Dr.N.G.P.ARTSANDSCIENCECOLLEGE(Autonomous)

REGULATIONS 2019-20 for Post Graduate Programme

(Outcome Based Education model with Choice Based Credit System)

M.Sc. BIOCHEMISTRY

(For the students admitted during the academic year2019-20 and onwards)

Programme:M.Sc. BIOCHEMISTRY

Eligibility:

The eligibility conditions for admission to M.Sc., in Biochemistry is candidateswith B.Sc., in Biochemistry, Biotechnology, Microbiology, Biomedical Science,Biomedical Instrumentation Science, Medical Lab Technology, Bioinformatics, Environmental Sciences, ClinicalLabTechnology, Biochemistry (Nanotechnology), Chemistry, Life Sciences, Botany, Zoology, Nutrition and dietetics or an Examinations accepted as equivalent thereby Academic Council, subject to such conditions as may be prescribed there to are permitted to appear and qualify for the **Master of Science Degree in Biochemistry Examination** of this College after a programme of study of two academic years.

Programme Educational Objectives:

1. Instill inquisitiveness in students to explore realms of modern biology (Moleculargenetics, Marine biochemistry, Pharmaceutical biochemistry, andImmunology, Enzymology and Clinical biochemistry) through interdisciplinary cutting edge research.

2. Empower students to acquire, develop and demonstrate skills in bio-instrumentation, bio-statistical and bio-informatic software and tools,and in the fields of Industrial Biochemistry, and Nanotechnology and Cancer biology to meet the relevant demands of traditional and emerging industries.

PROGRAMME OUTCOMES:

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

PO Number	PO Statement
PO1	Postgraduates are cognizant of progressive principles and concepts in diverse branches of modern biology that govern the integrity of dynamic bio-molecular assembly in varied life forms. Alumni are expressive of mastered wisdom to peers and public to expedite basic understanding of issues of social importance through practice and investigation.
PO2	Postgraduates are comprehensive of complex of biological systems, and they have broadened and perfected competency and skills in principal and contingent are as of modern biology. Thereby, alumni as an individual or as a team member can address, investigate, design, develop and demonstrate solutions to important issues facing humanity and preserve natural ecosystems.
PO3	Postgraduates are advantaged to identify and exploit functionally crucial areas in diverse branches of modern biology, and combine it with modern tools to investigate,design,develop, demonstrate and familiarize solutions to both basic and applied research questions in areas of industry, medicine, agriculture, pharmacy, food technology, biotechnology,etc. Alumni are valuable performers as an individual or in a team.
PO4	Postgraduates are competent to enroll in research programs and modeled to receptive of successful career options in diverse branches of modern biology as scholars, managers, counselors,writers, technical experts, field experts,teachers, entrepreneur and a responsible citizen. Alumni have acquired and developed skills to manage projects and finances as individual or as a team member. While discharging duties at varied capacities, postgraduates are inculcated to keep sustainable environment as a goal, and follow Ethics of professionals tature.
PO5	Postgraduates are infused with metamorphic qualities of education, and inspired to develop scientific temperament and lead a scientific way of life in facing socio-economical challenges that will benefit the society. Alumni are adept at evaluating their learning's to worldwide events. Thereby, they continue their learning lifelong.

TOTAL CREDIT DISTRIBUTION

Course	Credits	Total		Credits	Cumulative Total
Core	4	13x100	1300	52	90
Core	3	1x100	100	03	
CorePractical	3	3x100	300	09	
CorePractical	2	3x100	300	06	
CoreProject	8	1x100	100	08	
Discipline Specific Electives	3	4x100	400	12	
			2500	**90**	**90**

CURRICULUM

M.Sc. BIOCHEMISTRYPROGRAMME

Course Code	Course Category	Course Name	L	T	P	Exam(hours)	Max Marks			Credits
							CIA	ESE	Total	
First Semester										
193BC2A1CA	Core-I	Chemistry of Biomolecules	4	-	-	3	25	75	100	4
193BC2A1CB	Core-II	Biochemical techniques and Instrumentation	4	-	-	3	25	75	100	4
193BC2A1CC	Core-III	Enzymes and Enzyme Technology	4	-	-	3	25	75	100	4
193BC2A1CD	Core-IV	Cellular Biochemistry	4	-	-	3	25	75	100	4
193BC2A1CP	Core Practical-I	Practical:Enzymes, Cellular and CancerBiology	-	-	6	6	40	60	100	3
193BC2A1CQ	Core Practical-II	Practical:Biomolecules and Analytical Biochemistry	-	-	4	6	40	60	100	2
193MB2A1DA	DSE-I	Microbial Nanotechnology	3	1	-	3	25	75	100	3
193BC2A1DA		Cancer Biology, Diagnosis and Therapy								
193BT2A1DA		Protein Engineering								
Total			**19**	**1**	**10**				**700**	**24**

13/4/19
BoS Chairman/HoD
Department of Biochemistry
Dr. N. G. P. Arts and Science College
Coimbatore – 641 048

Academic Council
CHAIRMAN
Dr. N.G.P. Arts and Science College

Dr.NGPASC
COIMBATORE | INDIA

Course Code	Course Category	Course Name	L	T	P	Exam(h)	Max Marks			Credits
							CIA	ESE	Total	
Second Semester										
193BC2A2CA	Core-V	Immunology	4	-	-	3	25	75	100	4
193BC2A2CB	Core-VI	Metabolism	4	-	-	3	25	75	100	4
193BC2A2CC	Core-VII	Microbial Biochemistry	4	-	-	3	25	75	100	4
193BC2A2CD	Core-VIII	Genetics and Molecular Biology	4	-	-	3	25	75	100	4
193BC2A2CP	Core Practical-III	Practical: Metabolism and Immunology		-	6	6	40	60	100	3
193BC2A2CQ	Core Practical-IV	Practical: Microbial Biochemistry and Molecular Biology			4	6	40	60	100	2
193MB2A2DA	DSE-II	Medical Laboratory Techniques	3	1	-	3	25	75	100	3
193BC2A2DA		Biochemistry of Toxicology								
193BT2A2DA		Forensic Biotechnology								
Total			**19**	**1**	**10**				**700**	**24**

Course Code	Course Category	Course Name	L	T	P	Exam(h)	Max Marks			Credits
							CIA	ESE	Total	
Third Semester										
193BC2A3CA	Core-IX	Biostatistics and Research Methodology	4	-	-	3	25	75	100	4
193BC2A3CB	Core-X	Plant Biochemistry and Biotechnology	4	-	-	3	25	75	100	4
193BC2A3CC	Core-XI	Genetic Engineering	4	-	-	3	25	75	100	4
193BC2A3CD	Core-XII	Clinical Biochemistry	4	-	-	3	25	75	100	4
193BC2A3CP	Core Practical-V	Practical: Clinical Biochemistry	-	-	6	6	40	60	100	3
193BC2A3CQ	Core Practical-VI	Practical: Plant Biochemistry and Genetic Engineering	-	-	4	6	40	60	100	2
193MB2A3DA	DSE-III	Molecular Diagnostics in Microbiology	3	1	-	3	25	75	100	3
193BC2A3DA		System Biology								
193BT2A3DA		Molecular Therapeutics								
	Internship Training	A to C								
Total			**19**	**1**	**10**				**700**	**24**

Course Code	Course Category	CourseName	L	T	P	Exam(h)	Max Marks			Credits
							CIA	ESE	Total	
Fourth Semester										
193BC2A4CA	Core-XIII	Bio-ethics and Bio-safety	4	1	-	3	25	75	100	3
193BC2A4CB	Core-XIV	Endocrinology and Developmental biology	4	1	-	3	25	75	100	4
193BC2A4CV	Core-XV	Project	-	-	16	6	80	120	200	8
193MB2A4DA	DSE-IV	Microbial Technology	3	1		3	25	75	100	3
193BC2A4DA		Neurobiology								
193BT2A4DA		Stem Cell Technology								
Total			**11**	**3**	**16**				**500**	**18**
Grand Total									**2500**	**90**

DISCIPLINE SPECIFIC ELECTIVE

Students shall select the desired course of their choice in the listed elective course during Semesters V & VI

Semester I (Elective I)

List of Elective Courses

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

Semester II (Elective II)

List of Elective Courses

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

Semester III (Elective III)

List of Elective Courses

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

Semester IV (Elective IV)

List of Elective Courses

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

EXTRA CREDIT COURSES

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

S.No	Course Code	Name of the Course
1.	193BC2ASSA	Bionanotechnology
2.	193BC2ASSB	Inheritance, Evolution and Behaviour

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
193BC2A1CA	**CHEMIISTRY OF BIOMOLECULES**	**Theory**	**4**	**-**	**-**	**4**

PREAMBLE

This course has been designed for students to learn and understand

1. The overview of structural organization and functional properties of bio-molecules.
2. To gain an in-depth knowledge and understanding on the structure and functions of biological important macromolecules.
3. About the link between structure and function of biomolecules at a chemical level within a biological context

COURSE OUTCOMES

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

CO Number	CO Statement	Knowledge Level
CO1	Examine the structure and functions of complex polysaccharides.Assess the importance of carbohydrate containing proteins, homo and heteropolysaccharides.	K4 & K5
CO2	Determine the structure of protein. Explain elaborately the different structural levels of proteins.	K4 & K5
CO3	Value the importance of complex lipids. Infer the functions of saturated and unsaturated fatty acids	K4 & K5
CO4	Give an opinion on the different forms of DNA& RNA. Explain various hypotheses.	K4 & K5
CO5	Justify the structure and functions of important Biological molecules. Explain the role of lipid peroxidation and antioxidant.	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

193BC2A1CA	**CHEMIISTRY OF BIOMOLECULES**	**SEMESTER I**

Total Credits 4

Total Instructions Hours 48

Syllabus

Unit I Biology of polysaccharides 9h

Homo polysaccharides: Structure and biological functions of starch, cellulose, chitin, fructans, mannans, xylans, and galactans. Hetero polysaccharides: Structure and biological importance of sugar derivatives- glycosaminoglycans, proteoglycans. Glycoprotein – Blood group and bacterial cell wall polysaccharides, O- linked and N- linked oligosaccharides and Lectins.

Unit II Biology of Proteins 10h

Primary structure- determination of amino acid sequence of proteins. The peptide bond: Ramachandran plot. Secondary structure- weak interactions involved- alpha helix and beta sheet and beta turns structure. Pauling and Corey model for fibrous proteins. Collagen triple helix. Super secondary structures- helix-loop-helix,zinc finger and leucine zipper . Tertiary structure- alpha and beta domains. Quaternary structure- structure of hemoglobin. Solid state synthesis of peptides. Protein folding.

Unit III Biology of Lipids 10h

Lipids- classification- saturated and unsaturated fatty acids- Triacyl Glycerol, phospholipids- classification, structure and functions. Ceramides and sphingomyelins.Eicosanoids, Structure and functions of prostaglandins, thromboxanes, leukotrienes.Types and functions of plasma lipoproteins. Amphipathic lipids- membranes, micelles, emulsions and liposomes. Steroids- cholesterol structure and biological role- bile acids, bile salts.

Unit IV Biology of Nucleic acids 10h

DNA double helical structure. A, B and Z forms of DNA. Triple and quadruple structures. Chemicals that react with DNA, DNA sequencing procedures- Maxam Gilbert method and Sanger's dideoxy methods. Renaturation and denaturation. DNA bending: The Wedge model and Junction model, Protein induced bending. Crucifrom DNA, Left handed DNA. Types of RNA, Secondary and tertiary structure of RNA.

