTERNAL		Internal Max. marks	Overall Passing Minimum for total marks (Internal + External)
	Max. marks	Passing Minimum for External alone		
100	75	38	25	50
50	50	25	----	25

The following are the Distribution of marks for the Continuous Internal Assessment in the theory papers of PG programmes.

S. No.	For Theory– PG courses	Distribution of Marks
1	TESTS I (2 hours)	5
2	TESTS II / End semester Model test (3 hours)	10
3	OBE- Rubrics	10
	TOTAL MARKS	**25**

The following are the distribution of marks for the External Assessment in PG Theory courses

S. No.	For Theory– PG courses	Distribution of Marks	
1	Comprehensive (Written) Examination	65	50
2	Online MCQ Examination	10	--
	TOTAL MARKS	**75**	**50**

The following are the distribution of marks for External examinations (CE) and Continuous Internal Assessment (CIA) and passing minimum marks for the practical courses of PG programmes.

TOTAL MARKS	EXTERNAL		Internal Max. marks	Overall Passing Minimum for total marks (Internal + External)
	Max. marks	Passing Minimum for External alone		
100	60	30	40	50
200	120	60	80	100

The following are the distribution of marks for the Continuous Internal Assessment (CIA) in PG practical courses

S. No.	For Theory – PG Practical courses	Distribution of Marks	
1	Tests: Two tests out of which one shall be during the mid semester and the other to be conducted as model test at the end of the semester.)	24	48
2	OBE- Rubrics	16	32
	TOTAL MARKS	**40**	**80**

The following are the distribution of marks for the External Assessment in PG practical courses

S. No.	For Theory – PG Practical courses	Distribution of Marks	
1	Experiment-I	25	50
2	Experiment-II	25	50
3	Record & Viva-Voce	10	20
	TOTAL MARKS	**60**	**120**

The following are the distribution of marks for Project and Viva voce examinations/Industrial Training and Continuous Internal Assessments and passing minimum marks for the project courses/Industrial Training of PG programmes

TOTAL MARKS	EXTERNAL		Internal Max. marks	Overall Passing Minimum for total marks (Internal + External)
	Max. marks	Passing Minimum for External alone		
100	60	30	40	50
200	120	60	80	100

The following are the distribution of marks for the Continuous Internal Assessment in PG Project/ Industrial Training courses.

S. No.	For- PG Project courses/ Industrial Training	Distribution of Marks	
1	Review-I	8	16
2	Review-II	8	16
3	Review-III	8	16
4	OBE- Rubrics	16	32
	TOTAL MARKS	**40**	**80**

The following are the distribution of marks for the External Examination (CE) in PG Project / /Industrial Training courses

S. No.	For- PG Project courses/ Industrial Training Courses	Distribution of Marks	
1	Record Work and Presentation	40	80
2	Viva-Voce	20	40
	TOTAL MARKS	**60**	**120**

- The end semester examinations shall normally be conducted after completing 90 working days for each semester.

- The maximum marks for each theory and practical course (including the project work and Viva-Voce examination in the final Semester) shall be 100 with the following breakup.

(i) **Theory Courses**

Continuous Internal Assessment (CIA) : 25 Marks

End Semester Exams (ESE) : 75 Marks

(Online Exam: 10 Marks &Written Exam: 65 Marks)

(ii) **For Practical Courses**

Continuous Internal Assessment (CIA) : 40 Marks

End Semester Exams (ESE) : 60 Marks

Continuous Assessment OBE Rubrics Score Sheet

Degree: _____ Branch: _____ Semester: _____

Course Code: _____ Course: _____

Max. Marks: Internal:_____ External: _____ Total: _____

S. No.	REG. NO.	THEORY / PRACTICAL & LIBRARY CLASS PARTICIPATION (15) (Compulsory)				RUBRICS ASSESSMENT (SELECT ANY ONE)									Total Marks out of : 30	Total Marks out of : 16 / 10 / 08 / 04
						PAPERS / REPORTS (15)			ASSIGNMENTS (15)			CLASS PRESENTATION (15)				
		Library	Integration of Knowledge	Interaction & Participation	Demonstration of Knowledge	Organization & Knowledge	Format & Spelling	Reference / Experiments	Demonstration of Knowledge	Format & Spelling	Reference	Content & Coherence	Creativity and Speaking Skills	Duration of Presentation		
		6	3	3	3	5	5	5	5	5	5	5	5	5		
1																

a) Utilization of Library

Marks will be awarded to the student based on the hours spent in the library after the working hours and submission of report by the student.

Hours spent in Library	Marks	Type of Document submitted
2	1	Report/ Assignment/ Class presentation
4	2	
6	3	
8	4	
10	5	
12	6	

- During the Library hour, the student must spend time in reading the articles, books, journals of their subject of interest
- Each student should borrow minimum three books during the semester

b) Class Participation

Active participation in classroom discussion by the student will be evaluated based on Integration of knowledge, Interaction and Participation and demonstration of knowledge.

c) Papers / Reports/ Assignments/ Class Presentation

The student will be evaluated based on his ability to do analysis of application of theory to real world problems or creative extension of class room learning and his/her ability to communicate the given topic effectively and clearly. The following are the distribution of marks for the continuous internal assessment in PG practical courses

4. FOR PROGRAMME COMPLETION

Programme Completion (for students admitted during the A.Y.2019-20 and Onwards)

Student has to complete the following:

i) Core, EDC, DSE, Project as mentioned in the scheme
ii) Internship / Industrial/ Institutional training as mentioned in the scheme

Students must undertake industrial / institutional training for a minimum of 15 days and not exceeding 30 days during the II semester summer vacation. The students will submit the report for evaluation during III semester.

Based on the performance Grade will be awarded as follows:

Marks Scored	**Grade to be awarded**
75 and above	A
60-74	B
50-59	C
< 50	Re-Appearance

Course Code	Course Name	Category	L	T	P	Credit
193MB2A1CA	**CORE:** PRINCIPLES OF MICROBIOLOGY	**Theory**	4			4

PREAMBLE

This course has been designed for students to learn and understand

- History of Microorganisms
- Basic techniques in Microbiology
- Structure and composition of prokaryotic and eukaryotic cell

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Explain the theories to understand the importance of microorganisms. Summarise the contributions and discoveries of various scientists to microbiology.	K2
CO2	Apply the principles of sterilization and disinfection. Make use of the types of Media. Apply knowledge on Culture Maintenance and Preservation. Summarise the objectives and importance of Culture Collection Centres.	K2, K3
CO3	Compare and contrast the principles of Microscopy.	K4
CO4	To compare and understand the characteristics of internal and external structures of prokaryotic cells.	K2, K4
CO5	To compare and understand the characteristics of internal and external structures of Eukaryotic cells.	K2, K4

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	M	M	M	M
CO2	S	S	S	S	S
CO3	M	S	M	S	S
CO4	S	S	M	S	M
CO5	S	S	M	S	M

S Strong M Medium L Low

193MB2A1CA	CORE : PRINCIPLES OF MICROBIOLOGY	SEMESTER I

Total Credits: 4

Total Instructions Hours: 50

Syllabus

Unit I History 10 h

The historic foundations and development of Microbiology - Spontaneous generation- Germ theory of diseases – Cell theory – Contributions of Antony van Leuwenhoek – Joseph Lister – Robert Koch – Louis Pasteur – Edward Jenner – John Tyndall – Sergei N. Winogradsky – Salmon A. Waksman – Alexander Flemming - Paul Erlich – Fannie Hessie – Elie Metchnikoff.

Unit II Sterilization 10 h

Sterilization and disinfection - Physical and chemical control of microorganisms- Culturing of Bacteria – Isolation, purification and Cultivation of different types of Microorganisms -Aerobes and Anaerobes - Culture maintenance and Preservation - Culture Collection centres -ATCC, MTCC and NFMC.

Unit III Microscopy and staining 10

Principles of Microscopy- Light microscope, Inverted microscope, Electron microscope – TEM and SEM, Polarization microscope, Confocal, Perfocal, Atomic force microscope. Stains and staining principles: Simple, Gram staining, Negative staining, Capsule staining, Spore staining, Flagellar staining and Acid fast staining.

Unit IV Prokaryotic Cell Structure 10 h

Characteristics of Prokaryotic cells – Basic cell types: Prokaryotic cells – Size, shape and Arrangement – Overview of structure – Cell membrane. Internal membrane structure – Cytoplasm - Nucleoid – Inclusions - chlorosomes – carboxysomes - magnetosomes - phycobilisomes - Endospores. External structure – Cell Wall - Flagella and its function – Glycocalyx – Slime layer.

Unit V Eukaryotic cell Structure 10 h

Characteristics of Eukaryotic cells – Overview of structure – Plasma membrane - Cytoplasm – Cell nucleus – Mitochondria and Chloroplast – Endoplasmic reticulum – Golgi Apparatus – Lysosomes. External structures –Flagella – Cilia. General characters and Cell wall structure of Algae, Fungi and Protozoa.

Text Books

1 Black, J.G. 2013. Microbiology, 8th Edition. John Wiley and Sons.

2 Joanne Wiley, Linda Sherwood, Christopher J Woolverton. 2016. Prescott's Microbiology, 10th Edition. Mc Graw Hill Company.

References

1 Micheal T Madigan. 2014. Brock Biology of Microorganisms, 10th edition. Peareson Education. New Delhi.

2 Jeffrey C Pommerville. 2010. Alcamo's Fundamentals of Microbiology, 9th Edition. Jones and Bartlett Publishers.

3 Salle A.J. 2014. Fundamental Principles of Bacteriology 7th edition, Tata Mc Hill Publishing Company Ltd.,

4 Michael Pelczar. 2001. Microbiology, 5th Edition. Mc Graw Hill Book Company.

5 Pollard, Thomas D. Earnshaw, William C, Lippincott-Schwartz, Jennifer. 2014. Cell Biology. Saunders Publishers, USA.

Course Code	Course Name	Category	L	T	P	Credit
193MB2A1CB	**CORE:** BACTERIAL DIVERSITY AND METABOLISM	**Theory**	4			4

PREAMBLE

This course has been designed for students to learn and understand

- Phylogeny and Taxonomy of microbes
- Bergey's manual and its importance
- To comprehend the physiological, biochemical, metabolic, respiratory and nutritional pathways of microorganisms and its significance in microbial growth.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Describe the components of microbial systematic. Explain and evaluate methods and approaches used to study microbes. Apply the knowledge on taxonomic strategies and approaches used to name microorganisms and the criteria used to define genera, species and sub specific divisions within species. Develop an understanding diversity of Archaebacteria and to compare the characteristics of archaebacteria with eubacteria.	K3, K4
CO2	Understand the characteristics of eubacteria, their diversity and classification. To discuss the nutritional classification of microorganism based on carbon, energy and electron source.	K3, K4

CO3	To explain the effects of physical parameters on the growth of microorganisms. To understand the physiology of growth and modes of nutrient uptake by microorganisms.	K3, K4
CO4	To comprehend nomenclature, classification, kinetics and types of enzymes with an emphasis on nature of enzyme Inhibitions. To confer the significance of different pathways of Carbohydrate metabolism. To infer the concepts of fermentation, energy generation and Bioluminescence.	K3, K4
CO5	To acquire the knowledge on the concepts of biosynthesis of aminoacids, nucleotides, fatty acids and cell wall of Gram positive and Gram negative bacteria. To interpret and define the mechanism of photosynthesis, CO2 fixation and study about nutritional categorisation of microorganism based on organic carbon source.	K3, K4

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	M	S	M	S	S
CO2	S	S	M	S	S
CO3	S	S	S	S	S
CO4	S	S	S	S	S
CO5	S	S	S	S	S

S Strong M Medium L Low

193MB2A1CB	CORE: BACTERIAL DIVERSITY AND METABOLISM	SEMESTER I

Total Credits: 4

Total Instructions Hours: 50

Syllabus

Unit I Microbial taxonomy 9 h

Microbial systematic - Taxonomic ranks – Classification system – Phentic classification - Numerical taxonomy and Phylogenetic classification – Major characteristics used in taxonomy – Assessing microbial phylogeny – Constructing Phylogenetic Trees from Aligned Sequences, Interpreting Phylogenetic Trees, A Case Study of Phylogenetic Analysis- Major Division of Life - Whittaker's Five Kingdom concept - Bergey's manual (9th Edition) and its importance.

Unit II Bacterial Diversity 9 h

Introduction to Archaea – Archaeal cell wall, lipids and membranes, Genetics and molecular biology, metabolism. Archaeal taxonomy – Outline characteristics of Phylum – Crenarchaeota and Euryarchaeota. Eubacteria – Photosynthetic bacteria – Spirochaetes – Bacterioidetes. Characteristics of major groups. Proteobacteria – Alpha protobacteria: Rhizobiales – Rickettsiales. β Proteobacteia: Neisseriales. Gamma proteobacteria: Enterobacteriales – Pseudomonadales – Vibrionales.

Unit III Nutrition and Growth 10 h

Nutrition and Growth: Nutritional types of microorganisms – Phototrophs – Autotorphs – Lithotrophs – Organotrophs. Nutritional requirements. Environmental effects on Microbial growth – Temperature, pH, Pressure, Oxygen. Physiology of Growth – Growth curve. Growth measurements – batch, continuous and synchronous. Membrane transport – Diffusion, active and passive transport, group translocation, ion uptake.

Unit IV Enzyme and Energy 11 h

Enzymes and co enzymes: IUBMB classification and nomenclature of enzymes, active site, Lock and key Mechanism and induced fir hypothesis, Enzyme kinetics-

negative and Positive co-operatively, enzyme inhibition: Reversible – Competitive, Noncompetitive, uncompetitive and irreversible inhibition. Regulatory and Allosteric enzymes. General pathways of Carbohydrate metabolism: EMP pathway - Substrate level Phosporylation - HMP Pathway –EntnerDoudroff pathway - Glyoxalate pathway - Krebs cycle. Fermentations of carbohydrates – Homolactic – Mixed acid – Butane di ol – Propionic acid fermentation. β – Oxidation of Fatty acids. Energy production: Electron transport chain and Oxidative phosporylation. Pasteur Effect. Bioluminescence.

Unit V Amino acid metabolism and Photosynthesis 11 h

Biosynthesis of aspartate, pyruvate, histidine and serine amino acid families - purine and pyrimidine nucleotides, denovo and salvage pathway. Biosynthesis of fatty acids. Biosynthesis of gram positive and gram negative cell wall. Photosynthesis and Inorganic metabolism: Characteristics and metabolism of Autotrophs – Photosynthetic bacteria and Cyanobacteria – Autotrophic CO2 fixation and Mechanisms of Photosynthesis – Hydrogen bacteria – Nitrifying bacteria. Sulfur bacteria, Iron bacteria. Methylotrophs – Methanogens.

Text Books

1. Joanne Wiley, Linda Sherwood, Christopher J Woolverton. 2016. Prescott's Microbiology, 10th Edition. Mc Graw Hill Company.
2. Michael Madigan, 2015. Brock Biology of Microorganisms, 14th Edition. Pearson publishers. New Delhi.

References

1. Jeffrey C Pommerville. 2010. Alcamo's Fundamentals of Microbiology, 9th Edition. Jones and Bartlett Publishers.
2. Colwell, R.R., U.Simidu, and K. Ohwada. 1996. Microbial diversity in time and space. New York: Plenum Press, c1996. ISBN 0306451948.
3. David White, D. 2011. The physiology and Biochemistry of prokaryotes. Oxford University press. New York. 4th Edition
4. Gottschalk, G. 1986. Bacterial Metabolism 2nd edition. Springer – verlag. New York.
5. Doelle, H.W. 2014. Bacterial Metabolism 2nd revised edition. Academic press.

Course Code	Course Name	Category	L	T	P	Credit
193MB2A1CC	CORE: BIOINSTRUMENTATION	Theory	4			4

PREAMBLE

This course has been designed for students to learn and understand

- To comprehend the principle and instrumentation of diverse instruments for microbiology
- To procure knowledge on the working methods of different instruments.
- To appreciate its application in diverse fields

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	To understand the principles, instrumentation, types of centrifuge with an emphasis on applications of Analytical centrifuge. To impart knowledge on various techniques of purification of bio molecules by chromatography and their application.	K3
CO2	To become equipped with the operational principle and working methods of spectral instruments.	K3
CO3	To procure knowledge on the principles and techniques of various types of electrophoresis with emphasis on recovery and identification of electrophoresed molecules.	K2
CO4	To acquaint the concept of radioactivity and its types of decay. To describe the methods of detection and measurement of radioactivity based on different principles.	K3
CO5	Application of knowledge for the characterization of Biomolecules.	K4

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	S	S
CO2	S	S	S	S	S
CO3	S	S	S	S	M
CO4	S	S	M	S	M
CO5	S	S	S	S	S

S Strong M Medium L Low

193MB2A1CC	**CORE:** BIOINSTRUMENTATION	**SEMESTER I**

Total Credits: 4

Total Instructions Hours: 50

Syllabus

Unit I Centrifuge 9 h

Centrifugation, Analytical Ultra Centrifugation – Determination of Molecular weight and purity of macromolecules. Chromatography: Instrumentation, detection methods and Applications of TLC, Column, Gas, Ion Exchange, HPLC, Gel Filtration and GCMS.

