UNIVERSITY OF DELHI

MASTER OF BIOMEDICAL SCIENCES

(MBS)

(Effective from Academic Year 2025-26)

PROGRAMME BROCHURE

Syllabus as approved by the Committee of courses of ACBR held on 05-05-2025

CONTENTS

I. About the Department

Dr. B.R. Ambedkar Center for Biomedical Research (ACBR) came into existence in March 1991 with the foundation stone laid by the then Hon'ble Prime Minister of India Sh. Chandra Shekhar ji, on the occasion of the birth centenary of Baba Saheb Dr. B.R. Ambedkar. The mandate of the Centre is high-quality postgraduate education and research in Biomedical Sciences. The institute also has provision for doctoral and postdoctoral training to young scientists at the start of their research career to gain the skills and insights in frontier areas of Biomedical Sciences. During the last three decades, the Center has grown to a strength of 220, comprising faculty, students, Ph.D. scholars, and supporting staff.

Dr. B.R. Ambedkar Center for Biomedical Research (ACBR) is a unique center under the University of Delhi wherein a multi-specialty group of scientists work as a cohesive team and carry out active teaching and research. The absence of a formal departmental setup provides an excellent environment where faculty members interact with each other freely, which enhances teaching and research in the complementary areas. The emphasis of research investigations is mainly on chemistry and biology and is being carried out in some of the frontline areas of basic and applied biomedical sciences such as Genetics, Molecular Oncology, Infectious Diseases, Proteins Science, Drug Discovery and Drug Development, Pharmacology and Toxicology, Bioinformatics, Medical Biotechnology, Immunology, Genomics & Proteomics, Medicinal Chemistry, Cancer Genetics, Cardiovascular Biology, Neurobiology and Neuropharmacology, Structural Biology etc. Within a small span of time, ACBR has earned its name and fame both at the National and International level.

II. M. Sc. and M.Sc.- Ph.D. Combined Degree Programme in Biomedical Science Details:

Scope

The overall objective of the program is to foster a high-quality innovative research & teaching program and interdisciplinary knowledge to develop specialist academicians and intellectual leaders with excellent professional skills in biomedical sciences for better understanding and management of human health and disease.

Programme Objectives (POs):

The proposed programme **M. Sc.** and **M.Sc.-Ph.D. Combined Degree Programme** will be offered by Dr. B. R. Ambedkar Center for Biomedical Research (ACBR), University of Delhi, Delhi 110007. The programme will offer basic and advanced level theory and practical to train students for the 21st century and the Viksit-Bharat vision. The objectives of the **M. Sc.** and **M.Sc.-Ph.D. Combined Degree Programme** are to develop a multidisciplinary knowledge Centre and provide high-quality world-class teaching and research in biomedical sciences. ACBR envisions to achieve following programme specific objectives.

- To educate and train a new generation of young minds in biomedical sciences.
- To create a passion for research while inculcating a scientific temperament and a knowledge inquisitive mind with the main aim of contributing towards human health through basic cum applied research.
- Intellectual grooming of each student to be a potential leader in biomedical sciences.
- To teach beyond textbooks and rejuvenate the spirit of science.

Programme Specific Outcome

For achieving this, ACBR has structured its course amalgamating Biology and Chemistry in a fine mix. This gives each student an in-depth view of biology via the prism of chemistry. This includes aspects of cell and molecular biology, cancer biology, molecular oncology, biotechnology, bioinformatics, artificial intelligence and its applications in biology, biochemistry, infection and immunity, genetics, human physiology integrated with organic and medicinal chemistry, biomedical techniques, neurobiology, pharmacology and toxicology. All four semesters will prepare students to gain practical knowledge and skills needed to prepare them for higher education and other career options requiring such skills under the NEP-2020 programme.

Programme Structure:

As per the NEP-2020 guidelines, the **M.Sc. in Biomedical Science** programme will be offered as a two-year course divided into four semesters or a one-year programme divided into two semesters depending on the duration undergraduate degree of the student. A student who has completed 3-year undergraduate degree course will be eligible for 2 year M.Sc. programme and the student who completes 4-year undergraduate course will be eligible for one year M.Sc. programme.

Two-year M.Sc. programme will have a total of 88 credits with 22 credits in each semester. The second year of the programme will have three options and the student will have to opt for any of the options out of 1) M.Sc. with only coursework; 2) M.Sc. with coursework and research and 3) M.Sc. with research. The credit scheme is provided below.

The One-year M.Sc. programme will have a total of 44 credits with 22 credits in each semester. The programme will have three options: 1) M.Sc. with only coursework; 2) M.Sc. with coursework and research and 3) M.Sc. with research.

Eligibility for admission

Bachelor's degree in Biomedical Science/any branch of Life Sciences/Chemical Sciences/ Medical Sciences/Pharmacy.

Course Credit Scheme M.Sc. Biomedical Science

Programme Structure-1: (PG with only coursework)

Semester	Core Courses		Elective Course		Skill-Based Courses		Total Credits
	No. of courses	**Total credits**	No. of courses	**Total credits**	No. of courses	**Total credits**	
I	3	12	2	8	1	2	22
II	3	12	2	8	1	2	22
III	2	8	3	12	1	2	22
IV	2	8	3	12	1	2	22
Total Credits for the course	40		40		8		88

Programme Structure-2: (PG with coursework and research)

Semester	Core Courses		Elective Course		Skill-Based courses		Project work		Total Credits
	No. of courses	**Total credits**	No. of courses	**Total credits**	No. of courses	**Total credits**	No. of courses	Total credits	
I	3	12	2	8	1	2	-	-	22
II	3	12	2	8	1	2	-	-	22
III	2	8	2	8	-	-	1	6	22
IV	2	8	2	8	-	-	1	6	22
Total Credits for the course	40		32		8		12		88

Programme Structure-3: (PG with research)

Semester	Core Courses		Elective Course		Skill-Based courses		Research Methodology		Project work		Total Credits
	No. of courses	**Total credits**	No. of courses	**Total credits**	No. of courses	**Total credits**	No. of courses	Total credits	No. of courses	Total credits	
I	3	12	2	8	1	2			-	-	22
II	3	12	2	8	1	2			-	-	22
III	1	4	1	4	-	-	2	4	1	10	22
IV	-	-	1	4	-	-	1	2	1	16	22
Total Credits for the course	28		24		4		6		26		88

List of PGCF courses of M.Sc. in Biomedical Sciences

Type of Course	Type	Semester	Name of the Courses	Credits in each course			
				Lecture	Tutorial	Practical	Total
Semester - I							
Discipline Specific Core Course	DSC-1	I	Biochemistry of macromolecules	3	0	1	4
Discipline Specific Core Course	DSC-2	I	Biological Chemistry - I	3	0	1	4
Discipline Specific Core Course	DSC-3	I	Medical Microbiology	3	0	1	4
Discipline Specific Elective Course	DSE-1	I	From the Pool of DSEs given below*	4	0	0	4
Discipline Specific Elective Course	DSE-2	I	From the Pool of DSEs given below*	4	0	0	4
Generic Elective Course	GE-1	I	Biology of Aging	4	0	0	4
Skill Enhancement Course	SEC-1	I	Biomedical Laboratory Techniques - I	0	0	2	2
Semester -II							
Discipline Specific Core Course	DSC-4	II	Immunology	3	0	1	4
Discipline Specific Core Course	DSC-5	II	Genetics: Principles and Applications	3	0	1	4
Discipline Specific Core Course	DSC-6	II	Human Physiology -I	3	0	1	4
Discipline Specific Elective Course	DSE-3	II	From the Pool of DSEs given below**	4	0	0	4
Discipline Specific Elective Course	DSE-4	II	From the Pool of DSEs given below**	4	0	0	4
Generic Elective Course	GE- 2	II	Cancer Biology	4	0	0	4
Skill Enhancement Course	SEC-2	II	Biomedical Laboratory Techniques - II	0	0	2	2
Pool of Discipline Specific Elective Courses to be offered in 1st Semester*	i. Cell Biology ii. Bioethics and Biosafety iii. Application of Statistics in Biology						
Pool of Discipline Specific Elective Courses to be offered 2nd Semester**	iv. Molecular Biology v. Topics in Clinical Research vi. Biological Chemistry -II						

Type of Course	Type	Semester	Name of the Courses	Credits in each course			
				Lecture	Tutorial	Practical	Total
Semester - III							
Discipline Specific Core Course	DSC-7	III	Advanced Biomedical Techniques & Instrumentation	3	0	1	4
Discipline Specific Core Course	DSC-8	III	Pharmacology & Toxicology	3	0	1	4
Discipline Specific Elective Course	DSE-5	III	From the Pool of DSEs given below#	4	0	0	4
Discipline Specific Elective Course	DSE-6	III	From the Pool of DSEs given below#	4	0	0	4
Discipline Specific Elective Course	DSE-7	III	From the Pool of DSEs given below#	4	0	0	4
Generic Elective Course	GE- 3	III	From the Pool of GEs given below##	4	0	0	4
Skill Enhancement Course	SEC-3	III	Biomedical Laboratory Techniques - III	0	0	2	2
Semester-IV							
Discipline Specific Core Course	DSC-9	III	Recombinant DNA Technology	3	0	1	4
Discipline Specific Core Course	DSC-10	III	Bioinformatics, Computational Biology and Drug Design	3	0	1	4
Discipline Specific Elective Course	DSE-8	III	From the Pool of DSEs given below#	4	0	0	4
Discipline Specific Elective Course	DSE-9	III	From the Pool of DSEs given below#	4	0	0	4
Discipline Specific Elective Course	DSE-10	III	From the Pool of DSEs given below#	4	0	0	4
Generic Elective Course	GE- 4	III	From the Pool of GEs given below##	4	0	0	4
Skill Enhancement Course	SEC-4	IV	Biomedical Laboratory Techniques - IV	0	0	2	2
Pool of Discipline Specific Elective Courses to be offered in 3rd and 4th Semesters#	vii. Molecular Oncology						
	viii. Medicinal Chemistry						
	ix. Viral & Fungal Diseases						
	x. Advanced Immunology						
	xi. Advanced Toxicology						
	xii. Human Physiology II						
	xiii. Neurobiology						
	xiv. New Methods in Organic Synthesis						
	xv. Genome Biology						
	xvi. Applications of ML, DL and AI in Biomedical Science						
	xvii. Advances in Protein Sciences						

Generic Elective Courses to be offered in 3rd and 4th Semesters##	i. Structural Biology ii. Cardiovascular Biology						
List of Courses to be offered to students opting for Structure-3 of 'M.Sc. with Research' in 3rd and 4th Semester							
Semester III							
Discipline-Specific Core course related to the area identified for research	DSC-11	III	DSC-11 (Student may opt for any of the papers related to area of research from the 3rd semester)	4	0	0	4
Advanced Research Methodology of the core discipline	ARM-I	III	Advanced Research Methodology	2	0	0	2
Tools for Research	TR-I	III	Tools for Research	2	0	0	2
Semester IV							
Techniques of research writing	TRW	IV	Techniques of research writing	2	0	0	2

Detailed contents of

SYLLABUS FOR

MSc. AND M.Sc.-Ph.D. COMBINED DEGREE PROGRAM IN BIOMEDICAL SCIENCES

FOR THE POST-GRADUATE CURRICULUM FRAMEWORK UNDER THE NEW EDUCATION POLICY

SEMESTER-I AND SEMESTER-II

STRUCTURE I/II/III: 1st Year of PG curricular structure for 2 year PG Programmes (3+2)

Semester	DSC	DSE	2 Credit course	Dissertation/ Academic Project/ Entrepreneurship	Total Credits
Semester-I	**DSC (12 CREDITS) (3+0+1)** • Biochemistry of Macromolecules (DSC - 1) • Biological Chemistry - I (DSC - 2) • Medical Microbiology (DSC - 3)	**DSEs (Pool of Subjects) (8 CREDITS) (4+0+0)** • Cell Biology • Bioethics and Biosafety • Application of Statistics in Biology **GE** • Biology of Aging (GE-1)	**Skill-based course/ workshop/ Specialised laboratory/ Hands-on Learning (2 CREDITS) (0 + 0 + 2)** Biomedical Laboratory Techniques – I **(SEC-1)**	Nil	**22**
Semester-II	**DSC (12 CREDITS) (3+0+1)** • Immunology (DSC - 4) • Genetics: Principles and Applications (DSC - 5) • Human Physiology -I (DSC - 6)	**DSEs (Pool of Subjects) (8 CREDITS) (4+0+0)** • Molecular Biology • Biological Chemistry -II • Topics in Clinical Research **GE** • Cancer Biology (GE-2)	**Skill-based course/ workshop/ Specialised laboratory/ Hands-on Learning (2 CREDITS) (0 + 0 + 2)** Biomedical Laboratory Techniques – II **(SEC-2)**	Nil	**22**

SEMESTER-I

DSC-1 BIOCHEMISTRY OF MACROMOLECULES

Duration: 45 Hours + 30 Hour (Practical)

DISCIPLINE SPECIFIC CORE

Course title and Code	Total Credits	Credit distribution of the course			Eligibility Criteria	Prerequisite of the Course (if any)
		Lecture	Tutorial	Practical		
Biochemistry of Macromolecules (DSC-1)	**4**	**3**	**0**	**1**	Bachelor's degree in Biomedical Science/any branch of Life Sciences/ Chemical Sciences/ Medical sciences/ pharmacy	**NIL**

LEARNING OBJECTIVES:

- Students will understand protein structure, function and their relations has been key towards understanding almost all biological processes as proteins and enzymes are machineries in the cells.
- Contemporary biochemistry needs the thorough understanding of the basic processes like biosynthesis. This will be emphasized upon in the classes.
- Understanding of translation and how different protein complexes or domains interact to perform these processes.