Unit V Biology of Heterocyclic compounds 9 h

Hetero cyclic rings of biologically important compounds. Structure and biological importance of pyridine, pyrole, quinolene, pyrimidine, purine, pteridine, thiazole, imidazole and indole ring containing compounds. Porphyrine - structure and biologically important compounds containing porphyin ring.

Text Books

1 Nelson, D.L. and Cox, M.M. 2008. Lehninger Principles of Biochemistry, 5th edition. W.H. Freeman and Company, New York.

2 Richard R Sinden, 1994. DNA Structure and Function, Academic Press.

References

1 Berg, J.M., Tymoczko, J.L., Gatto Jr, G.J. and Stryer, L. 2015. Biochemistry, 8th edition, W.H. Freeman and Company, New York

2 Geoffrey Zubay,1993. Biochemistry, 3rd Edition.Wm.C.Brown Publishers

3 Voet, D. and Voet J.G. (2011). Biochemistry, 4th edition, John Wiley and Sons, New York.

4 Garrett, R.H. and Grisham, C.M. (2017). Biochemistry, 6th edition, Brooks/Cole Cengage Learning, Boston.

Course Code	Course Name	Category	L	T	P	Credit
193BC2A1CB	BIOCHEMICAL TECHNIQUES AND INSTRUMENTATION	**Theory**	4			4

PREAMBLE

This course has been designed for students to learn and understand

1 To provide an overview of the scientific basis of instruments.

2 To enable the students to understand the advantages and limitations of conventional and modern bio-analytical techniques.

3 To gain an in-depth knowledge and understanding of the key analytical techniques used in the areas of Spectroscopy, Centrifugation, Microscopy, Chromatography, Electrophoresis, Biophysics and Radioisotopes.

COURSE OUTCOMES

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

CO Number	CO Statement	Knowledge Level
CO1	Distinguish the principles, instrumentation and applications of conventional and recent techniques in the field of spectroscopy. Explain the principle and importance of advanced analytical techniques like ESR, NMR and MS.	K4 & K5
CO2	Distinguish the preparative and analytical ultracentrifugation techniques. Compare and contrast the principles, instrumentation, and applications of conventional and advanced microscopic methods.	K4 & K5
CO3	Evaluate the advantages and disadvantages of ancient and recent techniques in chromatography.	K4 & K5
CO4	Assess and explain the importance of different types of electrophoresis and blotting techniques.	K4
CO5	Examine the different biophysical techniques like X ray diffraction, ORD and CD. Understand the basics of radioactivity and examine the benefits of using radio-isotopic techniques.	K3, K4 & 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	M	S	S
CO4	S	S	M	S	S
CO5	S	S	M	S	S

S Strong M Medium L Low

193BC2A1CB	BIOCHEMICAL TECHNIQUES AND INSTRUMENTATION	SEMESTER I

Total Credits: 4
Total Instructions Hours: 48

Syllabus

Unit I Spectroscopic techniques 10 h

Principle, instrumentation and applications of Colorimetry, UV-Visible, IR, Fluorescence spectrophotometry, Turbidimetry, Luminometry and Flame emission spectrometry. Principle and applications of Electron Spin Resonance, Nuclear Magnetic Resonance, Mass and Raman Spectroscopy.

Unit II Centrifugation techniques and Microscopy 10 h

Principle, technique and applications of preparative ultracentrifugation- differential centrifugation, density gradient centrifugation (caesium chloride and sucrose density gradients) and analytical ultracentrifugation.

Basic principles, instrumentation and applications of Light, Compound microscope, Fluorescence microscopy, Phase contrast microscopy, Scanning electron microscopy (SEM), Transmission electron microscopy (TEM) and Confocal microscopy.

Unit III Chromatographic techniques 10 h

Principle, technique and applications of paper, TLC, HPTLC, column, affinity, ion-exchange, gel filtration, hydrophobic interaction and adsorption chromatography. Principle, components, limitations and applications of GC, GC-MS, HPLC, RP-HPLC and FPLC.

Unit IV Electrophoresis and Blotting techniques 9 h

Principle, technique and applications of paper, gels - Agarose, Native and SDS-PAGE, Isoelectric focusing, 2D PAGE, Denaturing gels for RNA, Urea-PAGE, Electrophoresis in DNA sequencing, Peptide mapping, N-terminal sequencing of proteins, Next generation sequencing.

Principle, technique and applications of western, southern and northern blotting. Chemiluminescence and Phosphorimaging.

Unit V Biophysical and Radio-isotopic methods 9 h

Principles and applications of X-ray diffraction, ORD and circular dichroism. Radioisotopes in Biochemistry, Types of radiation, half-life and units of radioactivity, Detection and measurement of radioactivity– Principle, instrumentation and applications of Liquid scintillation counter and Geiger-Muller counter. Autoradiography and its applications.

Text Books

1 Sawhney and Singh, 2015. Introductory Practical Biochemistry, 11th Edition. Narosa Publishing house.

2 Wilson and Walker, 2010. Principles and Techniques of Biochemistry and Molecular Biology, 7th Edition. Cambridge University Press.

References

1 Boyer, R.F. 2012. Modern Experimental Biochemistry, 3rd Edition. Pearson Education Inc and Dorling Kindersley Publishers.

2 Cooper, T.G. 2011. The Tools of Biochemistry, John Wiley and Sons.

3 PelczarJr, Chan and Krieg, 2012. Microbiology, 5th Edition. Tata McGraw Hill.

4 Srivastava, S. 2010. Molecular Techniques in Biochemistry and Biotechnology, 1st Edition. New Central Book Publishers.

Course Code	Course Name	Category	L	T	P	Credit
193BC2A1CC	ENZYMES AND ENZYME TECHNOLOGY	**Theory**	4			4

PREAMBLE

This course has been designed for students to learn and understand

1 To enable the students to understand the structure, function and mechanism of action of enzymes.

2 To provide in-depth knowledge and understanding on current and possible future applications of enzyme technologies

3 To acquire knowledge in the field of biosensors and immobilized enzymes

COURSE OUTCOMES

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

CO Number	CO Statement	Knowledge Level
CO1	Examine the structural and functional properties of enzymes, experiment methods of enzymes isolation and purification, Measure the enzyme activity	K3, K4 & K5
CO2	Understand and prove the kinetics of enzyme-mediated reactions, distinguish different types of enzyme inhibition and its kinetics, solve simple problems related to enzyme kinetics	K4 & K5
CO3	Evaluate the enzyme specificity, determine the mechanism of enzymes action and understand the regulation of enzyme activity	K4 & K5
CO4	Describe elaborately how enzymes can be used in industry, Value the importance of enzymes in clinical diagnostics and therapeutics.	K4 & K5
CO5	Develop immobilized enzymes using different methods and appraise its applications, Propose a minor project on enzyme isolation, purification and application	K4, K5 & K6

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	M	M
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

193BC2A1CC	**ENZYMES AND ENZYME TECHNOLOGY**	**SEMESTER I**

Total Credits: 4

Total Instructions Hours: 48

Syllabus

Unit I Classification, Purification and Active Site 9h

Nomenclature and classification of enzymes, isolation and purification of enzymes- by different methods, criteria of purity- specific activity. Active site- determination of active site amino acids- chemical probe, affinity label, and site-directed mutagenesis, intrinsic and extrinsic regulations. Models of enzyme substrate binding- Lock and key model and Induced Fit model. Structure of active site investigation. Coenzymes and cofactors in enzyme catalyzed reaction. Multi-enzyme complex-occurrence, isolation and properties. Measurement of enzyme activity- two point assay, kinetic assay, using radio-labelled substrates.

Unit II Enzyme Kinetics and Inhibition 10h

Kinetics of single substrate enzyme- catalysed reactions- Michaelis-Menten equation, importance of V-max, Km, MM equation, and turnover number; Lineweaver- Burk plot, Eadie- Hofstee plot, Hanes- Woolf plot and Eisenthal and Cornish - Bowden plot. Kinetics of Allosteric enzymes- MWC and KNF models Hill' equation coefficient. Sequential and non-sequential bisubstrate and multi-substrate reactions. Enzyme inhibition- types and kinetic differentiation. Simple problems related to enzyme kinetics

Unit III Mechanism of Enzyme Action and Regulation 10h

Enzyme specificity, Mechanism of enzyme action- general acid-base catalysis, covalent catalysis, proximity and orientation effects, role of metal ion in enzyme catalysis, mechanism of serine proteases- chymotrypsin, lysozyme, and ribonuclease. Metal activated enzymes and metalloenzymes. Role of metal ions in carbonic anydrase, superoxide dismutase, carboxy peptidase. Regulation of enzyme activity-covalently modified regulated enzymes, allosteric enzymes, isozymes.

Unit IV Industrial and Clinical Uses of Enzymes 10h

Enzymes applications in food and allied industries- sources of industrial enzymes, thermophilic enzymes, amylases, glucose isomerases, cellulose degrading enzymes, lipases, proteolytic enzymes in meat and leather industry, detergents and cheese production.

Clinical enzymology- Enzymes as thromblytic agents, anti-inflammatory agents, digestive aids. Therapeutic use of asparginase, streptokinase. Enzymes and isoenzymes in diagnosis- LDH, CK, transaminases, phosphateases, amylase and cholinesterase.

Unit V Immobilized Enzymes and Biosensors 9h

Immobilized enzymes-various methods of immobilization, kinetics and applications of immobilized enzyme. Enzymes as diagnostic reagents. Biosensors: Principle, technique and mechanism of Biosensors. Calorimetric biosensors, potentiometric biosensors, Amperometric biosensors, optic biosensors, and immune-sensors. Enzyme engineering: Artificial enzymes.Abzymes and synzymes,Antioxidant enzymes.

Text Books

1 Palmar, T. 2004. Understanding enzymes, 1st edition, East West Press Pvt. Ltd., New Delhi.

2 Bhatt S.M. 2014. Enzymology and Enzyme technology, 15th edition, S. Chand publishing Ltd, New Delhi.

References

1 Palmer, T. and Bonner, P.L. 2004. Enzymes: Biochemistry, Biotechnology, Clinical chemistry, 1st edition, East West Press Pvt. Ltd., New Delhi.

2 Price, N.C. and Stevens, L. 1999. Fundamentals of Enzymology, 3rd edition, Oxford University Press.

3 Choudhary, N.L. and Singh, A. 2012. Fundamentals of Enzymology, 1st edition, Oxford Book Company

4 Berg, J.M., Tymoczko, J.L., Gatto Jr, G.J. and Stryer, L. 2015. Biochemistry, 8th edition, W.H. Freeman and Company, New York

Course Code	Course Name	Category	L	T	P	Credit
193BC2A1CD	CELLLULAR BIOCHEMISTRY	**Theory**	4			4

PREAMBLE

This course has been designed for students to learn and understand

1 This course offers an overview on cellular organization and function

2 Students can gain an in-depth knowledge and understanding on cellular transport, communication, division, and cancer

3 Structure and function of biological membranes including the roles of gradients in energy transduction

COURSE OUTCOMES

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

CO Number	CO Statement	Knowledge Level
CO1	Distinguish the composition and orientation of macromolecules constituting bio-membranes. Explain methods and models to investigate bio-membranes structure and function..	K4&K5
CO2	Distinguish various types of transport system in cells.Compare and contrast different transport process in cells.	K4&K5
CO3	Evaluate pathways of energy generation and utilization, cytoskeleton organization in a cell.	K4&K5
CO4	Assess and explain molecules of cellular integration and pathways of cellular communication.	K4
CO5	Examine cell division events and process of cell death.Understand events leading to cellular transformation	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	M	M	M	M	M

S Strong M Medium L Low

193BC2A1CD	CELLLULAR BIOCHEMISTRY	**SEMESTER I**

Total Credits: 4

Total Instructions Hours: 48

Syllabus

Unit I Membrane Biology 9 h

Bio-membrane structure- fluid mosaic model; Membrane lipids- fluidity, Asymmetry phase transition, Liposomes, Scott Syndrome. Membrane proteins- Types, Orientation, Mobility- Experiments, flippases, proteins or RBC membrane, Bacteriorhodopsin, Porins-aquaporin. RBC ghosts, solubilisation of proteins, lipid anchored proteins. Carbohydrates- cell surface carbohydrates-Lectins.