Unit II Spectroscopy 11h

Colorimetry: Instrumentation, Application and Analysis – Qualitative and Quantitative. Spectrophotometry: Instrumentation and Applications of UV, Visible, IR, NMR, FTIR, Atomic absorption, Mass Spectroscopy and MALDI – TOF. Instrumentation and Applications of Spectrofluorometry and Flame Photometry.

Unit III Electrophoresis 11 h

Electrophoresis: Electrophoresis of Proteins – SDS – PAGE, Native Gel, Gradient Gel, Iso Electric Focusing, 2D Page, Cellulose Acetate Electrophoresis, Western Blotting - Detection, Estimation and Recovery of Proteins in gel. Electrophoresis of Nucleic acids – Agarose Gel Electrophoresis – staining and destaining, Analysis of Electrophoresis Results - Electrophoresis of RNA – Capillary Electrophoresis – Microchip Electrophoresis.

Unit IV Radiometry 9 h

Detection and Measurement of Radioactivity –Detection based on gas ionization - Autoradiography and its applications– Scintillation Counting- Safety Aspects – Biosensors and its applications.

Unit V Quantification Methods for Biomolecules 10 h

Separation and Quantitative determination of Macromolecules: Carbohydrates, Lipids, Amino acids - Isolation and Characterization of Microbial pigments: Chlorophylls and Carotenoids. Determination of Protein structure. Determination of Molecular weight of proteins.

Text Books

1. L Veerakumari. 2011. Bioinstrumentation, 1st Edition. MJB Publishers.
2. Keith Wilson and John Walker. 2010. Principles and Techniques of. Biochemistry and Molecular Biology. 7thedition. Cambridge University Press.

References

1. Plummer .T David. 2004. An Introduction to Practical Biochemistry. 3rd Edition. TMH Publishers.
2. Terrance G Cooper, 2010. The tools of Biochemistry, 2nd edition. John Wiley and sons.
3. Rodney Boyer, 2000. Modern Experimental Biochemistry. 3rd Edition, Pearson education Publishers.
4. Swahney S K and Singh R. 2014. Introductory Practical Biochemistry, Narosa Publishing House.
5. Gedder, A. and L. E. Balser, 2008. Principles of applied Biomedical instrumentation. 3rd edition John Wiley and Sons Publications.

Course Code	Course Name	Category	L	T	P	Credit
193MB2A1CD	CORE: MYCOLOGY AND PHYCOLOGY	Theory	4			3

PREAMBLE

This course has been designed for students to learn and understand

- Diversity of Fungi and Algae
- Characteristics of Fungi and Algae
- Applications of Fungi and Algae for human welfare

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Describe the structural components of fungi Develop an understanding diversity of fungi through classification	K3, K4
CO2	Understand the characteristics of fungi and its importance in environment	K3, K4
CO3	Describe the structural components of algae Develop an understanding diversity of algae through classification	K3, K4
CO4	To Understand the characteristics of algae and its importance in environment	K3, K4
CO5	To acquire the knowledge on the current applications of algae and fungi for human benefit. To learn the ways of sustaining better environment through algae and fungi	K3, K4

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	M	S	M	S	S
CO2	S	S	M	S	S
CO3	S	S	S	S	S
CO4	S	S	S	S	S
CO5	S	S	S	S	S

S Strong M Medium L Low

193MB2A1CD	CORE: MYCOLOGY AND PHYCOLOGY	SEMESTER I

Total Credits: 3

Total Instructions Hours: 50

Syllabus

Unit I Fungi and Classification 11 h

Introduction & Historical overview of mycology , General characteristics: cell structure; growth, environmental conditions for growth; nutrition and life cycle patterns, parasexuality and heterothallism - Fungi –Taxonamy and Systematics- fungal classification (Alexopolus) and phylogeny- Fungal Metabolism, Fungal Growth-Apical growth Fungi- Reproduction and Life cycles

Unit II Importance of Fungi 11 h

Importance of fungi in Human life. Fungal endophytes of tropical plants and their applications: Endophytic fungi, colonization and adaptation of endophytes. Endophytes as latent pathogens and biocontrol agents-Mushrooms and their medical relevance , Mycotoxins and Mushroom poisoning Fungi- Saccharomyces cerevisiae-Model organism- Mycorrhiza - ectomycorriza, endo mycorrhiza and vesicular arbuscular mycorrhiza - Role of Mycorrhiza in agriculture - Lichens

Unit III Algae and Classification 10 h

Algae: Distribution; - Cell wall- Photosynthesis - nutrition and culture- classification (Fritch's), reproduction and life cycles; Overall metabolism in algae (synthesis of Carbohydrates and lipids)

Unit IV Importance of Algae 9 h

Algal toxins, algal bloom & its control, algae as a source of antibiotics, industrial use of microalgae: Algae as food and animal feed supplement- Algae as source of Biodiesel, ethanol and Biochar- Alage and waste water treatment- Cosmetic applications of algae- Importance of Macroalgae in human welfare.

Unit V Applications of Algae and Fungi 9 h

Practical Aspects of Microbial Diversity - Measurement of algal growth, strain selection and large scale cultivation - Concept, mechanism, advantages and applications of unique micro biome- VAM, Lichens, Seaweeds.

Text Books

1. Alexopolus CJ, Mims CW, Blackwell M (2002). Introductory Mycology, 4th edition,Wiley India Pvt. Ltd, India.
2. Michael Madigan, 2015. Brock Biology of Microorganisms, 14th Edition. Pearson publishers. New Delhi.

References

1. Moore D, Robson GD, Anthony P, Trinci J (2011). 21st Century Guidebook to Fungi,Cambridge University Press, UK.
2. Colwell, R.R., U.Simidu, and K. Ohwada. 1996. Microbial diversity in time and space. New York: Plenum Press, c1996. ISBN 0306451948.
3. Graham LE, Graham JM, Wilcox LW (2009). Algae, 2nd edition, Benjamin Cummings, San Francisco.
4. Algae: Anatomy, Biochemistry and Biotechnology by Laura Barsanti and Paolo Gualtieri. Taylor and Francis Group, LLC; 2006.
5. Mycotechnology: Present status and future prospects. Edited by Mahendra Rai. I.K., International Publishing House Pvt. Ltd.; 2007.

Course Code	Course Name	Category	L	T	P	Credit
193MB2A1CE	CORE: COMPREHENSIVE BIOLOGY	Theory	3	1	-	3

PREAMBLE

This course has been designed for students to learn and understand

- To train and mediate CSIR/NET Life science Course material, through practice tests every week.
- To increase scientific discussion on scientific questions similar to CSIR /GATE Question models
- To increase the number of students clearing the Competitive exams through scheduled practice plan

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Understand the importance and application of CSIR-NET syllabus and preparation.	K1
CO2	Prepare for competitive exams like CSIR/GATE	K2
CO3	Critical thinking ability by practicing MCQs for the CSIR contents	K2
CO4	Understand the inheritance and structural alterations of chromosomes	K2, K3
CO5	Understand the molecular evaluation and brain behavior	K2, K3

MAPPING WITH PROGRAMME OUTCOMES

COs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	M	S
CO2	S	M	S	S	M
CO3	M	S	M	M	M
CO4	S	S	M	S	M
CO5	S	M	S	M	S

S Strong M Medium L Low

193MB2A1CE	**CORE:** COMPREHENSIVE BIOLOGY	**SEMESTER I**

Total Credits: 3

Total Instructions Hours: 40

Syllabus

Unit I Structure of atoms, molecules and chemical bonds 8 h

Composition, structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins). Interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.). Principles of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics, colligative properties). Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isozymes. Conformation of proteins (Ramachandran plot, secondary structure, domains, motif and folds). Conformation of nucleic acids (helix (A, B, Z), t-RNA, micro-RNA). Stability of proteins and nucleic acids.

Unit II Basic concepts of developmental biology 8 h

Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development Gametogenesis, fertilization and early development: Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis, establishment of symmetry in plants; seed formation and germination.

Unit III System Physiology of Animal 8 h

Blood and circulation - Blood corpuscles, haemopoiesis and formed elements, plasma function, blood volume, blood volume regulation, blood groups, haemoglobin, immunity, haemostasis. Cardiovascular System: Comparative anatomy of heart structure, myogenic heart, specialized tissue, ECG – its principle and significance, cardiac cycle, heart as a pump, blood pressure, neural and

chemical regulation of all above.
Nervous system - Neurons, action potential, gross neuroanatomy of the brain and spinal cord, central and peripheral nervous system, neural control of muscle tone and posture. Sense organs - Vision, hearing and tactile response.

Unit IV Inheritance biology 8 h

Gene mapping methods: Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids, development of mapping population in plants. Extra chromosomal inheritance: Inheritance of Mitochondrial and chloroplast genes, maternal inheritance. Human genetics: Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders. Quantitative genetics: Polygenic inheritance, heritability and its measurements, QTL mapping.

Unit V Evolution 8 h

Emergence of evolutionary thoughts Lamarck; Darwin–concepts of variation, adaptation, struggle, fitness and natural selection; Mendelism; Spontaneity of mutations; The evolutionary synthesis. Origin of cells and unicellular evolution: Origin of basic biological molecules; Abiotic synthesis of organic monomers and polymers; Concept of Oparin and Haldane; Experiement of Miller (1953); The first cell; Evolution of prokaryotes; Origin of eukaryotic cells; Evolution of unicellular eukaryotes; Anaerobic metabolism, photosynthesis and aerobic metabolism.
Paleontology and Evolutionary History: The evolutionary time scale; Eras, periods and epoch; Major events in the evolutionary time scale; Origins of unicellular and multi cellular organisms; Major groups of plants and animals; Stages in primate evolution including Homo. Molecular Evolution: Concepts of neutral evolution, molecular divergence and molecular clocks; Molecular tools in phylogeny, classification and identification; Protein and nucleotide sequence analysis; origin of new genes and proteins; Gene duplication and divergence.

Text Books

1	UGC NET/JRF/SLET Upkar's life sciences by Kumar Pushkar and Dr.A.P.Singh
2	UGC CSIR NET/SLET(JRF&LS) LIFESCIENCES by Ashish Nagesh, Prashanth Kumar and QuaisherJ.Hossain

References

1	Pathfinder Academy CSIR-JRF-NET Life Sciences
2	Cell and Molecular Biology - Author: E.D.P. De Robertis and E.M.F. De Robertis Jr. Publisher: Lea &Febiger
3	Plant breeding. Author: B.D. Singh. Publisher: Kalyani publishers
4	http://www.easybiologyclass.com/csir-jrf-net-life-sciences-previous-year-question-papers/
5	Schaum's Outline of Human Anatomy and Physiology. Author: Van De Graaff Kent M. Publisher: Mcgraw-Hill Companies.

193MB2A1CP	CORE PRACTICAL : PRINCIPLES OF MICROBIOLOGY, MICROBIAL DIVERSITY AND BIOINSTRUMENTATION	SEMESTER I

Total Credits: 3

Total Instructions Hours: 75

S.No	Contents
1	Bacterial Staining techniques Gram, b. Acid-fast, c. Spore d. Capsule and e. Negative staining.
2	Morphological observation of Fungi – Slide culture, LPCB Mount. Culturing and Morphological identification of Algae
3	Micrometry – Measurement of microorganisms.
4	Motility determination- Hanging drop and soft agar inoculation.
5	Enumeration of Microorganisms from soil: Bacteria, Fungi and Actinomycetes.
6	Determination of bacterial generation time - Direct microscopic method and turbidity method
7	Effect of various intrinsic factors on the growth of bacterium and fungi – pH, Temperature
8	Anaerobic technique – Roll tube method
9	IMViC test, Hydrogen sulphide test, Oxidase test, Calalase test, Urease test
10	Preferential utilization of sugar - Carbohydrate fermentation & TSI
11	Polymer degradation – Starch, Gelatin, Casein
12	Quantitative determination of Sugar by DNSA method
13	Quantitative determination of Protein by Lowy et al method
14	Separation techniques: Chromatography- Paper, TLC and Column.
15	Isolation and Quantification of Pigments from Algae.

16	Demonstration of Instruments- PCR, Inverted Microscope, Stereo Microscope, Flurescence Microscope

References

1. Kannan, N. 1997. Laboratory Manual of General Microbiology, 1st edition, Panima Publishing house.
2. Aneja. K.R., 2012. Experiments in Microbiology, Plant Pathology and Biotechnology, 2nd edition. New age publishers.
3. James G. Cappuccino, Natalie Sherman. 2013. Microbiology: A Laboratory Manual (10th Edition) 10th Edition.
4. Rajan S. Selvi Christry.R. Experimental Procedures in Lifesciences. CBS Publishers & Distributors Pvt Ltd.
5. David T. Plummer, 1992. An introduction to practical Biochemistry, Third Edition, Tata McGraw Hill publishing Com. Ltd., New Delhi.

Course Code	Course Name	Category	L	T	P	Credit
193MB2A1DA	ELECTIVE: MICROBIAL NANOTECHNOLOGY	Theory	3	1		3

PREAMBLE

This course has been designed for students to learn and understand

- The role of microbes and other eukaryotes in the synthesis of nanoparticles
- Advanced methods of synthesis and designing of nano particles
- Educate the potential applications of nano particles/ materials in a variety of areas.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	To apply the basics of Nanosciences, able to differentiate particles at macro, micro and nano level	K2, K3
CO2	To know the synthesize of nanoparticles at the laboratory scale	K3
CO3	Understand the characterization techniques involved in nanotechnology	K3
CO4	To explore the interdisciplinary applications of nanotechnology	K2,K3
CO5	To learn the positive and negative aspects of nanotechnology and its present status in India	K2

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	M	S	M	S
CO2	S	M	M	M	M
CO3	M	M	M	M	M
CO4	M	M	M	M	M
CO5	M	M	M	M	M

S Strong M Medium L Low

193MB2A1DA	ELECTIVE: MICROBIAL NANOTECHNOLOGY	SEMESTER I

Total Credits: 3

Total Instructions Hours: 48

Syllabus

Unit I Introduction to bionanotechnology 9 h

History – concept and future prospects – application in Life Sciences. Terminologies – nanotechnology, bionanotechnology, nanobiomaterials, biocompatibility, nanomedicine, nano tube, nanowires, quantum Dots, nanocomposite, nanoparticles, nanosensors. Emergnece of Bionanotechnology.

Unit II Synthesis of nanoparticles 10 h

Molecular nanotechnology – nanomachines – collagen. Applications of nanoparticles – cancer therapy – nanoparticles in manipulation of biomolecules and cells. Cytoskeleton and cell organelles. Types of nanoparticles production – physical, chemical and biological. Microbial synthesis of nanoparticles - bacteria, fungi and yeast – principle and mechanism of synthesis.

Unit III Types of nanoparticles and methods of characterization 10 h

Types of Nanoparticles – Silver, Gold and Titanium. Physical and chemical properties of nanoparticles. Characterization– UV-Vis spectroscopy, particle size analyzer, Electron Microscopy – HRTEM, SEM, AFM, EDS, XRD. Other tools and techniques required for bionanotechnology: X- Ray crystallography, NMR, rDNA technology, site directed mutagenesis, fusion proteins.

Unit IV Applications of bionanotechnology 10 h

Drug and gene delivery – protein and nanoparticle mediated. Nanoparticles in drug targeting, MRI, DNA and Protein Microarrays. Nanotechnology in health sectors - Development of green chemistry – commercial viability of nanoparticles. Nanomedicines, Antibacterial activities of nanoparticles. Nanotechnology in agriculture. Toxicology in nanoparticles – Dosimetry. Advantages of nanoparticles – drug targeting, protein detection, MRI,

Unit V Merits and demerits of nanoparticles 9 h

Health and safety implications from nanoparticles: Health issues – Environmental issues – Need for regulation – Societal implications - Possible military applications – Potential benefits and risks for developing countries – Intellectual property issues. Bioinformatics: molecular modeling, docking, computer assisted molecular design.