LEARNING OUTCOMES:

- Students will be able to have a comprehensive understanding of the diversities of protein structure, mechanisms how enzymes work and also the structure function relation.
- Students will also develop ideas of how important the fidelity of protein folding in the cells and its connectivity to the development of human diseases.
- The basic concepts of the protein biosynthesis, and translation will also be revised.
- The students will be able to learn various experimental techniques leading to

the development of these concepts. This will initiates the analytical and experimental approach of solving any problem.

- Practical part of the paper will help to develop skills on protein purification, analysis, quantitation and checking purity by various techniques.

Unit I: Protein Structure **(12 Hours)**

L1-3. Introduction to protein folding, native state, concept of macro states & ensembles and formation of secondary and tertiary structures, properties of α-helix, helix-capping mechanisms; ß sheets, central and edge beta strands; shielding mechanisms of edge beta strands; turns and loops; non-repetitive structures.

L4-5. Introduction to supersecondary structures, packing patterns of secondary structures; common structural motifs, helix bundle motif, ß-hairpin motif (ß-meander/jellyroll), ß-α-ß hairpin motif.

L6-8. Domains, structural diversity of domains with appropriate examples; coiled-coil domain, calcium binding domain, barrels, Rossman fold, thioredoxin fold, death domain etc, domain swapping with examples

L9. Structural proteins: structure of collagen, keratin and other fibrous proteins.

L10. Structure and function of haemoglobin: conformational alteration upon binding of oxygen and it's release, structural allostery caused by the binding of haemoglobin ligands CO, CO_2 and NO.

L11-12. Discussion and Class Test

Unit II: Enzymology **(14 Hours)**

L13. General characteristics of enzymes, definition of coenzyme, holoenzyme, prosthetic groups, classification, active site, activation barrier.

L14-16. Different models of enzyme catalysis: Lock and key model, induced-fit model and non-productive binding model, transition state theory. Rate constant (K_o), Michaelis-Menten equation, kinetic parameters of enzyme-mediated catalysis (Km, Kcat and Vmax), Numerical problems on enzyme kinetics.

L17-20. Mechanism of reversible enzyme inhibition (competitive, non-competitive and uncompetitive) and their physiological significances; examples of enzyme inhibitors used a drugs. Irreversible enzyme inhibition: group specific inhibitor, reactive substrate analog, transition state analogs; catalytic antibodies with appropriate examples.

L21. Determination of active sites and turnover number, factors affecting enzyme functions.

L22. Multi substrate enzyme kinetics: Single displacement kinetics (ordered, random) and Ping-pong mechanism.

L23-24. Regulation of enzyme function: Limited proteolysis, ligand binding and functional allostery, post-translational modifications (enzymatic and non-enzymatic)

L25-26. Tutorial & Class Test

Unit III: Protein purification, physical separation & Analysis (8 Hours)

L27. Methods of protein production, isolation, purification strategies, concept of inclusion body.

L28-29. Chromatography (ion exchange, affinity, size exclusion, FPLC),

L30. Dialysis, molecular sieving, PAGE, isoelectric focusing.

L31-32. Methods of protein sequencing: N and C-terminal analysis, Edman degradation, protein sequencing by mass spectrometry.

L33-34. Quiz and Debate

Unit IV: Translation (11 Hours)

L35. Translation in Prokaryotes-initiation.

L36. Activation of amino acid, role of 30s and 50s ribosomal subunits.

L37. Role of 30s and 50s ribosomal subunits, initiation factors.

L38-39. Shine-dalgarno sequences, Kozak sequences, selection of first AUG in eukaryotic mRNA with experimental evidence.

L40. Elongation factors, peptidyl transferase termination signal, release factors.

L41-42. Inhibition of protein synthesis - by antibiotics and inhibitors of eukaryotic translation

L43. Methods to determine Half-life of protein.

L44-45. Discussion and Revision

Practicals: 1 credit (30 Hours)

1. Preparation of buffers and other solutions.
2. Salting in and salting out of proteins.
3. Void Volume estimation.
4. Desalting of proteins by dialysis.
5. Desalting of proteins by using Sephadex G-25.
6. Protein estimation by Lowry’s & Bradford methods.

7. Protein estimation by Lamberts & beer law.
8. Protein & Nucleic Acid blasts, Clustal W and sequence alignment etc.
9. Measurement of Enzyme activity parameters.
10. Measurement of Enzyme inhibition.

ESSENTIAL READINGS

1. Voet, D., Voet, J. G., & Pratt, C. W. (2022*).* Fundamentals of Biochemistry: Life at the Molecular Level *(*6th ed.).
2. Nelson, D. L., & Cox, M. M. (2021*).* Lehninger Principles of Biochemistry (8th ed.). W. H. Freeman. ISBN: 978-1319228002.
3. Berg, J. M., Gatto Jr., G. J., Hines, J., Tymoczko, J. L., & Stryer, L. (2023). *Biochemistry* (10th ed.). Macmillan Learning. ISBN: 978-1319333621.
4. Jones, A. M., Smith, K. P., & Patel, D. R. (2023). A Comprehensive Review of Protein Purification Techniques: Advancements, Challenges, and Future Prospects. Journal of Proteomics & Bioinformatics, 16(3), 45-68.
5. Luo, L., Zhang, Y., Zhang, C., & He, S. (2023*).* A new classification of protein supersecondary structures. PLoS Computational Biology, 19(3), e1011023.
6. Su, X., Wang, Y., & Zhao, H. (2024*).* Jelly roll structures: Evolutionary perspectives and functional significance. Nature Structural Biology, 31(2), 215-230.

SUGGESTED READINGS

1. Proteins: Structure and Function; David Whitford; John Wiley & Sons, 2013.
2. Proteins: structures and molecular properties by Thomas E Creighton; Ed. 3rd; Freeman, 2010.
3. Biochemistry by Jeremy M. Berg, John L. Tymoczko, Lubert Stryer; Ed. 6th; W. H. Freeman, 2007.
4. Brändén, C.-I., & Tooze, J. (1999). Introduction to Protein Structure (2nd ed.). New York: Garland Publishing.
5. Fundamentals of Protein structure and function, Buxbaum Engelberg; Ed. 6th; Springer, 2015.

SEMESTER-I

DSC-2 BIOLOGICAL CHEMISTRY-I

Duration: 45 Hours + 30 Hour (Practical)

DISCIPLINE SPECIFIC CORE

Course title and Code	Total Credits	Credit distribution of the course			Eligibility Criteria	Prerequisite of the Course (if any)
		Lecture	Tutorial	Practical		
Biological Chemistry-1 (DSC-2)	**4**	**3**	**0**	**1**	Bachelor's degree in Biomedical Science/any branch of Life Sciences/ Chemical Sciences/ Medical sciences/ pharmacy	**NIL**

LEARNING OBJECTIVES:

- This course aims to bring together the various facets of organic chemistry with an overview of its applications in medicinal chemistry and biology.
- They will also learn the principles of various reactions and compounds and their applications in biomedical sciences.

LEARNING OUTCOMES:

- At the end of the course students will be able to appreciate the underlying chemistry of many of the important biological processes.
- Students will develop understanding of chemical entities which can and those which cannot be isolated such as carbocations, carbanions and free radicals.
- Student will learn reactions in organic chemistry along with an understanding of their stereochemistry.
- Students will learn heterocyclic chemistry with a view to understanding molecules which make modern day medicines.

Unit I: Reactive Intermediates in Organic Reactions (10 Hours)

L1-2. Carbocation stability, formation and reactions with examples

L3-4. Carbanions, pKa values, methods of formation, stability, shapes and reactions

L5-6. Free radicals their stability, methods of synthesis and reactions
L7-8. Examples of reactive intermediates with applications to biological systems,
L9-10. Benzynes, carbenes, radical cations and radical anions,

Unit II: Stereochemistry of Organic compounds (10 Hours)

The definition of the following terms with suitable examples:
L11. Elementary treatment of symmetric elements,
L12. Chirality, polarimetry
L13. Prochirality (enantiomer, epimer, diastereomer),
L14. Absolute and relative configuration, R & S notation.
L15-16. Enantiotopic and diastereotopic faces, endo and exo faces.
L17-18. Regioselective, enantioslective stereoselective and stereospecific reactions
L19. Conformation of 2,3-dibromobutane, E & Z notations,
L20. Cyclohexane diols

Unit III: Mechanism and stereochemistry of following reactions (11 Hours)

L21-22. Substitution reactions
L23. Addition reactions,
L24. Oxidation and reduction.
L25. Elimination reactions
L26. Ester formation and hydrolysis.
L27. Aromaticity,
L28-29. Aromatic and Nucleophilic substitution,
L30-31. Woodward Hoffmann rules, photocyclization.

Unit IV:

Asymmetric synthesis (8 Hours)

L32. Examples of Asymmetric synthesis involving active substrate
L33-34. Cram and Prelog rule,
L35. Examples of asymmetric synthesis involving active reagents and active catalysts
L-36-37. Chiral synthesis (with suitable examples)
L38. Asymmetric epoxidation
L39. Sharpless asymmetric epoxidation

Heterocyclic chemistry (3 Hours)

L40-42. Structure, synthesis and reactivity of the following heterocycles and their significance in biology and the synthesis of medicines: Furan and pyrrole; Thiophene and imidazole; Oxazole and thiazole, Pyridine, quinoline and isoquinoline

New Concepts in Biological Chemistry **(3 Hours)**

L43 Covalent organic Frameworks

L44 Bioconjugation of organic molecules to macromolecules

L45 Photocatalysis in addition reactions.

ESSENTIAL READING

1. Organic Chemistry Organic Chemistry. 2017. T. W. Graham Solomons, Craig B. Fryhle, Scott A. Snyder
2. Organic Chemistry by Morrison Boyd and Bhattacharjee 7th Edition 2016 Pearson Education India
3. Organic Chemistry by Jonathan Clayden, Nick Greeves and Stuart Warren 2nd Edition Oxford University Press 2012.

SUGGESTED READING:

1. March's advanced organic chemistry: reactions, mechanisms, and structure, Smith, Michael B. and March, Jerry; Ed.7th; Wiley-Interscience; 2013
2. Guidebook to mechanism in organic chemistry; Sykes, Peter; Ed. 6th; Pearson; 2006
3. Asymmetric synthetic methodology; Ager David J. and East, Michael B; CRC Press; 1996
4. Stereochemistry: conformation and mechanism; Kalsi, P.S. Ed. 6th; New Age; New Delhi; 2005.
5. Stereochemistry of organic compounds; Eliel, Ernest L and Wilen, Samuel H. and Mander, Lewis N. John Wiley & Sons Inc.; New York; 2008.