Unit II Membrane Transport 10 h

Membrane transport- Overview, Passive diffusion, Facilitated diffusion in erythrocytes. Carriers and Ion-Channels. Ion cone. Gradients. Uniporter Catalyzed transport. Active transport systems. Transport process driven by ATP-Ion Pumps:Calcium, APT ase; Na+K+ATPase; Mechanism, Gastric H+K+ATP ase; Mechanism, Gastric H+K+ ATP ase, ATP ases that transport peptides and drugs. ABC superfamily- Bacterial PM permeases, Mammalian MDR proteins: Transport process driven by light and ion gradients. Co-transport by Symporters and antiporters. Group translocation Osmosis and Receptor mediated endocytosis.

Unit III Energy metabolism and Cytoskeleton 9 h

Mitochondria- Reduction potentials, electron transport chain Overview, Complexes, Q-cycle, Cyt-C oxidase complex, Translocation of Protons and the establishment of a proton, motive force Machinery for ATP formation. Chemi-osmotic mechanism, APT Synthase Experiments. inhibitions of Oxidative phosphorylation. Uncouplers. Microtubules- Organization and dynamics, Kinesin and dynem. Microfilaments- Action- Structures, Assembly, Myosin. Cilia and Flagella- Structure and functions, Intermediary fi1aments. Striated muscle-structure, excitation- contraction.

Unit IV Cellular Integration 10 h

Cell-Cell and Cell-matrix adhesion: An overview.Cell-Cell, interaction: ECM; Collagen, hyaluronan&proteolycans, laminin, integrins and fibronectins. Cell-Cell adhesion- CAMs

Specialised junctions- Desmosomes, Gap junctions, Adhesion molecules-Cadherins-Connexins. Cell-Cel1 signaling- Signaling molecules and their receptors: functions of cell surface receptors, pathways of intracellular signal transduction, second

messengers. (G-protein coupled receptors, receptor tyrosine kinases. Ras. MAP kinases.

Unit V Protein Transport and degradation 10 h

Protein targeting: post-translational modifications in prokaryotes and eukaryotes, role of signal peptide, role of endoplasmic reticulum and golgi apparatus (protein targeting- signal sequence hypothesis, targeting of proteins to different compartment of mitochondria, ER, plasma membrane, lysosomes, peroxisomes and chloroplast) translocation, heat shock proteins, molecular chaperons, glycosylation, SNAPs and SNAREs, bacterial signal sequences, mitochondrial, chloroplast and nuclear protein transport, endocytosis-viral entry, ubiquitin TAG protein destruction. Sumoylation

Text Books

1 Rodwell, V.W., Bender, D.A., Botham, K.M., Kennelly, P. and Weil, P.A. 2015. Harper's Illustrated Biochemistry, 30th edition. The McGraw-Hill Inc

2 Verma, P.S. and Agarwal, V.K. 2014. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, 1st edition, S. Chand and Company Limited, New Delhi.

References

1 Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. and Walltre, P. 2015. Molecular Biology of the cell, 6th edition, Taylor and Francis Company

2 Kar, G., Iwasa, J. and Marshall, M. 2016. Karp's Cell and Molecular Biology: Concepts and Experiments, 8th edition, John Wiley and Sons, USA

3 Cooper, G.M. and Hausman, R.E. 2007. The Cell: A Molecular Approach, 4th edition, Sinauer Associates, Inc., USA

4 Harvey Lodish, Arnold Berk, Paul Matsudaira, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, Lawrence Zipursky, and James Darnell. 2016. Molecular Cell Biology 8th edition, WH Freeman and Company, New York

Course Code	Course Name	Category	L	T	P	Credit
193BC2A1CP	PRACTICAL I: ENZYMES, CELLULAR AND CANCER BIOLOGY	**Practical**		-	6	3

Total Credits: 3
Total Instructions Hours: 72

CONTENTS

1. Observation of prokaryotic and eukaryotic cells with the help of light microscope.
2. Mitosis and cell cycle in Onion root-tip cell.
3. Cell counting and viability (Yeast/Bacteria).
4. Determination of osmotic fragility of a cell (Goat RBC).
5. Desalting of proteins by dialysis.
6. Effect of pH on enzyme activity of catalase.
7. Effect of Temperature on enzyme activity of catalase.
8. Effect of substrate concentration on enzyme activity of catalase.
9. Purification of acid phosphatase from potato.
10. Immobilization of enzyme and measurement of its activity.
11. Kinetics of activity loss of an enzyme in the presence of trace amounts of metals.
12. Study of cell viability/ death assay by use of trypan blue or MTT assay.

Text Books

1. Bisswanger H. John, 2012, Practical Enzymology, 2nd edition, Wiley & Sons.
2. Prem Prakash Gupta, Neelu Gupta 2017 Essentials of Practical Biochemistry , Second edition, The health sciences publisher.

Course Code	Course Name	Category	L	T	P	Credit
193BC2A1CQ	PRACTICAL II: BIOMOLECULES AND ANALYTICAL BIOCHEMISTRY	**Practical**		-	4	2

Total Credits: 2

Total Instructions Hours: 48

S.No	Contents
1	Isolation and estimation of starch from potato
2	Isolation and estimation of DNA and RNA from goat liver (genomic)
3	Isolation and estimation of Bacterial Nucleic acids
4	Estimation of sodium by flame photometry
5	Agarose gel electrophoresis of genomic and plasmid DNA
6	Separation of amino acids sugars and lipids by thin layer chromatography
7	Separation of plant pigments by column chromatography
8	PCR Technique (demonstration)
9	Separation of serum protein by PAGE
10	Isolation and estimation of glycogen from the material.

Text Books

1. Srivastava S, 2010. Molecular Techniques in Biochemistry and Biotechnology, 1st edition, New Central Book Publishers.
2. Keith Wilson, John Walker, 2010. Principle of Practical Biochemistry, 7th edition, Cambridge University Press.

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

Total Credits: 3

Total Instructions Hours: 48

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	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	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.**
    a. 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
193MB2A1DA	ELECTIVE I: MICROBIAL NANOTECHNOLOGY	**Theory**	3	1		3

PREAMBLE

This course has been designed for students to learn and understand

1. The role of microbes and other eukaryotes in the synthesis of nanoparticles
2. Advanced methods of synthesis and designing of nano particles
3. 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	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 I: MICROBIAL NANOTECHNOLOGY	**SEMESTER I**

Syllabus

Total Credits: 3

Total Instructions Hours: 48

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-I: CANCER BIOLOGY, DIAGNOSIS AND THERAPY	Theory	3		0	3

PREAMBLE

This course has been designed for students to learn and understand

1. This course offers an overview on cancer, mutations causing cancer, repair mechanism and multiples of diagnostic and treatment methods for cancer.
2. Students can gain an in-depth knowledge and understanding on 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
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	S	S	S

S Strong M Medium L Low

193BC2A1DA	ELECTIVE-I: 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
193BC2A2CA	**CORE :** IMMUNOLOGY	CORE	4	1	-	4

PREAMBLE

This course has been designed for students to learn and understand

- This course offers an overview on the ability of our immune system to defend against invading pathogens in a logical fashion and characteristics of antigens, antibodies and the nature of antigen- antibody reactions.
- Students can gain an in-depth knowledge of immune-pathology, immunotherapy and learn techniques practiced in the immunology field

COURSE OUTCOMES

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

CO Number	CO Statement	Knowledge Level
CO1	Illustrate the cells involved in immune response.	K2 &K4
CO2	Demonstrate factors and forces of Ag-Ab interaction.	K3, K4 &K5
CO3	Compare different pathways of complement activation	K3, K4 &K5
CO4	Predict allergic responses. Transplantation, cancer	K4 &K5
CO5	Analyze types of immune-techniques and vaccines	K4 &K5

MAPPING WITH PROGRAMME OUTCOMES

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

S Strong M Medium L Low

193BC2A2CA	CORE : IMMUNOLOGY	**SEMESTER II**

Total Credits: 4
Total Instruction Hours: 48 h

Syllabus

Unit I Cells of Immune System and Immune Responses 10 h

Cells of Immune System: Haematopoiesis, haematopoietic growth factors, Regulation of haematopoiesis, Lymphoid cells-T-cells, B-cells-lymphoblast and null cells, granulocytes, monocytes and macrophages, CD antigens and membrane molecules of immune cells. Development, maturation, activation and differentiation of T-cells and B-cells, adhesion molecules. Immune Responses: Humoral and cell-mediated immune responses, primary and secondary immune responses, cells and molecules involved in innate and adaptive immune response. Theory of clonal selection.

Unit II Antigens, Antigen Recognition, Immuno-globulins and Antigen antibody interaction 10 h

Antigens: B-cell epitopes, T-cell epitopes, antigenicity and immunogenicity, factors influencing immunogenicity, Haptens, adjuvants; Immunoglobulins: Structure and functions, Isotype, allotypes, Idiotypes; Classes, Immunoglobulins super family, Gene rearrangement and antibody diversity, class switching. T-cell receptor and its diversity. Antigen Recognition: MHC-Genetic organization and inheritance, Antigen processing and presentation (Cytosolic and Endocytic pathway). Antigen antibody interaction: forces involved in Ag-Ab interaction, Factors governing antigen-antibody interactions, affinity, avidity, valency, cross reactivity.

Unit III Complement, Cytokines, Cytotoxicity, Immune Responses to Infections and AIDS 8 h

Complement Activation: Complement activation pathways (classical, alternative and Lectin), Biological consequence of complement activation. Cytokines: IL, IFN, TNF, CSF- role in immune regulation, Cytokine receptors, Cytokine antagonists. Cell mediated cytotoxicity: mechanism of T cell and NK cell mediated lysis, antibody dependent cell mediated cytotoxicity and macrophage mediated cytotoxicity. Immune responses to infections: bacteria (tuberculosis) and parasites (malaria). Primary and secondary immunodeficiency diseases. AIDS: Structure of HIV, destruction of T cells, CD4+/CD8+ ratio, immunity to HIV virus, AIDS vaccine.

Unit IV Hypersensitivity, Autoimmunity, Animal Models, Transplantation and Cancer immunology 10 h

Hypersensitivity reactions: Type I, II, III & IV. Immunological tolerance. Autoimmunity:Concept,eneral mechanism, (organ specific, non-organ specific), Autoimmune disease in human-Rheumatoid arthritis, Myasthenia gravis, Systemic lupus erythematosus. Experimental Animal Models: inbred strains, SCID mice, nude, knockout mice. Transplantation immunology: Immunologic basics of Graft rejection, MHC antigens in Cancer immunology: transplantation and HLA tissue typing, Immunosuppressive therapy. Tumor antigens, Immune response to tumor antigens, Tumor evasion of the immune system, Cancer immunotherapy..

