UNIVERSITY OF DELHI

CNC-II/093/1/EC-1275/25/03
Dated: 15.07.2025

NOTIFICATION

Sub: Amendment to Ordinance V

(ECR 07-3/ dated 23.05.2025)

Following addition be made to Appendix-II-A to the Ordinance V (2-A) of the Ordinances of the University;

Add the following:

The syllabi of Semester VII and VIII of the following Departments under the Faculty of Inter-Disciplinary & Applied Sciences based on Undergraduate Curriculum Framework 2022, is notified herewith for the information of all concerned:

(i) Bio-Chemistry – B.Sc. (Hons.) Biochemistry – ***Annexure-1***
(ii) Microbiology – B.Sc. (Hons.) Microbiology - ***Annexure-2***

REGISTRAR

Semester VII

DISCIPLINE SPECIFIC CORE COURSE - (DSC-19)
ADVANCED TECHNIQUES IN BIOCHEMICAL RESEARCH

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Advanced Techniques in Biochemical Research (BCH-DSC-19)	**4**	**2L**		**2P**	**Class XII with Science and Biology**	**-**

Learning Objectives

The objective of the course is to provide students with a sound background of the latest techniques used in biochemistry research and to provide them with an understanding of the principles underlying these techniques. The course is designed to impart laboratory skills in the form of practical exercises so that students can apply this knowledge to augment their research acumen and improve their understanding of the subject.

Learning outcomes

After completion of the course students will:

- Students will acquire knowledge about the principles and applications of latest methods used to analyze nucleic acids and proteins.
- Students will learn about the principle and applications of microscopy and various cell biology techniques. Students will also be exposed to various methods of labeling DNA, proteins and whole cells and their applications in research.
- Combine different biochemical methods to address a complex biological question.
- The course will also provide them an opportunity for hands-on-experience to develop their laboratory skills expected of any biochemist working in a research lab.

SYLLABUS OF DSC-19

BCH-DSC-19: ADVANCED TECHNIQUES IN BIOCHEMICAL RESEARCH

Semester – VII

Theory

Credits: 2 **Total Hours: 30**

UNIT I: Methods for Analysis of Nucleic Acids **No. of hours: 14**

Introduction to hybridization methods and labeling (Biotinylation, Fluorescent tags etc): Southern hybridization, *In situ* hybridization. Binding of nucleic acids with protein: Electrophoretic Mobility Shift Assay (EMSA), Chromatin immunoprecipitation (ChIP). Gene expression analysis: Reporter assays - example luciferase assay, semi-quantitative RT-PCR and quantitative real time PCR (qRT-PCR), DNA Microarrays and NGS.

UNIT II: Methods for Analysis of Proteins **No. of hours: 09**

Protein-Protein Interaction: Immunoprecipitation, Yeast two hybrid, Quantitative Proteomics: 2D protein gel electrophoresis, 2D-DIGE, Structural Analysis: Mass Spectrometry, MS/MS, CD Spectra and X Ray Crystallography.

UNIT III: Microscopy Based Techniques **No. of hours: 04**

Fluorescence microscopy, Confocal microscopy, Scanning electron microscopy, Transmission electron microscopy.

UNIT IV: Cell Biology Techniques **No. of hours: 03**

Flow cytometry, FACS, BrDU assay, Annexin V assay and TUNEL assay

2.3 Practical:

Credit: 2 **Total Hours: 60**

1. Southern Blotting
2. RT-PCR /qRT-PCR
3. SDS PAGE and Western Blotting
4. Virtual Lab for EMSA
5. Virtual lab on 2D-DIGE