Practical: **1 credit (30 Hours)**

1. Recrystallization and Melting Determination
2. Thin Layer Chromatography (mixture of 2 compounds)
3. Thin Layer chromatography (mixture of 3 compounds) Claisen Schmidt reactions
4. Infrared spectroscopy (instrumentation and spectra analysis)
5. Cannizarro reaction

7&8. Optical activity by polarimetry of known optically active compound of known concentration and hence to determine concentration of unknown sample

9. Column chromatography.
10. Aldol condensation

SEMESTER-I

DSC-3 MEDICAL MICROBIOLOGY

Duration: 45 Hours + 30 Hours (Practical)

DISCIPLINE SPECIFIC CORE

Course title and Code	Total Credits	Credit distribution of the course			Eligibility Criteria	Prerequisite of the Course (if any)
		Lecture	Tutorial	Practical		
Medical Microbiology (DSC-3)	**4**	**3**	**0**	**1**	Bachelor's degree in Biomedical Science/any branch of Life Sciences/ Chemical Sciences/ Medical sciences/ pharmacy	**NIL**

LEARNING OBJECTIVES:

- Medical Microbiology course has been designed to understand the scientific basis of traditional and modern microbiological concepts relevant for understanding the medically important Bacteria, parasites, fungi and viruses.
- Adequate emphasis has been given to the structural, biochemical characteristics of bacteria with respect to diseases they cause with relevant emphasis on epidemiology, diagnostics and therapeutics.
- The course also deals with the problem of emerging antimicrobial resistance with reference to known pathogens.
- The course has been designed to integrate the practical and theorical based knowledge for deep understanding of the important bacterial and parasitic diseases microbial structure, growth and development, methods and sterilization techniques in the context of study of microbes are included.
- The pathogenic microbes and the diseases caused by them are included to broaden the perspective of the subject. Lastly the course deals with the problem of emerging antimicrobial resistance with reference to known pathogens.
- The course has been designed to get integrated practical based knowledge about medically important bacteria, fungi, viruses and parasites.

LEARNING OUTCOMES

- The course will also enable the students to understand the principles of a range of techniques as applied to medical microbiology and their application in diagnostic research microbiology.
- Students will gain insights on the techniques to study medical microbiology, nature of various infectious agents and diseases pathologies caused by common bacteria, fungi and viruses and approaches to prevent these infections.
- The students will be able to understand the structure and function of medically important bacteria and parasites.
- In addition they will also understand pathogenesis, diagnosis, clinical features, virulence factors and treatment strategies of medically important bacteria and parasites.

Unit I: **(9 Hours)**

L1. History and scope of medical microbiology. **(1 Hour)**

Structural identification of Bacteria **(8 Hours)**

L2-3. How are bacteria different in terms of colony morphology and pattern of arrangement. Bacterial morphology: detailed structural features of gram positive and gram negative bacteria, Staining techniques for identification of bacteria. Detailed structure and functions of various bacterial organelles, cell wall, cell membrane, ribosomes, flagella, spores, capsules, storage components, quorum sensing.

L4-6. Techniques to study morphology of bacteria, nutritional and conditional requirements of bacteria: Macro- and micronutrients, growth of bacteria, temperature, pH, moisture and desiccation, oxygen and carbon dioxide requirements of bacteria.

L7-9. Identification of bacteria using biochemical methods.

Unit II. Asepsis, Sterilization, Disinfection and Microscopy Techniques **(6 Hours)**

L10-11. Aseptic techniques, methods for pure culture isolation. Cultivation methods for bacteria. Types of Nutrient media for bacteria. Aerobic and anaerobic culture methods

L12-13. Sterilization and disinfection: definition, importance, Physical agents: autoclave, hot air sterilization, incinerators, pasteurisation, tyndallisation, methods of quality check. Radiation and filtration techniques, Laminar flow hoods. Chemical disinfectants, uses of halogen compounds, alcohol based compounds, aldehydes, detergents, heavy metals. Methods for developments and quality check of disinfectants, phenol coefficient test.

L14-15. Microscopy: History, basic principles of microscopy. Bright field, darkfield and phase contrast microscopy. Florescence microscopy, Confocal microscopy, SEM and TEM.

Unit III : Medical Bacteriology/Medically important bacteria (15 Hours)

L16-17. Normal flora of human body and their significance. Nosocomial infections.

L18-21. GI tract infections: Salmonella, Shigella, E. coli, Helicobacter pylori

L22-24 Chemotherapy: structure and mechanism of action of Cell wall inhibitors, antimetabolites. Antimicrobial chemotherapy, protein synthesis inhibitors, Nucleic acid inhibitors. Methods for estimation of antimicrobial activity. Mechanisms of Antibiotic resistance. Literature for new emerging antibiotics.

L25-28. Urinogenital infections: E.coli, Chlamydia trachomatis, Neisseria gonorrhoea

L29-31. Infections of the respiratory system: commensals vs infectious organisms, Diagnosis, prevalence, virulence, treatment and vaccines against: Mycobacterium tuberculosis, Cornybacterium diphtheriae Streptococcus pneumoniae, Staphylococcus aureus, Haemophilus influenzae in India and the world.

Unit IV: (13 Hours)

Medical parasitology (11 Hours)

L32-33. Medical parasitology overview and classification of medically important parasites. Nematodes: Ascaris sp., Necator americanus.

L34. Lymphatic filariasis : Wuchereria bancrofti, Brugia malayi, Mansonia ozardi

L35. Cestodes: Taenia solium, Taenia saginata, Diphyllobotherium latum

L36. Trematode: Faciola hepatica, Faciolopsis buskii

L37. Medically important protozoans: Malaria, Babesia

L38. Medically important protozoans: Trypanosoma , Leishmania

L39-43.Medically important protozoans: Giardia, Entamoeba, Toxoplasma, Trichomonas, Cryptosporidium.

Medically important Fungi and Viruses (2 Hours)

L44-45. Overview of Medically important fungi and Viruses

Practicals: 1 Credit (30 Hours)

1-3. Demonstration of sterilization techniques related equipment and use of aseptic techniques for preparation of pure cultures. Plating methods and identification of colony morphology of key bacteria.

4-6. Demonstration of differential staining techniques like Gram's staining, AFB staining, spore staining etc. Differentiation of flagellate vs non-flagellate bacteria.

7-8. Differential diagnosis of bacteria based on biochemical tests.

9-10. Spread plate technique and antibiotic sensitivity assay.

ESSENTIAL READINGS:

1. Prescott's Microbiology by Joanne Willey, Kathleen Sandman, and Dorothy Wood; 12th Edition, McGraw-Hill Education, 2022.
2. Medical Microbiology by Patrick R. Murray, Ken S. Rosenthal, and Michael A. Pfaller; 10th Edition. Elsevier Health Sciences, 2022.
3. Brock Biology of Microorganisms by Michael T. Madigan, Kelly S. Bender, Daniel H. Buckley, W. Matthew Sattley, and David A. Stahl; 16th Edition, Pearson,2021.
4. Topley and Wilson's Microbiology and Microbial Infections by Geoffrey L. Smith et al., Ed. 11th, Wiley-Blackwell, 2019.
5. Sherris & Ryan's Medical Microbiology by Kenneth J. Ryan, Nafees Ahmad, W. Lawrence Drew, and J. Andrew Alspaugh; 8th Edition, McGraw-Hill Education, 2021.

SUGGESTED READINGS

1. Topley and Wilson's Microbiology and Microbial Infections by Leslie Collier and Albert Balows and Max Sussman; Ed. 9th; 6-Volume Set; A Hodder Arnold Publication, 2000.
2. Medical Microbiology by Geo. Brooks and Karen C. Carroll and Janet Butel and Stephen Morse; Ed. 24th; McGraw-Hill Medical, 2007.
3. Microbiology by Lansing M. Prescott and John P. Harley and Donald Klein; Ed. 6th; McGraw-Hill Science, 2004.
4. Medical microbiology: a guide to microbial infections: pathogenesis, immunity, laboratory diagnosis and control by David Greenwood and Richard C. B. Slack and John F. Peuthere, ed. 17th Ed. Churchill Livingstone; 2007.
5. Fundamental Virology: Fields and Knipe, ed. Raven Press, 1991.
6. Strauss, E. G. and Strauss, J. H., "Viruses and Human Disease", Academic Press, 2002.
7. Flint, S.J., Enquest, L.W., Krug, R. M., Racaniello, V. R., and Skalka, A. M., "Principles of Virology: Molecular Biology, Pathogenesis and Control", ASM Press. 2000.

SEMESTER-II

DSC-4 IMMUNOLOGY **Duration: 45 Hours + 30 Hour (Practical)**

DISCIPLINE SPECIFIC CORE

Course title and Code	Total Credits	Credit distribution of the course			Eligibility Criteria	Prerequisite of the Course (if any)
		Lecture	Tutorial	Practical		
Immunology (DSC-4)	**4**	**3**	**0**	**1**	Bachelor's degree in Biomedical Science/any branch of Life Sciences/ Chemical Sciences/ Medical sciences/ pharmacy	**NIL**

LEARNING OBJECTIVES:

- The immunology course has been formulated to understand the basics of vertebrate Immune system at the molecular, cellular and organ system level and to know how our body defends to the "danger/ foreign" challenges.
- The students will understand the working of the primary and secondary lymphoid systems in mouse and human.
- There will be practical and theoretical illustrations of functions of cells of innate immune responses like macrophages and dendritic cells
- And processes such as through estimation of reactive oxygen species, reactive nitrogen species, malondialdehyde, protein- carbonyl adducts, process of phagocytosis and activation of immune cells etc.

LEARNING OUTCOMES

- Immunology is one of the foundation courses for the biomedical sciences students.
- Students will gain insights into the organization and workings of the immune system and the immune responses at the molecular, cellular and organ system level.
- They will also understand the mechanisms of cell mediated and humoral immune responses at organ system, cellular and molecular level.
- The students will be prepared to take further advanced courses/research in immunology, immunodiagnostics, immunopathogenesis and immune-therapeutics.

Unit I Immune system overview (7 hours)

L1. History and scope of immunology

L2. Introduction to immune system. What is an immune response? Concepts of innate and acquired Immune responses, active and passive Immunity, natural and artificial immunity, primary and secondary immune responses.

L3. Lymphoid System- overview. Lymphatic system and lymphocyte traffic. Lymphoid tissue. primary and secondary lymphoid organs. Anatomical and functional significance of Thymus and bone marrow

L4. Anatomy and functional significance of spleen ,various lymph nodes, MALT, GALT, NALT, ILT.

L5. Cells involved in the Immune Response: structural and functional features of cells involved in immune responses and their relative significance. Lymphocytes (B& T lymphocytes), NK Cells.

L6. Mononuclear phagocytes, antigen- presenting cells, polymorphonuclear cells, eosinophils, basophils and mast cells. Cluster designation of Ag specific receptors.

L7: Evolution of cells and molecules of the immune system with associated functions.

Unit II Innate immune system (10 Hours)

L8. Innate immune system: overview. Cells and receptors of the innate immune system. Diversity in Antigen recognition receptors of innate immunity.

L9-11. Antigen recognition and presentation overview: dendritic cells: discovery types and functions: DC1 vs DC2 vs Follicular DC. DC priming of T independent antigens. DCs as immune-therapeutics.

L12. Signalling from Toll Like Receptors.

L13. Cell surface and intracellular antigen/pathogen recognition systems

L14. Secretory receptors of innate immune system and their functions.

L15. Danger hypothesis. Macrophages: types, location and function. Neutrophils and NK cells: mode of action and neutralization of pathogens. Oxygen dependent and independent killing of pathogens and the antioxidant mechanisms. Reactive oxygen species, reactive nitrogen species and their roles in innate immune system.

L16-17.Complement System. Nomenclature of complement system. Classical, Lectin and Alternative activation of the complement pathway. Assays for complement activation. Biological Effects of complement system, Regulation of complement system. Complement system related diseases.

Unit III: Adaptive Immune Responses

Humoral Immunity: Molecular and effector mechanisms (9 Hours)

L18-20.Antibody Generation, structure and function: Overview of humoral immunity, clonal selection theory. Structure of immunoglobulins, immunoglobulin classes and their functions.

L21-23. Antibody effector mechanisms. Antibody receptors, basis of antibody diversity. Mechanisms of immunoglobulin gene recombination and B cell development.

L24-25. Mechanisms and effects of somatic hypermutations on the antibody diversity. Affinity maturation and development of memory responses..

L26: Antibody responses in vivo. Enhanced secondary responses, mechanism of Ab Class switching, significance of isotype switching.