Text Books

1. Parthasarathy BK. Introduction to Nanotechnology, Isha Publication. 2007.
2. Elisabeth Papazoglou and Aravind Parthasarathy. Bionanotechnology. Morgan and Claypool Publishers. 2007.

References

1. Bernd Rehm. Microbial Bionanotechnology: Biological Self-assembly Systems and Biopolymer-based Nanostructures. Horizon Scientific Press. 2006.
2. David E Reisner and Joseph D Bronzino. Bionanotechnology: Global Prospects. CRC Press. 2008.
3. Ehud Gazit. Plenty of Room for Biology at the Bottom: An Introduction to Bionanotechnology. Imperial College Press. 2006.
4. Kamali Kannangara. Nanotechnology: Basic science and emerging technologies- Mick Wilson, Overseas Press. 2005.
5. Pradeep T. Nano Essentials understanding nanoscience and Nanotechnology. 1st edition. TMH publications. 2007.

Course Code	Course Name	Category	L	T	P	Credit
193BC2A1DA	ELECTIVE: CANCER BIOLOGY, DIAGNOSIS AND THERAPY	Theory	3	1	0	3

PREAMBLE

This course has been designed for students to learn and understand

- An overview on cancer, mutations causing cancer, repair mechanism and multiples of diagnostic and treatment methods for cancer.
- The basic principles of cancer development and available therapeutic approaches.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Compare and contrast benign and malignant tumors. Explain morphological characteristics of cancer cells.	K4 & K5
CO2	Justify molecular basis of the cancer. Distinguish interdisciplinary areas in cancer biology. Elaborate the carcinogenetic process.	K4, K5 & K6
CO3	Discuss about molecular mechanism of oncogenesis and tumor biology. Compare and explain the role of cell cycle in cancer. Value the importance of nutrition given to cancer patients.	K4, K5 & K6
CO4	Judge the role of tumor suppressor genes and apoptosis. Elaborate on epigenetics.	K5 & K6
CO5	Elaborate on the choice of diagnosis and therapy available for cancer patients.	K5 & K6

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	M	S	S	M
CO2	S	S	M	S	S	M
CO3	S	S	S	S	S	M
CO4	S	S	M	S	S	M
CO5	S	S	S	S	S	M

S Strong M Medium L Low

193BC2A1DA	ELECTIVE: CANCER BIOLOGY, DIAGNOSIS AND THERAPY	SEMESTER I

Total Credits: 3

Total Instructions Hours: 48

Syllabus

Unit I **Introduction** 9 h

Introduction: Cancer cell-morphology and growth characteristics. Types of growth-hyperplasia, dysplasia, anaplasia and neoplasia. Types and prevalence of cancer. Nomenclature of neoplasms, classification based on origin/organ. Differences between benign and malignant tumors.

Unit II **Carcinogenesis** 10 h

Cancerepidemiology. Cancer endocrinology. Cancer causing agents-radiation, viruses, chemicals. Multistep carcinogenesis: Initiation, Promotion, Progression. Para-neoplastic syndromes. Mutation- definition, significance, rates and frequency. Mutagenic agents. Molecular basis of mutagenesis, induced and spontaneous mutations, crossing over and segregation. Various types of mutations- addition, deletion, inversion, reciprocal, translocation, insertional translocation and frame-shift mutations. Chemical carcinogenesis- genetic and epigenetic carcinogens, pro-carcinogens and co-carcinogens, promoters and initiators, testing for carcinogenecity, Ames test. Cancer biology and biochemistry-aberrant metabolism during cancer development.

Unit III **Tumor Markers and Signal Transduction** 10 h

Oncogenes- RNA and DNA tumor viruses, retroviruses and viral oncogenes. Src and Ras gene, mechanism and characteristic of cell transformation. Molecular mechanism of oncogenesis- proto oncogenesis, oncogene, oncoproteins, tumour suppressor genes involved in cancer. Tumormarkers; cellular proto-oncogenes-oncogene activation. Radiation- effect of ionising radiations on DNA, chromosomal aberrations. Genetic basis of cancer, metastasis, use of tumor markers in detection and monitoring of cancer. Signal transduction in cancer: cell- cell interactions, cell

adhesion-invasion and metastasis - VEGF signaling and angiogenesis; role of transcription factors. Growth factors-EGF, TNF-α and TGF-β and growth factor receptors. Free radicals and antioxidants in cancer. Diet and cancer

Unit IV **Cell Cycle, Cell Death and Cancer** 10 h

Cell Cycle Regulation cancer: control of the cell cycle-cyclins and CDKs, and tumor suppressor genes p53, p21 Rb, BRAC1 and BRAC2. Telomeres, and Immortality; Epigenetics- role of DNA methylation in gene silencing- epigenetic silencing of tumor-suppressor genes. Role of DNA-methylation in gene silencing-epigenetic silencing of tumor-suppressor genes; Death-signaling pathways-mitochondrial and death receptor pathways, apoptosis and cancer (Intrinsic and extrinsic pathways). Mechanism of apoptosis. Impact of apoptosis on oncogenesis. Principles and methods of cancer diagnosis-biochemical, genetic, cytotoxic, cell growth and viability tests.

Unit V **Cancer Diagnosis and Cancer Therapy, Stem Cells and Cancer** 9 h

Diagnostics of cancer by histo-pathlogy, MRI scan, PET-scan, cytogenetis test, kariotype, FISH. Strategies of anticancer drug therapy–chemotherapy-gene therapy. Immuno-therapy and Radiotherapy. Immune therapy, surgical therapy. Principles of cancer biomarkers and their applications. Stem Cells and Cancer.

Text Books

1 McKinnell R. G, Parchment R. E., Perantoni A. O, BarryPierce,Damjanov.I,.2006. The Biological Basis of Cancer, Second Edition, Cambridge University Press, United Kingdom.

2 The Biology of Cancer: R. A. Weinberg. Garland Science. 2006.

Franks,L.M. and Teich,N.M. 1991. An introduction to Cellular and Molecular Biology of cancer, 2nd Edition, Oxford University Press.

Vincent,T. et al., 2011. Principles and Practice of Oncology: Primer of the Molecular Biology of Cancer, 1st Edition, Lippincott Williams and Wilkins.

References

1 Weinberg,R.A. 2013. The Biology of Cancer, 2nd Edition, Garland Science.

2 Hesketh,R. 2013. Introduction to Cancer Biology, Cambridge University Press.

3 Pelengaris,S. and Khan,M. 2002. The Molecular Biology of Cancer, 2nd Edition, Wiley Blackwell.

COURSE CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
193BT2A1DA	PROTEIN ENGINEERING	THEORY	3	1		3

Total Credits: 3
Hours Per Week: 4

PREAMBLE:

1. To study the function and application of proteins.
2. To analyze folding of proteins.
3. To learn the protein engineering and designing

COURSE OUTCOMES

On successful completion of the course, students will be able to:

CO Number	CO Statement	Knowledge Level
CO1	Understand the bond and modification of protein	K3, K4
CO2	Acquire knowledge on protein Architecture	K3, K4
CO3	Impart knowledge on the various electromagnetic radiation	K3, K4, K5
CO4	Focus on DNA binding factors	K4, K5
CO5	In depth understanding of designing of protein and its applications Documentation, Inspection and certification	K4, K5

Mapping with Programme Outcomes

COs/Pos	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	S	S
CO2	S	S	S	S	S
CO3	S	S	S	S	S
CO4	S	S	S	S	S
CO5	S	S	S	S	S

S-Strong; M-Medium; L-Low

193BT2A1DA	ELECTIVE I: PROTEIN ENGINEERING	SEMESTER – I

Total Credits: 3
Total Instruction Hours: 48

CONTENTS

UNIT - I

Bonds and Energies in Protein Makeup **10 h**

Covalent, Ionic, Hydrogen, Coordinate, hydrophobic and Vander walls interactions in protein structure. Amino acids, their characteristics, molecular properties (size, solubility, charge, pKa). Chemical reactivity in relation to post-translational modification (involving amino, carboxyl, hydroxyl, thiol, imidazole groups).

UNIT – II

Protein Architecture **10 h**

Primary structure, peptide mapping, peptide sequencing - Edman method. Secondary structures, super secondary structure, nucleotide binding folds, prediction of substrate binding sites. Tertiary structure, Domains, folding, denaturation and renaturation. Overview of methods to determine 3D structures. Quaternary structure: Modular nature, formation of complexes. Ramachandran Plot.

UNIT - III

Elucidation and characterization of Proteins **8 h**

Interaction with electromagnetic radiation (radio, micro, infrared, visible, ultraviolet, X-ray) and elucidation of protein structure. Characterization of protein using NMR spectroscopy, x ray crystallography, spectroscopic and calorimetric methods.

UNIT – IV

Structure-function relationship of Proteins **10 h** DNA-binding proteins: prokaryotic transcription factors, Helix-turn-Helix motif in DNA binding, *trp* repressor, Eukaryotic transcription factors, Zn fingers, helix-turn - helix motifs in homeodomain, Leucine zippers. Membrane proteins - characteristics, transmembrane segments. Bacteriorhodopsin and photosynthetic reaction center.

UNIT - V

Protein engineering and Designing **10 h**

Overview, advantages, principles with specific examples: thermal stability, T4-lysozyme, recombinant insulin. Strategies for design of novel protein, production of *de novo* protein design. Computer methods in protein modeling. Understanding catalytic design by engineering trypsin, chymotrypsin and elastase, substrate-assisted catalysis and other commercial applications.

TEXT BOOKS:

1. *Walsh, G.* 2014. **Proteins: Biochemistry and biotechnology**. 2nd edition. Wiley Blackwell. NJ, USA.
2. *Wiliamson, M.P*. 2012. **How Proteins Work.** Garland Science, NY, USA

REFERENCES:

1. *Voet D. and Voet G.*2001. **Biochemistry.** 3rd Edition. John Wiley and Sons.
2. *Branden C. and Tooze J*. 1999. **Introduction to Protein Structure.**

2nd edition. Garland Publishing, NY, USA.

3. *Creighton T.E.*1993. **Proteins.** 2nd Edition. Freeman WH.

4. *Moody P.C.E. and Wilkinson A.J.* 1990. **Protein Engineering.** IRL Press, Oxford, UK.
5. *Craik, C.S., Cleland, J.L.* 1996. Protein Engineering: Principles and Practice. Wiley Blackwell, NJ, USA.

Course Code	Course Name	Category	L	T	P	Credit
193MB2A2CA	**CORE:** MICROBIAL GENETICS AND MOLECULAR BIOLOGY	CORE	4		-	4

PREAMBLE

This course has been designed for students to learn and understand

- The fundamentals behind classical genetics
- Mechanisms of gene replication and expression
- The knowledge of Genetic material exchange and mutations

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Understand and appraise the biological process by a historical approach to study classical systems of gene regulation in bacteria.	K2
CO2	Understand the topology of DNA and RNA.To compare and contrast the mechanisms of replication, transcription and translation.	K3
CO3	Explain the processes behind mutation and other modifications.	K3
CO4	Develops knowledge and summarize the DNA transfer mechanisms and the role of transposons.	K4
CO5	Identify and distinguish genetic regulatory mechanisms at different levels.	K4

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	M	S
CO2	M	S	S	S	S
CO3	S	S	M	S	S
CO4	S	S	M	M	M
CO5	S	S	M	M	S

S – **Strong** **M** – **Medium** **L** – **Low**

193MB2A2CA	CORE: MICROBIAL GENETICS AND MOLECULAR BIOLOGY	**SEMESTER II**

Total Credits: 4
Total Instruction Hours: 48 h

Syllabus

Unit I Classical Genetics 9 h

Mendel's Laws: Monohybrid - Dihybrid - Test cross, concept of dominance, segregation, independent assortment; Chromosome theory of inheritance. Chromosomes & crossing over. Sex-influenced and limited inheritance. Chromatin structure and organization.

Unit II DNA and RNA 9 h

DNA and RNA as genetic material. Nucleic Acid chemical composition, C value paradox, Physical structures of DNA, Circular and Superhelical DNA. RNA-Structure and types. DNA Replication – Basic rule for replication of all nucleic acids - Geometry of DNA replication – Enzymology.

Unit III Gene Expression 10 h

Transcription – Enzymatic synthesis of RNA -polymerases – RNA chain initiation – Elongation – Termination and release of newly synthesized RNA. Transcription in Eukaryotes – Transcription unit concept. Genetic code. Translation – Transfer of RNA and aminoacylsynthetases – codon, anticodon interactions – Wobble hypothesis. Post transcriptional and translational modification.

Unit IV Mutation 10 h

Mutation – types of Mutation - Biochemical basis of mutation –Spontaneous and induced mutation. Mutagenicity testing. DNA repair mechanisms: Photo reactivation – Excision repair – Recombination repair – SOS repair.

Unit V Gene transfer 10 h

Mechanisms of Gene transfer in bacteria – Transformation – Transduction and Conjugation. Phage genetics, Phage T mutants, Genetic recombination, Genetic mapping of T4 Phage. Regulation of gene activity – Operon model- positive and negative operon: (Lac, Trp), Autoregulation – translational regulation.

Text Books

1. Freidfelder,D (1995). Microbial genetics. (1th Edn.) New Delhi: Narosa Publishing House
2. Freifelder,D (2004). Molecular Biology. (1Edn.) New Delhi: Narosa Publishing House

References

1. Klug .W.S. and Cummings, M.R., (2016). Essentials of Genetics. (9 Edn.) New Delhi: Pearson Publishers.
2. Robert H Tammarin, (2008). Principles of Genetics. (7 Edn.) New Delhi: McGraw Hill Publishers.

Course Code	Course Name	Category	L	T	P	Credit
193MB2A2CB	Core: Food Microbiology and Food Quality Control	CORE	4	-	-	4

PREAMBLE

This course has been designed for students to learn and understand

- The relation between food and microbes.
- The importance of fermented foods, food borne diseases and food quality control
- The contribution of food laws and regulations

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	To understand the relation between the food and microbes and spoilage of various types of food by microbes.	K2
CO2	To describe the food infections, poisoning, various food borne microorganisms and the production of various fermented food products.	K3
CO3	To acquaint the knowledge on indicator organisms and examination of food for the identification of spoilage causing microorganisms.	K3
CO4	To become equipped with in house quality assurance in food industry and, GMP, SSOP and HACCP Principles	K4
CO5	To describe about the food laws and regulations. To understand the GHP and waste disposal in food industry.	K4

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	M	M
CO2	M	S	M	S	S
CO3	S	M	S	M	M
CO4	S	S	M	S	S
CO5	S	S	S	M	S

S ~~**Strong**~~ **M** **Medium** **L** **Low**

193MB2A2CB	Core: Food Microbiology And Food Quality Control	**SEMESTER II**

Total Credits: 4
Total Instruction Hours: 48 h

Syllabus

Unit I Spoilage and preservation 12 h

Food as a substrate – Incidence and types of microorganisms in food – Contamination and Spoilage of Meat, Poultry, Sea foods, Vegetables, Fruits. Principles of food preservations: Asepsis, Preservation by use of High temperature, Low temperature, Canning, Drying, Radiation and Food additives.

Unit II Microbial impacts in food 9 h

Fermented foods - Meat and fishery products – Country cured hams, Dry sausages, Katsuobushi. Fermented milk products –, Yoghurt and Cheese. Food poisoning – Food borne diseases- Bacterial and Non- Bacterial.

Unit III Food spoilage testing 10 h

Indicator organisms – Direct examination – culture techniques – enumeration methods – plate – Viable & Total Count; Alternative methods – Dye reduction tests , electrical methods , ATP determination: Rapid methods, immunological methods – DNA / RNA methodology – Laboratory accreditation.

Unit IV Quality assurance in food industry 8 h

In house Committee for quality assurance, Persons involved, Internal Microbial Quality control Policy, Quality Check at every step from collection of raw materials till it reaches the customer, GMP, SSOP, HACCP- Principles & Applications.

Unit V Food laws and regulations 9 h

National – PFA Essential Commodities Act (FPO, MPO etc.). International – Codex Alimentarius, ISO – 9000 series, ISO 22000 & BS 5750. Regulatory Agencies – WTO, FSSAI. Hygiene and sanitation in food sector General Principles of Food Hygiene, GHP for commodities, equipment, work area and personnel, cleaning and disinfect ion (Methods and agents commonly used in the hospitality industry), Safety aspects of processing water (uses & standards) and Waste Water & Waste disposal.