6. Virtual lab on Microarray
7. Tour of a State-of-the-art Instrumentation Facility

2.4 Essential readings:

1. Green, M. R., & Sambrook, J. (2012). *Molecular cloning: A laboratory manual* (4th ed., Vol. 1-3). Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
2. Wilson, K., & Walker, J. (Eds.). (2010). *Principles and techniques of biochemistry and molecular biology* (7th ed.). Cambridge: Cambridge Univ. Press.
3. Ausubel, F.M. et al. (2012). *Current protocols in molecular biology*. New York: John Wiley & Sons.
4. Bisen, P. S., & Sharma, A. (2013). *Introduction to instrumentation in life sciences*. Boca Raton: CRC Press.
5. Bonifacino, J. S., Dasso, M., Lippincott-Schwartz, J., Hartford, J. B., & Yamada, K. M. (Eds.). (1999). *Current protocols in cell biology*. New York: John Wiley.
6. Coligan, J. E., Dunn, B. M., Ploegh, H. L., Speicher, D. W., & Wingfield, P. T. (1995). *Current protocols in protein science*. New York: John Wiley & Sons.
7. Levine, S., & Johnstone, L. (2008). *The ultimate guide to your microscope*. New York: Sterling Pub.
8. Schimmel. (2013). *Biophysical Chemistry*. MacMillan Higher Education.

Suggested readings:

1. Golemis, E., & Adams, P. D. (2005). *Protein-protein interactions: A molecular cloning manual* (2nd ed.). Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
2. Sheehan, D. (2010). *Physical biochemistry: Principles and applications* (2nd ed.). Chichester: Wiley-Blackwell.

3. Teaching Learning Process and Assessment Methods

Facilitating the Achievement of Course Learning Outcomes**

Unit No.	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
I	The student will learn about the methods used in analysis and manipulation of nucleic acid	Classroom teaching with visual aids, power point presentations, videos, discussions on applications	Quizzes, assignments and analytical problem-solving questions, paper presentations

II	The student will understand about the various techniques involving protein-protein interactions, their separation, and structural characterization	Classroom teaching with visual aids, power point presentations, experimental data from journals, 3D models, discussions	Assignments, class tests, analytical questions. Students will be asked to analyze and present papers on protein-protein interactions.
III	The students will get familiar with microscopy-based techniques and their application	Presentations, classroom teaching, audio and visual aids, trip to a facility. MOOCs will be used.	Assignments, class tests, class presentations, Mid-term assessment
IV	The students will understand the basics and application of various techniques in the field of cell biology	Powerpoint presentations, trip to a facility to show instruments, audio & visual aids. Special lecture will be arranged by expert in cell biology techniques.	Assignments, class tests, class presentations

(Assessment tasks enlisted here are indicative in nature)**

4. Keywords

Southern Blotting, Colony hybridization, EMSA, Western Blotting, Immuno-precipitation, Pull down assay, FACS, Flow Cytometry

Semester VII

DISCIPLINE SPECIFIC ELECTIVE COURSE - (DSE-9)
MOLECULAR BASIS OF INFECTIOUS DISEASES

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Molecular Basis of Infectious Diseases (BCH-DSE-9)	**4**	**2L**		**2P**	**Class XII with Science and Biology**	**-**

Learning Objectives

The course aims to provide knowledge about various microbial infectious agents that cause diseases in humans, the concepts of treatment and the biochemical basis of mechanism of action and drug resistance for various antimicrobial agents. The course will also provide an outline of the various strategies that are employed for preventing infectious diseases and the role of vaccination in eradication of diseases. It will cover the concept of emergence and re-emergence of diseases and its impact worldwide. The course will also summarize the significance of hygiene, sanitation, drugs and vaccination in prevention and eradication of infectious diseases.

Learning Outcomes

1. Upon completion of this course, a student will:
2. Understand various classes of pathogens and their mode of action and transmission.
3. Be exposed to the molecular basis of treatment, diagnosis and vaccine design strategies for all the diseases listed.
4. Gain insight into host immune responses that ensue subsequent to infection.
5. Learn the details of diseases such as tuberculosis, AIDS and malaria which are highly prevalent in the Indian subcontinent.

SYLLABUS OF DSE-9

BCH-DSE-9: MOLECULR BASIS OF INFECTIOUS DISEASES

Semester – VII

Theory

Credits: 2 **Total Hours: 30**

Unit I: Introduction to Infectious diseases **No. of Hours: 4**

Basic understanding of infection cycle, nosocomial infections, emerging and re-emerging infections, pathogenic agents of biological warfare, Source, reservoir and transmission of pathogens, reproduction number, LD50, Sanitation and Biosafety levels.