Major Histocompatibility Complex (MHC) molecules (4 Hours)

L27 : Major Histocompatibility Complex (MHC) overview and significance. Structure of MHC class I Molecules, Structure of MHC class II molecules.

L28-29. Genomic organisation of the MHC locus in mice and humans. Diversity of MHC molecules and their effect of immune response modulation. Gene polymorphism and polygeny on MHC locus and their effect on the disease pattern with respect to resistance and susceptibility to diseases. Structure and assembly of MHC molecules/peptide complexes.

L30: Antigen recognition processing, presentation and cross-presentation of antigens by DC subsets. Mechanisms of Antigen Processing (exogenous and endogenous antigens) and Presentation to T-lymphocytes ($CD4^+$ and $CD8^+$).

Cell mediated Immunity: Molecular and effector mechanisms (4 Hours)

L31-33. Cell mediated immune response. Overview, T lymphocyte classification, lineage and mechanisms of development of T cells in thymus. Structure of T cell receptors. Mechanisms of recombination and diversity of TCR genes, self restriction and self-

tolerance mechanisms. Regulation of innate and humoral responses by T cells. T cell APC interactions and modulation of Immune responses.

L34. T independent and T dependent Defense Mechanisms. Cell mediated cytotoxicity. Idiotypic modulation of immune responses.

Unit IV: Immune responses and their regulation (11 Hours)

L35-36. Antigens, classification of antigens based on their interaction and functions. Superantigens, interaction of Antigens with Antigen Presenting Cells, Antibody, Lymphocytes. Idiotypic Modulation of Response, Neuroendocrine Modulation of Responses, Genetic control of Immune Response.

L37-38. Mechanism of antigen-antibody interactions. Experiment based evidence to calculate antigen binding sites, avidity, affinity. Immunological Techniques: Principles, significance and methods; Agglutination (Direct/Indirect). Precipitation (Radial and double immunodiffusion) and Radio-immunoassays. Immunological techniques: Immunoflorescence (direct/indirect). Enzyme linked Immunosorbent assay (principles of various types of ELISA) and its variants. Magnetic cell sorting, Flowcytometry, western blotting.

L39: Techniques for generation of polyclonal and monoclonal antibodies. Hybridoma Technology for Mab Production.

L40-41: Immunopathology: overview Rh-blood groupings, Autoimmune Diseases, Basis of breach of central and peripheral tolerance.

L42-44.Overview of Hypersensitivity Reactions (type I and type IV), Role of 1gE, Mast cells, Genetic basis of Allergic Response and pathogenesis.

L 45. Vaccines: History and overview, adjuvants, and types of vaccines.

Practicals: 1 Credit (30 hours)

1-3.To demonstrate that activation of peritoneal macrophages/ myeloid lineage cells by lipopolysaccharides results in reactive oxygen production (RNS) and reactive nitrogen species production. Estimation will be done by flowcytometry, Colorimetry and microscopy assays.

3-6. The antigen antibody interaction mechanisms will be demonstrated by precipitation and agglutination assays (octerlony, Mancini methods and indirect agglutination tests).

6-9. Separation of different cells in mixed cultures will be done using MACS and/or FACS.

10. Proinflammatory cytokine expression will be demonstrated in activated cells by ELISA or immunofluorescence.

ESSENTIAL READINGS:

1. Janeway's Immunobiology by Kenneth Murphy and Casey Weaver; 10th Edition, Garland Science, 2022.
2. Kuby Immunology by Judith A. Owen, Jenni Punt, and Sharon Stranford; 9th Edition, W.H. Freeman and Company, 2022.
3. Roitt's Essential Immunology by Peter J. Delves and Seamus J. Martin; 14th Edition, Wiley-Blackwell, 2021.
4. Cellular and Molecular Immunology by Abul K. Abbas, Andrew H. Lichtman, and Shiv Pillai; 10th Edition, Elsevier Health Sciences, 2021.
5. Clinical Immunology: Principles and Practice by Robert R. Rich, Thomas A. Fleisher, William T. Shearer, Harry W. Schroeder, Anthony J. Frew, and Cornelia M. Weyand; 5th Edition, Elsevier, 2019.
6. Fundamental Immunology William Paul (Ed) 2017. Lippincott Williams & Wilkins.

SUGGESTED READINGS:

1. Immunology; Ed.7th by David Male and Jonathan Brastoff and David B. Both and Ivan Roitt; Mosby Elsevier; 2006.
2. Immunology of infection diseases by Stefan H. E. Kaufmann and Alan Sher and Rafi Ahmed; ASM Press, Washington; 2002.
3. Essentials of immunology & serology by Jacqueline H. Stanley; DELMAR; Australia; 2002.

SEMESTER-II

DSC-5 GENETICS: PRINCIPLES AND APPLICATIONS

Duration: 45 Hours + 30 Hours (Practical)

DISCIPLINE SPECIFIC CORE

Course title and Code	Total Credits	Credit distribution of the course			Eligibility Criteria	Prerequisite of the Course (if any)
		Lecture	Tutorial	Practical		
Genetics: principles and applications (DSC-5)	**4**	**3**	**0**	**1**	Bachelor's degree in Biomedical Science/any branch of Life Sciences/ Chemical Sciences/ Medical sciences/ pharmacy	**NIL**

LEARNING OBJECTIVES:

- This compulsory course, offered in the second semester, aims to revisit and reinforce Mendelian Genetics in the context of modern molecular biology.
- Although undergraduate courses typically introduce Mendelian Genetics, our experience suggests that a refresher is necessary to appreciate the evolved implications and meanings of genetic terminology.
- By integrating molecular biology with genetics, this course will demonstrate the logical and analytical foundations of inheritance.
- Explore deviations from Mendelian principles, and highlight the significant contributions of model systems in understanding the genetic basis of biological processes and systems.

LEARNING OUTCOMES:

Upon completing this course, students will gain a deep understanding of the fundamental principles of genetics, from Mendel's pioneering work to the latest advancements in epigenetics. They will be able to:

- Recognize the molecular logic underlying segregation ratios and inheritance patterns.

- Understand why purely Mendelian patterns of inheritance are unlikely in real-world systems.
- Appreciate the intuition of key figures like Barbara McClintock, Sydney Brenner and the contributions of T.H. Morgan and his academic lineage.
- Comprehend genetic interactions at the molecular level.
- Identify the genetic basis of various chromosomal anomalies and syndromes.
- Understand novel mutational processes and gene mapping techniques using model organisms like Caenorhabditis elegans, Drosophila, yeast, and Neurospora.
- Learn about the original experiments that shaped our understanding of mutation, genetic analysis, and bacterial-viral interactions.
- Grasp current concepts in mutations, and sex determination in humans, C. elegans and Drosophila.
- By the end of the course, students will have a comprehensive understanding of genetics, from its foundational principles to its latest advancements and applications.

UNIT I: Patterns of Inheritance (13 hours)

L1-2: Single gene inheritance pattern
L3-4: Multiple alleles and polygenic inheritance
L5-6: Gene Interactions
L7: Autosomal vs Sex-linked inheritance
L8-10: Extra chromosomal Inheritance
L11: Pedigree analysis
L12-13: Probability and statistics in genetics

UNIT II: Mutation, Genetic variation and Genetic Mapping (12 hours)

L14-19: Spontaneous occurrence of mutations in bacteria Lederberg and Lederberg experiment, Types of mutations i.e. point mutations, deletions, rearrangements, insertions, dynamic mutations (repeat expansions) with appropriate examples, Chromosomal anomalies and related syndromes.
L20: Genetic variation, Transposable Elements and its applications
L21-22: Genetic linkage, Crossing Over and recombination
L23-24: Gene mapping
L25-26: Mutation Mapping, Reverse and Forward Genetics

UNIT III: Microbial (Bacterial & Yeast) and Phage Genetics (7 hours)

L27-28: Genetic Transfer in Bacteria and Genetic Map construction in Bacteria
L29-30: Mating type switching in Saccharomyces cerevisiae
L31-33: Phage Biology and its Genetics exemplified by fine structure of rII region, work of Seymour Benzer and Phage Applications

UNIT IV: Introduction to Population Genetics and Applied Genetics (11 hours)

L34-39**:** Definition, aim and scope of population genetics, Gene-Pool and Hardy-Weinberg Law, Human polymorphism (transient and balanced), X-linked polymorphism, Genetic drift, mutation, and gene flow.

L39-43: Societal use of Genetics: Agricultural Genetics (genetic engineering), Medical genetics (genetic disorders, genetic testing), exemplified by Angela Cannings case; Forensic genetics (DNA fingerprinting, paternity testing), and Ethical issues in genetics.

L44-45**:** Revision and Assessment

Explore network and molecular processes regulating gene function, including yeast mating type switching and phage lambda, highlighting evolutionarily maintained themes of differential expression and functional specialization during development.

Practicals: 1 Credit (30 Hours)

1. Drosophila Genetics: Fly media preparation, stages of life cycle, Observation of mutant phenotypes and recognition of mutants
2. Drosophila as a model: Human disease models in Drosophila.
3. *Caenorhabditis elegans* Genetics: Media Preparation, Identification of larval stages, males and hermaphrodites.
4. *C. elegans* as a model of aging studies.
5. Metaphase chromosome preparation: Demonstration of cell culture, Chromosome preparation, staining & observation.
6. Selection based on Auxotrophy: Yeast mutants selection and determination of mutation based on differential media.
7. Genetic Cross in model organism
8. Analysis of Progeny after crossing

ESSENTIAL READINGS:

1. Introduction to Genetic Analysis by Anthony J.F. Griffiths, Susan Wessler, Sean B.Carroll,
   John Doebley. 12th Edition, 2020
2. Concepts of Genetics by Michael R. Cummings, William S. Klug, Charlotte A. Spencer, Michael A. Palladino and Darell Killian. 12th Edition, 2019.

SUGGESTED READINGS:

1. Principles of Genetics. Eldon J. Gardner, Michael J. Simmons and D. Peter Snustad, 8th Edition, 1991.
2. The genetics of human population. Cavalli-Sforza, LL and Bodmer. Revised edition, 1999.

ADDITIONAL RESOURCES

- Online resources (e.g., NCBI, Genetic Alliance)
- Research articles and reviews.
- Case studies and group discussions

SEMESTER-II

DSC-6 HUMAN PHYSIOLOGY-1

Duration: 45 Hours + 30 Hours (Practical)

DISCIPLINE SPECIFIC CORE

Course title and Code	Total Credits	Credit distribution of the course			Eligibility Criteria	Prerequisite of the Course (if any)
		Lecture	Tutorial	Practical		
Human Physiology-1 (DSC-6)	**4**	**3**	**0**	**1**	Bachelor's degree in Biomedical Science/any branch of Life Sciences/ Chemical Sciences/ Medical sciences/ pharmacy	**NIL**

LEARNING OBJECTIVES:

- The goal of human physiology is to explain the physical and chemical factors that are responsible for our origin and sustainability of life. In human physiology-I course, we attempt to explain the various features and mechanisms of the human body that make it a living being.
- This course starts with the basic understanding of being living from the cell itself and in the process, course through various organ systems their structure and functioning.
- Understanding how various organ systems especially cell membranes, muscular system, Circulatory system and Nervous system work together to maintain homeostasis under physiological and pathological conditions.
- Applying the basic knowledge of physiology to understand the cause and consequences of various clinical conditions associated with different organ systems.
- Further students will develop skills for scientific research to understand the mechanisms of physiological processes disrupted in disease states and exploring novel therapeutic approaches.

LEARNING OUTCOMES:

Human physiology I: This course is a part of core course offered in second semester. On satisfying the requirements of this course, students will have the knowledge and skills to:

- Describe the anatomy and histology of nervous system and cardiovascular system.

- Understand the indications for, interpretation of, and risks of the common cardiovascular testing modalities for normal and diseased states.
- Become familiar with the emergency sign and symptoms in case of cardiac/ nervous system dysfunction.
- Be aware of the i) symptom and approach knowledge, ii) disease based knowledge for nervous system dysfunction.
- Create awareness for the importance of healthy mind and heart.

UNIT I: **(14 hours)**

Membrane and muscle physiology: **(6 hours)**

Cell membranes are ubiquitous from cell organelle to organ system so it's imperative to understand the basic structure and function of membranes and how they can modulate the function of an organ system as whole starting with the emphasis on the nerve and skeletal muscle cell.