Text Books

1. Frazier. W.C and D.C Westhoff, (2008). Food Microbiology. (5th Edn.) Delhi: McGraw Hill publishing Co.,.
2. Jay,J. M. (2007). Modern Food Microbiology. (7Edn.) New York: Van Nostra and Rainhokdd Co.

References

1. Adams. M. R and M. D Moss,. (2008). Food Microbiology. (3 Edn.) New Delhi: Panama Publishers..
2. www.fssai.gov.in
3. D Kumar Bhatt, Priyanka Tomar,. (2010). An Introduction to Food Science Technology and Quality Management. (Edn.) New Delhi: Kalyani Publishers.

Course Code	Course Name	Category	L	T	P	Credit
193MB2A2CC	CORE: ENVIRONMENTAL AND AGRICULTURAL MICROBIOLOGY	CORE	4	-	-	4

PREAMBLE

This course has been designed for students to learn and understand

- To explore the diverse distribution of micro biome in different milieu.
- To appreciate its beneficial role in the process of recycling.
- To explain the biogeochemical cycle.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	To explore the community of microflora present in air and indicators of air pollution. To understand the types of Bacterial, Viral and Fungal airborne diseases and the effect of air pollution on plants and animals.	K2
CO2	To understand the sources of soil pollution and concept of Biogeochemical cycling	K2
CO3	To compare the characteristic features of microbial populations of symbiotic and non symbiotic nitrogen fixers, phosphate solubilizers and phytopathogens.	K2, K3
CO4	To comprehend the distribution of microorganisms in various sorts of aquatic environments.	K3
CO5	To analyse the concepts of solid waste management. To comprehend the different value added products from the solid wastes.	K3

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	M	S	S	M
CO2	S	M	S	S	M
CO3	S	S	S	S	S
CO4	S	M	S	M	M
CO5	S	S	S	S	S

S Strong **M Medium** **L Low**

193MB2A2CC	CORE: ENVIRONMENTAL AND AGRICULTURAL MICROBIOLOGY	**SEMESTER II**

Total Credits: 4
Total Instruction Hours: 48 h

Syllabus

Unit I Aerobiology 9 h

Microbial contamination of air - Sources of contamination -Biological indicators of air pollution. Enumeration of bacteria from air - Air sampling devices. Significance of air Micro flora, Outline of Airborne diseases (Bacterial, Fungal and Viral), Effect of Air pollution on plants and Humans. Air sanitation - UV light, HEPA filters, desiccation, Incineration.

Unit II Soil Microbiology 9 h

Structure, Types, Physical and Chemical properties - Soil microbes (Types and Enumeration) - Weathering and Humus formation, Soil pollution - Sources. Biogeochemical cycling – Nitrogen, Carbon, Phosphorous, Sulphur and Iron cycles and its importance.

Unit III Microbes in Agriculture 10 h

Nitrogen Fixing Microorganisms - Symbiotic and free - living nitrogen fixers (Rhizobium, Azotobacter, Azospirillum, Frankia, BGA and Azolla) - Phosphate solubilizers (Phosphobacterium and Aspergillus) – Phytopathogens - Bacterial, Fungal and Viral diseases (Wilt, Blight, Canker and Mosaic only) - Control measures.

Unit IV Aquatic Microbiology 10 h

Microbiology of water (Fresh and Marine) - Water Pollution and Waterborne Pathogens. Assessment of water quality (Chemical and Microbial) Bacteriological examination of water - Indicator organisms. Microbiology of Sewage - Waste water treatment – primary, secondary and tertiary – Biological oxygen demand (BOD) and (COD).

Unit V Waste Management 10 h

Recycling of Solid wastes – landfills, vermicomposting – Value added products from wastes - Biogas, Mushroom and SCP production. Biodegradation of Complex Polymers (Cellulose, Hemicellulose, Lignin, Chitin and Pectin), Bioremediation (In-situ, Ex -situ, Intrinsic and Engineered), Bioleaching (Copper and Uranium) – Introduction to biodegradation of recalcitrant's (Xenobiotics).

Text Books

1. Atlas R. M and Bartha, (2005). Marketing Management. (5th Edn.) Delhi:Prentice Hall.
2. Joseph C Daniel, (1999). Environmental Aspects of Microbiology. (1Edn.) Chennai: Bright Sun publishers.

References

1. Alexander,M. (1977). Introduction to soil microbiology. (2 Edn.) New York: John Wiley & Sons, Inc.,.
2. Black,J. G. (2013). Microbiology. (8 Edn.) New Delhi:John Wiley and Sons.
3. Maier RM, Pepper IL and Gerba CP,. (2009). Environmental Microbiology. (2 Edn.) New Delhi:Academic Press.
4. Michael Madigan, (2015). Brock Biology of Microorganisms. (15 Edn.) New Delhi:Pearson publishers.

Course Code	Course Name	Category	L	T	P	Credit
193MB2A2CD	CORE: VIROLOGY	CORE	3	1	-	3

PREAMBLE

This course has been designed for students to learn and understand

- To get the basic knowledge on general properties of viruses
- To impart knowledge on bacterial, plant and animal viruses and their diagnosis
- The role and production of antiviral agents and their mode of action

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Understands the basic classification of viruses, cultivation and characterization.	K3
CO2	Develops the skills of Routine and Molecular Diagnosis with special reference to Virology.	K3
CO3	Basic knowledge on structure, genome replication, protein synthesis and assembly of DNA and RNA containing bacteriophages and Classification.	K2
CO4	Able to differentiate DNA and RNA containing animal viruses.	K3
CO5	Application of virology in viral vaccines, preparation, recombinant viruses and gene therapy.	K2

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	M	M	M	M
CO2	S	M	M	M	M
CO3	S	M	M	M	M
CO4	S	M	M	M	M
CO5	S	S	S	S	M

S Strong **M Medium** **L Low**

193MB2A2CD	CORE: VIROLOGY	**SEMESTER II**

Total Credits: 3
Total Instruction Hours: 48 h

Syllabus

Unit I Introduction to Viruses 9 h

General properties and Classification of Viruses. Cultivation and purification of viruses - In vivo and in vitro systems for virus growth - Principles of bio-safety, containment facilities, maintenance and handling of laboratory animals and requirements of virology laboratory.

Unit II Bacteriophages and Plant Viruses 9 h

Structure, genome replication, protein synthesis and assembly of DNA containing bacteriophages – T4, lambda, Mu, ΦX174 & M13 phages and RNA containing bacteriophages - MS2 and Φ6 group. Mechanism of viral entry, multiplication and release from host cell of DNA containing plant viruses – CaMV and Gemini Virus - RNA containing plant viruses - TMV, Cowpea mosaic viruses, Bromo mosaic viruses and Satellite viruses.

Unit III Animal Viruses 10 h

Mechanism of viral entry, multiplication and release from host cell. Pathogenicity and Clinical manifestation of DNA containing animal viruses - Adeno viruses, Herpes viruses, Pox viruses, Variola virus. RNA containing animal viruses -Picorna virus, Rhabdo virus, Hepatitis viruses, Orthomyxo virus, H1N1, Paramyxovirus, Retroviruses - HIV and Rubella virus. Emerging viruses – Ebola, Dengue, Chikungunya. Virions and Prions.

Unit IV Diagnostic Methods 10 h

Immunodiagnosis – haemagglutination, haemagglutination inhibition, Complement fixation, neutralization, Western blot, RIPA, flowcytometry and immunohistochemistry. Nucleic acid based diagnosis - Nucleic acid hybridization, Polymerase chain reaction, Microarray and nucleotide sequencing.

Unit V Prophylaxis 10 h

Viral Vaccines - Conventional vaccines and recombinant vaccines-immunomodulators (cytokines). Antivirals – anti retrovirals — mechanism of action and drug resistance. Modern approaches of virus control - Anti-sense RNA, siRNA, ribozymes.

Text Books

1. Stainier R.V., Ingraham, J.L., Wheelis, M.L. and Painter P.R, (2007). The General Microbiology . (5 Edn.) New Delhi: Printice-Hall of India (Pvt.) Ltd.,.
2. Dimmock, N. J., Easton, A. J., and Leppard, K. N.,. (2007). Introduction to Modern Virology. (5Edn.) USA: Blackwell publishing.

References

1. Luria S.E. Darnel, J.E Jr. Baltimore. D and Campbell A.,I.N. (1978). General Virology. (3 Edn.) New Delhi: Wiley and sons.
2. Ananthanarayanan R and CK Jayaram Panicker,I.N. (Year). Introduction to Medical Microbiology. (2 Edn.) New Delhi: Orient Longman.
3. Black JG, (2017). Microbiology – Principles and Explorations. (8 Edn.) John Wiley & Sons Inc. New York.
4. Rogger Hull,I.N. (2001). Mathews Plant Virology. (4 Edn.) New Delhi: Academic press..

Course Code	Course Name	Category	L	T	P	Credit
193MB2A2CE	CORE - PHARMACEUTICAL MICROBIOLOGY AND QUALITY ASSURANCE	CORE	3	1	-	3

PREAMBLE

This course has been designed for students to learn and understand

- Sterility in pharmaceutical products
- Role of a qualified microbiologist in Pharma Industry
- Validation and its importance in quality assurance of pharmaceutical products.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Identify and analyse unexpected results during routine analyses and solutions based on scientific and regulatory considerations by preventive and corrective actions programs.	K3
CO2	Acquire a working knowledge of Indian GMP to the manufacture of pharmaceuticals, blood products, and natural health products	K3
CO3	Interpret the requirements for testing of raw materials, in-process samples, and finished product in accordance with pharmacopoeia compendia standards.	K3
CO4	Operate, validate, and calibrate a variety of laboratory equipment used in pharmaceutical industrial labs.	K3
CO5	Understand the concept of quality systems and compliance in the regulated industry and the role of quality assurance and documentation.	K2

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	M	M	M	S	S
CO2	S	S	M	S	S
CO3	S	S	S	S	S
CO4	S	S	S	S	S
CO5	S	S	S	S	S

S Strong M Medium L Low

193MB2A2CE	CORE - PHARMACEUTICAL MICROBIOLOGY AND QUALITY ASSURANCE	**SEMESTER II**

Total Credits: 3
Total Instruction Hours: 48 h

Syllabus

Unit I An introduction to pharmaceutical microbiology 9 h

WHO good manufacturing practices: Principles for pharmaceutical products- Quality management in the drug industry: Heating, Ventilation and air-conditioning systems of sterile and non-sterile pharmaceutical firms – water sampling and testing, Types of Water in pharmaceutical industry and their uses.

Unit II Sterility and spoilage in pharmaceutical products 9 h

Types of spoilage, Factors affecting microbial spoilage – assessment of microbial spoilage – preservation. Environmental monitoring in sterile and non sterile area – Sterilization control - sterilization monitors and Quality assurance of products.

Unit III Sterility testing methods and Regulations 10 h

Sterile and non sterile pharmaceutical products and their testing protocols: Sterility test - Microbial Limit Test - Bacterial endotoxin test (LAL test). Microbiological quality and regulatory requirements: Immunological products - Containment system integrity – Veterinary antimicrobial products - Bio therapeutics and manufactured products.

Unit IV Quality assurance in Pharmaceutical industry 10 h

The role of the Qualified Person in microbiological quality assurance - Safety in microbiology - Rapid enumeration and identification methods - Selection and use of cleaning and disinfection agents in pharmaceutical manufacturing - Measurement of biocide effectiveness - International disinfectant testing protocols. Personal Qualification procedure for clean area entry - Clean-in-Place, Sterilization-in-place, Clean room design, operation and regulatory standards.

Unit V Validation in quality assurance 10 h

Microbiological quality assurance. Validation and types. Validation of aseptic processing and media fill, Internal and Regulatory Auditing of the pharmaceutical microbiology department. Report writing and Documentation in microbiology lab.

Text Books

1. Philip Kotler, R (2014). Quality assurance of pharmaceuticals A compendium of guidelines and related materials Volume 2. (2 updated Edn.) Delhi: Prentice Hall.
2. W.B.Hugo&A.D.Russel (2007). Pharmaceutical Microbiology. (4Edn.) New Delhi: Blackwell Scientific Publications.

References

1. Dr Norman Hodges and Professor Geoff Hanlon (2012).Essential Microbiology for Pharmacy and Pharmaceutical Science. (1 Edn.) Wiley Blackwell
2. Geoff Hanlon and Tim Sandle, (2015). Industrial Pharmaceutical Microbiology – Vol&VolII: standards & Controls.(5Edn.):Euromed Communications.
3. Madigan ,M. (2006). Brock Biology of Microorganisms. (11 Edn.) USA: Pearson-Prentice Hall.

193MB2A2CP	Core Practical: Applied Microbiology, Virology and Genetics	**SEMESTER II**

Total Credits: 3
Total Instructions Hours: 72 h

S.No	Contents
1	Isolation and separation of chromosomal DNA from bacteria.
2	Isolation of Antibiotic resistant mutants
3	Isolation and titration of coli phages
4	Cultivation of virus by Egg inoculation
5	Isolation of air borne bioparticles (Settling plate method)
6	Isolation of nitrogen fixers – free living (Azotobacter, Azospirillum) symbiotic (Rhizobium)
7	Isolation of Microbes (bacteria and fungi) from spoiled food
8	Determination of Milk quality - Dye reduction test
9	Quality analysis of therapeutic products - Microbial Limit test
10	Water quality analysis - Membrane filtration method
11	Determination of Minimal Inhibitory Concentration
12	Total Blood cell count - granulocytes and agranulocytes

Note: Out of 12 experiments 10 can be performed.

References

1. James G. Cappuccino. 2016. Microbiology: A Laboratory Manual, 10th edition. Benjamin/Cummings Publishing House.

2. Aneja. K.R. 2012. Experiments in Microbiology, plant pathology and biotechnology, 4th Edition. New age publishers.

3. Rajan S. and Selvi Christy, 2018. Experimental Procedures in Life Sciences. CBS Publishers & Distributors Pvt Ltd, India.

4. Kannan,N. 1997. Laboratory Manual of General Microbiology, 1st edition, Panima Publishing House

Course Code	Course Name	Category	L	T	P	Credit
193MB2A2DA	Elective II: Medical Laboratory Techniques	CORE	3	1	-	3

PREAMBLE

This course has been designed for students to learn and understand

- To study Laboratory principle and organization
- Understanding the processing of blood, urine, stool and sputum
- The importance of laboratory maintenance

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Understand the laboratory principle and organization of clinical laboratory	K2
CO2	Apply the knowledge on antiseptics and disinfectants.	K3
CO3	Understand the collection and processing of blood.	K3
CO4	Explain the methods involved in collection and processing of urine, stool and sputum.	K4
CO5	Impart the responsible of maintaining laboratory equipments and Biomedical waste management.	K3

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	M	S
CO2	M	S	S	S	S
CO3	S	S	M	S	S
CO4	S	S	M	M	M
CO5	S	S	M	M	S

S Strong M Medium L Low

193MB2A2DA	Elective II: Medical Laboratory Techniques	**SEMESTER II**

Total Credits: 3
Total Instruction Hours: 48 h

Syllabus

Unit I Introduction to Clinical laboratory 9 h

Basic laboratory principles - Organization of clinical laboratory - Biosafety in containment laboratory - National and International GLP (Good laboratory Practices) - Role of medical laboratory technician - personnel hygiene and safety measures –Nosocomial infection.

Unit II Antiseptics & Disinfectants 9 h

Definition -Types - Mode of Action – Uses. Antimicrobial agents and Antibiotics: Introduction, mechanism of action, classification and uses, Antibiotic susceptibility testing - Stokes, Kirby-Bauer method, Minimal Inhibitory Concentration and Minimal Bactericidal Concentration.

Unit III Collection and processing of blood 12 h

Collection and processing of blood sample- separation of serum and plasma - Sampling errors - Preservation of samples. Determination of Total Count, Differential Count, Erythrocyte Sedimentation Rate, Hemoglobin concentration (Hb), Bleeding Time & Clotting Time. ABO Blood group system. Determination of blood glucose, Urea, Cholesterol and Bilirubin. Profiling - Liver function test, Renal function tests. Hormones - T3, T4, TSH, FSH, LH, Prolactin, Insulin.

Unit IV Processing of Urine, Stool and Sputum sample 12 h

Collection, transport and Storage of Urine, Stool and Sputum sample. Macroscopic and Microscopic examination - Urine: sugar, albumin, bile salts, bile pigments and ketone bodies - Pregnancy Test. Stool – Cyst, Ova, Mucus, Pus, RBC, Reduced sugar, Occult blood. Sputum –Petroff's method, AFB staining, Culture and sensitivity.