Unit II: Diseases caused by Bacteria **No. of. Hours: 10**

Classification of bacterial pathogens based on structure and nutritional requirements. Study of tuberculosis: History, causative agent, infection and pathogenicity, diagnostics, prevention/precautions, therapeutics and vaccines, drug resistance. Other diseases – Typhoid, Diphtheria, Tetanus, Cholera, Plague.

Unit III: Diseases caused by Virus **No. of. Hours: 10**

Unit Overview of structure, viral virulence factors and host pathogen interactions; detailed study of AIDS (including opportunistic infections) and Influenza: history, causative agent, pathogenesis, diagnostics, drugs, prevention/precautions; overview of other viral diseases including Hepatitis A/B/E, Dengue, Polio, Rabies, SARS.

Unit IV: Fungal and Parasitic Infections **No. of. Hours: 6**

Detailed study of Malaria: history, causative agents, vectors, life cycle, Host parasite interactions, diagnostics, drugs, vaccine development, prevention/precautions. Other diseases including Kala Azar, Amoebiasis, Giardiasis. Fungal diseases such as Candidiasis: general disease characteristics, medical importance, pathogenesis, diagnosis and treatment, antifungal drugs, prevention/precautions.

2.3 Practical:

Credit: 2 **Total Hours: 60**

1. Permanent slides of pathogens: *Mycobacterium tuberculosis*, *Leishmania*, *Plasmodium falciparum*
2. Gram staining
3. Acid fast staining of non-pathogenic *Mycobacterium smegmatis*

4. WIDAL test as a diagnostic test for Typhoid
5. MIC determination using Kirby Bauer / Alamar Blue assay
6. PCR as a diagnostic tool/dry lab.
7. Case studies on SARS, Rabies, Dengue, Polio and Plague
8. Case studies on Malaria, Amoebiasis and Giardiasis
9. Research presentation on current trends in infectious diseases

Essential readings:

1. Jawetz, Melnick & Adelbergs (27th ed.), *Medical Microbiology*. McGraw Hill Education. ISBN-10: 0071790314; ISBN-13: 978-007179031.
2. Kenneth J. Ryan, C., George Ray (2010), *Sherris Medical Microbiology: An introduction to infectious diseases*. McGraw-Hill. ISBN-13: 978-0071604024 ISBN-10: 0071604022
3. Prescott, Harley, Wiley, J.M., Sherwood, L.M., Woolverton, C.J. Klien's (2008). Microbiology (7th ed.). Mc Graw Hill International Edition (New York) ISBN: 978-007-126727
4. Pier, Lyczak and Wetzler, *Immunology, infection and immunity. ASM Press.* Print ISBN:9781119739555 |Online ISBN:9781683672111 |DOI:10.1128/9781555816148

3. Teaching Learning Process and Assessment Methods

Facilitating the Achievement of Course Learning Outcomes**

Unit No.	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
I	Students will develop an understanding of important terminologies used in infectious diseases, transmission of pathogens and will gain insight into host immune responses that ensue following infection. They will understand the importance of biosafety equipment for people who work on infectious disease-causing pathogen.	Traditional chalk and board teaching aided with Power Point presentations. Videos for Biosafety levels will be shared.	Regular question answer sessions, MCQs and unit-test for internal assessment.
II	Students will learn classification of bacteria and study various bacterial virulence factors. They will learn the pathophysiology of Mycobacterium tuberculosis	Traditional chalk and board teaching aided with Power Point presentations. Animations and video tutorials will be used to	Group discussion, Quiz will be conducted, and students will be asked to deliver Power Point

	and study ways to prevent and treat Tuberculosis. They will also learn about various bacterial diseases (Typhoid, Diphtheria, Tetanus Cholera, Plague) their molecular mechanisms and intervention strategies	teach pathogen-host interactions.	presentations on the assigned topics
III	Students will learn about virus structure and viral virulence factors. They will understand the pathophysiology of the HIV, Influenza and study ways to diagnose and prevent disease. The students will also learn about secondary infections that can happen with AIDS. Students will learn about other various viral diseases (Hepatitis, Rabies, Dengue, Polio and SARS) their molecular mechanisms, diagnosis and intervention strategies. An introduction to Coronavirus will also be done.	Classroom teaching from research papers, chalk and board method of teaching and use of powerpoint presentation. Audio visual to demonstrate the viral infection, transmission and pathogenesis.	Group discussion, Quiz will be conducted, and students will be asked to deliver Power Point presentations on the assigned topics
IV	Students will learn about various parasitic diseases, host parasite interaction, their molecular mechanisms of infection, diagnosis and intervention strategies. Students will also learn about fungal diseases (Candidiasis), molecular mechanisms, diagnosis and intervention strategies	Classroom teaching from research papers, chalk and board method of teaching and use of powerpoint presentation.	Group discussion, Quiz will be conducted, and students will be asked to deliver Power Point presentations on the assigned topics