L1: Organization and functional systems of the cell with reference to nerve and muscle cells: Fluid mosaic model of the membrane, Fluidity, Transport of ions and molecules through cell membrane: diffusion and active transport.

L2: *Concept of Membrane potentials:* types of membrane potential, resting membrane potential, graded and action potentials, methods to record and observe membrane potential.

L3-6: Physiologic anatomy of skeletal muscle, neuromuscular transmission and excitation-contraction coupling, Molecular mechanisms of muscle contraction, Energetics of muscle contraction, muscle fatigue, motor unit recruitment, size principle, muscle mechanics, and Electromyogram.

Cardiovascular Physiology **(8 hours)**

L7-8: Blood and circulation: blood corpuscles, haemotopoiesis and formed elements, plasma function, Hemostasis and blood coagulation, Blood banking, blood groups, and Transfusion.

L9-10: Physiology of cardiac muscle (contractile and auto-rhythmic myocytes), Cardiac Cycle Control and Regulation of excitation, contraction and conduction of heart pumping, Heart sounds

L11-12: Characteristics of normal electrocardiogram, analysis of ECG for various myopathies, Cardiac arrhythmias

L13-14: Physical characteristics and basic theory of circulation, Vascular dispensability and functions of arterial and venous systems, Microcirculation and lymphatic system, Capillary fluid exchange, interstitial fluid and lymph flow, Local control of blood flow by tissues and humoral regulation, Nervous regulation of circulation, Cardiac output, venous return and their regulation, coronary circulation.

UNIT II: Overview of the Nervous System (12 hours)

L15-16: Neuron and classification of nerve cell, nerve fibers, nerve, intracellular trafficking of neuron, Resting membrane potential of nerves, Nerve action potential, neurotransmitters: synthesis, models of exocytosis of synaptic vesicles and its inhibitors, synapse: types, pre and post synaptic regulation.

L17-19: Anatomical and functional division of nervous system, Spinal cord and cranial nerve, Blood-Brain barrier, Cerebral Blood Flow, Regulation of Cerebral Circulation.

L20-21: Motor Units, Motor neurons types and characteristic of upper and lower motor neuron, lesions of upper and lower motor neuron. Muscle Receptors,

L22-26: Posture: Neural Systems Controlling Postural Orientation and Stability, Automatic Postural Reactions, Postural Reflexes: Infant to Adult, Spinal Reflexes. Grouping of Motor pathways: direct and indirect pathways, Cortical and brain stem control of motor function.

UNIT III: Cognitive System, Learning and Memory (5 hours)

L27: Neural Basis of Instinctual Behavior & Emotions: Limbic Functions: behavior, Sexual Behavior, Fear & Rage, Motivation

L28-29: Cerebral Cortex: Intellectual functions of brain, learning and memory, Physiologic anatomy of cerebral cortex, Functions of specific cortical areas, Association areas, Function of brain in communication - language input and output, Function of corpus callosum and anterior commissure.

L30-31: Thoughts, consciousness and memory: Memory formation, types of memory, molecular pathway of memory formation, Activating-driving systems of brain, Functional anatomy and functions of limbic system and hypothalamus, States of brain activity, Brain waves, Origin in brain of brain waves (EEG).

L32-33: Sleep: Slow-wave sleep, REM sleep, Basic theories of sleep and awake, Physiological Mechanisms of Sleep and Waking, dreams sleep deprivation, Epilepsy, Psychotic behavior and dementia - roles of specific neurotransmitter systems.

UNIT IV: Sensory Physiology **(12 hours)**

L34-35: Neuronal circuits for processing information, "Coding" of Sensory Information, Electrical & Ionic Events in Receptors.

L36-37: Somatic sensations: Tactile and position senses, Sensory pathways for transmission of somatic signals into the central nervous system, Sensory receptors, Transmission in dorsal column – medial lemniscal system.

L38-39: Pain and thermal sensations: Pain receptors and their stimulation, Dual transmission of pain signals into the central nervous system, Types of pain.

L40-42: **Eye**: The Image-Forming Mechanism (accommodation and visual acuity), Receptor and Photochemistry of vision, Neural function of retina. Visual Pathways and effects of lesions of these pathways

L43-44: **Hearing and equilibrium**: Tympanic membrane and ossicular system, Cochlea, Central auditory mechanisms, directionality of sound, Vestibular sensations and maintenance of equilibrium, auditory and vestibular reflexes, oculo-vestibular system

L45: **Taste and smell**: Anatomical aspects of olfaction and gustation, Receptors and sensory transduction of olfaction and gustation & Neuronal Pathways of olfaction and gestation

Practicals: **1 credit (30 hours)**

Blood physiology

1. Preparation and staining of blood smear with Leishman's stain and Identification of the various types of blood cells.
2. To record the Bleeding time and clotting time

Histopathology

1. Demonstration of biological sample retrieval, sectioning (cryotome/microtome), fixation and staining of various tissue types from rodent tissue sample.
2. Study of various types of human tissues in normal and diseased condition from permanent slides

Electrophysiology (using appropriate hardware and software)

1. To observe, record, and correlate motor unit recruitment and muscle fatigue with increased power of skeletal muscle contraction through Electromyogram (EMG).
2. To observe rate and rhythm changes in the ECG associated with body position and estimate the mean electrical axis of the QRS complex
3. To record the Reaction time for various Short term memory test.
4. To record an EEG of different areas of brain from an awake, resting subject.

ESSENTIAL READING:

1. Physiological Reviews, Americal Physiological society, journals.physiology.org, 2025
2. Chaudhry R, Miao JH, Rehman A. Physiology, Cardiovascular. 2022 Oct 16. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan–. PMID: 29630249.
3. Neuroscience Online, an Open-Access Neuroscience Electronic Textbook https://nba.uth.tmc.edu/neuroscience/.
4. Jain, A.K. (2020). Human Physiology In Nutshell (5th ed.). Arya Publishing Company.]
5. Review of medical physiology by William F. Ganong; Ed. 26th Edition ; McGraw Hill; 2019. By Kim Barrett, Susan Barman, Jason Yuan and Heddwen Brooks. ISBN10: 126012240.
6. Human Physiology : Practical Manual Paperback – Notion Press (27 February 2023); by Dr. Savahat (Author). ISBN-13 : 979-8889865568.
7. Exploring Anatomy & Physiology in the Laboratory, Morton Publishing Company; 3 edition (2017).

SUGGESTED READING:

1. Textbook of medical physiology by Arthur C. Guyton and John E. Hall; Ed.13th & 14th, 2016.
2. Principles of anatomy and physiology by Gerard J. Tortora and Bryan Derrickson; Ed.15th; John Wiley; 2016.
3. Hole's Human Anatomy & Physiology , McGraw-Hill Education; 14 edition, 2015
4. Medical Physiology: A cellular and molecular approach by Walter F. Boron and Emile L. Boulpaep; Saunders; Ed. 3rd , 2017.
5. Physiology by Robert M. Berne and Matthew N. Levy; Mosby; ELSEVIER, Ed.7th 2018.
6. Principles of Neural Science, (Kandel) 5th Edition, 2013.
7. Fundamental Neuroscience, ELSEVIER 4th Edition, 2012
8. Neuroscience Fifth Edition Dale Purves, George J. Augustine, David Fitzpatrick, William C. Hall, Anthony-Samuel LaMantia, and Leonard E. White, 2018.
9. Physiology Practical, Written by the members of Department of Physiology and Neurobiology, Eötvös Loránd Ildikó világ iuniversity. http://physiology.elte.hu/gyakorlat/jegyzet/Physiology_Pactical_(2013).pdf

POOL OF DISCIPLINE SPECIFIC ELECTIVES

FOR SEMESTERS I AND II

Pool of Discipline Specific Elective Courses to be offered in 1st Semester	i. Cell Biology
	ii. Bioethics and Biosafety
	iii. Application of Statistics in Biology
Pool of Discipline Specific Elective Courses to be offered 2nd semester	iv. Molecular Biology
	v. Topics in Clinical Research
	vi. Biological Chemistry -II

DETAILED SYLLABUS

DSE-(i) **CELL BIOLOGY** **Duration: 60 Hours**

DISCIPLINE SPECIFIC ELECTIVE

Course title and Code	Total Credits	Credit distribution of the course			Eligibility Criteria	Prerequisite of the Course (if any)
		Lecture	Tutorial	Practical		
Cell Biology (DSE-i)	**4**	**4**	**0**	**0**	Bachelor's degree in Biomedical Science/any branch of Life Sciences/ Chemical Sciences/ Medical sciences/ pharmacy	**NIL**

LEARNING OBJECTIVES

- The main aim of this paper is to acquaint students with cell and its function in the living organism
- Students will learn in detail about the ordered processes of transport of molecules I a form of proteins within different intracellular compartments inside a cells.
- Cell survival and cell death is to understanding the organized mechanism of these processes and its regulation will help the students to understand the imbalances in fundamental ordered process leading to many diseases particularly cancer.
- Cell proliferation and division to study the developmental process and managing signalling proteins to overcome the stress microenvironment.

LEARNING OUTCOMES:

- The students will gain insights into the organization and workings of human cells organelle structure and functions.
- Elaborate study on types of human cells and the communication of signalling messages between cells, will develop understanding the concept of tissues and organ.
- Study the mode of cell to cell communication and response can also be interpreted under genotoxic stresses, which help students to study more in building the concept in disease diagnosis and therapeutics.

Unit-I. Biomembrane and Organelles of eukaryotic cells (21 hours)

L1-L2 Basic structure, lipid and protein composition and their basic functions. Transport of molecules across membranes.

L3-L4. Passive and active transport across membranes, glucose transport

L5-L6. Cytosolic pH maintenance

L7-L8. Ion channels & Neuronal action potential

L9. ABC transporters

L10-11. Lipid rafts

L12-13. Introduction basic structure and function of various organelles, Endoplasmic Reticulum, Golgi bodies, mitochondria endosomes, lysosomes etc.

L14-15. Protein trafficking across the organelle and modification

L16-17. Separation and visualization methods of various cell organelles.

L18-19. Mitochondria, ATP synthesis

L20. Muscle & Nerve Cells.

L21. Class test

Unit-II. Nucleus and Chromosome Structure (7 hours)

L22-23. Introduction: Prokaryotic and Eukaryotic genome and its organization, eukaryotic chromosome.

L24-25. Basic structure of DNA; hairpins and cruciform, Z-DNA, triple helix.

L26-27. DNA Supercoiling: Histones, nonhistone proteins, topoisomerases and telomerase

L28. Discussion and Revision

Unit-III. Cytoskeleton, ECM Proteins and Cell Adhesion (15 hours)

L29-30. Cytoskeleton proteins, and Cell motility and shape,

L31-32. Microfilaments and actin filaments, Actin binding proteins

L33-35. Tubulin dynamics, Tubulin functions, chromosome arrangement

L36-38. Cell-Cell interaction, Cell junctions,

L39-40. Adhesion proteins, Cadherin, Integrins

L41-42. Adhesion proteins: Selectin, Leukocyte rolling mechanism

L43. Cell locomotion and migration

Unit-IV. Cell Cycle and cell signaling (17 hours)

L44. Cell cycle: G1 phase G1 to S transition

L45. Rb protein phosphorylation

L46. Cell cycle checkpoints in cell cycle regulation

L47. Introduction to cell surface receptors, and concept of receptors.

L48-50. G-protein mediated signalling, Cyclic-AMP, secondary messengers

L51-52. Receptors Tyrosine Kinases, Non- Receptor Tyrosine Kinases

L53-55. Apoptosis, Proapoptotic and Antiapoptotic proteins , Inhibitor of apoptosis (IAP) Family proteins

Cell death mechanisms in health and diseases

L56-57. Cell Differentiation, Stress response proteins and its pathways, Post translational modifications in stress response

L58-59. General responses to hyperthermia nutritional deprivation and other stressors, AMPK signalling

L60. Quiz.

ESSENTIAL READINGS:

1. Molecular Biology of the Cell by Bruce, Alberts and Alexander Johnson and Julian Lewis, and Martin Raff; Ed. 6th; Garland Science; 2014.