Unit V Maintenance of Laboratory 12 h

Maintenance of Laboratory Equipment's – Centrifuge, calorimeter, microscope, incubator, autoclave. Laboratory Certification process – National Accreditation Board for Laboratories, Indian Standard Organization - Standard Operating Procedure - Clinical Laboratory records.Biomedical waste management – Danger sign.

Text Books

1. Ananthanarayanan R and CK JayaramPanicker, (1994). Textbook of Microbiology. (10 Edn.) Delhi: Orient Longman.
2. Monica Cheesbrough, (2018). District Laboratory Practice in Tropical Countries. (2Edn.) USA:Cambridge University Press.

References

1. Bailey and Scotts,. (1994). Diagnostic Microbiology. (9 Edn.) New Delhi: Baron and Finegold CVMosby Publications.
2. Jawetz E Melnic JL and Adel berg EA,. (1998). Review of Medical Microbiology. (10 Edn.) USA: LangeMedical Publications.
3. Mackie and McCatney,. (1994). MedicalMicrobiology. (14 Edn.) New Delhi: Church will Livingston.
4. Patrick.K.Murray,I.N. (2012). Medical Microbiology. (4 Edn.) USA: Mosboy Publishers.

Course Code	Course Name	Category	L	T	P	Credit
193BC2A2DA	ELECTIVE II- BIOCHEMISTRY OF TOXICOLOGY	ELECTIVE	3	1	-	3

PREAMBLE

This course has been designed for students to learn and understand

- The biochemical basis of toxicology.
- The effects & metabolism of toxins.
- General toxicology, methods of toxicity testing, toxins from microbes, carcinogenic & teratogenic toxins, pesticide, metal and chemical toxicology.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Value the importance of toxicology. Explain about factors which influence toxicity.	K5
CO2	Distinguish and evaluate the biochemical effects of toxic agents on cellular macromolecules and tissues.	K4 & K5
CO3	Compare and perceive different genetic methods used for testing toxicity.	K4 & K5
CO4	Examine the effects and metabolism of various microbial toxins, teratogens and carcinogens.	K4
CO5	Justify the mode of action of toxic pesticides, heavy metals, chemicals and air pollutants.	K5

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	S	S
CO2	S	S	M	S	S
CO3	S	S	S	S	S
CO4	S	S	M	S	S
CO5	S	S	M	S	S

S Strong M Medium L Low

193BC2A2DA	ELECTIVE-II: BIOCHEMISTRY OF TOXICOLOGY	**SEMESTER II**

Total Credits: 3
Total Instruction Hours: 48 h

Syllabus

Unit I Introduction to Toxicology 9 h

Definition and scope of toxicology, Classification of toxic agents. Dose-response relationship: Synergism and Antagonism - Determination of ED50 and LD50. Acute and chronic exposures, Factors influencing toxicity - Abiotic and Biotic factors, Chemical interactions - Bioaccumulation and Bio-magnification.

Unit II Biochemical basis of Toxicology 9 h

Mechanisms of Toxicity, Interaction of toxicant with target molecules - Disturbance of excitable membrane function. Altered calcium homeostasis. Covalent binding to cellular macromolecules. Tissue specificity of toxicity - Metabolism of haloalkanes, haloalkenes and their toxic effects on tissues.

Unit III Principles and procedures of testing for acute toxic effects 10 h

Toxicity testing - Genetic toxicity testing and mutagenesis assays - In-vitro test systems - Bacterial mutation tests: Reversion test and Fluctuation tests. In-vivo mammalian mutation tests - Host mediated assay and Dominant lethal test. Use of drosophila in toxicity testing. DNA Repair assays, Chromosome damage test. Toxicity testing in animals.

Unit IV Effects and Metabolism of toxins 10 h

Fungal toxins, Mycotoxins - Aflatoxins, Bacterial toxins - Exotoxins (types-I, -II and -III) and Endotoxins, Viral toxins, Algal toxins, Teratogens, Carcinogens, Mutagens, Snake venom toxin, Spider, Scorpion and Jellyfish toxins, Antivenom. Xenobiotic metabolism: Phase 1– III reactions, Cytochrome-P450.

Unit V Pesticide toxicology, Metal toxicology, Chemical toxicology, Air and water pollutants 10 h

Mechanism and site of action of Chlorinated organics (DDT, BHC), organophosphates and carbamates. Mode of action of toxic heavy metals - arsenic, mercury, cadmium and lead. Biochemical effects of ozone, peroxyacetyl nitrate (PAN), carbon monoxide, nitrogen oxides, sulphur dioxide and cyanide. Common air pollutants, water pollutants and their sources, air pollution due to methyl-isocyanate (MIC) and asbestos. Case studies.

Text Books

1. Klaassen Curtis, D (2001). Casarett and Doull's Toxicology. (6th Edn.) London: McGraw Hill.
2. Hodgson,E. (2010). A textbook of Modern toxicology. (4thEdn.) New Jersey: John Wiley and Sons Inc.

References

1. Duffus and Worth,. (2006). Fundamental Toxicology. (10 Edn.) London: Royal Society of Chemistry.
2. De,A.K. (2017). Environmental Chemistry. (8th Edn.) NewDelhi:Newage International Publishers.
3. Manahan Stanley , E. (2003). Toxicological Chemistry and Biochemistry. (3 Edn.) Florida: CRC Press LLC.
4. Ballantyne Marrs and Syversen,. (2011). General, Applied and Systems Toxicology. (3 Edn.) New Jersey: John Wiley and Sons..

Course Code	Course Name	Category	L	T	P	Credit
193BT2A2DA	ELECTIVE II : FORENSIC TECHNOLOGY	CORE	3	1	-	3

PREAMBLE

This course has been designed for students to learn and understand

- Keep abreast with all recent developments and emerging trends in Forensic Medicine, Medical Ethics and the Law.
- Interpret histo-pathological, microbiological, DNA profile and other investigative reports for medico-legal purposes.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Impart the concepts of Forensic Serology and examine Forensic samples	K3, K4
CO2	Know the basics of serogenetic markers and its significance in Forensic Science	K3, K4
CO3	Interpret and examine forensic evidence of DNA typing	K3, K4
CO4	Discuss the different methods if DNA profiling	K4, K5
CO5	Distinguish and inspect the data generated from DNA fingerprints and to store the data.	K4, K5

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	M	S	S	M
CO2	S	S	S	M	M
CO3	S	S	S	S	S
CO4	S	S	S	S	S
CO5	M	S	S	S	M

S Strong M Medium L Low

193BT2A2DA	ELECTIVE II : FORENSIC TECHNOLOGY	**SEMESTER II**

Total Credits: 3
Total Instruction Hours: 48 h

Syllabus

Unit I Forensic Serology 8 h

Nature of Blood, Blood Stain Pattern – Interpretation and Significance, Age of Blood Stains, Collection and Preservation of Blood, Semen, Saliva, Urine, Faeces and Milk Samples, Identification of Biological Stains by Chemical, Biochemical, Crystal-Chromatographic and Spectroscopic Methods.

Unit II Serogenetic Markers 10 h

Introduction of Blood Groups – Biochemistry and Genetics of ABO, MN and Rh systems, Serum proteins: Hp -Transferrin, LDH, Cellular Proteins: PGM, ADA, G6PD, Haemoglobin Variants: Hbf, Hbs, Hbc, HbA, Determination of Sex and Race from Blood, White Blood Group System – HLA and its Forensic Significance.

Unit III DNA isolation from specimen 10 h

Collection and Preservation of physical evidence for DNA typing, Forensic DNA Analysis- Isolation of DNA, Determination of quality and quantity of DNA, Slab Gel & Capillary Electrophoresis, DNA detection, Fluorescent dyes and silver staining.

Unit IV DNA Typing 11 h

RFLP analysis, PCR amplification - Sequence polymorphism (HLA DQA1, Polymarker Amplitype PM6, Mitochondrial DNA), Length polymorphism (STRs, Gender identification, D1S80), Instrumentation for STR typing, STR Genotyping, Automated analysis system, Applications of DNA profiling, Legal standards for admissibility of DNA profiling.

Unit V Interpretation of DNA Typing Results 9 h

Determination of genetic concordance, Evaluation of results- Bayes theorem, Hardy Weinberg law, Frequency estimate calculations- Population sub structure-Likelihood rations.

Text Books

1. Richard Saferstein,E (2020). Forensic Science Handbook. (2nd Edn.) Delhi:Prentice Hall.
2. Allan Jamieson and Scott BaderAuthor, (2016). A Guide to Forensic DNA Profiling. (10Edn.) UK: John Wiley & Sons.

References

1. John Butler ,M. (2005). Forensic DNA Typing - Biology, Technology, and Genetics of STR Markers. (2nd Edn.) United States: Academic Press.
2. John Butler, M (2009). . Fundamentals of Forensic DNA Typing. (1st Edn.) United States: Academic Press.
3. Stuart James, H and William EckertAuthor,G., (1993). Interpretation of blood stain evidence at Crime scenes. (2nd Edn.) US: CRC Press.
4. William Tilstone, J, Kathleen Savage, A and Leigh Clark, A. (2006). Forensic Science: An Encyclopedia of History, Methods and Techniques. (1st Edn.) California: ABC – CLINO Inc. .

Course Code	Course Category	Course Name	L	T	P	Exam (h)	Max Marks			Credits
							CIA	ESE	Total	
Third Semester										
193MB2A3CA	Core - XI	Immunology and Immuno-Technology	4	-	-	3	25	75	100	4
193MB2A3CB	CORE - XII	Medical Microbiology I - Bacteriology And Virology	4	-	-	3	25	75	100	4
193MB2A3CC	Core - XIII	Medical Microbiology II - Mycology And Parasitology	4	-	-	3	25	75	100	4
193MB2A3CD	Core – XIV	Genetic Engineering	4	-	-	3	25	75	100	4
193MB2A3CE	Core – XV	Research Methodology, Biostatistics and Bioinformatics	3	1	-	3	25	75	100	3
193MB2A3CP	Core Practical-III	Immunology, Medical Microbiology and Genetic Engineering	-	-	6	9	40	60	100	3
193MB2A3DA	DSE-III	Molecular Diagnostics in Microbiology	3	1	-	3	25	75	100	3
193BC2A3DA		System Biology								
193BT2A3DA		Molecular Therapeutics								
193MB2A3CT	Internship Training	A to C								
		Total	**22**	**2**	**6**	**27**	**190**	**510**	**700**	**25**

EXTRA CREDIT COURSES

The following are the courses offered under self study to earn extra credits:

S. No.	Course Code	Course Name
1	193MB2ASSA	Developmental Biology
2	193MB2ASSB	Inheritance Biology

Course Code	Course Name	Category	L	T	P	Credit
193MB2A3CA	IMMUNOLOGY AND IMMUNOTECHNOLOGY	CORE	4	-	-	4

PREAMBLE

This course has been designed for students to learn and understand

- The structural features of the components of the immune system
- The functions of Immune system.
- The mechanisms involved in Immune system development and responsiveness

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Describe the role of the immune system. Differentiate various cells involved in immune responses.	K2,K4
CO2	Describe the basic mechanisms, division and functional interplay of innate and adaptive immunity.	K2, K4
CO3	Prioritize the application of immunology in diagnostic and therapeutic techniques and research.	K4
CO4	Discriminate the features of B and T cell in Immune responses.	K4
CO5	Connect Tissue transplantation and graft rejection. Categorize vaccines and its types.	K4

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	M	M
CO2	M	S	M	S	S
CO3	S	M	S	M	M
CO4	S	S	M	S	S
CO5	S	S	S	M	S

S Strong **M Medium** **L Low**

193MB2A3CA	IMMUNOLOGY AND IMMUNOTECHNOLOGY	SEMESTER III

Total Credits: 4

Total Instruction Hours: 48 h

Syllabus

Unit I History and Scope of Immunology 10 h

Historical background and scope of Immunology, Basis of Human Defence mechanisms - First line defence – Anatomical and physiological barriers – Second line defence – Fever, inflammation, Phagocytosis and interferon – Third line defence - Cells and organs of immune system.

Unit II Immunity & Types 10 h

Immunity – types of immunity – Natural, acquired, specific and non specific, cell mediated and humoral, active and passive immunity. Antigens - properties, Epitopes, haptens, adjuvant, cross reactivity. Antibodies - properties, structure (primary & secondary) and isotypes. Diversity and specificity. Anti antibodies. Complement pathway.

Unit III Antigen-Antibody reactions 10 h

Antigens and antibody reactions - Introduction and classification of antigens and antibody reactions - Agglutination and precipitation reaction. Strength of antigen and antibody binding - affinity & avidity. Therapeutic applications of monoclonal antibodies and Complement fixation reaction. Immunofluorscence, RIA, RAST, ELISA and Flow cytometry - RT- PCR.

Unit IV Lymphocyte Response 9 h

Response of B-cell and T-cell to antigens. B-cell and T-cell products. Hyper sensitivity - Type I, II, III and IV - MHC antigens - types and functions. Immunity to infectious diseases - Viral, bacterial and protozoan.

Unit V Transplantation Immunology 9 h

Transplantation immunology - Tissue transplantation and grafting - Mechanism of graft acceptance and rejection - HLA typing - Tumor immunology - Immunodeficiency diseases and auto immunity. Vaccines - Types and vaccination methods.

Text Books

1 Roitt, IM, 2017, "Essential Immunology", 13th edition, Wiley-Blackwell Publishers, United States.

2 Kuby, 2018, "Immunology', 8th edition, W.H.Freeman Publishers, New York.

References

1 Lauren M. Sompayrac, 2019, "How Immune System Works", 6th edition, Wiley-Blackwell, United States.

2 Raif S. Geha and Luigi D. Notarangelo, 2016, "Case Studies in Immunology : A Clinical Companion", 7th edition, Garland Science Publishers, United States.

3 Tizard, I R, 1995, "Immunology an Introduction", 4th edition. Saunders College Pub, United States.

4 https://microbenotes.com/category/immunology/

Course Code	Course Name	Category	L	T	P	Credit
193MB2A3CB	MEDICAL MICROBIOLOGY I – BACTERIOLOGY AND VIROLOGY	CORE	4	-	-	4

PREAMBLE

This course has been designed for students to learn and understand

- The infections and epidemiology of infections
- The pathogenesis involved in bacterial and viral infections.
- Diagnosis involved in bacterial and viral infections.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Describe the infection, the role of epidemiology of infectious diseases and control of epidemics	K2
CO2	Discriminate the pathogenicity involved in gram positive and gram negative cocci	K4
CO3	Contrast the pathogenicity involved in gram positive and gram negative bacilli	K4
CO4	Prioritize the emerging viral infections and control measures	K4
CO5	Compare and classify the treatment procedures and therapeutic measures for viral diseases	K4

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	M	M
CO2	M	S	M	S	S
CO3	S	M	S	S	S
CO4	S	S	M	S	S
CO5	S	S	S	M	S

S Strong M Medium L Low

193MB2A3CB	MEDICAL MICROBIOLOGY I – BACTERIOLOGY AND VIROLOGY	SEMESTER III

Total Credits: 4

Total Instruction Hours: 48 h

Syllabus

Unit I Infections 10 h

Infections - Definitions- Epidemic, Pandemic, Endemic diseases- Epidemiology of Infectious diseases, Infectious diseases cycle- Investigation of epidemics- control of epidemics. Nosocomial infections.

Unit II Bacterial Infections - Cocci 10 h

Morphology, Pathogenicity and laboratory diagnosis - Gram positive & negative cocci - Staphylococcus aureus, Streptococcus pyogenes, Pneumococcus, Neisseria gonorrhoea and Neisseria meningitidis, Mycobacterium tuberculosis, Mycobacterium leprae, Treponema pallidum, Leptospira.

Unit III Bacterial Infections - Bacilli 10 h

Morphology, Pathogenicity and laboratory diagnosis - Gram positive and Gram negative organisms - Bacillus anthracis, Corynebacterium diptheriae, Clostridium botulinum, Clostridium tetani, Escherichia coli, Klebsiella, Proteus, Salmonella, Shigella, Pseudomonas, Vibrio cholerae.

Unit IV Emerging viral diseases 9 h

Emerging viral diseases: Ebola, Dengue. Current scenario of viral infection and control - Seasonal diseases: SARS, MERS, Swine flu, Corona virus - WHO initiatives in controlling the diseases - CDC and ICMR guidelines.