Unit V Vaccines and Immuno-techniques 10 h

Vaccines: Active and passive immunization, whole organism vaccines, recombinant vector vaccines, DNA vaccines, synthetic peptide vaccines, multivalent sub-units vaccines, general side effects of vaccines (review). Immunotechniques: Hybridoma technology-Introduction, Antibody engineering (production of monoclonal antibodies), Immunotherapy with genetically engineered antibodies. Detection of molecules using agglutination, precipitation, immune-diffusion, immune-electrophoresis, ELISA, RIA, western blot, immune-precipitation, flow-cytometry/cell sorting and immune-fluorescence microscopy, immune-histochemistry.

Text Books

1 Richard A Goldsby, Thomas J.Kindt, Barbara A Osborne and Janis Kuby. R (2003). Immunology. (5th Edn.) Delhi:Prentice Hall.

2 Tizard, Ian R. (2004). Immunology (An Introduction). (10thEdn.) Delhi: Thomson Publishers.

References

1 Nandini Shetty. (2005). Immunology. (2nd Edn.) Delhi: New Age International Publishers.

2 Delves P.J., Martin S.J., Burton D.R. and Roitt I.M., (2006). Roitt's Essential Immunology. (11 Edn.) USA: Wiley-Blackwell.

3 Richard A Goldsby, Thomas J.Kindt, Barbara A Osborne. (2018). Kubys Immunology. (5th Edn.) England: W.H.Freeman and Company.

4 Fathimunisa Begum. (2014). The Elements of Immunology. (1st Edn.) Delhi: PHI Learning Private Limited r.

Course Code	Course Name	Category	L	T	P	Credit
193BC2A2CB	**CORE :** METABOLISM	CORE	4	-	-	4

PREAMBLE

This course has been designed for students to learn and understand

- This course offers an overview of energy generation and utilization in a biological system
- Students can gain an in-depth knowledge of bioenergetics, and catabolic and anabolic pathways of biologically vital macromolecules
- Students can gain the knowledge of regulation of metabolic pathways

COURSE OUTCOMES

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

CO Number	CO Statement	Knowledge Level
CO1	Explain the bioenergetics principles and Illustrate the Electron transfer and Oxidative phosphorylation	K3
CO2	Demonstrate the carbohydrate metabolism. Introduces the regulation and analysis of metabolic pathways.	K5
CO3	Illustrate the lipid metabolism and relate it with clinical lab findings.	K4
CO4	Explain and justify amino acids and porphyrin metabolic pathways and their regulations	K5
CO5	Illustrate the nucleic acid metabolism and its regulation Predict the pattern of disease with altered metabolism	K6

MAPPING WITH PROGRAMME OUTCOMES

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

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

193BC2A2CB	CORE : METABOLISM	**SEMESTER** II

Total Credits: 4
Total Instruction Hours: 48 h

Syllabus

Unit I Bioenergetics, ETC and Oxidative Phosphorylation 9 h

Enthalpy, Entropy and Free energy, Standard state free energy change-Free energy change in a reaction- Importance of coupled process in living things-Phosphoryl group transfers and ATP-Biological Oxidation -Reduction reactions.

Electron Transfer reaction in Mitochondria: Components of ETC and its organization-Thermodynamics of Electron Transport- Sequence of Electron Transport. Oxidative Phosphorylation-ATP synthase- Structure and Mechanism of action- Inhibitors of ETC – Uncouplers- P/O ratio- Mitochondrial Transport systems- Glycerophosphate shuttle system, Malate-aspartate shuttle system.

Unit II Pathway regulation, analysis and Carbohydrate Metabolism 10 h

Pathway Regulation- Regulation of Intermediary metabolism-Role of regulatory enzymes-Energy charge-Interplay of kinetic and thermodynamic factors. Strategies for pathway analysis- Single step and Multistep pathway analysis.

Glycolysis and gluconeogenesis– Pathway, Key enzymes and Co-ordinate regulation. Pyruvate dehydrogenase complex and the regulation of this enzyme through reversible covalent modification. The citric acid cycle and regulation. The pentose phosphate pathway, Glucuronic acid pathway. Metabolism of glycogen and regulation. Metabolism of galactose and fructose. The glyoxylate cycle, Cori cycle, Anaplerotic reactions.

Unit III Lipid Metabolism 9 h

Lipid metabolism: Lipogenesis-Biosynthesis of long chain fatty acid- Fatty acid synthase complex- Control of acetyl CoA carboxylase-Role of hormones-Effect of diet on fatty acid biosynthesis. Biosynthesis of triacylglycerol and phospholipids. Biosynthesis and degradation of cholesterol and its regulation. β Oxidation of fatty acids– Regulation of fatty acid metabolism. Ketogenesis and its control. Lipoprotein metabolism. Biosynthesis of Prostaglandins, Thromboxanes and Leukotrienes.

Unit IV Metabolism of Amino acids 10 h

Amino acids metabolism: An overview on Gamma-glutamyl cycle. An overview-Methionine as methyl donor (SAM pathway). An overview & regulation of urea cycle. Biosynthesis of Alpha-ketoglutarate family, Pyruvate family. 3-Phosphoglycerate family, Aspartate family and Aromatic amino acid family.

Allosteric regulation of glutamine synthase.

Porphyrin metabolism: Biosynthesis and degradation of hemoglobin, chlorophyll and cytochrome and their regulation.

Unit V Nucleic acids metabolism and Integrated Metabolism 10 h

Nucleic acid metabolism: Pathways of purines and pyrimidines biosynthesis (both de novo and salvage pathways) and degradation. Regulation of purine biosynthesis: PRPP aminotransferases. Regulation of pyrimidine biosynthesis: Aspartate carbamoyltransferase. Regulation of deoxyribonucleotides by activators and inhibitors.

Integration of metabolism: Three forms of energy storage-Metabolism in a multicellular organism-Metabolic interaction among major organ systems-Brain, Muscle, Heart, Adipose tissue and Liver. Disturbances in fuel metabolism-Starvation, Diabetes Mellitus, Obesity.

Text Books

1 Nelson, D.L. and Cox, M.M., (2017). Lehninger Principles of Biochemistry. (7th Edn.) New Delhi: Macmillan Learning.

2 Garrett, R.H. and Grisham, (2017). Biochemistry. (6thEdn.) Boston: Brooks/ColeCengage Learning.

References

1 Rodwell, V.W., Bender, D.A., Botham, K.M., Kennelly, P. and Weil, P.A.,. (2018). Harper's Illustrated Biochemistry. (31st Edn.) New York: The McGraw-Hill Inc.

2 Veer Bala Rastogi and Aneja.K.R , (2016). Zubay's Principle of Biochemistry. (5th Edn.) New Delhi: Medtec Publishers.

3 Berg, J.M., Tymoczko, J.L., Gatto Jr, G.J. and Stryer, L, (2019). Biochemistry. (9th Edn.) New York: W.H. Freeman and Company.

4 Voet, D. and Voet J.G,. (2011). Biochemistry. (4th Edn.) New York: John Wiley and Sons.

Course Code	Course Name	Category	L	T	P	Credit
193BC2A2CC	**CORE :** MICROBIAL BIOCHEMISTRY	CORE	4		-	4

PREAMBLE

This course has been designed for students to learn and understand

- This course offers an overview on major metabolic and energy exchange pathways in microbial cell homeostasis.
- Students can gain an in-depth knowledge on applications of biotechnology in diverse areas of agriculture, medicine and environmental biology
- Students can learn detail the production of antibiotics, amino acids, vitamins and single cell protein from microbial source.

COURSE OUTCOMES

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

CO Number	CO Statement	Knowledge Level
CO1	Examine the importance of microbial nutrition. Determine bacterial growth and its growth kinetics.	K3,K4 & K5
CO2	Evaluate and explain elaborately the central metabolic pathways existing in microbes.	K5 & K6
CO3	Compare different types of fermentation technology.	K5 & K6
CO4	Value the application of microbes in agriculture, mining, and energy production and food industry.	K5
CO5	Discuss in detail the production of antibiotics, amino acids and single cell protein from microbial source.	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**

193BC2A2CC	CORE : MICROBIAL BIOCHEMISTRY	**SEMESTER II**

Total Credits: 4
Total Instruction Hours: 48 h

Syllabus

Unit I Microbial Nutrition, Medium, Growth and Measurement 10 h

Microbial Nutrition- nutritional requirements and uptake of nutrients by microbial cells; Transport of sugars into bacterial cell– the bacterial phosphotransferase system. Nutritional groups of microorganisms (autotrophs, heterotrophs and mixotrophs). Growth media- synthetic, complex, selective, enrichment and differential media. Microbial Growth- different phases of growth in batch cultures, synchronous, continuous and biphasic growth. Factors influencing microbial growth. Methods for measuring microbial growth– Direct microscopy, viable count estimates, turbidometry and biomass. Bacterial Cell cycle.

Unit II Microbial Energy and Synthesis Biology 9 h

Energy yielding metabolism– carbohydrates– EMP, HMP, TCA– importance in bacteria. Phosphoketolase pathway, ED pathway, characteristics of electron transport in bacteria. Bacterial Chemotaxis and quorum sensing.

Biosynthesis of cell wall– peptidoglycan, teichoic acid, lipids; biosynthesis of straight and branched chain fatty acids, unsaturated fatty acids and cyclopropane fatty acids. Synthesis of triacylglycerols, phospholipids, glycolipids and polyisoprenoids. Metabolism of purines and pyrimidines.

Unit III Fermentation Technology 10 h

Fermentation technology– Principles of fermentation, surface, submerged and solid-state fermentations. Batch, fed batch, semi-continuous and continuous culture techniques. Design and operation of fermentors, Agitation and aeration, Types of fermentors continuous stirred tank fermentor (CSTF), air-lift fermentor, Types of reactions in fermentations. Microbial production of Primary metabolites: organic acids (Acetic acid, lactic acid, and citric acid), Amino acids (glutamic acid, lysine, threonine, phenylalanine) and Vitamins (B12, B2, and vitamin-C). Strategies for strain improvement and maintenance of the industrial strains, Downstream processing, Bioreactors.

Unit IV Industrial and Agricultural Fermentation Technology 10 h

Genetically modified organisms. Enzymes- amylase, proteases, streptokinase, Production of biogas from agricultural wastes. Production of bio-insecticides from bacteria and fungi.

Environmental Microbiology: Microbiology of food-food spoilage, controlling food spoilage, types of food borne diseases, microbiology of fermented food. Applied

environmental microbiology- water purification and sanitary analysis. Waste water treatment. Bio-degradation, bioremediation and bio-augmentation.

Unit V Bio-Pharmaceuticals 9 h

Production of antibiotics – source, production, recovery and uses of penicillin, tetracycline, amoxicillin. Production of bacterial and fungal polysaccharides; Commercial production of xanthan gum. Single cell protein-production and application.

Text Books

1 Joanne. M. Willey, Linda M. Sherwood, Christopher. J. Wollverton, (2011). Prescott's Microbiology. (8th Edn.) New York Mc Graw Hill International Edition:.

2 El-Mansi, E.M.T. Bryce C.F.A. Daou, B, Sanchez.S, Demain .A.L.,. (2014). Fermentation Microbiology & Biotechnology. (3rdEdn.) UK: Taylor & Francis Group.

References

1 Lanshing, M Prescott, John. P. Harley, Donald. A. Klein. (2009). Microbiology. (4th Edn.) New York: Mc Graw Hill International Edition.

2 Srivastava. M. L. (2008). Fermentation Technology. (1st Edn.) NewDelhi : Narosa Publishing House.

3 Prave. P, Faust. U, Sittig. W, Sukatsch D. A. (2004). Fundamentals of biotechnology, (2nd Edn.) NewDelhi: Panima Publishing Corporation.