2. Molecular Cell biology by Harvey Lodish and Arnold Berk, Chris A. Kaiser, and Monty Krieger; Ed. 9th; 2021.

3. Recent reviews published in peer review journals, Nature cell biology, Cell etc.

DSE-(ii) BIOETHICS AND BIOSAFETY Duration: 60 Hours

DISCIPLINE SPECIFIC ELECTIVE

Course title and Code	Total Credits	Credit distribution of the course			Eligibility Criteria	Prerequisite of the Course (if any)
		Lecture	Tutorial	Practical		
Bioethics and Biosafety (DSE -ii)	**4**	**4**	**0**	**0**	Bachelor's degree in Biomedical Science/any branch of Life Sciences/ Chemical Sciences/ Medical sciences/ pharmacy	**NIL**

LEARNING OBJECTIVES:

- Students will be taught nuances of modern biotechnology and innovation-oriented scientific research that have prompted formulation of new policies and regulatory guidelines
- These would have a direct impact on protection against potential harms and/or exploitation of research participants.
- Students will be made aware of the establishment of a bioethics framework involving biomedical scientists, religious scholars, physicians, philosophers, legal experts, sociologists, and lay intellectuals.
- They will be taught how these will have a proactive directional impact on the interrelation of medicine, ethics, law and religion vis-a-vis existent ethical standards and futuristic adaptability with the local/ state/ region/ international norms.

LEARNING OUTCOMES:

- Learn about gradation of moral and ethical norms from simpler to higher levels for initiating right actions to ‘first do no harm’
- Learn about Prayers, Oaths, Covenants, Declarations, Guidelines and Codes which have relevance to bioethics.
- Recognize the key features of the Ayurveda, Unani and Siddha systems of medicine.
- Outline the ethical and moral values as described in the authentic texts of Ayurveda, Siddha and Unani systems of medicine.

- Clinical research and guidelines for collecting clinical samples and drug trials.
- Understanding the biosafety rules in handling biological materials.
- Animal ethics and guidelines of CPCSEA.
- Disposal of hazardous reagents and biological materials

Unit-I. Introduction to bioethics, codes, covenants (14 hours)

L1-6. Declarations and guidelines. Defining Bioethics in relation to Profession, Society, and Biomedicine, need of bioethics. Prayers and Oaths in Bioethics and Covenants in Bioethics. Declarations: The Declaration of Geneva, WMA's Declaration of Helsinki (DOH, 1964) Universal Declaration on Bioethics and Human Rights and Guidelines, Codes of Bioethics.

L7-14: Indian Philosophy of life, Various Philosophical systems, Issues in philosophy, Goals of life: purusharthas. Dharma and other moral concepts. Indian traditional systems of medicine and their ethical principles: Introduction, Ayurveda, Siddha, Unani.

Unit-II. Ethics and Guidelines (20 hours)

L15-25: Benefit-risk assessment, Informed consent process, Requisites, Responsibility of researchers. Documentation of informed consent process, Electronic consent, Specific issues in clinical trials. Informed Consent in different settings, Waiver of Consent, Gatekeeper's Consent/ permission, Children and Assent, Vulnerable population. Privacy and confidentiality, Distributive justice, Payment for participation, Compensation for research related harm, Ancillary care, Conflict of interest, Selection of vulnerable and special groups as research participants, Community engagement, Post research access and benefit sharing. Guidelines for drug trials.

L26-32**:** Terms of reference for ethics committees (EC), Composition of an EC, Roles and responsibilities of EC, Submission and review procedures, Review of multicentric research, Record keeping and archiving, Administration and management.

L33-35**-:** Introduction to animal ethics, CPCSEA guidelines, handling of animals and guidelines for use of animals.

Unit III: Biological materials, biobanking and datasets (8 hours)

L33- 41. Biobanking, Storage of biospecimens and data with their personal identifiers. Ethical issues related to donors, Biological material/data in forensic departments of laboratories, Governance of biobank/biorepository.

Unit IV: Biosafety **(18 hours)**

L42-L60**:** Biosafety Principles, Laboratory Practices and Techniques, Risk analysis and control of biohazards, Dissemination of contaminants. Relationship between risk hazard, exposure, and safe guard. Use of recombinant DNA technology, manipulation of genes of bacteria, viruses and human cells. Transport, storage and precautions in use and disposal of clinical samples and biological samples. Safety equipment-Biosafety cabinets; Biosafety levels: BSL1, BSL2 and BSL3 facilities. Cartagena protocol on Biosafety. Biosafety Guidelines and regulations. Precautions associated with use of radioisotopes. Disposal of used reagents and chemicals. Disposal of biological material (bacterial culture, yeast cultures, cells, tissues and animals). Laboratory security and emergency response.

ESSENTIAL READINGS:

1. The Reference Book of Bioethics and Biosafety by Kalaimani Subramani, Kalaimathi R V, Murugesan S, 2024.
2. Ethical Guidelines for Biomedical Research on Human Subjects 2017. Indian Council of Medical Research, New Delhi.
3. Recent Central Drugs Standard Control Organization. Good Clinical Practices-Guidelines for Clinical Trials on Pharmaceutical Products in India. New Delhi: Ministry of Health; 2017.
4. Various case studies will be provided to the students

SUGGESTED READINGS:

1. The Oxford Textbook of Clinical Research Ethics, Ezekiel J. Emanuel, Oxford University press, 2008.

Laboratory biosafety manual, World Health Organization, 4th edition, 2020

DSE-(iii) APPLICATIONS OF STATISTICS IN BIOLOGY Duration: 60 Hours

DISCIPLINE SPECIFIC ELECTIVE

Course title and Code	Total Credits	Credit distribution of the course			Eligibility Criteria	Prerequisite of the Course (if any)
		Lecture	Tutorial	Practical		
Applications of statistics in biology (DSE-iii)	**4**	**4**	**0**	**0**	Bachelor's degree in Biomedical Science/any branch of Life Sciences/ Chemical Sciences/ Medical sciences/ pharmacy	**NIL**

LEARNING OBJECTIVES:

- Students will be taught how statistics plays a crucial role in data validation, analysis and interpretation.
- Students will be made aware that without which clinical, social science research and other researches involving huge number of samples would not be possible.
- The present course dealt with various common statistical methods involved in biological science research like tools for describing central tendency, correlation, and regression analysis, probability, hypothesis testing and methods of sampling of biological data.

LEARNING OUTCOMES:

- Students will get skills in different ways of hypothesis testing and methods of sampling of biological data sets.
- Additionally, they will be able to interpret and analyze data containing large pool of biological samples to yield correlative insights.

Unit I: Measures of central Tendency (11 hours)

L1-L4. Concept & biological significances of Mean, mode, Median, Graphical representation of statistical data.

L5-7. Concept, & biological significances of measures of dispersion: mean deviation, Standard deviation, Covariance, Standard error.

L8-9. Case studies relevant to measure of central tendencies and measure of dispersion.

Ll0-11. Class test

Unit II: Correlation and Regression analysis (17 hours)

L12-13. Definition of correlations, Karl Pearson's Co-efficient of correlation, Co-efficient of variation.

L14-15. Case studies relevant to the Correlations and Karl Pearson's correlation.

L16-18.Rank correlation, Tied ranks, Relation between two variables, Scatter diagram.

L19-20. Case studies relevant to rank correlation and tied ranks.

L21-23. Definition of regression analysis, curve fitting (linear and nonlinear), principles of least squares, two regression lines,

L24-25. Case studies highlighting the importance of regression analysis, curve fitting and least square method in biology.

L26-27. Definition of clustering, K-mean clustering, PCR analysis, Hierarchical clustering

L28-29. Class test

Unit III: Probability and Distribution (13 Hours)

L30-31. Theorems on probability, Random experiments, sample space, conditional probability, Bayes theorem

L32. Case studies relevant to the above topic.

L33-34. Exponential distribution, Gamma distribution, Beta distribution.

L35-36. Case studies highlighting the biological relevance of the above topic.

L37-38. Binomial, Poisson distribution, Normal distributions. Standard normal distributions and Z score, applications.

L39-40. Case studies relevant to the topic and its biological applications.

L41-42. Revision and Test

Unit IV: Methods of Sampling of biological data and analysis using (17 hours)

L43-45. Hypothesis testing, Null and alternative hypothesis, Concept and illustration of Type I and Type II error, P-value,.

L46-47. 't' and 'Z' and 'F' tests of significance for small and large samples (with appropriate examples),

L48-50. Case studies highlighting the biological relevance of the above topic.

L51-53. Parametric and Non-parametric tests (Chi Square test, Anova one way and two way), Multiple testing.

L54-56. Case studies highlighting the importance of these topics and biological relevance.

L57-L60. Discussion and class test

ESSENTIAL READINGS

1. John E. Freund.'s Mathematical statistics with application by Irwin Miller and Marylees Miller; 8th Edition, published on July 14, 2021. Publisher: Pearson
2. Biostatistics: A Foundation for Analysis in the Health Sciences – Wayne W. Daniel 11th Edition, published on November 13, 2018.
3. Introduction to Biostatistics – P.K. Banerjee (S. Chand Publishing) 4th Revised Edition, published in 2015. ISBN: 9788121923293
4. Biostatistics: A Manual of Statistical Methods for Use in Health, Nutrition, and Anthropology – K. Visweswara Rao (Jaypee Brothers Medical Publishers) 2nd Edition, published in 2009.

SUGGESTED READINGS

1. Introductory statistics by Prem S. Mann; 5th Ed.; John Wiley; 2003.
2. Biostatistics: a foundation for analysis in the health sciences by Wayne W. Daniel; 8th Ed.; John Wiley; 2005.
3. Basic statistics by A. L. Nagar and R. K. Das; 2nd Ed.; Oxford; 2002.
4. Biostatistics: a manual of statistical methods for use in health, nutrition and anthropology by K. Visweswara Rao; Jaypee Borthers, 1996.
5. John E. Freund.'s mathematical statistics with application by Irwin Miller and Marylees Miller; Ed.7th; Pearson; 2006.

DSE-(iv) MOLECULAR BIOLOGY Duration: 60 Hours

DISCIPLINE SPECIFIC ELECTIVE

Course title and Code	Total Credits	Credit distribution of the course			Eligibility Criteria	Prerequisite of the Course (if any)
		Lecture	Tutorial	Practical		
Molecular Biology (DSE-iv)	**4**	**4**	**0**	**0**	Bachelor's degree in Biomedical Science/any branch of Life Sciences/ Chemical Sciences/ Medical sciences/ pharmacy	**NIL**

LEARNING OBJECTIVES

- Molecular Biology is a core course wherein students will be explained the various basic processes of the prokaryotic and eukaryotic cells.
- Several essential techniques used in understanding its gene expression, DNA synthesis, transcription, and translation will also be explained.

LEARNING OUTCOMES:

- Student should be able to understand the differences and similarities in prokaryotic and eukaryotic gene expression and its regulation.
- Student will be able to analyze the data on protein DNA interaction.
- Students should be able to design experiments for testing whether a new protein is a transactivator and how to identify the binding site on a promoter.

Unit I: DNA replication and transcription in prokaryotes and eukaryotes (23 hours)

L1: Concept of origin of replication, experimental evidence for bidirectional and semiconservative replication.

L2: Mechanism of DNA Replication: Structure and function of DNA polymerases. Experimental approach to differentiate and identify replication proteins.

L3: Role of helicase, primase, gyrase, topoisomerase and other proteins in DNA replication in *E.coli*.

L4: Replication mechanism in viruses, mitochondrial DNA replication (D loop)

L5: Replication in eukaryotes, differences from prokaryotes, experiments to prove the model of replication.

L6: Initiation of replication, proteins involved, their functions, Inhibitors of replication.

L7: Elongation and termination of DNA synthesis in prokaryotes and eukaryotes.,

L8-9: Replication at telomeres, Diseases associated with defective DNA replication.

L10. Basic concepts of transcription in prokaryotes using E. coli as an example

L11. Structure & function of RNA polymerases.

L12. Transcription initiation, proteins involved in initiation,

L13. Experimental evidence to check their function.

L14. Transcription elongation and termination.

L15. Transcription in eukaryotes- differences and similarities, inhibitors of transcription

L16. Structure of TFIID, and other general transcription factors.

L17. Methods to identify the subunits of complexes.

L18. Post transcriptional regulation of transcription (polyadenylation, capping), mechanism and their role in transcription

L19. Transcription regulation by methylation, acetylation of histones.