(Assessment tasks enlisted here are indicative in nature)**

Keywords

Infection, Pathogen, Immune response, Diagnosis, Vaccines, Diseases

Semester VII

DISCIPLINE SPECIFIC ELECTIVE COURSE - (DSE-10)
NEUROBIOLOGY

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Neurobiology (BCH-DSE-10)	**4**	**2L**		**2P**	**Class XII with Science and Biology**	**-**

Learning Objectives

The course neurobiology being offered aims to provide the students with an understanding of the cellular and molecular mechanisms operating in the human brain. Students will learn the electrical and signaling pathways that operate in the neurons. The objective of this course is also to enable students to comprehend the transduction of external signals and the integration of this information into higher level brain functioning.

Learning outcome

- Students would be introduced to neuroscience and Cellular neurophysiology
- Students would understand the anatomical layout of the nervous system relevant to physiological functions.
- Students would be able to appreciate the excitable properties of neurons and the function of synapses and explore neural circuits along with important neurotransmitters.
- Students will gain understanding of cellular and molecular mechanisms governing neural development, plasticity, and the establishment of memory.
- They would also comprehend the nature and causes of learning disabilities and neurodegenerative diseases

SYLLABUS OF DSE-10
BCH-DSE-10: NEUROBIOLOGY
Semester – VII

Theory

Credits: 2 **Total Hours: 30**

UNIT 1: Introduction and Anatomy of nervous system **No of classes 5**

Understanding structural hierarchy in the nervous system. Cells of the nervous system: classification; Neuroglia and their function; Neuron and structure; Structure of nerve; Neural growth; Blood Brain Barrier; Formation and composition of cerebrospinal fluid; Introduction to neuroanatomy: Neural meninges, Brain stem, cerebellum, limbic system and cerebral cortex; Spinal cord.

UNIT 2: Neurochemistry **No of classes 10**

Neuron as an excitable cell: resting membrane potential, ion channels, generation of action potential, graded and spike potentials, patch clamp technique; the Synapse: electrical and chemical synapse, Synaptic neurotransmitter release, synaptic plasticity; Neurotransmitter: Structural and molecular mechanisms of acetylcholine, catecholamines, serotonin, glutamate, glycine, histamine , GABA, neuropeptides like PYY, enkephalins, endorphins, substance P, orexin and anorexic peptides; Neurotransmitter receptors: metabotropic and ionotropic; saltatory conduction and axonal transport.

UNIT 3: Neurophysiology **No of classes 7**

The concept of neural circuits and neuronal pools. Introduction to sensory perception, sensory receptor types and somatosensory pathway; Perception of touch and pain; Perception of chemical senses: taste and smell; Autonomic nervous system: sympathetic and parasympathetic; Somatic nervous system: reflex arc and neuromuscular junction.

UNIT 4: Neural processes and Neurodegenerative diseases **No of classes 8**

Circadian rhythm, EEG and sleep; Memory: Types. memory loss, LTP and learning, learning disabilities, aphasias, Emotional and motivational conditioning in neural responses; Neurodegenerative disorders- Parkinson's disorder; Neurochemical basis of drug abuse.

2.3 Practical:

Credit: 2 **Total Hours: 60**

1. To make a temporary mount of a neuron.
2. Virtual laboratory on patch clamp.
3. Acetylcholinesterase assay in different brain areas.
4. Assay of a neurotransmitter (catecholamines)
5. Study of sensation of touch smell and taste, understanding desensitization and adaptation.