4 Patel. A.H. (2016). Industrial Microbiology. (2nd Edn.) Trinity Press: NewDelhi.

Course Code	Course Name	Category	L	T	P	Credit
193BC2A2CD	**CORE :** GENETICS AND MOLECULAR BIOLOGY	CORE	4	-	-	4

PREAMBLE

This course has been designed for students to learn and understand

- The core principles of genetics and molecular biology.
- How genetic information flows from DNA to RNA to protein and its regulation mechanisms.
- Demonstrate knowledge of the molecular machinery of living cells

COURSE OUTCOMES

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

CO Number	CO Statement	Knowledge Level
CO1	Demonstrate knowledge of the basics principles of Mendelian and Non-Mendelian genetics and display a broad understanding of core genetics concepts	K3 & K4
CO2	Explain the mechanisms of DNA replication, RNA synthesis and processing, and protein synthesis.	K3, K4 & K5
CO3	Describe the processes of gene regulation and predict how a gene will be expressed under specific circumstances.	K3, K4 & K5
CO4	Describe the molecular events of DNA damage & repair.	K4 & K5
CO5	Analyse and critically present primary scientific literature in the genetics and molecular biology field.	K5 & K6

MAPPING WITH PROGRAMME OUTCOMES

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

193BC2A2CD	CORE : GENETICS AND MOLECULAR BIOLOGY	**SEMESTER** II

Total Credits: 4
Total Instruction Hours: 48 h

Syllabus

Unit I Genetics 10 h

Mendelian Principles, Segregation, Independent Assortment, Dominance relations, Multiple alleles, Incomplete dominance, Over dominance. Gene interaction, Epistasis, lethality and lethal genes, Sex determination and sex linkage, linkage and crossing over, gene mapping. Chromosomal theory of inheritance, Chromosomal aberrations, maternal effects. Introduction to Population genetics, gene frequency, factors affecting gene frequency. Genetic drift, Pedigree analysis and genetic counseling. Fine structure of Gene, cistron, recon, Structures of Eukaryotic and Prokaryotic genes. Cytoplasmic genetic systems- mitochondria and chloroplast DNA. Experimental evidence for DNA as the genetic material.

Unit II Replication and Recombination 9 h

Structure of DNA and RNA- Composition, Types and Functions. Replication in prokaryotes: replication in circular chromosomes- Cairns model, rolling circle model. Eukaryotic replication, replication fidelity. Replication in RNA virus (retroviruses) and plasmid replication. Inhibitors of replication. DNA recombination: Homologous, site specific and transposition, Homologous recombination: Holliday Model and Rec BCD pathway. Site-specific recombination: Lambda phage integration, and excision rearrangement. Transposition: Prokaryotic transposition, conservative and replicative transposition. Eukaryotic transposable elements, yeast and Drosophila transposons.

Unit III Transcription 9 h

Transcription- definition, coding strand, template strand, sense strand and antisense strand, promotor, DNA-dependent RNA polymerase, role of Pribnow box, template binding, prokaryotic transcription, Rho-dependent and independent transcription, posttranscriptional processing in prokaryotes, alternative splicing, RNA editing. Eukaryotic transcription, post-transcriptional modifications of eukaryotic RNAs, RNA splicing, introns and splicing reactions, exons and enhancers.

Unit IV Translation and Gene regulation 10 h

Genetic code- definition, deciphering of the genetic code, codon dictionary, salient features of genetic code. Structure of t-RNA, activating enzymes, binding of amino acids to t-RNA, wobble mechanism and its significance, composition of prokaryotic

and eukaryotic ribosomes, leader sequence, Shine-Dalgarno sequence, reading frame-shift, prokaryotic and eukaryotic protein biosynthesis- initiation, elongation, translocation and termination, polysomes. Protein folding – Chaperon mediated and independent. Inhibitors of protein synthesis. Regulation of gene expression in prokaryotes-operon model, lac, trp, arabinose operons, repression and attenuation. Regulation of gene expression in eukaryotes - Britten-Davidson model, transcriptional regulation. C-value paradox, repetitive DNA.

Unit V DNA Damage and Repair 10 h

Mutagenesis - Spontaneous and Induced mutations – Physical and Chemical mutagenesis, Molecular mechanisms of mutagenesis – Transition, Transversion, Frame Shift, mis-sense and non-sense mutations. DNA repair - Direct reversal repair, double strand break repair in mammals, Excision repair - base and nucleotide excision repair, mismatch repair, recombination repair, SOS response and mutagenic repair.

Text Books

1 Ajoy Paul, (2011). Text book of Genetics. (1st Edn.) Kolkatta: Books and Allied (P) Ltd.

2 Jeyanthi, G.P. (2009). Molecular Biology. (1stEdn.) Chennai: MJP Publisher.

References

1 Robert F. Weaver,. (2011). Molecular biology. (5th Edn.) London: McGraw-Hill Education.

2 Karp, G., Iwasa, J. and Marshall, W., (2015). Karp's Cell and Molecular Biology: Concepts and Experiments. (8th Edn.) New Jerssey: John Wiley and Sons.

3 Klug, W.S., Cummings, M.R., Spencer, C.A., Palladino, M.A. and Killian, D., (2018). Concepts of Genetics. (12th Edn.) London: Pearson Education.

4 Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A. and Martin, K.C.,. (2016). Molecular Cell Biology. (8th Edn.) New York: W.H. Freeman.

193BC2A2CP	PRACTICAL-III: METABOLISM AND IMMUNOLOGY	**SEMESTER II**

Total Credits: 3
Total Instructions Hours: 72 h

S.No	Contents
1	Estimation of pyruvate by DPNH (2,4-dinitrophenylhydrazine) method
2	Estimation of reducing sugar by Benedict's method
3	Estimation of MDA as an index of Lipid Peroxidation
4	Induction of Hydrolytic enzymes proteinases/amylases/lipases during germination
5	Estimation of amino acids - Methionine
6	Estimation of Phopholipids
7	Estimation of Lipoproteins
8	Precipitation reaction- Single and Double Immunodiffusion
9	Detection of antigens by ELISA technique
10	Precipitin Ring Test
11	Isolation of Immunoglobulins
12	Raising of antibodies in Rabbit/Rat
13	Purification of antibodies by dialysis
14	Ammonium sulphate precipitation for preparation of crude immunoglobulin
15	Determination of antigen identity
16	Immuno-electrophoresis of serum proteins

Note: Out of 16 experiments Minimum of 8 are mandatory

References

1. Frank C. Hay and Olwyn, M.R. Westwood (2002). Practical Immunology. (4th Edn.) United States:Blackwell Science.

2. Harold Varley, Alan H Gowenlock, Janet R McMurray and Donald M McLauchlan (2006). Varley's practical clinical biochemistry. (6th Edn.) London : Heinemann Medical Ltd.

193BC2A2CQ	PRACTICAL-IV: MICROBIAL BIOCHEMISTRY AND MOLECULAR BIOLOGY	**SEMESTER II**

Total Credits: 2
Total Instructions Hours: 48 h

S.No	Contents
1	Staining technique - Gram staining, Negative staining.
2	Determination of microbial growth -turbidity method.
3	Media preparation, sterilisation (Nutrient agar, Nutrient broth, plates, slants) and Culture techniques - pour plate, spread plate and streak plate method
4	Isolation and purification of bacteria and Fungi-serial dilution techniques.
5	Determination of antibiotic sensitivity.
6	Biochemical Characterization of Bacteria 1. Indole test 2. Methyl Red test 3. Triple Sugar Iron Agar test 4. Voges Proskauer test 5. Citrate Utilization test 6. Catalase test 7. Urease test 8. Oxidase test 9. Nitrate test
7	Amplification of desirable gene by Polymerase chain reaction.
8	Preparation of competent cells by calcium chloride method and transformation.
9	Restriction digestion of DNA.
10	Isolation of DNA fragment from Agarose gel.
11	Protein purification by ammonium sulphate precipitation.
12	Southern blotting (Demonstration).

Note: Out of 12 experiments Minimum of 8 are mandatory

References

1. Jayaraman, (2015). Laboratory Manual in Biochemistry. (1st Edn). Chennai: New Age international publication.

2. Chaitanya, K V. (2013). Cell and Molecular Biology – A laboratory manual. (1st Edn.) New Delhi : PHI publisher.

3. Gakhar S.K, (2013). Molecular Biology- A laboratory manual. (1st Edn.) New Delhi : I.K International.

4. Sharma R K (2008). Basic techniques in Biochemistry and Molecular Biology. (1st Edn.) New Delhi: I K international Pvt Ltd.

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 BIOTECHNOLOGY	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 BIOTECHNOLOGY	**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, DNA Barcoding, 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										
193BC2A3CA	Core-IX	Biostatistics and Research Methodology	4	-	-	3	25	75	100	4
193BC2A3CB	Core-X	Plant Biochemistry and Biotechnology	4	-	-	3	25	75	100	4
193BC2A3CC	Core-XI	Genetic Engineering	4	-	-	3	25	75	100	4
193BC2A3CD	Core-XII	Clinical Biochemistry	4	-	-	3	25	75	100	4
193BC2A3CP	Core Practical-V	Practical: Clinical Biochemistry	-	-	6	6	40	60	100	3
193BC2A3CQ	Core Practical-VI	Practical : Plant Biochemistry and Genetic Engineering	-	-	4	6	40	60	100	2
193BT2A3DA	DSE-III	Molecular Therapeutics	3	1	-	3	25	75	100	3
193MB2A3DA		Molecular Diagnostics in Microbiology								
193BC2A3DA		System Biology								
Total			**19**	**1**	**10**	**-**	**-**	**-**	**700**	**24**

EXTRA CREDIT COURSES

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

S. No.	Course Code	Course Title
1.	193BC2ASSA	Bionanotechnology
2.	193BC2ASSB	Inheritance, Evolution and Behaviour

Course Code	Course Name	Category	L	T	P	Credit
193BC2A3CA	BIOSTATISTICS AND RESEARCH METHODOLOGY	CORE	4	-	-	4

PREAMBLE

This course has been designed for students to learn and understand

- The role of statistics in research.
- Testing of hypothesis for small and large samples.
- The fundamental knowledge of the concepts of probability and standard distributions which can describe real life phenomenon.

COURSE OUTCOMES

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

CO Number	CO Statement	Knowledge Level
CO1	Organize statistical survey, classify the methods for collecting and analyzing qualitative and quantitative data	K3, K4 & K5
CO2	Interpret data using measures of central tendency, variation, and correlation regression analysis.	K5 & K6
CO3	Discuss the utility of sampling theory, probability and theoretical distributions in conducting research.	K5
CO4	Assess various tests of significance for the purpose of making inferences based on available data.	K5
CO5	Discuss the objectives of conducting research, Formulation of research problem.	K5 & K6

MAPPING WITH PROGRAMME OUTCOMES

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

S Strong M Medium L Low

193BC2A3CA	BIOSTATISTICS AND RESEARCH METHODOLOGY	SEMESTER III

Total Credits: 4

Total Instruction Hours: 48 h

Syllabus

Unit I Methods for Collection Data 8 h

Organising a statistical survey - Planning and executing the survey. Source of data – Primary and secondary data, Collection - observation; interview; enquiry forms, questionnaire schedule and check list. Classification and tabulation of data. Diagrammatic & graphic presentation of data. Parametric and non parametric tests.

Unit II Statistical Measures 12 h

Measures of central tendency: arithmetic mean, median, mode, quartiles, deciles and percentiles. Measures of variation: range, quartile deviation, mean deviation and standard deviation. Correlation analysis: Scatter diagram, Karl Pearson's coefficient of correlation and Spearman's rank method. Regression analysis. Introduction to R programming. MS Excel, Introduction to SPSS package.