L20. Inhibitors of transcription in prokaryotes and eukaryotes

L21. Determining the mRNA half-life of mRNA.

L22. Promoter structure and Transcription by RNA polymerase I,

L23. Structure of Promoter and Transcription by RNA polymerase III

L24. Revision

Unit II: Regulation of gene expression in prokaryotes (11 hours)

L25. Coordinated control of clustered genes-operon model, with example of inducible systems like Lac– Operon.

L26. Experimental proof for the operon, use of mutants of I gene, O^c mutants in understanding operon function

L27. Role of cyclic AMP, catabolite repression and regulation by glucose.

L28. Repressible systems like Trp operon. Concept of attenuation

L29. Trp operon contd.

L30. Arabinose operon concepts of dual role of regulatory protein

L31. Arabinose operon continued

L32. Identification and understanding the role of sRNA in gene regulation in prokaryotes.

L33. Other regulatory pathways in prokaryotes

L34-35. Revision and Test

Unit III: Regulation of gene expression in eukaryotes (15 hours)

L36. Introduction: Organization of genes in eukaryotic DNA Repetitive DNA sequences, multiple regulatory sequences, activators, coactivators, repressors

L37. Activators contd., enhancers. Modular structure of transactivators (Zn fingers, HLH, HTH etc).

L38. Repressor complexes, mechanism of their function in gene regulation.

L39. Regulation of gene expression by hormone receptors. Concept of half-site.

L40. Methods used to study protein-DNA interactions EMSA controls, supershift etc.

L41. DNA foot printing, reporter assays to prove binding.

L42. Homodimers and heterodimers in differential gene regulation with examples. Diseases linked with altered gene expression

L43. Methods used to study protein-protein interactions (i) yeast two hybrid, controls, library screening to identify new interacting partners.

L44. Concept of co-Immunoprecipitation, uses, advantages and disadvantages of two techniques

L45. Alternate splicing in gene regulation, mechanism.

L46. Alternate splicing contd. splicing factors etc, gene editing

L47. Ribozymes–Structure and mechanism of action.

L48. microRNA, siRNA and their role in gene regulation.

L49. lncRNA and its role in gene regulation.

L50. CRISPR-Cas system and its role in gene regulation.

Unit IV: Chromatin remodelling (10 hours)

L51: Introduction to chromatin remodelling concepts and factors involved. Role of various remodelling proteins such as NURF, ACF

L52: Role of DNA and histone methylation and histone acetylation in chromatin remodelling and gene regulation.

L53: Concept of insulators, nuclear matrix in gene regulation

L54: Methods to understand chromatin remodelling.

L55-60. Discussion and Tests

ESSENTIAL READING

1. Molecular Cell Biology by Lodish, H., Berk, A., Zipursky, S. L., Matsudaira, P., Baltimore, D. and James Darnell, J., Freeman, 9th edition, 2021.
2. Biochemistry Voet, D. &Voet, J. G.. Wiley, 8th edition, 2021
3. Berg, J. M., Tymoczko, J. L. and Stryer, L. Biochemistry. Freeman, 10th edition, 2021.
4. Alberts, B. et al. Essential Cell Biology, Garland, 7th edition, 2021.

SUGGESTED READING

1. Mathews, C. K. & Van Holde, K. E. & Ahern, K. G. Biochemistry. Addison Wesley, 7th edition, 2021.
2. Jocelyn E Krebs; Elliott S Goldstein; Stephen T Kilpatrick Lewin"s Gene XII, Burlington, MA : Jones & Bartlett Learning, 2018.

DSE-(v) TOPICS IN CLINICAL RESEARCH Duration: 60 Hours

DISCIPLINE SPECIFIC ELECTIVE

Course title and Code	Total Credits	Credit distribution of the course			Eligibility Criteria	Prerequisite of the Course (if any)
		Lecture	Tutorial	Practical		
Topics in clinical research (DSE-v)	**4**	**4**	**0**	**0**	Bachelor's degree in Biomedical Science/any branch of Life Sciences/ Chemical Sciences/ Medical sciences/ pharmacy	**NIL**

LEARNING OBJECTIVES

- Covers the fundamentals of clinical trials, drug development, regulatory affairs, and ethical considerations within the field.
- Students will be taught how lab to field experiments are designed.
- They will also be made aware of the different regulatory requirements and rules that need to be kept in mind while designing a clinical trial.

LEARNING OUTCOMES: Upon completion of this course, it is expected that students shall be able to:

- Know the new drug development process.
- Understand the regulatory and ethical requirements.
- Appreciate and conduct the clinical trials activities
- Know safety monitoring and reporting in clinical trials
- Manage the trial coordination process

Unit-I: Clinical Research and Clinical Trial Design (19 hours)

L1-9: Definition, Scope and Types of Clinical Research, Understanding Epidemiology, (infectious disease, cancer and genetics) Pharmacology and Pharmaceuticals, Good Clinical Practices (GCP), Introduction to Bioavailability and Bioequivalence.

L10-19: Designing of protocol, Pharmaco-epidemiology, Introduction to Quality Assurance and quality control, Good Laboratory Practice (GLP) and Accreditation, Study population and sample size, medical report writing and publication of results.

Unit-II: Regulatory processes in Clinical Research (18 hours)

L20- 29: Definition and theories of Ethics and Foundation, Independent Ethics Committee, Informed Consent, Integrity in Clinical Research, Conflicts of Interest. Ethical principles governing informed consent process. Structure and content of a Patient Information Sheet. Structure and content of an Informed Consent Form. The process of taking informed consent and documentation.

L30-39: History and Role of Regulations in Clinical Research, Clinical Research regulations in India – CDSCO guidelines, ICMR guidelines. Clinical trial application requirements in India- IND and NDA. USFDA regulations to conduct drug studies. Clinical Research regulations in UK – Medicines and Healthcare Products Regulatory Agency (MHRA). Clinical Research regulations in Europe (EMEA). Non-Disclosure Agreement, GMP regulations, Patent and Patent laws.

Unit-III: Clinical Research and Management (9 hours)

L40- 49: Clinical Study Preparation, Pre-clinical Trials, Clinical drug development phases, Phase 0 studies, Phase I and subtype studies (single ascending, multiple ascending, dose escalation, Phase II studies (proof of concept or principle, studies to establish efficacy), Phase III studies (Multi ethnicity, multinational, registration studies), Phase IV studies (Post marketing). Bridging studies and pilot studies. Documentation, Monitoring, Audit and Inspection of trial study. Pharmaco-vigilance. Drug Safety.

Unit-IV: Biostatistics and Data Management (10 hours)

L50-60: Role of Statistics in clinical research, Trial design and analysis, Data management and validation, Consideration of SAE (serious adverse effects), Bioinformatics, software and IT in Clinical Research.

ESSENTIAL READINGS:

1. Epidemiology and Biostatistics: An Introduction to Clinical Research, Bryan Kestenbaum, 2nd Ed., Publisher: Springer, 2018.

2. Recent Central Drugs Standard Control Organization. Good Clinical Practices-Guidelines for Clinical Trials on Pharmaceutical Products in India. New Delhi: Ministry of Health; 2017.

3. Ethical Guidelines for Biomedical Research on Human Subjects 2017. Indian Council of Medical Research, New Delhi.

4. The Pharmaceutical Regulatory Process (Drugs and the Pharmaceutical Sciences), Ira R. Berry, 1st Ed., Informa HealthCare, 2008.
5. Fundamentals of Biostatistics, Bernard Rosner, Duxbury Press; 6thEd., 2005.

SUGGESTED READINGS:

1. Adaptive Design Methods in Clinical Trials, Shein-Chung Chow,CRC,2006.
2. Introduction to Randomized Controlled Clinical Trials,2ndEd., John N.S.Matthews,CRC,2006.
3. The Oxford Textbook of Clinical Research Ethics, Ezekiel J.Emanuel, Oxford University press, 2008.

DSE-(vi) BIOLOGICAL CHEMISTRY-II Duration: 60 Hours

DISCIPLINE SPECIFIC ELECTIVE

Course title and Code	Total Credits	Credit distribution of the course			Eligibility Criteria	Prerequisite of the Course (if any)
		Lecture	Tutorial	Practical		
Biological Chemistry-II (DSE-3)	**4**	**4**	**0**	**0**	Bachelor's degree in Biomedical Science/any branch of Life Sciences/ Chemical Sciences/ Medical sciences/ pharmacy	**NIL**

LEARNING OBJECTIVES:

- The course aims to impart to the students a thorough understanding of chemical macromolecules found in biological systems.
- Synthetic macromolecules and their self- assembly are also discussed as is the important area of nanotechnology.
- Carbohydrate chemistry forms an essential part of this course. Enzyme and coenzyme catalysis is thoroughly discussed.

LEARNING OUTCOMES:

- At the end of the course students will be able to appreciate the underlying chemistry of many important biological processes.
- They will also be trained in to the various methods used to study the reaction mechanisms

Unit I: Molecules and macromolecules in biological systems (19 hours)

L1. Amino acids, peptides and proteins,
L2. Structure and Functions of proteins
L3. Formation of peptide bonds.
L4-6. Protecting groups and peptide bond formation.

L7-9. Protein degradation and sequencing of amino acids.
L10. DNA and RNA bases.
L11-12. Nucleosides and nucleotides, phosphodiesters
L13-14. Formation of N- and C- glycosides,
L15-16. Conformation and configuration of 5 carbon and 6-carbon sugars.
L17-19. Maltose, Sucrose and Lactose.

Unit II: Synthetic macromolecules and polymers in biology (12 hours)

L20-21. Building of macromolecules and molecular frameworks and their biomedical applications.
L22-23. Synthetic strategies for artificial systems that mimic biological entities.
L24-27. Applications of supramolecular principles to molecular diagnosis, therapeutic applications of supramolecular chemistry.
L28-30. Nanotechnology and its applications in drug delivery and other biomedical applications
L31. Doyens of organic chemistry: Jean Marie- Lehn, Fraser Stoddart and Frederick Sanger.

Unit III: Mechanisms in Biological Chemistry (15 hours)

L32-33. Active methylene groups,
L34-35. Aldol and retroaldol reactions.
L36. Schiff bases and enamine reactions,
L37-40. Nitrogen, phosphorus and sulfur ylides.
L41. Umpolung reaction,
L42. Michael addition,
L43. Polymer supported organic reactions,
L44-46. Phase transfer catalysis, Equivalence of these reactions in biological system

Unit IV: Enzyme, Coenzyme systems and Mechanism of coenzyme catalysis (13 hours)

L47-48. Enzyme classifications, Inhibitors.
L49-50. Mechanisms of Enzymes.
L51. Coenzyme A.
L52. NAD+ and NADPH.
L53. FMN and FAD.
L54. Biotin
L55. PLP
L56. TPP
L57. Lipoic acid, tetrahydrofolate, ascorbic acid,
L58. Cyanocobalamine and
L59. Cytochrome P-450
L60: Test

ESSENTIAL READINGS

1. Carbohydrate Chemistry: Proven Synthetic Methods Vol 4 2017, Ed : Christian Vogel and Paul Murphy
2. Introduction to Enzyme and Coenzyme Chemistry 3rd Edition 2012: Wiley Blackwell
3. Introduction to nano: Basics to nanoscience and nanotechnology, 2015 Springer Author: Amretashis Sengupta and Chandan Kumar Sarkar
4. Amino Acids: Biochemistry and Nutrition 2013 CRC PRESS, Author: Guoyao Wu
5. Enantioselective Organocatalysed reactions II 2011 Springer, Author: Rainer Mahrwald
6. Supramolecular chemistry 71: 1995 Associated Press, Author: Jean Marie Lehn

GE-1 **BIOLOGY OF AGING** **Duration: 60 Hours**

SEMESTER I

GENERIC ELECTIVE

Course title and Code	Total Credits	Credit distribution of the course			Eligibility Criteria	Prerequisite of the Course (if any)
		Lecture	Tutorial	Practical		
Biology of Aging (GE-1)	**4**	**4**	**0**	**0**	Bachelor's degree in Biomedical Science/any branch of Life Sciences/ Chemical Sciences/ Medical sciences/ pharmacy	**NIL**

LEARNING OBJECTIVES:

- This course provides an overview of the aging process and its effects on the human body. It explores key biological mechanisms of aging and examines how age-related physiological changes increase vulnerability to disease.
- The module also investigates the biological factors and stressors that accelerate aging and how they impact various body systems.
- It highlights the distinction between chronological and biological age, emphasizing factors that influence the rate of aging.
- The course aims to help students understand the biological processes underlying aging, analyse the theories and mechanisms of aging, examine the impact of aging on various physiological systems, and discuss potential interventions and strategies for promoting healthy aging.