Unit V Treatment for Viral Infections 9 h

Treatment of viral infections - Antiviral drugs for viral infections other than Human Immunodeficiency Virus - Chemotherapy of viral infections - Main targets for antiviral drugs - Currently available drugs for emerging viral infections.

Text Books

1 Ananthanarayan and Paniker, 2013, "Textbook of Microbiology", 9th edition, Universities Press Private Ltd.. India.

2 Chakraborty P, 2013, "A Text book of Microbiology", 3rd revised edition, New Central Book Agency Pvt Ltd. Calcutta.

References

1 Bailey and Scotts, 2013, "Diagnostic Microbiology", 13th edition, Baron and Finegold CV Mosby Publications., United States.

2 Brooks G., Carrol K.C., Butel J. and Morse S, 2012, "Jawetz Melnick and Adelberg Medical Microbiology", 26th Edition. Lange Medical Publications USA

3 Mackie and McCartney, 1994, "Medical Microbiology No I and II". 14th edition, Churchill Livingston, London.

4 Luria S.E. Darnel, J.E Jr. Baltimore. D and Campbell A, 1978, "General Virology", 3rd edition, John Wiley and sons. USA.

Course Code	Course Name	Category	L	T	P	Credit
193MB2A3CC	MEDICAL MICROBIOLOGY II - MYCOLOGY AND PARASITOLOGY	CORE	4	-	-	4

PREAMBLE

This course has been designed for students to learn and understand

- The concept of infectious disease process, transport, processing and examination of medically important fungi
- The concept of infectious disease process, transport, processing and examination of medically important parasite
- Helminthic infections and emerging parasitic infections

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Recognize the concept of infectious disease process. Demonstrate the processing of clinical samples.	K1, K4
CO2	Classify the morphology, cultural characteristics and pathogenesis of fungal infections.	K4
CO3	Illustrate the morphology, cultural characteristics and pathogenesis of subcutaneous mycosis.	K3
CO4	Recommend the collection and processing of clinical samples to identify the intestinal parasitic infection.	K5
CO5	Construct the techniques for the processing of clinical samples to identify the intestinal parasitic infection.	K3

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	M	S	M	S	S
CO2	S	M	S	S	S
CO3	M	S	S	S	S
CO4	S	S	S	S	S
CO5	S	S	S	S	S

S Strong **M Medium** **L Low**

193MB2A3CC	MEDICAL MICROBIOLOGY II -MYCOLOGY AND PARASITOLOGY	SEMESTER III

Total Credits: 4

Total Instruction Hours: 48 h

Syllabus

Unit I Fungal Infections 10 h

Morphology, Taxonomy, classification of fungi, detection and recovery of fungi from clinical specimens. Classification of medically important Fungi (Morphology, Infection & Reproduction), Immunity to Fungal Infections. Culture Media and Stains in Mycology, Normal fungal flora of human beings, Specimen collection, preservation, Transportation & Identification of Mycological Agent. Biochemical tests for fungal identification, Anti-fungal agents - sensitivity test and quality control – Fungal culture collection methods – Antifungal susceptibility test.

Unit II Dermatophytes 10 h

Dermatophytes and agents of superficial mycoses - Trichophyton. Edidermophyton and Microsporum. Yeasts of medical importance - Candida, Cryptococcus. Pityriasis versicolor, White piedra, Black piedra, Tinea nigra, Mycotoxins. Allergic Fungal diseases - Mycetismus.

Unit III Subcutaneous and other Mycosis 10 h

Subcutaneous Mycosis – Mycetoma, Sporotrichosis, Chromoblastomycosis, Systemic Mycosis- Histoplasmosis, Blastomycosis, Coccidioidomycosis, Opportunistic Mycosis – Candidiasis, Aspergillosis, Miscellaneous Mycosis- Otomycosis. Fungal infections in eyes.

Unit IV Introduction and classification of parasites 9 h

Introduction and classification of parasites - Laboratory diagnostic techniques in parasitology - Examination of faeces, cultivation, Direct and concentration methods -Intestinal amoebae - Entamoeba histolytica, Entamoeba coli. Free living amoebae -Naegleria fowleri, Acanthamoeba spp. Intestinal and genital flagellates - Giardia, Trichomonas. Blood and tissue flagellates - Leishmania donovani, Trypanosoma cruzi. Haemosporina - Malarial parasites. Coccidian - Toxoplasma, Cryptosporium.

Unit V Helminthic Infections 9 h

Helminthic Infections - Taenia solium, T. Saginata, Echinococcus granulosus, Fasciola hepatica, Paragonimus westermani and Schistosomes, Ascaris lumbricoids, Ancylostoma duodenale, Trichuris triuchura, Enterobius vermicularis and Wuchereria bancrofti. Blood smear examination - Serology and Molecular agnosis - PCR. Emerging parasitic infection.

Text Books

1. Chander J. 2017, "Text Book of Medical Mycology", 4th Edition. Jaypee Brothers Medical Pub. New Delhi.
2. Errol Reiss, H. Jean Shadomy, G. Marshall Lyon, 2016, "Fundamental Medical Mycology", Wiley-Blackwell. Unites States.

References

1. Reiss E. Shadomy H.J. and Lyon G.M, 2011, "Fundamental Medical Mycology", Wiley-Blackwell. Unites States.
2. Brooks G., Carrol K.C., Butel J. and Morse S, 2012, "Jawetz Melnick and Adelberg Medical Microbiology", 26th Edition. Lange Medical Publications USA.
3. Chatterjee K.D, 2019, "Parasitology: Protozoology and Helminthology", 13th Edition. CBS Publishers & Distributors Pvt. Limited. New Delhi.
4. Arora DR, 2020, "Medical Parasitology",. 5th Edition. CBS Publishers & Distributors Pvt. Limited. New Delhi.

Course Code	Course Name	Category	L	T	P	Credit
193MB2A3CD	GENETIC ENGINEERING	CORE	4	-	-	4

PREAMBLE

This course has been designed for students to learn and understand

- The basis of Microbial cloning process
- The availability of different kinds of cloning vectors
- The characterization of the cloned DNA

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Illustrate the cloning and the methods of handling and quantification of DNA and RNA.	K2, K3
CO2	Review the Vectors and its properties for gene cloning. Describe the plant vectors and animal vectors.	K2
CO3	Recognize the direct and indirect method of screening of recombinants and blotting techniques.	K3
CO4	Compare and contrast the characters of cloned DNA.	K4
CO5	Express Site directed mutagenesis, design and construction of novel proteins and enzymes.	K2, K4

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	S	M
CO2	S	S	M	S	M
CO3	S	S	M	S	M
CO4	S	S	M	S	M
CO5	S	S	M	S	M

S Strong M Medium L Low

193MB2A3CD	GENETIC ENGINEERING	SEMESTER III

Total Credits: 4

Total Instruction Hours: 48 h

Syllabus

Unit I Cloning 10 h

Cloning - Isolation and purification of nucleic acids (chromosomal DNA, RNA & Plasmids) – Methods of handling and quantification of DNA and RNA - Restriction endonucleases: types and characteristics - DNA methylases – Ligases – Adapters, Linkers and Homo polymer tailing.

Unit II Vectors 10 h

Vectors – properties - types of vectors – plasmids– host range and incompatibility – Vectors constructed based on bacteriophages (M13 & Lambda), cosmids, phagemids and BACs - Eukaryotic vectors - Yeast vectors (YAC) – animal (retroviruses, adenoviruses) and plant vectors (Ti plasmid based vectors and caulimoviral vector) – expression vectors - shuttle vectors.

Unit III Gene transfer techniques 10 h

Gene transfer techniques in plants, animals and microbes - Transformation, electroporation, microprojectile system, liposome mediated transfer, genegun etc. Agrobacterium-mediated gene transfer in plants – Ti plasmid: structure and functions, Ti plasmid based vectors - advantages. Chloroplast transformation. Screening: Direct: Insertional inactivation, plaque phenotype and indirect methods: Immunochemical detection - Nucleic acid hybridization, Blotting - Dot and Colony Blotting. Chromosome walking. Chromosome jumping.

Unit IV Characterization of cloned DNA 9 h

Characterization of cloned DNA: Restriction mapping - restriction fragment length polymorphism (RFLP) - Polymerase chain reaction (PCR) - Types of PCR and their applications. DNA sequencing: Primer walking, Maxim and Gilbert method, dideoxy method, automated sequencing and micro array. Genomic DNA libraries - cDNA libraries.

Unit V Protein Engineering 9 h

Site Directed Mutagenesis, Protein Engineering. Design and construction of novel proteins and enzymes. Protein Folding – Designer Enzymes – Semi synthetic enzyme used in organic solution, Abenzyme and other antibody protein conjugates.

Text Books

1 Old. RW and Primbrose, 2001, "Principle of Gene Manipulation", 6th edition. Blackwell Scientific Publication, Boston.

2 T.A Brown, 2018, "Genomes 4", 4st edition, John- Wiley & Sons, Australia.

References

1 Devarajan Thangadurai, Jeyabalan Sangeetha, 2015, "Genomics and Proteomics : Principles, Technologies, and Applications", ISBN No. 9781498723114, Apple Academic Press Inc. Oakville, Canada.

2 Klug, W. S., & Cummings, M. R, 2016, "Concepts of genetics", 11th edition. Pearson Educational Ltd, Bangaluru.

3 Maria Sandkvist , Eric Cascales , Peter J. Christie, 2019, "Protein Secretion in Bacteria", 1st Edition, American Society for Microbiology, Washington DC, United States.

4 Manikanda Boopathi N, 2020, "Genetic Mapping and Marker Assisted Selection: Basics, Practice and Benefits", 2nd edition, Springer Verlag, Singapore.

Course Code	Course Name	Category	L	T	P	Credit
193MB2A3CE	RESEARCH METHODOLOGY BIOSTATISTICS AND BIOINFORMATICS	CORE	3	1	-	3

PREAMBLE

This course has been designed for students to learn and understand

- The range of conceptual, methodological and statistical skills in future research and professional work.
- The basis of statistical tools and its usage
- The basics of bioinformatics tools and its applications

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Categorize and design a research study. Recognize the process and analysis of research data.	K1, K4
CO2	Interpret the reports for statistical and qualitative data. Demonstrate competence in open defense presentation.	K2, K3
CO3	Practice the collection, classification and tabulation of data. Formulate and interpret graphs appropriately.	K3, K5
CO4	Comprehend and compute the basic descriptive statistical measures.	K2, K4
CO5	Understand the bioinformatics, databases and its applications.	K2, K3

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	S	M
CO2	S	S	S	S	S
CO3	S	S	M	S	S
CO4	S	S	S	S	S
CO5	S	S	S	S	S

S Strong M Medium L Low

193MB2A3CE	RESEARCH METHODOLOGY BIOSTATISTICS AND BIOINFORMATICS	SEMESTER III

Total Credits: 3

Total Instruction Hours: 48 h

Syllabus

Unit I Research Methodology: An Introduction 10 h

Research Methodology - Meaning and objectives and types of research. Research approaches - Research Process. Defining the research problem - Research design. Sampling – types and design. Data collection methods for bioscience research - Processing and analysis of data.

Unit II Thesis Preparation and presentation 10 h

Writing the Research Report (Thesis and publications): Components of research report - Title, Authors, Addresses, Abstract, Keywords, Introduction, Materials and Methods, Results, Discussion, Summary, Acknowledgements and Bibliography. Preparation for 'Open Defense Presentation. Bibliometrics. Journals – Writing of Research / Review article – H index, I index, Web of science, Scopus, SCI indexed – Plagiarism.

Unit III Basic Biostatistics and Descriptive statistics 10 h

Definition- Importance of Biostatistics. Collection, Classification and Tabulation data. – Graphical and diagrammatic representation of numerical data – Graphs – Histogram, Frequency curve.

Unit IV Analysis- Univariate, Bivariate and Multivariate 9 h

Calculation of statistical averages- Mean, median, Mode in series of individual observations, discrete series, continuous. Measure of dispersion - Standard deviation. Correlation – Simple and coefficient of correlation. Level of significant test- t-test - SPSS –R programme.

Unit V Bioinformatics- Introduction and data bases 9 h

Definition, History, Scope and Applications. Opportunities in Bioinformatics. Importance of databases, Nucleic acid (DNA and RNA) sequence - Protein databases and Structure databases. Drug designing – Softwares - Data analytics.

Text Books

1 Gupta S P, 2009, "Specifications of Statistical methods", 28th Edition, Sultan Chand & sons. Delhi.

2 Kothari C R, 2004, "Research Methodology: Methods and Techniques", New Age International, New Delhi.

References

1 Khan Irfan A and Atiya Khanum, 2009, "Fundamentals of Biostatistics", ISBN: 81-900441-0-9 , Ukaaz Publications, Hyderabad.

2 Zar JH, 2006, "Biostatistical analysis", 4th Edition. Pearson education Inc. New Jersey.

3 Sundar Rao PSS, Richard J, 2006, "Introduction to Biostatistics & Research methods", Prentice -Hall of India (P) Ltd, New Delhi.

4 Pranab Kumar Banerjee , 2007, " Introduction to Bio-Statistics: A Textbook of Biometry", 3rd Revised Edition, S Chand Publishers, New Delhi.

193MB2A3CP	CORE PRACTICAL - III: IMMUNOLOGY, MEDICAL MICROBIOLOGY AND GENETIC ENGINEERING	SEMESTER III

Total Credits: 3
Total Instructions Hours: 72 h

S.No	Content
1	Production of Chick Antibodies - Demonstration
2	Serological test for HBsAg and HBcAg
3	Dot ELISA
4	Immunodiffusion – Ocuterlony method
5	Isolation & Identification of bacteria from clinical samples - Urine, Pus, Sputum, Stool, Wound samples.
6	Antibiotic susceptibility test - Kirby Bauer technique, Stokes method
7	Isolation and identification of clinically important fungi - Candida albicans, Aspergillus sp.,
8	Observation of parasites - Entamoeba histolytica, Trichomonas vaginalis, Plasmodium vivax, Leishmania donovani.
9	Transformation, Conjugation, Screening by Blue white selection
10	Restriction Digestion Analysis
11	Western Blotting
12	PCR, Rapid Diagnostic Kit method for viruses - Demonstration

Note: Out of 12 – 10 Mandatory

References

1. Aneja K R, 2012, "Experiments in Microbiology, plant pathology and biotechnology", 4th Edition. New age publishers, Kolkata.
2. James C Cappuccino, 2013, "Microbiology A laboratory manual", 1st edition, Pearson education publishers, Bangaluru.
3. Rajan S and Selvi Christy, 2018, "Experimental Procedures in Life Sciences", ISBN 13: 9789386478252, CBS Publishers, India.
4. Kannan N, 1997, Laboratory Manual of General Microbiology, 1st edition, Panima Publishing House, New Delhi.

Course Code	Course Name	Category	L	T	P	Credit
193MB2A3DA	MOLECULAR DIAGNOSTICS IN MICROBIOLOGY	DSE	3	1	-	3

PREAMBLE

This course has been designed for students to learn and understand

- Microbes and its involvement in causing life threatening diseases
- The identification of microbes through traditional methods
- The identification and characterization of microbes using different molecular techniques

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Recall the concept of molecular diagnostics of microorganism.	K2, K3
CO2	Demonstrate the traditional methods of identification of bacteria, fungi, virus, protozoans, and parasites	K3
CO3	Identify microbes based on nucleic acid sequencing and PCR based identification methods	K2, K3
CO4	Illustrate the microbial identification based on proteins and different blotting techniques.	K4
CO5	Develop the hybridization techniques to identify and confirm the type of microbe	K5

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	S	M
CO2	S	S	S	S	M
CO3	S	S	S	S	M
CO4	S	S	S	S	M
CO5	S	S	S	S	M

S Strong M Medium L Low

193MB2A3DA	MOLECULAR DIAGNOSTICS IN MICROBIOLOGY	SEMESTER III

Total Credits: 3

Total Instruction Hours: 48 h

Syllabus

Unit I Introduction 10 h

History and Transcending of diagnostics over time – Traditional and molecular diagnostics – Significance of molecular diagnostics – Scope for Molecular diagnostics - Rise of diagnostic industry in Indian and global scenario. Diseases - Infection – mode of transmission in infections, factors predisposing to microbial pathogenicity, types of infectious diseases - bacterial, viral, fungal, protozoans and other parasites. Host-Parasite Interactions.