Unit III Probability 8 h

Definition, concepts, theorems (proof of the theorems not necessary) and calculations of probability. Theoretical distributions: Binomial, Poisonn and Normal distribution. Normal distribution: importance, properties, conditions and constants of the distribution (proof not necessary)

Unit IV Sampling distribution and test of significance 12 h

Errors in hypothesis testing, standard error and sampling distribution. Sampling of variables (large samples and small samples). Student's 't' distribution and its applications. Chi - square test & goodness of fit. Analysis of variance- one way and two-way classification, Duncan's Multiple Range Test. Design of experiment - completely randomized design and randomized block design.

Unit V Research Methodology 8 h

Research: General-Introduction, types and classification of research-diagnostic, descriptive, and exploratory research. Topology for literature research-scientific methods-components of scientific methods. Formulation of research paper. Research design-types of research design – histological design, descriptive design, formation of hypothesis, synopsis writing. An approach for National and International Research funding agencies

Text Books

1. Gupta S P, 2014, "Statistical Methods", 43rd edition, Sultan Chand and Sons publications, New Delhi.
2. Pillai R S N and Bagavathi, 2017," Statistical Theory and Practices", 8th edition, S. Chand and company Ltd, New Delhi

References

1. Ajai S Gaur and Sanjaya S. Gaur, 2009," Statistical methods for practice and Research: A guide to data analysis using SPSS". 2nd edition, Sage Publications Pvt. Ltd., New Delhi.
2. Kothari C R, 2019, "Research Methodology Methods and Techniques", 2nd edition; New Age International, New Delhi.
3. Devore J L, 2014, “Probability and Statistics for Engineering and the Sciences", 8th Edition, Cengage Learning, New Delhi.
4. Gupta S C and Kapoor V K, 2017," Fundamentals of Mathematical statistics", Sultan Chand & Sons, New Delhi.

Course Code	Course Name	Category	L	T	P	Credit
193BC2A3CB	PLANT BIOCHEMISTRY AND BIOTECHNOLOGY	CORE	4	-	-	4

PREAMBLE

This course has been designed for students to learn and understand

- The primary metabolic pathways occurring in plants, various kinds of plant metabolites, their industrial potential and its production.
- Plant tissue culture, molecular aspects of plant breeding and gene transfer technology.
- Plant cell physiology and the role of hormones in plant growth.

COURSE OUTCOMES

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

CO Number	CO Statement	Knowledge Level
CO1	Illustrate biochemical events associated with plant cell and explain photosynthesis.	K3 & K4
CO2	Examine the mechanism of Nitrogen fixation & Identify the biochemical events of plant growth & development.	K3 & K4
CO3	Gain knowledge about the importance of plant growth regulators & secondary metabolites in industries.	K5
CO4	Choose proper genetic engineering tools for the improvement of crops.	K5
CO5	Develop skills and knowledge to conduct basic research work in plant biochemistry and biotechnology.	K6

MAPPING WITH PROGRAMME OUTCOMES

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

193BC2A3CB	PLANT BIOCHEMISTRY AND BIOTECHNOLOGY	SEMESTER III

Total Credits: 4

Total Instruction Hours: 48 h

Syllabus

Unit I Photosynthesis and Water Absorption 8 h

Introduction to Plant cell. Photosynthesis: Apparatus, role of photosynthetic pigments, Biochemistry of Dark and light reaction - photo systems I and II, Photosynthetic electron transport - cyclic and non-cyclic photophosphorylation. Carbon reactions in Calvin cycle (C3 plants), Hatch slack pathway (C4 plants), Crassulacean acid metabolism, factors affecting photosynthesis. Biochemical basis of photorespiration (PR pathway) – C2 cycle.

Water absorption – Mechanism of water absorption, symplast and apoplast concept, Transpiration – types, mechanism and factors affecting transpiration.

Unit II Nitrogen Metabolism and Plant growth and development 9 h

Nitrogen metabolism: Development and structure of root nodules, Role of nod factors in nodule development. Structure of plant nitrogenase system, Symbiotic nitrogen fixation and its regulation. Formation and assimilation of ammonia.

Biochemistry of seed development, dormancy, germination, fruit development, ripening and Senescence. Structure and function of phytochrome, flowering, photoperiodism and vernalization.

Unit III Plant Hormones and Secondary Metabolites 12 h

Plant hormones: Structure, biosynthesis and biochemical mode of action of auxins, gibberellins, cytokinins, abscisic acid and ethylene. Secondary metabolites: classification, biosynthesis and functions of terpenoids, alkaloids, phenolics, tannins, lignin, waxes and anthocyanins. Secondary metabolites in clinical, cosmetic and food industries (each with any two examples).

Responses of plants to biotic (pathogen and insects) and abiotic (water, temperature and salt) stresses. Overview on Toxins of plant origin and Antioxidative defense system in plants.

Unit IV Plant Tissue Culture 9 h

Introduction to tissue culture - Media composition and preparation. Micropropagation, callus induction, cell suspension and protoplast culture, organogenesis and somatic embryogenesis. Haploid production – Anther, pollen, embryo and ovule culture. Selection of hybrid cells, cybrids, somaclonal variation. Germplasm storage and cryopreservation. Applications of tissue culture for crop improvement and for the overproduction of plant secondary metabolites (Bioreactors).

Unit V Transgenics in Plants 10 h

Importance of RFLP, RAPD and SCAR in plant breeding management. Agrobacterium and crown gall tumors – Ti plasmid and Ri plasmid vectors. Mechanism of T-DNA transfer to plants. Plant viral vectors, Direct transformation of plants by physical methods. Promoters, Selectable markers and reporter genes used in plant vectors. Application of transgenesis in crop improvement – Insect resistance, disease resistance, virus resistance, herbicide resistance, and abiotic stress resistance. Transgenesis for male sterility and improved nutrition; Transgenic plants - Ethics, Bt cotton, Bt brinjal, Plant genome-Rice. Pros and Cons of GM crops

Text Books

1. Verma S K and Verma M, 2013, "A textbook of Plant Physiology, Biochemistry and Biotechnology", 6th edition, S. Chand & Co, New Delhi.
2. Singh B D, 2014, "Plant Biotechnology", 1st edition, Kalyani Publishers, Kerala.

References

1. Buchanan B B, Gruissem W and Jones R L, 2015, "Biochemistry and Molecular Biology of Plants", 2nd edition, Wiley Blackwell, New Jersey.
2. Heldt H W and Piechulla B, 2016, "Plant Biochemistry", 4th edition, Academic Press, Cambridge, United States.
3. Slater A, Scott N and Fowler M, 2008, "Plant Biotechnology – The genetic manipulation of plants", 2nd edition, Oxford University Press, Oxford, England.
4. Altman A and Hasegawa P M, 2011, "Plant Biotechnology and Agriculture: Prospects for the 21st Century", 1st edition, Academic Press, Cambridge, United States.

Course Code	Course Name	Category	L	T	P	Credit
193BC2A3CC	GENETIC ENGINEERING	CORE	4	-	-	4

PREAMBLE

This course has been designed for students to learn and understand

- the emergence and early development and application of technology
- biotechnological applications of Genetic Engineering, for example, Cloning, Vectors, transgenic animals, treating diseases etc
- the gene transfer methods and transgenic animals

COURSE OUTCOMES

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

CO Number	CO Statement	Knowledge Level
CO1	Distinguish the transmission and Mendelian genetics. Compare the recessive and dominance in Mendelian inheritance.	K4 & K5
CO2	Explain the role of restriction endonucleases in Restriction mapping. Support of nucleic acid probes in application.	K4 & K5
CO3	List of different types Vectors and its applications.	K4 & K5
CO4	Explain the cloning techniques. Distinguish Cultured insect cell expression systems; mammalian cell expression systems.	K4 & K5
CO5	Analyze the expression of cloned genes by gene transfer techniques in animal cells.Applications of transgenic animals .	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	S	S

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

193BC2A3CC	GENETIC ENGINEERING	SEMESTER III

Total Credits: 4

Total Instruction Hours: 48 h

Syllabus

Unit I Introduction of genetics and genetic engineering 8 h

Introduction to genetics and genetic engineering and rDNA technology, gene cloning, specialized tools and techniques, benefits of gene cloning. Isolation and purification of DNA: Preparation of total Cellular DNA, plasmid DNA, bacteriophage DNA, plant cell DNA, isolation of mRNA from mammalian cells.

Unit II Probes and Techniques 10 h

Restriction endonucleases – types and functions; restriction mapping. Nucleic acid probes and their applications – cloned probes, oligonucleotide probes; labeling of nucleic acid probes. Nucleic acid hybridization techniques – liquid and dot blot technique; Southern and Northern hybridization; in situ hybridization; whole mount in situ hybridization. FISH. Polymerase chain reaction – types and applications. DNA fingerprinting, Chemical synthesis of genes. Principles of DNA sequencing: Sanger's sequencing, Next generation sequencing and Introduction to Illumina or Pyro-sequencing.

Unit III Cloning and Cloning Strategie 10 h

Cloning vectors and Cloning strategies – salient features. Plasmids vectors , Bacteriophage vectors, Cosmid vectors, DNA (single stranded) vectors, viral vectors. Transposons vectors. High capacity cloning vectors – bacterial artificial chromosomes, phage P1, yeast artificial chromosomes and PACs. Genomic and cDNA cloning. cDNA library

Unit IV Expression vector systems 10 h

Expression vectors – vectors for maximizing protein synthesis, fusion proteins. Expression vectors – expression of cloned genes in E. coli. Cloning and expression of cloned genes in Bacillus subtilis. Cloning in yeasts; yeast expression vectors, over expression in yeast. Expression in baculovirus system. Cultured insect cell expression systems; mammalian cell expression systems. Recombination, selection and screening methods and processes.

Unit V Gene transfer methods and Transgenic animals 10 h

Gene transfer methods in animal cells – calcium phosphate copreceipitation, ectroporation, microinjection, using viral vectors. Transfer, cotransfer, selectable markers like TK, PSV, PRSV and reporters genes. Gene targeting in animal cells; transfer and expression of cloned genes in Drosophila. Gene knockout. Methods for

production of transgenic animals (mice, sheep, goat, fish, pig, cow etc.,) – retroviral, DNA microinjection and engineered stem cell methods. Applications of transgenic animals; transgenic animals as models/in the prevention of human diseases like cystic fibrosis, muscular dystrophy and anticancer therapy, Gene Editing- CRISPR Cas 9 and TALEN.

Text Books

1 Primrose S B and Twyman R M, 2014, "Principles of Gene Manipulation and Genomics", 7th Edition, Blackwell Publishers, USA and UK.

2 Jane K and Setlow, 2016, "Genetic Engineering principles and Methods", Volume 27, 2006th edition, Plenum Press, New York and London .

References

1 Ernst L Winnacker, 2003, "From Genes to Clones, Introduction to Gene Technology", Panima Publishing Corporation, New Delhi.