LEARNING OUTCOMES:

Upon completing this course the students will be able to:

- Describe Biological Basis and Physiological Consequences of aging, including the main theories of aging and molecular mechanisms.
- Identify Life-Style Modifications to counteract aging and age-related diseases, such as calorie restriction, exercise, and antioxidants.
- Apply Knowledge of biological aging to health-related outcomes, including understanding how age creates vulnerability for disease and designing preventative interventions.
- Critically evaluate research in the field of aging and apply new knowledge to promote healthy aging and extend lifespan

Unit I: Introduction to Aging Biology and Theories of Aging (16 hours)

L 1: Overview of aging and its impact on society
L 2-3: Historical perspectives on aging research
L 4-6: Current trends and future directions in aging research
L 7-8: Evolutionary theories of aging
L 9-11: Cellular theories of aging (telomere shortening, epigenetic changes)
L 12-13: Molecular theories of aging (DNA damage, protein homeostasis)
L 14-16: Systems biology approaches to understanding aging

Unit II: Cellular and Molecular Mechanisms of Aging (15 hours)

L 17-19: Cellular senescence and its role in aging
L 20-22: Mitochondrial dysfunction and aging
L 23-25: Proteostasis and aging
L 26-28: Epigenetic regulation of aging
L 29-31: Role of inflammation and oxidative stress in aging

Unit III: Physiological Changes with Aging (12 hours)

L 32-34: Changes in the nervous system with aging
L 35-37: Aging and the immune system
L 38-40: Cardiovascular changes with aging
L 41-43: Musculoskeletal changes with aging

Unit IV: Interventions and Strategies for Healthy Aging (17 hrs)

L 44-45: Caloric restriction and its effects on aging
L 46-47: Exercise and physical activity in promoting healthy aging
L 48-49: Nutritional interventions for healthy aging
L 50-51: Potential pharmacological interventions for aging
L52-57: Case studies such as Hutchinson-Gilford Progeria Syndrome, Centenarians with a lower risk of age-related diseases, Caloric Restriction: A study demonstrating the benefits of caloric restriction on health span.
L58-60: Discussion and assessment

ESSENTIAL READING:

1. Sugar, J. A. (2020). Introduction to aging: A positive interdisciplinary approach.
2. Weinert, B. T., & Timiras, P. S. (2018). Physiology of Aging.
3. Masoro, E. J., & Austad, S. N. (2019). Handbook of the Biology of Aging.
4. Sierra, F. (2019). Biology of Aging.

ADDITIONAL RESOURCES:

- Online resources (e.g., National Institute on Aging, American Federation for Aging Research)
- Latest Research articles and reviews from the following Journals:

- Journal of Gerontology, Ageing Research Reviews, Journal of Aging and Health, Age and Ageing, Research on Aging, Aging, Ageing Cell
- Case studies and group discussions

GE-2 **CANCER BIOLOGY** **Duration: 60 Hours**

SEMESTER II

GENERIC ELECTIVE

Course title and Code	Total Credits	Credit distribution of the course			Eligibility Criteria	Prerequisite of the Course (if any)
		Lecture	Tutorial	Practical		
Cancer biology (GE-2)	**4**	**4**	**0**	**0**	Bachelor's degree in Biomedical Science/any branch of Life Sciences/ Chemical Sciences/ Medical sciences/ pharmacy	**NIL**

LEARNING OBJECTIVES

- The main aim of this paper is to acquaint students with the basics of cancer biology
- Cellular mechanisms leading to initiation and progression of cancer growth. Describe the characteristics of cancer cells that explain high mortality rate.
- Different types of cancers, its etiology and epidemiological impact will be taught.
- Cancer diseases diagnosis and treatment strategies will be discussed.

LEARNING OUTCOMES

- Students will develop understanding about cancer and its origin
- They will learn the molecular controls that govern the cellular microenvironment and interaction of immune cells and cancer
- They will also get acquainted in recent advancement in cancer disease diagnosis and treatment strategy

- Students who successfully complete this course will acquire in depth understanding and advanced knowledge of a range of general and specialized areas in cell biology of cancer

Unit 1: Cancer overview (16 hours)

L1-L3: Cancer terminologies and its overview. Etiology and epidemiology of cancer

L4-L6: Types of cancer, susceptibility to cancer different organs and tissues

L7-L9: Normal cells and cancer cells, oncogenes and tumor suppressors

L10-L12: Hypothesis of Clonal origin of cancer and its malignant phenotype

L13- L15: Gene amplification and Gene mutation.

L16: Class test

Unit 2: Chromosomal De-arrangement and Cancer (13 hours)

L17- L19: Types of chromosomes, karyotyping and Gene banding

L20-L22: Types Chromosome translocation. Deletion, Duplication, Inversion

L23-L25: Oncogene amplification by chromosome breakage and fusion bridge cycle

L26-L28: Philadelphia chromosome: Chronic myeloid leukaemia (CML) and some acute lymphoblastic leukaemia (ALL).

L29-L30: Quiz

Unit 3: Cancer Cell Metabolism (16 hours)

L31-L33: Glycolysis, Oxidative phosphorylation and ATP synthesis

L34-L36: Cytoplasmic structures and organelles in cancer cells: Cytoskeleton, Lysosomes and Mitochondria

L37-L 39: Warburg effect and acidic environment

L40-L42: Tumor metabolism and its remodelling

L43-L45: Receptor tyrosine kinase and non-receptor tyrosine kinases

L46: Discussion

Unit 4: Cell-Cell Adhesion and Cancer Therapeutics (15 hours)

L47-L49: Cell interaction with neighbouring cells and ECM (integrins, cadherins, fibroblasts, collagen, fibronectin)

L50-L52: Alterations leading to metastasis: release of matrix metalloproteinases (MMPs), epithelial to mesenchymal transition (EMT) and angiogenesis

L53-L55: Cancer Immuno-therapeutics

L56-L57: Cancer cell antigens, Cancer biomarkers

L58: Cancer transcriptome

L59: Oncolytic viruses

L60: Revision

ESSENTIAL READING:

1. Principles of cancer treatment and anticancer drug development. 1st ed 2019, Wolfgang Link

2. The Cell: A Molecular Approach, by Geoffrey M Cooper, Robert E Hausman, 15 Dec 2015

3. Karp, G. (2013). 7th Edition. Cell and molecular biology: Concepts and experiments. New Jersey, USA: Wiley Publishers. ISBN-978-0470483374.

SEMESTER -I

SEC-I **BIOMEDICAL LABORATORY TECHNIQUES-I** **Duration: 30 Hours**

SKILL BASED COURSE

Course title and Code	Total Credits	Credit distribution of the course			Eligibility Criteria	Prerequisite of the Course (if any)
		Lecture	Tutorial	Practical		
Biomedical Laboratory Techniques-I (SEC-1)	**2**	**0**	**0**	**2**	Bachelor's degree in Biomedical Science/any branch of Life Sciences/ Chemical Sciences/ Medical sciences/ pharmacy	**NIL**

LEARNING OBJECTIVES:

The BMLT course has been designed to impart practical based skills to use basic instruments like spectrometers, Fluorimeters, bright filed and phase contrast Microscopes and fluorescence microscopes. The student will be given basic training to use these equipment and their usage in diagnosis of various diseases will be emphasized.

LEARNING OUTCOMES:

- The students will learn basics about instruments in a medical laboratory, their usage with practical based training.
- This includes a hands-on learning and experience in different techniques that will be useful to them later on in their research as well as any laboratory set ups in employment.

List of Practicals:

- Demonstration of spectrophotometer
- Detection and estimation of concentration of DNA, RNA using spectrophotometer.
- Detection and estimation of protein using spectrophotometer.
- Demonstration of brightfield and phase contrast microscope.

- Study of tissue specimens using Haematoxylin Eosin (H&E) staining and bright field microscopy of live cell specimens.
- Demonstration of fluorescence microscope.
- Demonstration of use of intrinsic and extrinsic fluorochromes in biomedical applications.
- Study of indirect (IFA) and direct fluorescence imaging in tissue and live cells.

ESSENTIAL READINGS:

1. Physical Biochemistry: Principles and Applications. By David Sheehan. Dec 2000 Molecules 5(12); DOI: 10.3390/51201517.
2. Introduction to Light Microscopy: Tips and Tricks for Beginners (Hardback) | Released: 12 Jun 2019; By: Dee Lawlor (Author) , Lawlor, Dee (Author) | Publisher: Springer | Publisher Imprint: Springer
3. Principles and techniques in histology, microscopy and photomicrography Singh DR. 2018.

SEMESTER -II

SEC-2 BIOMEDICAL LABORATORY TECHNIQUES-II Duration: 30 Hours

SKILL BASED COURSE

Course title and Code	Total Credits	Credit distribution of the course			Eligibility Criteria	Prerequisite of the Course (if any)
		Lecture	Tutorial	Practical		
Biomedical Laboratory Techniques-II (SEC-2)	**2**	**0**	**0**	**2**	Bachelor's degree in Biomedical Science/any branch of Life Sciences/ Chemical Sciences/ Medical sciences/ pharmacy	**NIL**

LEARNING OBJECTIVES:

The course has been designed to practically train the students in important diagnostic techniques related to heamatology, microbiology, enzyme assays, detection of proteins using western blot and microscopy. The students will have practical based training in diagnosing diseases and conditions, such as diabetes, anemia, infections, immune system modulations, genetic diseases etc.

- Monitoring chronic diseases or conditions, such as diabetes autoimmune diseases
- Required to check for normal organ functioning, including liver, kidneys, heart, and thyroid
- For prognosis of a treatment

LEARNING OUTCOMES

- Students will get an hands-on experience in different techniques used in laboratory based diagnostics such in blood sample analyses.
- Additionally they will learn about the ways by which different organs carryout various functions that if dysregulated lead to disorders.
- Next they will have learnt how to identify these disorders by simple laboratory based techniques.

List of Practicals

Hematology

1. To quantify the number of WBCs in a blood sample for understanding the body's immune response and overall health.
2. To quantify the number of RBCs in a blood sample and estimation of haemoglobin to diagnose or monitor conditions like anaemia.

Liver function tests

3. To estimate the Alanine aminotransferase and Aspartate transferase enzyme activities for liver function test

Diabetes status

4. To estimate the fasting sugar and Hb1Ac in blood.

Diagnosis of bacterial infections

5- 6. To prepare pure culture of bacteria from skin isolate and study the staining characteristics, biochemical profile and antibiotic sensitivity using stokes method.

Immunology-based diagnostic methods

7. To demonstrate the estimation of antibodies against autoantigens in serum samples using ELISA/Western blot methods
8. Standardization of ELISA using checkerboard titration methods

Human Genetics

9. Staining methods for chromosome banding and analysis using publically available data.

ESSENTIAL READINGS:

1. Human Genetics and Genomics: A Practical Guide. Bahar Taneri, Esra Asilmaz, Türem Delikurt, Pembe Savas, SeniyeTargen, Yagmur Esemen. ISBN: 978-3-527-68263-8 February 2020
2. Prescott's Microbiology by Joanne Willey, Kathleen Sandman, and Dorothy Wood; 12th Edition, McGraw-Hill Education, 2022.
3. Medical Microbiology by Patrick R. Murray, Ken S. Rosenthal, and Michael A. Pfaller; 10th Edition. Elsevier Health Sciences, 2022.
4. Brock Biology of Microorganisms by Michael T. Madigan, Kelly S. Bender, Daniel H. Buckley, W. Matthew Sattley, and David A. Stahl; 16th Edition, Pearson,2021.

5. Chaudhry R, Miao JH, Rehman A. Physiology, Cardiovascular. 2022 Oct 16. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan–. PMID: 29630249.
6. Jain, A.K. (2020). Human Physiology In Nutshell (5th ed.). Arya Publishing Company.
7. Review of medical physiology by William F. Ganong; Ed. 26th Edition; McGraw Hill; 2019. By Kim Barrett, Susan Barman, Jason Yuan and Heddwen Brooks. ISBN10: 126012240.