Unit II Traditional disease diagnosis methods and tools 10 h

Diagnosis of infection caused by Bacteria - Streptococcus, Salmonella, and Mycobacterium. Diagnosis of fungal infections - Dermatophytosis, Candidiasis and Aspergillosis. Diagnosis of viruses - Adenoviruses, Rhabdo Viruses, and Retroviruses. Diagnosis of Protozoans: Malaria, Trypanosomiasis, Leishmaniasis. Study of helminthic diseases - Fasciola hepatica and Ascaris lumbricoides.

Unit III Molecular Diagnosis using Immunoglobins 10 h

Introduction - antigen-antibody binding interactions and assays - monoclonal, and polyclonal antibodies. Agglutination - RIA, ELISA's, chemiluminescence, immunofluorescence, Western blots - Bioluminescence. Proteins and Amino acids, Qualitative and quantitative techniques: Protein stability, denaturation; amino acid sequence analysis.

Unit IV Molecular Diagnosis using Nucleotides 9 h

Automated DNA sequencing- Principles, Methods and Instrumentation- Advances in DNA sequencing - New Generation sequencing Methods, Pyrosequencing, BLAST, FASTA, Microarrays, SAGE. Nucleic acid amplification methods and types of PCR: Reverse Transcriptase-PCR, Real-Time PCR, Inverse PCR, Ligase Chain Reaction. RACE, RNA fingerprinting.

Unit V Hybridization and Sequencing 9 h

Southern, Northern, in-situ (including FISH), microarrays – types and applications; Protein extraction and analysis (including PAGE and its variations); Western Blot, Southern, northern, dot/slot blot; electrophoresis, nucleic acid probe preparation

Text Books

1. Thomas J Kindt, Barbara A Goldsby, Richard Osborne 2006, "Kuby's Immunology", W. H. Freeman Publishers, New York.
2. William B Coleman, Gregory J Tsongalis, 2005, "Molecular Diagnostics: For the Clinical Laboratorian", 2nd Edition, Hanuma Publishers, New Delhi.

References

1. Upadhya and Nath, 2016, "Biophysical Chemistry: Principles and Techniques", 4th Edition, Himalaya Publishing House Pvt. Ltd. New Delhi.
2. Keith Willson and Kenneth H. Goulding. 1991, "A Biologist's Guide to Principles and Techniques of Practical Biochemistry", 3rd Edition, Cambridge University Press, USA.
3. Keith Willson and John Walker, 2010, " Principles and Techniques of Biochemistry and Molecular Biology", 7th Edition, Cambridge University Press, US.
4. Lele Buckingham and Maribeth L. Flaws, 2019, "Molecular Diagnostics: Fundamentals, Methods & Clinical applications", 3rd Edition, F. A. Davis Company, Philadelphia.

Course Code	Course Name	Category	L	T	P	Credit
193BC2A3DA	SYSTEMS BIOLOGY	DSE	3	1	-	3

PREAMBLE

This course has been designed for students to learn and understand

- The structure, dynamics and basic design principles of biological systems
- The transformation of biology from a descriptive to a predictive science
- The systems biology of evolution

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Distinguish designed and evolved systems	K2 & K3
CO2	Elucidate structures of any networks in the biological systems	K2 & K3
CO3	Elucidate mechanisms of dynamics of any networks in the biological systems	K3 & K4
CO4	Relate systems dynamics with organism evolution	K4 & K5
CO5	Design and create synthetic biological networks for various applications	K5 & K6

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	M	M
CO2	S	S	M	M	M
CO3	S	S	S	M	M
CO4	S	S	S	S	S
CO5	S	S	S	S	S

S Strong M Medium L Low

193BC2A3DA	SYSTEMS BIOLOGY	SEMESTER III

Total Credits: 3
Total Instruction Hours: 48 h

Syllabus

Unit I Introduction to Systems Biology 10 h

System biology concept: designed and evolved systems. Biological Networks: elements (Nodes-Gene, Edges-Protein, Receptor, Ligand, Morphogens, Field, Metabolites, Neurotransmitters), interaction, motifs, circuits, modularity, switch, dynamics, regulation, superimposed networks. Examples for biological networks: transcriptional, developmental, signal transduction, metabolic and neuronal networks. Emergent property. Random networks, Scale-free networks, small-world networks. Degree distribution, Clustering coefficient. Self-organizing (SOM) and connectivity maps, and its uses.

Unit II Systems Structure-I 9 h

Transcription Networks: Recurring Network Motifs-Regulation-Auto-regulation: positive auto-regulation (PAR) and negative auto-regulation (NAR). Feed Back Loop (FBL)- Positive Feed Back Loop, Negative Feed Back Loop. Feed Forward Loop (FFL), coherent-FFL and incoherent-FFL. Interlocked FFL. Lactose (simple), Arabinose (C-FFL), Flagella (C-FFL), Galactose (I-FFL) systems in E. coli and B.subtilis Sporulation Network.

Unit III Systems Structure-II 9 h

Transcription Networks: Sensory Transcription Networks-Regulation: Single-Input Module (SIM)-Last-In-First-Out (LIFO) and First-In-First-Out (FIFO). Multi-Output Forward Loop: Bi-Fans and Dense Overlapping Regulons (DOR). Arginine (LIFO), Flagella production (FIFO) and CRP (cAMP Response Protein) (DOR) system in E. coli. Double-Positive Feedback Loop and Double-Negative Feedback Loop. Regulating Feed Back and Regulated Feed Back.

Unit IV Systems Dynamics and Evolution 10 h

Stochasticity, Robustness (cancer-HIF-1 VEGF, uPAR), Fragility (Diabetes mellitus) and Organisms Diversity. Robustness Trade-offs. Robustness and evolvability-environmental and genetic perturbation. e.g. λ-phage life cycle (genetic switch), Bacterial chemotaxis, Developmental plasticity (patterning in fruit fly development) and tumor resistance against therapies (EGFR).

Unit V Mechanism of Systems Dynamics 10 h

Principle of Robustness: System control-Negative feedback loop-stable system dynamics (Bacterial chemotaxis). Positive feedback loop-bistability (λ-phage life cycle). Redundancy, Modular design (liver-glucose and lung-oxygen physiology) and Decoupling (protein folding-Hsp90). Self-extending symbiosis: horizontal gene transfer, serial endosymbiosis and oocyte-mediated vertical transfer of symbionts.

Text Books

1 Uri Alon, 2020, "An Introduction to Systems Biology: Design Principles of Biological Circuits" 2nd Edition, Chapman & Hall/CRC, Taylor and Francis group, New York, USA

2 Edda Klipp, Wolfram Liebermeister, Christoph Wierling, Axel Kowald, Hans Lehrach, and Ralf Herwig, 2009, "Systems Biology A Text Book", 1st Edition, WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim, Germany.

References

1 Michael T. Madigan, John M. MarTinko, Kelly S. Bender, Daniel H. Buckley and David A. Stahl, 2015, "Brock Biology of Microorganisms", 4th Edition, Pearson Education Inc, Illinois, USA.

2 John E. Hall, 2016, "Guyton and Hall Textbook of Medical Physiology", 13th Edition, ELSEVIER Inc, Philadelphia, USA

3 Scott F. Gilbert, 2010, "Developmental Biology", 9th Edition, Sinauer Associates, Inc, Massachusetts USA

4 Robert A. Weinberg, 2014,"The Biology of Cancer", 2nd Edition, Garland Science, Taylor & Francis Group, New York, USA

Course Code	Course Name	Category	L	T	P	Credit
193BT2A3DA	MOLECULAR THERAPEUTICS	DSE	3	1	-	3

PREAMBLE

This course has been designed for students to learn and understand

- The types of PCR and its applications in diagnosis
- The importance about the human genome project
- The interaction of molecules based on given therapy

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Sketch the process of drug targeting and gene therapy	K3
CO2	Estimate the current techniques of gene delivery and other therapeutic products	K3,K4
CO3	Summarize recombinant gene therapy	K3,K4,K5
CO4	Integrate pathogenic diseases and metabolic disorders	K4, K5
CO5	Design concept of immunotherapy and its applications	K3,K4,K5

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	S	S
CO2	S	S	S	S	S
CO3	S	S	S	S	S
CO4	S	S	M	S	S
CO5	S	S	M	M	S

S Strong M Medium L Low

193BT2A3DA	MOLECULAR THERAPEUTICS	SEMESTER III

Total Credits: 3

Total Instruction Hours: 48 h

Syllabus

Unit I Concepts of Gene Therapy and Drug Delivery 09 h

Gene Therapy, Drug targeting and drug delivery system. Intracellular barriers to gene delivery, overview of inherited and acquired diseases for gene therapy, virus mediated gene transfer. Liposome and Nanoparticles mediated gene delivery

Unit II Stem cells and Tissue Engineering 10 h

Cellular therapy; Stem cells: definition, properties and potency of stem cells; Sources: embryonic and adult stem cells; Concept of tissue engineering; Role of scaffolds; Role of growth factors; Role of adult and embryonic stem cells; Clinical applications; Ethical issues.

Unit III Recombinant Gene therapy 10 h

Recombinant therapy, Clinical application of recombinant technology, Erythropoietin, insulin analogs and its role in diabetes, Recombinant human growth hormone, streptokinase and urokinase in thrombosis. Recombinant coagulation factors

Unit IV Microbial Pathogenicity 10 h

Factors predisposing to microbial pathogenicity, types of infectious diseases. General concept of infectious disease, Progression of Infection and Disease - Entrance (Portal of entry), Colonization (Adherence; Adhesion; Attachment), Prevention of Host Defenses, Antigenic Variation, Penetration into Host Cytoskeleton, Damage to Host Cells, Production of Toxins

Unit V Immunotherapy 09 h

Phage and their application, Immunotherapy, Monoclonal antibodies and their role in cancer, role of recombinant interferons, Immunostimulant and Immunosupressors in organ transplants, role of cytokine therapy in cancer. Vaccines: types, recombinant vaccines and clinical applications

Text Books

1 Palsson, B. and Bhatia, S. N. 2004. Tissue Engineering. 2nd Edition. Prentice Hall. USA

2 Greenwell, P. and McCulley, M. 2008. Molecular Therapeutics: 21st century medicine. 1st Edition. Wiley-Blackwell. USA

References

1 Coleman, W.B. and Tsongalis, G.J. 2006. Molecular Diagnostics for the Clinical Laboratory. 2nd Edition. Humana Press. USA

2 Leonard, DGB. 2016. Molecular Pathology in Clinical Practice. 2nd Edition. Springer International Publishers. USA

3 Whitehouse, D. and Rapley, R. 2012. Molecular and Cellular Therapeutics. 1st edition. Wiley – Blackwell Publications. USA

4 Quesenberry, P.J. , Stein, G.S. et al. 1998. Stem Cell Biology and Gene Therapy. 1st edition. John Wiley and Sons Publications. USA

193MB2ASSA	SELF STUDY: DEVELOPMENTAL BIOLOGY	SEMESTER III

Total Credits: 1

Syllabus

Unit I Basic concepts of development

Basic concepts of development: Potency, commitment, specification, induction, competence, determination and differentiation; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development.

Unit II Gametogenesis, fertilization and early development

Gametogenesis, fertilization and early development: Production of gametes, cell surface molecules in sperm - egg recognition in animals; embryo sac development and double fertilization in plants; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis, establishment of symmetry in plants.

Unit III Morphogenesis and organogenesis in animals

Morphogenesis and organogenesis in animals: Cell aggregation and differentiation in Dictyostelium; axes and pattern formation in Drosophila, amphibia and chick; organogenesis – vulva formation in Caenorhabditis elegans , eye lens induction, limb development and regeneration in vertebrates; differentiation of neurons, post embryonic development - larval formation, metamorphosis; sex determination.

Unit IV Morphogenesis and organogenesis in plants

Morphogenesis and organogenesis in plants: Organization of shoot and root apical meristem; shoot and root development; leaf development and phyllotaxy; transition to flowering, floral meristems and floral development in Arabidopsis and Antirrhinum.

Unit V Cell death and aging

Programmed cell death (PCD), aging and senescence - Programmed cell death in plants and animals - Apoptosis and Necrosis - Molecular Markers to determine Apoptosis.

Text Books

1. Scott F Gilbert, 2013, "Developmental Biology", 10th Edition, Sinauer Associates, inc, Sunderland.
2. Kumar Pushkar, Singh AP, 2010, "CSIR-UGC NET/JRF/SLET Life Sciences", Upkar Prakashan, Agra, India

References

1. 2020, "CSIR-JRF-NET Life Sciences Book Combo Set with Ecology", Pathfinder Publication, New Delhi
2. Ashish Nagesh, Prashanth Kumar, Quaisher J Hossain, 2018, "UGC CSIR NET/SLET (JRF&LS) LIFE SCIENCES", Arihant Publishers, New Delhi
3. Singh BD, 2009, "Plant Breeding: Principles and Methods", 11th Edition, Kalyani Publishers, India
4. Van De Graaff Kent M, 2010, "Human Anatomy and Physiology", 2nd Edition, McGraw-Hill Education, New Delhi

193MB2ASSB	SELF STUDY: INHERITANCE BIOLOGY	SEMESTER III

Total Credits: 1

Syllabus

Unit I Mendelian principles

Mendelian principles: Dominance, segregation, independent assortment. Concept of gene: Allele, multiple alleles, pseudoallele, complementation tests. Extensions of Mendelian principles: Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters.

Unit II Gene mapping methods

Gene mapping methods: Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids, development of mapping population in plants. Extra chromosomal inheritance: Inheritance of Mitochondrial and chloroplast genes, maternal inheritance.

Unit III Microbial genetics

Microbial genetics: Methods of genetic transfers – transformation, conjugation, transduction and sex - Induction, mapping genes by interrupted mating, fine structure analysis of genes.

Unit IV Human genetics

Human genetics: Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders. Quantitative genetics: Polygenic inheritance, heritability and its measurements, QTL mapping.

Unit V Mutation

Mutation: Types, causes and detection, mutant types lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis. Structural and numerical alterations of chromosomes: Deletion, duplication, inversion, translocation, ploidy and their genetic implications. Recombination: Homologous and non - homologous recombination including transposition.

Text Books

1 Gardner, E. J. Simmons, M. J& Snustad, D. P. 2006, "Principles of Genetics", 8th Edition, Wiley & sons, New Jersey.

2 Freifelder S, 1987, "Microbial Genetics", 1st Edition. Jones & Bartlett, Boston.

References

1 David Freifelder, 1998, "Essentials of Molecular Biology, 3rd Edition, Jones and Bartlett Publishers, US.

2 Lewin.B, 1990. Genes, 1st edition, Oxford University Press, US

3 Klug .W.S. & Cummings, MR. 1996, Essentials of Genetics, Mentics Hail. NewJersey.

4 Prescott, Harley, Klein. 2002. Textbook of Microbiology,5th Edition. McGraw Hill Education, New York.

Fourth Semester										
193MB2A4CV	Core	Project and Viva - voce	-	-	16	-	80	120	200	8
193MB2A4CA	Core	Bioprocess Technology	4	1	-	3	25	75	100	3
193MB2A4CB	Core	Bioethics, Biosafety and IPR	4	1	-	3	25	75	100	3
193MB2A4DA	Elective	Microbial Technology	3	1	-	3	25	75	100	3
193BC2A4DA		Neurobiology								
193BT2A4DA		Stem Cell Technology								
		Total	**11**	**3**	**16**				**500**	**17**
Grand Total									**2600**	**90**

Course Code	Course Name	Category	L	T	P	Credit
193MB2A4CA	BIOPROCESS TECHNOLOGY	CORE	4	1		3

PREAMBLE

This course has been designed for students to learn and understand

- The concept of fermentation and fermentor types.
- The flow of Upstream and Downstream processing.
- The application of economical microorganisms for the industrial production of bioactive compounds.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	To introduce the concept of fermentation and its range To impart information on the component parts of Fermentation process To explain the fermentor design, construction, types and Application of diverse types of fermentors.	K3
CO2	To describe the characteristics and applications of industrially important microorganisms To procure knowledge on the types and methods of screening industrially important microorganisms To illustrate the methods of preservation and improvement of industrially important strains.	K3
CO3	To comprehend the methods of inoculum development, Formulation and Sterilization of fermentation media for Upstream processing.	K2
CO4	To categorise the different types of fermentation and cultures To explain the different methods of product recovery in Downstream processing.	K4,K2
CO5	To confer the mechanism of industrial production of commercially important molecules from microorganisms To define the concept and applications of microbial transformations.	K2, K3

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	M	M
CO2	S	M	S	S	S
CO3	S	M	S	M	M
CO4	S	S	M	M	S
CO5	S	S	M	S	M

S Strong **M Medium** **L Low**

193MB2A4CA	BIOPROCESS TECHNOLOGY	SEMESTER IV

Total Credits: 3

Total Instruction Hours: 48 h

Syllabus

Unit I Introduction to Fermentation Process: 10 h

An introduction to Fermentation Process - The range of Fermentation Process - Microbial biomass, Enzymes, Metabolites, Recombinant products, Transformation processes - Component parts of Fermentation process - Fermentor Design and Construction - Fermentor types – Bioreactors for Aerobic fermentation - Stirred Bioreactors - Reactors for immobilized cells - Heat exchange, Stirring and Mixing, Gas exchange and Mass transfer.