2 Brown TA, 2016, 'Gene cloning and DNA Analysis an Introduction", 7th Edition, Blackwell Publishing , USA and UK.

3 Dubey RC, 2014, "Advanced Biotechnology", S.Chand & Company,New Delhi, India.

4 Rajagopal K, 2012, "Recombinant DNA Technology and Genetic Engineering", McGraw Hill Education, India.

Course Code	Course Name	Category	L	T	P	Credit
193BC2A3CD	CLINICAL BIOCHEMISTRY	CORE	4	-	-	4

PREAMBLE

This course has been designed for students to learn and understand

- the metabolic disorders, diagnosis and management of disease through the analysis of blood, urine and other body fluid by different techniques
- tests to identify the functions of the organs
- the relevance of biochemistry to health and disease

COURSE OUTCOMES

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

CO Number	CO Statement	Knowledge Level
CO1	Summarize about the Specimen collection and processing, Evaluate the use of biochemical data and Automation in Clinical Laboratory	K4&K5
CO2	Explain about the factors that influence disorders associated with coagulation and hemoglobin.	K4
CO3	Analyze the relation between biomolecules and diseases.	K4
CO4	Assess the function of organ by clinical diagnosis and outline on Clinical Enzymology.	K5
CO5	Predict the importance of molecular diagnosis of disease and forensic biochemistry	K5

MAPPING WITH PROGRAMME OUTCOMES

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

S Strong M Medium L Low

193BC2A3CD	CLINICAL BIOCHEMISTRY	SEMESTER III

Total Credits: 4

Total Instruction Hours: 48 h

Syllabus

Unit I Specimen collection and processing, use of Biochemical data, Automation 10 h

Specimen collection and processing: Collection of blood by various methods, anticoagulants of blood. Collection of urine-timed urine specimens, urine preservatives. Collection of feces and Amniotic fluid- Handling of specimen for testing-Use of Biochemical data in clinical medicine-Diagnosis, Management, Screening-. Acquisition and interpretation of biochemical data- Test Request- Factors Affecting Test Results- Interpretation of Results- Predictive Value of Tests- - Automation in the clinical biochemistry: Processes -Laboratory information systems-robotics-Types of automation.

Unit II Blood and coagulation 9 h

Blood and coagulation: The coagulation cascade -Laboratory tests of coagulation - Interpretation of coagulation-tests- Blood Transfusion- Blood group antigens- Laboratory transfusion tests-Investigation of suspected transfusion-reaction- Haemolytic disease of the newborn-Porphyrias- erythropoietic and hepatic , Haemolysis -Anemia- Iron deficiency anaemia-Inherited and acquired haemolytic anaemias -Diagnosis of Haemolysis-Haemoglobinopathies- sickle cell anemia, Thalassemia- Alpha and Beta); - Laboratory Diagnosis of Haemoglobinopathies

Unit III Metabolic disorders 9 h

Disorders of carbohydrate metabolism: glycogen storage diseases, galactosemia, fructosuria. Hypoglycemia, hyperglycemia, Diabetes mellitus-classification, metabolic abnormalities, diagnosis and management.

Disorders of lipid metabolism: lipoproteinaemias. Lipid storage diseases-Gaucher's and Tay sach's disease. Fatty liver and Atherosclerosis.

Disorders of amino acid metabolism:, Phenylketonuria, alkaptonuria, albinism, and maple syrup urine disease.

Disorders of purine and pyrimidine metabolism: gout and orotic aciduria.

Unit IV Liver and Renal functions tests, Clinical Enzymology 10 h

Liver function tests: Jaundice- Definition, types,Causes, consequences, Laboratory diagnosis and treatment in jaundice, Tests related to excretory (bile pigments) synthetic (plasma proteins, prothrombin time) detoxifying (hippuric acid, NH3, aminopyrine) and metabolic (galactose) functions.

Renal function tests: clearance of tests - urinary calculi, renal hypertension - principles of peritoneal and hemodialysis - urinalysis for normal and abnormal constituents.

Clinical Enzymology- plasma functional and nonfunctional enzymes. Enzymes in health and disease- Creatinine kinase, Amonotransferases, amylase and alkaline phosphatase.

Unit V Molecular clinical and Forensic Biochemistry 10 h

Molecular clinical Biochemistry-Techniques of Genetic Analysis-Detection of specific sequences in DNA -Detection of mutations-Applications of DNA Analysis - Prenatal diagnosis-Screening-Inherited diseases – Cystic fibrosis- Multifactorial and polygenic disease-Familial hypercholesterolaemia-Gene Therapy -Stem cells in gene therapy -Gene therapy in cancer.

Forensic biochemistry- Samples and Sampling-Poisoning with Endogenous Agents-γ-Hydroxybutyrate –Insulin. Post-Mortem Biochemistry:Vitreous humour. Specific Diagnostic Problems-Anaphylaxis reactions-Diabetes

Overview- Point of Care Technology Instruments. Use of AI in diagnostics, Quality assurance in clinical laboratories – Six Sigma concept

Text Books

1 William J Marshal, Marta Lapsley, Andrew P Day and Ruth M Ayling, 2014, "Clinical Biochemistry: metabolic and Clinical aspects", 3rd edition, Churchill Livingstone, London.

2 Burtis and Bruns, 2014, "Tietz fundamentals of Clinical Chemistry and Molecular Diagnostics", 7th edition, Saunders, US.

References

1 Gerhard Meiserbag & Willian H Simmons, 2016, "Principles of Medical Biochemistry", 4th edition, Elsevier Health Sciences, US.

2 Luxton R, 2008, "Clinical Biochemsitry", 2nd Edition, Scion Publishing Limited, England.

3 Gowenlock A H, 2006, "Varley's Practical clinical biochemistry", 6th edition, CBS Publishers, New Delhi.

4 Rifai N, 2017, "Tietz Text book of clinical chemistry and molecular diagnosis", 6th edition, Elsevier Health Sciences, US.

193BC2A3CP	CORE PRACTICAL : CLINICAL BIOCHEMISTRY	SEMESTER III

Total Credits: 3
Total Instructions Hours: 72 h

S.No	List of Experiments
1	Estimation of blood glucose
2	Estimation of haemoglobin in blood
3	Estimation of Serum cholesterol
4	Estimation of serum calcium
5	Estimation of creatinine in serum/ urine/ Creatinine clearance
6	Assay of serum acid and alkaline phosphatase
7	Assay of serum AST/ALT
8	Estimation of serum total proteins and albumin
9	Glucometer (demonstration)
10	Paper chromatography of aminoacids in urine
11	Estimation of amylase activity in saliva
12	Estimation of Bilirubin in Serum

Note: Out of 12 - 10 Mandatory

References

1. Gowenlock A H, 2006, "Varley's Practical clinical biochemistry", 6th edition, CBS Publishers, New Delhi.
2. Victor J Temple, Rachael Rowe, Nigani Willie and Samson Grant, 2013, "A Practical Manual in Biochemistry & Clinical Biochemistry", 4th edition, University of Papua New Guinea Press, Papua New Guinea.
3. Luxton R, 2008, "Clinical Biochemsitry", 2nd Edition, Scion Publishing Limited, England.
4. William J Marshal, Marta Lapley,Andrew P Day, Ruth M Ayling, 2014, "Clinical Biochemistry: metabolic and Clinical aspects", 3rd edition, Churchill Livingstone, London.

193BC2A3CQ	CORE PRACTICAL : PLANT BIOCHEMISTRY AND GENETIC ENGINEERING	SEMESTER III

Total Credits: 2
Total Instructions Hours: 48 h

S.No	List of Experiments
1	Estimation of total chlorophyll, chlorophyll-a and chlorophyll-b pigments from leaves and its separation using TLC
2	Qualitative analysis of secondary phytochemicals in medicinal plants
3	Estimation of total alkaloids
4	Estimation of total phenols
5	Estimation of total flavonoids
6	Estimation of phytosterols
7	Sterilization and media preparation
8	Callus Induction-Carrot and Micropropagation-Rose
9	Demonstration of Agrobacterium mediated genetic transformation
10	Ligation of DNA into linearized plasmid
11	Restriction fragment length polymorphism
12	Random amplified polymorphic DNA

Note: Out of 12 - 10 Mandatory

References

1. Sadasivam S and Manickam A, 2018, "Biochemical Methods" 3rd edition, New Age International Publishers, New Delhi.
2. Giri C C and Archana G, 2007, "Plant Biotechnology – Practical Manual", 1st edition, I.K. International, New Delhi.
3. Green M R and Sambrook J, 2014, "Molecular Cloning - A Laboratory Manual ", 4th Edition, Cold Spring Harbor Laboratory Press, USA.
4. Carson S, Miller H B, Srougi M and Witherow D S, 2019, "Molecular Biology Techniques: A classroom laboratory manual", 4th edition, Academic Press, Cambridge, England.

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

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

193BC2ASSA	SELF STUDY : BIONANOTECHNOLOGY	SEMESTER III

Total Credit: 1

Syllabus

Unit I Nanotechnology

An introduction. Development of nanobiotechnology - Historical background overview. Nanosized effects surface to volume ratio. Types of nanostructure and physicochemical properties of nanomaterials. Nanoparticles, quantum dots, nanotubes, nanowires, Graphenes, Fullerenes, Nano Peapods, and Semiconductor Nanoparticles. Metal-based Nanostructures, dendrimers.

Unit II DNA based Nanostructures

DNA-protein nanostructures-Methods- Self assembled DNA nanotubes—Nucleic acid Nanoparticles, DNA as a Biomolecular template-DNA branching-Metallization- Properties. Nanobiosensors: Science of Selfassembly - From Natural to Artificial Structures. Nanoparticles in Biological Labeling and Cellular Imaging.

Unit III Protein and Peptide based Nanostructures

Chemistry and structure, Assembly, recrystalisation, diagnosis- Engineered Nanopores- Methods of production. Microbial nanoparticles production-Magnetosomes- Bacteriorhodopsins- Nanoproteomics.

Unit IV Synthesis & Characterization of Nanomaterials

Top-down (Nanolithography, CVD), Bottom-up (Sol-get processing, chemical synthesis). Bio-synthesis of nanomaterials - Green synthesis. Characterization of Nano material: Absorption, Fluorescence, and Resonance; Microscopy measurements: SEM, TEM, AFM and STM.

Unit V Applications of Nanobiotechnology

Miniaturized devices in nanobiotechnology - types and applications, lab on a chip concept. Nanotechnology in biomedical and Life Sciences: Nanomedicine, drug delivery, nanocapsule; nanorobots; nanopharmacology. Nanobiotechnological applications in Environment and food - detection and mitigation.

Text Books

1. Nicolini C, 2009, "Nanobiotechnology and Nanobiosciences", 1st edition, Jenny Stanford Publishing Pvt. Ltd., Singapore
2. Vo-Dinh T, 2019, "Nanotechnology in Biology and Medicine: Methods, Devices, and Applications", 2nd edition, CRC Press, Florida

References

1. Mirkin C A and Niemeyer C M, 2007, "Nanobiotechnology – II: more concepts and applications". Wiley VCH, New Jersey.
2. Shoseyov O and Levy I, 2008, "Nanobiotechnology: Bioinspired Devices and Materials of the Future", 1st edition, Humana Press, New Jersey.
3. Sharon M, Sharon M, Pandey S and Oza G, 2012, "Bio-nanotechnology Concepts and applications", 1st edition, Ane Books Pvt. Ltd, New Delhi.
4. Saudagar P and Divakar K, 2019, "Recent Trends in Nanobiotechnology: Food and Biomedical Applications", Central West Publishing, Australia.

193BC2ASSB	SELF STUDY : INHERITANCE, EVOLUTION AND BEHAVIOUR	SEMESTER III

Total Credit: 1

Syllabus

Unit I Inheritance Biology

Introduction to Mendelian principles, deviations and Extensions of Mendelian principles. Gene mapping methods: Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids. Extra chromosomal inheritance: Inheritance of mitochondrial and chloroplast genes. Microbial genetics: Methods of gene transfers - transformation, conjugation, transduction and sexduction, mapping genes by interrupted mating, fine structure analysis of genes. Human genetics: Karyotypes and genetic disorders. Quantitative genetics: Polygenic inheritance, heritability and its measurements, QTL mapping.

Unit II 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; Experiment of Miller (1953); The first cell; Evolution of prokaryotes; Origin of eukaryotic cells; Evolution of unicellular eukaryotes; Anaerobic metabolism, photosynthesis and aerobic metabolism.

Unit III 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.

Unit IV The Mechanisms

Population genetics – Populations, Gene pool, Gene frequency; Hardy-Weinberg Law; concepts and rate of change in gene frequency through natural selection, migration and random genetic drift; Adaptive radiation; Isolating mechanisms; Speciation; Allopatricity and Sympatricity; Convergent evolution; Sexual selection; Co-evolution.

Unit V Brain, Behavior and Evolution

Approaches and methods in study of behavior; Proximate and ultimate causation; Altruism and evolution-Group selection, Kin selection, Reciprocal altruism; Neural basis of learning, memory, cognition, sleep and arousal; Biological clocks; Development of behavior; Social communication; Social dominance; Use of space and territoriality; Mating systems, Parental investment and Reproductive success; Parental care; Aggressive behavior; Habitat selection and optimality in foraging; Migration, orientation and navigation; Domestication and behavioral changes.

Text Books

1. Pierce B A, 2017, "Genetics: A Conceptual Approach", 6th edition, W.H. Freeman, New York.
2. Workman L and Reader W, 2015, "Evolution and Behaviour", 1st edition, Routledge - Taylor and Francis, United Kingdom.

References

1. Gardner E J, Simmons M J and Snustad D P, 2006, "Principles of Genetics" 8th edition, John Wiley & Sons, New York.
2. Rastogi V B, 2018, "Organic evolution (Evolutionary Biology)", 13th edition, Medtech Publishers, New Delhi.
3. Bateson P, 2017, "Behaviour, Development and Evolution". Open Book Publishers, United Kingdom.
4. Cartwright J, 2008, "Evolution and Human Behaviour: Darwinian Perspectives on Human Nature", 2nd edition, MIT Press, Cambridge, MA.

Course Code	Course Category	Course Name	L	T	P	Exam (h)	Max Marks			Credits
							CIA	ESE	Total	
Fourth Semester										
193BC2A4CA	Core-XIII	Bio-ethics and Bio-safety	4	1	-	3	25	75	100	3
193BC2A4CB	Core-XIV	Endocrinology and Developmental biology	4	1	-	3	25	75	100	4
193BC2A4CV	Core -XV	Project	-		16	6	80	120	200	8
193MB2A4DA	DSE- IV	Microbial Technology	3	1		3	25	75	100	3
193BC2A4DA		Neurobiology								
193BT2A4DA		Stem Cell Technology								
Total			**11**	**3**	**16**	**-**	**-**	**-**	**500**	**18**

Course Code	Course Name	Category	L	T	P	Credit
193BC2A4CA	BIO-ETHICS AND BIO-SAFETY	CORE	4	1	-	3

PREAMBLE

This course has been designed for students to learn and understand

- concepts of patent rights and regulatory framework for the product safety
- the patenting of biotechnological processes, regulation of bioethics and the biosafety rules, the laws governing biotechnology and related field at national and international level
- basic and Good Laboratory Practices (GLP), Standard Operating Procedures (SOP),ethical perspective of handling potentially harmful biomaterials

COURSE OUTCOMES

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

CO Number	CO Statement	Knowledge Level
CO1	Explain biosafety and bioethics concepts, demonstrate good laboratory practices and apply the standard operating procedures for research	K2 & K3
CO2	Apply Biosafety practices in appropriate Biosafety labs	K3
CO3	Understand and analyze the basic principles and legal framework of IPR and its application to biotechnology	K2 &K4
CO4	Understand the basic issues of IPR, Biosafety & Bioethics	K2 &K3
CO5	Create awareness on the Biosafety, Bioethics and patenting of biotechnological processes and products	K6

MAPPING WITH PROGRAMME OUTCOMES

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

S Strong M Medium L Low

193BC2A4CA	BIO-ETHICS AND BIO-SAFETY	SEMESTER IV

Total Credits: 3

Total Instruction Hours: 60 h

Syllabus

Unit I Introduction to Biosafety 12 h

Introduction to Bio-safety; Different levels of Bio-safety; Basic Laboratory and Maximum Containment Laboratory; Containments-Types; Biological weapons; The Cartagena Bio-safety protocol (CAB); Role of IBSC; Guidelines for rDNA research activities; General guidelines for research in transgenic plants; Role of RCGM; Assessment of risks associated with GMO; General issues related to environmental release of transgenic plants, animals and microorganisms; Role of GEAC; Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP)

Unit II Bioethics Principles and Practices 12 h

Introduction to Bioethics; Animal Rights; Ethical, Legal and Social Implications (ELSI) of Human Genome Project; Ethical issues related to research in embryonic stem cell research and cloning

Unit III Introduction to IPR 12 h

Definitions: Physical and Intellectual Property, Tangible and Intangible Property; General Agreement on Trade and Tariff (GATT); TRIPS; World Trade Organizations (WTO); Establishment and functions of GATT, WTO and WIPO; WTO-Guidelines and Summits

Unit IV Intellectual Property Rights 12 h

Different types of intellectual property rights (IPR): Patents, Trade mark, Trade secret, Copy right and Geographical Indications; Requirement of patentability; Compulsory licenses; Biotechnological examples of patent, trademark, trade secret, copyright; Traditional Knowledge

Unit V Patent application 12 h

Patent application; Rules governing patents; Patent related cases: Licensing of Flavr Savr™ tomato as a model case; Bio-piracy case studies on patents (Basmati rice, Turmeric, and Neem); Indian Patent Act, 1970; Recent amendments, Biodiversity act of 2002

Text Books

1. Subbaram N.R, 2003, “What Everyone Should Know about Patents?”,2nd Edition, Pharma Book Syndicate, Hyderabad, India
2. Sree Krishna V, 2007, "Bioethics and Biosafety in Biotechnology",1st Edition, New Age International (P) Limited Publishers, New Delhi, India

References

1. Glick, Bernard R, Pasternack, Jack J and Patten, Cheryl L, 2010, "Molecular Biotechnology: Principles and Applications of Recombinant DNA", 4th Edition, ASM Press, Washington, DC, USA
2. Chawla H.S, 2020, "Introduction to Plant Biotechnology", 3rd revised Edition, Oxford & IBH Publishing Co. Pvt. Ltd, New Delhi, India
3. Sateesh M.K, 2008, "Bioethics and Biosafety", I.K.International Publishing House Pvt. Ltd, New Delhi, India.
4. Prabuddha Ganguli. 2008, “Intellectual Property Rights”, 1st Edition, Tata McGraw Hill Publishing Company Limited, New Delhi, India.

Course Code	Course Name	Category	L	T	P	Credit
193BC2A4CB	ENDOCRINOLOGY AND DEVELOPMENTAL BIOLOGY	CORE	4	1	-	4

PREAMBLE

This course has been designed for students to learn and understand

- the endocrine system and its specific secretions
- the various disorders related to each hormone due to their hypo and hyper secretion
- mechanisms involved in growth and development of complex organisms

COURSE OUTCOMES

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

CO Number	CO Statement	Knowledge Level
CO1	Explain the role of endocrine system in maintaining homeostasis and signal transduction	K2
CO2	Illustrate and evaluate the biochemical and physiological effects of pituitary, hypothalamic, Thyroid hormones	K3,K5
CO3	Evaluate the molecular, biochemical and physiological effects Adrenal, Gonadal and Neurohormones	K5
CO4	Demonstrate the basic concepts of developmental biology that occur within all living organisms, and fundamental processes of fertilization	K5
CO5	Demonstrate the basic concepts in the organogenesis, cell death and regeneration	K6

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	M	S	S
CO4	S	S	M	S	S
CO5	S	S	M	S	S

S Strong M Medium L Low

193BC2A4CB	ENDOCRINOLOGY AND DEVELOPMENTAL BIOLOGY	SEMESTER IV

Total Credits: 4

Total Instruction Hours: 60 h

Syllabus

Unit I Homeostasis and Signal Transduction 12 h

Hormones and homeostasis: Neuroendocrine Integration in homeostasis. Classes of chemical messengers. Hormone secretion. Transport and clearance. Feed back control of secretion. Signal transduction: Plasma membrane receptors, Adenylate kinase, Role of G Proteins, protein kinases, tyrosine kinases, inositol phosphates, calcium and Calmodulin. Steroid hormone receptors.

Unit II Hypothalamic, Pituitary, pineal and pancreatic hormones 12 h

The endocrine hypothalamus- Hypophysiotropic hormones- Chemistry & biochemical functions

Pituitary gland- Hormones of the pituitary gland, Chemistry & biochemical functions. Growth Factors-PGDF, EGF, IGF-II and erythropoietin;

Pineal gland- Hormones of the pineal gland- Chemistry& biochemical functions;

Thyroid gland- Thyroid hormones- Chemistry and Biochemical functions; Pancreas- Insulin/glucagon, Somatostatin– chemistry and biochemical functions.

Hormones involving in calcium metabolism

Unit III Adrenal, Neuro and Reproductive hormones 12 h

Adrenal gland- Hormones of Adrenal gland-Chemistry and biochemical functions; Gastrointestinal hormones- cholecystokinin, substance P, summary of the neuroendocrine control of GI

Neurohormones- The brain- Renin- Angiotensin, and Urotensin, Opioid peptides – endorphins & enkephalins

Hormones of female reproductive system: ovarian steroid hormones- Chemistry & biochemical functions, Hormonal changes during pregnancy and lactation

Hormones of Male reproductive system: Source, synthesis, chemistry and metabolism of Androgens

Endocrine dysfunction- Hypophyseal, Thyroid, parathyroid adrenal, & pancreas Clinical evaluation of endocrine functions-over view

Unit IV Fertilization, Embryonic development in plants and animals 12 h

Developmental Biology - an overview: Introduction of animal development: Development among unicellular eukaryotes –Acetabularis, Naegleria. The origins of sexual reproduction;

Fertilization: structure of gametes, recognition of sperm and egg –action at distance and contact of gametes

Early Embryonic Development in animals: Blastula formation, Types of Cleavage, Gastrulation and formation of germ layers in animals. Embryonic developments in plants;

Early Embryonic Development in plants: Gametogenesis, Fertilization, Embryo sac development and double fertilization in plants

Unit V Organogenesis and Cell death and regeneration 12 h

Organogenesis in animals – an overview: Tissue organization and stem cells; development of nervous system, mesodermal and endodermal organs.

Organogenesis –vulva formation in Caenorhabditis elegans;

Cell death and regeneration: Concept of regeneration; programmed cell death; aging and senescence

Text Books

1. Handley M.E, 2009, "Endocrinology",6th Edition, Prentice Hall, USA
2. Gilbert S.F, Singer S.R, 2006,“Developmental Biology", 8th Revised Edition, Sinauer Associates Inc, USA,

References

1. Hall J.E, 2015, "Guyton and Hall Textbook of medical physiology", 13th Edition , W.B. Saunders company publisher, USA
2. Rodwell, V.W, Bender, D.A, Botham, K.M, Kennelly, P and Weil, P.A, 2018, “Harper’s Illustrated Biochemistry”, 31st Edition, The McGraw-Hill Inc,USA.
3. Verma P.S, V.K. Agarwal V.K, 2010, "Chordate Embryology Developmental Biology", 1st Edition, S. Chand publishers, India.
4. Slack. J.M.W, 2012, "Essential Developmental Biology", 3rd Edition, Wiley-Blackwell publishers, USA

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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