Unit II Industrially important Microorganisms: 9 h

Industrially important Microorganisms - Isolation (Primary and Secondary screening), Preservation and Strain improvement (Mutation, Recombination, Regulation, Gene technology and Use of Genetic methods).

Unit III Upstream processing: 10 h

Upstream processing - Development of Inoculum for Fermentation process - Media for Industrial Fermentation – Formulation, Optimization and Sterilization, Various stages in Upstream (Inoculum preservation, Growth of the inoculum, Fermenter preculture and Production fermentation).

Unit IV Fermentation Types and Cultures: 9 h

Fermentation Types and Cultures –Batch, Continuous, Fed-batch - Basic Growth Kinetics - Submerged and Solid state Fermentation - Downstream Processing - Recovery and Purification of Intracellular and Extracellular Products (Flocculation, Flotation, Filter systems, Centrifugation, Disintegration, Chromatography, Extraction, Crystallization, Precipitation and Drying).

Unit V Microbial production of Commercial Products: 10 h

Microbial production of Organic acids (Citric acid and Acetic acid), Enzymes (Amylase and Protease), Aminoacids (Lysine and Glutamic acid), Antibiotics (Penicillin, Streptomycin and Griseofulvin), Vitamins (Riboflavin, Cyanocobalamine and Ascorbic acid) - Biosynthesis of Ergot alkaloids - Microbial transformation - Steroids and Sterols, Non-steroid compounds, Antibiotics and Pesticides.

Text Books

1 Crueger W and Crueger A. 1991. Biotechnology. A textbook of Industrial Microbiology. Sinauer Associates Inc.,U.S.

2 Stanbury P T and Whitaker 1984. Principles of Fermentation Technology, 1str Edition. Adithya Books pvt ltd. New Delhi.

References

1 Peppler. H.J. 1997. 2 nd edition. Microbial Technology. Microbial Processes. Vol I & II. Academic Press.Cambridge.

2 Demain A.J. and Solomon INA, 1999. 2nd edition. Manual of Industrial Microbiology and Biotechnology. ASM press.USA.

Course Code	Course Name	Category	L	T	P	Credit
193MB2A4CB	BIOETHICS, BIOSAFETY AND IPR	CORE	4	1	-	3

PREAMBLE

This course has been designed for students to learn and understand

- To understand the commercial aspects of biological products developed and its intellectual protection.
- To introduce the concepts of Biosafety regulations and incept its importance in the biological research field.
- To enable the understanding of ethical concepts surrounding life science research.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	To gain awareness about IPR and to take measures for protecting their ideas	K3
CO2	To emphasize on IPR issues and need for knowledge in patent.	K2
CO3	To introduce basic concepts of bio safety and to study its impact on the quality of human life.	K3
CO4	To recognise the importance of bio safety practices and guidelines in research.	K2
CO5	To make students learn about the legal safety and public policy issues raised due to the rapid progress in microbiology and development of new products.	K2

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	M	S	S	M
CO2	S	M	M	S	M
CO3	S	S	S	S	S
CO4	S	M	S	M	M
CO5	S	S	M	S	S

S Strong M Medium L Low

193MB2A4CB	BIOETHICS, BIOSAFETY AND IPR	SEMESTER IV

Total Credits: 3

Total Instruction Hours: 60 h

Syllabus

Unit I Introduction to Intellectual Property Rights 12 h

Concepts of IPR - Designs - Trademarks - Trade secrets - Domain name - Geographical indications - Copy Rights - Evolution of patent law - History of Indian patent system - International conventions and treaties.

Unit II Patents 12 h

Classification of patents in India - Classification of patents by WIPO - Categories of patent - Special patent - Patenting of biological products - Patentable and non-patentable inventions in India and abroad - Rights of patent holder and co-owner - Infringement of patent rights and offenses - Patenting life forms - Biodiversity and IPR - Bioinformatics patenting - Gene Patenting.

Unit III Introduction to Biosafety 12 h

Risk assessment - Cartagena protocol on biosafety - Capacity building - Biosafety guidelines in India evolved by DBT - Rules for the storage and manufacture of hazardous microorganisms and GMO - Bio safety management.

Unit IV Biological Agents 12 h

Classification of biological agents - Categories of bio hazardous waste - Labelling and disposal. General safety - Permit for the movement and import of GMOs - Biosafety issues of products developed by rDNA technology - Ecological safety assessment of recombinant organisms - Web based information on biosafety of GMOs.

Unit V Bioethics 12 h

Bioethics and its scope - Different approaches to ethics - Biological weapons - social and ethical implications of biological weapons - Importance of Good Laboratory practices.

Text Books

1 Gopalakrishnan NS and Agitha TG, 2014, "Principles of Intellectual Property", 2nd Edition, Eastern Book Company, Lucknow, India.

2 Deepa goel and Shomini Prasas, 2013, "IPR, Biosafety and Bioethics", Pearson Education, New Delhi, India.

References

1 Ben Mepham, 2008, "Bioethics - an introduction for the biosciences", Oxford University Press, UK.

2 Deepa Goel, Shomini Parashar, 2013, "IPR, Biosafety and Bioethics", Pearson India.

3 Website - http://www.wipo.int/portal/index.html.en

4 https://iprlawindia.org/

5 https://bch.cbd.int/protocol

Course Code	Course Name	Category	L	T	P	Credit
193MB2A4DA	MICROBIAL TECHNOLOGY	DSE	3	1	-	3

PREAMBLE

This course has been designed for students to learn and understand

- The production of Sustainable products using Microorganisms.
- The importance of Microorganisms in Pharmaceutical sector.
- How to explore the ideas in commercial level.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Inculcate the knowledge about microbial products.	K3
CO2	Exemplify the ideas about the production and uses of Biofuel and Biofertilizer.	K4
CO3	Demonstrate the commercial production of Biopolymers using Microorganisms.	K3
CO4	Understand the way cells and enzymes were immobilised for industrial uses.	K4
CO5	Explore the production of vaccines and toxoids.	K4

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	M	S	S	S
CO2	S	S	M	S	S
CO3	S	M	S	S	S
CO4	S	M	S	M	S
CO5	S	S	M	S	S

S Strong M Medium L Low

193MB2A4DA	MICROBIAL TECHNOLOGY	SEMESTER IV

Total Credits: 3

Total Instruction Hours: 60 h

Syllabus

Unit I Microbial products 12 h

Single Cell Protein and its Economic Aspects: Bacterial, Actinomycetous, Yeast, Fungal and Algal Proteins – Brewer's and Baker's yeast – Food and Fodder yeast – Mushroom (Agaricus, Oyster) and Products from Higher fungi (Ganoderma lucidum).

Unit II Production of Biofuel & Biofertilizer 12 h

Production, Methods and Uses of Bioethanol (S cerevisiae) – Biodiesel (Chlorella) – Biohydrogen (Chlamydomonas) – Biogas (Methanobacteria) . Biofertilizer -Types , Mass production and Applications.

Unit III Biopolymer production 12 h

Production and Uses of Polyhydroxybutyrate (PHB) – Xanthan – Alginate – Cellulose – Cyanophycin – Levan - Melanin -Adhesive Protein - Rubber - Polyhydroxyalkanoates - Hyaluronic acid.

Unit IV Immobilization of Cells & Enzymes 12 h

Cells – Surface attachment of cells – Entrapment within porous matrices: Hydrogel Entrapment method, Preformed support materials – Containment behind a barrier: Microencapsulation, Immobilization using membranes – Self aggregation of cells – Enzymes: Methods for Enzyme immobilization – Carrier binding method, Intermolecular cross linking – Applications of Immobilized cells and Enzymes.

Unit V Microbial products with pharmaceutical importance 12 h

Vaccines – Steps of Manufacturing – Growing the microbes and separation – Preparation of Live and killed vaccine – Standardization of vaccine – Preparation of Toxoid and uses – BCG Vaccine – Cholera vaccine – Rabies vaccine – Diptheria toxoid.

Text Books

1 Patel A H, 2012, "Industrial Microbiology", 2nd Edition, Trinity Press, New Delhi.

2 El-Mansi E M T, Bryce C F A, Dahhou B, Sanchez S, Demain A L, Allman A R, 2012, "Fermentation Microbiology and Biotechnology", 3rd Edition, CRC Press, USA.

References

1 Bernard R Glick, Jack J Pasternek, Cheryl L Patten, 2010, " Molecular Biotechnology - Principles and Applications of Recombianant DNA", 4th Edition, ASM Publishers, USA.

2 Nidhi Goel, 2013, "Pharmaceutical Microbiology", 1st Edition, Narosa Publishing House, New Delhi.

3 Puvanakrishnan R, Sivasubramanian S, Hemalatha T, 2012, "Microbial Technology - Concepts amd Applications", 1st Edition, MJP Publishers, New Delhi.

4 https://agritech.tnau.ac.in/org_farm/orgfarm_biofertilizertechnology.html

Course Code	Course Name	Category	L	T	P	Credit
193BC2A4DA	NEUROBIOLOGY	DSE	3	1	-	3

PREAMBLE

This course has been designed for students to learn and understand

- Overview of nervous system organisation and function.
- Neuronal transmission in the body.
- Pathways and mechanisms of neuronal disorders.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Understand the morphogenesis of the central nervous system and histology of the nervous system.	K4 & K5
CO2	Examine the functioning of the components of the nervous system	K4 & K5
CO3	Elucidate the role of different neurotransmitters in nerve impulse conduction	K4 & K5
CO4	Understand the process of vision, olfaction and taste sensation in detailed pathways	K4 & K5
CO5	Analyse the neurologic process behind the different neurological diseases	K4 & K5

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	M	M
CO2	S	S	S	M	M
CO3	S	S	S	M	M
CO4	S	S	M	M	M
CO5	S	S	S	M	S

S Strong M Medium L Low

193BC2A4DA	NEUROBIOLOGY	SEMESTER IV

Total Credits: 3

Total Instruction Hours: 48 h

Syllabus

Unit I Morphogenesis of central nervous system and Histology of the Nervous System 11 h

Morphogenesis of central nervous system:Early aspects of development, The spinal cord, The brain (Myelencephalon, Metencephalon, Mesencephalon, Prosencephalon, Diencephalon, Telencephalon, Basal Ganglia, Commissures).

Histology of the Nervous System: The neuron: nerve cell body, nucleus, cytoplasm, dendrites, axon. Axonal Transport:fast anterograde, slow anterograde and fast retrograde transport.Types of neurons:multipolar, bipolar, pseudo-unipolar, and unipolar. Neuroglia: astrocytes, oligodendrocytes, microglia, and ependymal cells. Myelinated axons.

Unit II Design and functioning of the Nervous System 11 h

Neuron, Sensory Receptors, Effectors, information processing, memory. Major Levels of Central Nervous System Function: spinal cord level, lower brain level and higher brain level. Structure and permeability of neuronal membrane: membrane transport proteins, mode of transport, synapse: types (chemical and electrical), Physiologic Anatomy of the Synapse: Presynaptic Terminals, Action Potential and propagation, equilibrium membrane potential, resting membrane potential, ReceptorProteins, Ion Channels (properties and classification), Second Messenger system, Excitation/inhibition in post synaptic membrane.

Unit III Neurotransmitters 10 h

Neurotransmitters: definition, properties, classes, mechanism of neurotransmitter release. Synthesis, release, physiological and clinical considerations of acetyl choline, GABA, dopamine, norepinephrine, epinephrine, serotonin, histamine, nitric oxide. Receptors: nicotinic acetyl choline, NMDA and opioid receptors.Mechanisms of Regulation of Receptors: Desensitization and Down-Regulation.

Unit IV Visual, Olfaction and Taste system 8 h

Visual system: components of eye, different layers of retina, photoreceptors, phototransduction, processing of signals by retinal cells,color vision, visual and retinal fields, visual pathways, visual reflex.

Olfaction and Taste: organisation, receptors, sensory transduction, central pathways for olfaction and taste.

Unit V Neurological diseases 8 h

Description, neurochemistry, pathology and clinical intervention of neurological diseases: Parkinson's disease, schizophrenia, Huntington's disease, Alzheimer's disease, epilepsy and depression disorder.

Text Books

1 Allan Siegel, Hreday N. Sapru, 2018, "Essential Neuroscience", 4th Edition, Lippincott Williams & Wilkins, a Wolters Kluwer business, United States.

2 John E. Hall, Arthur C. Guyton, 2021, "Guyton and Hall Textbook of Medical Physiology", 14th edition, Saunders, an imprint of Elsevier Inc., United States.

References

1 Alan Longstaff, 2011, "Instant notes. Neuroscience", 3rd edition, Taylor & Francis Group, United Kingdom.

2 Dale Purves, George J. Augustine, David Fitzpatrick, William C. Hall, Anthony-Samuel lamantia, James O. Mcnamara, S. Mark Williams, 2017, " Neuroscience", 6th edition, Sinauer Associates, Inc.USA

3 Kim E. Barrett, Susan M. Barman, Scott Boitano, William F. Ganong, Heddwen L. Brooks, 2019, "Ganong's Review of Medical Physiology", 26th edition, McGraw Hill Education, United States.

4 Harald Sontheimer, 2015, "Diseases of the Nervous System", 1st Edition, Academic Press, United States.

Course Code	Course Name	Category	L	T	P	Credit
193BT2A4DA	STEM CELL TECHNOLOGY	DSE	3	1	-	3

PREAMBLE

This course has been designed for students to learn and understand

- The types of Stem cells
- Characteristics of different stem cells in animals and plants.
- Applications of stem cells in various dimensions.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Know the process of stem cell and storage	K2,K3
CO2	Understand the stem cell importance in plants	K3, K4
CO3	Imparts knowledge on the stem cells in animals	K3,K4,K5
CO4	In depth understanding of haemopoietic stem cell	K4,K5
CO5	Focus on stem cell therapies and its application	K4,K5

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	M	S	S	S
CO2	S	S	S	S	S
CO3	S	M	S	S	S
CO4	S	S	M	M	M
CO5	S	S	S	S	S

S Strong M Medium L Low

193BT2A4DA	STEM CELL TECHNOLOGY	SEMESTER IV

Total Credits: 3

Total Instruction Hours: 48 h

Syllabus

Unit I Stem Cells and Cellular Pedigrees 11 h

Scope of stem cells – definition of stem cells – concepts of stem cells – differentiation , maturation , proliferation , pluripolericy, self – maintainance and self – renewal – problems in measuring stem cells – preservation protocols.

Unit II Stem Cell Concept in Plants 9 h

Stem cell and founder zones in plants – particularly their roots – stem cells of shoot meristems of higher plants.

Unit III Stem Cell Concept in Animals 10 h

Skeletal muscle stem cell – Mammary stem cells – intestinal stem cells – keratinocyte stem cells of cornea – skin and hair follicles –Tumour stem cells, Embryonic stem cell biology - factors influencing proliferation and differentiation of stem cells – hormone role in differentiation.

Unit IV Haemopoietic Stem Cell 9 h

Biology – growth factors and the regulation of haemopoietic stem cells.

Unit V Potential Uses of Stem Cells 9 h

Cellular therapies – vaccines – gene therapy – immunotherapy – tissue engineering – blood and bone marrow – Fc cells.

Text Books

1 Potten CS, 1997, "Stem cells", Elsevier, USA.

2 Robert Paul Lanza , 2006, "Essentials of stem cell biology", 2nd edition, Academic Press, USA.

References

1 Song Li, Nicolas L'Heureux, Jennifer Elisseeff, 2011, "Stem Cell and Tissue Engineering", 1st Edition, World Scientific Publishers, Singapore.

2 Robert Lanza, John Gearhart, Brigid Hogan, 2006, "Essentials of Stem Cell Biology", 2nd Edition, Macmillan Publishing Solutions, USA.

3 Low WC and Verfaillie CM, 2007, "Stem Cell and Regenerative Medicine", 1st Edition, World Scientific Publishers, Singapore.

4 Lanza R and Atala A, 2007, "Essential of Stem Cell Biology", 3rd Edition, Academic Press, USA.

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