6. Reflex arc through knee jerk assay
7. Understanding EEG and case studies on sleep, epilepsy and mood disorders.
8. Drosophila/ zebrafish behavioral experiment.
9. Case studies on learning disabilities, neurodegenerative disease, autism spectrum disorders and schizophrenia.
10. Field trip to see EEG and fMRI.

Suggested reading:

1. Medical Neurobiology (2011) 1st ed., Peggy Mason, Oxford University press, ISBN-13: 978-0195339970.
2. Principles of Neural Science (2000) 4th ed., Eric R Kandel, James H Schwartz & Thomas M Jessell, McGraw Hill (USA), ISBN: 0-07-112000-9.
3. Clinical Neuroanatomy and Neuroscience (2012) 6th ed., M J Turlough Fitzgerald, Gregory Gruener & Estomih Mtui, Elsevier, ISBN: 978-0-7020-4042-9. Bijlani, Guyton

3. Teaching Learning Process and Assessment Methods

Facilitating the Achievement of Course Learning Outcomes**

Unit No.	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
I	The students will be able to learn the anatomy and physiological roles of cells of the nervous system. They would gain the knowledge about the importance of cerebrospinal fluid and Blood Brain Barrier	Teaching will be conducted both through black board mode and power point presentation mode Students would also learn concepts by conducting lab practicals.	Students will be assessed through the assignment and tests Lab skills will be tested
II	Students would be able to understand the concept of nerve action potential, its generation and importance. They will also learn about the role of synapse and the importance of chemicals in neural signaling.	Teaching will be conducted both through black board mode and power point presentation mode Students would also learn concepts by conducting lab practicals.	Students will be assessed through the assignment and tests. MCQs will also be given to assess the understanding of few concepts Lab skills will be tested
III	Students will learn about the concept of neuronal circuits and neuronal pools.They will also learn about the different perceptions including pain, touch, smell and taste	Teaching will be conducted both through black board mode and power point presentation mode Videos to demonstrate various	Students will be assessed through the assignment and tests. MCQs will also be given to assess the understanding of few concepts

		perceptions will be shown to students to understand the theoretical concept Students would also learn concepts by conducting lab practicals. Field visit will help them get an experiential training in the method used in reading brain function like fMRI and EEG. analysis of such data with discussions will help them understand concepts better.	Lab skills will be tested Data obtained from experiments like maze testa and sensory perception tests and other related topics can be presented and discussions conducted.
IV	The students will learn about various neural processes including memory and learning. They will also get to know about the physiology of some of the common neurodegenerative disorders	Teaching will be conducted both through black board mode, power point presentation mode as well as by demonstrating the experiment. Students would also learn concepts by conducting lab practicals.	Students will be assessed through the assignment and tests case studies discussions will make them understand the neurophysiological aspects of neurodegenerative and other neurological diseases better.

(Assessment tasks enlisted here are indicative in nature)**

Keywords

Brain anatomy, cerebrospinal fluid, neurochemistry, saltatory conduction, sensory perception, reflex reactions, sleep, memory and learning, mood and neurological disorders.

Semester VII

DISCIPLINE SPECIFIC ELECTIVE COURSE - (DSE-11)
DEVELOPMENTAL BIOLOGY

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Developmental Biology (BCH-DSE-11)	4	2L		2P	Class XII with Science and Biology	-

Learning Objectives

The objective of this course is to provide basic knowledge of the development processes, different molecular and cellular mechanisms which are involved in animal development. This course would also highlight the importance of different animal models in the study of developmental processes. The course would also give knowledge about the concept of stem cells, totipotency.

Learning Outcomes

On successful completion of the course, students will:

- Students will acquire knowledge about basic concepts of developmental processes, fertilization, germ layer formation and patterning of body plan.
- Students will gain detailed insight into the molecular events of embryogenesis, importance of various model systems and their applications in understanding human development and associated defects.
- Students will learn about Stem cells, their roles in development and significance in development of regenerative medicines, current applications and advancement in stem cell research.

SYLLABUS OF DSE-11

BCH-DSE-11: DEVELOPMENTAL BIOLOGY

Semester – VII

Theory

Credits: 2 **Total Hours: 30**

UNIT 1: Introduction to Developmental Biology **No of hours: 10**

History, Evolutionary embryology and Basic concepts of developmental biology, Overview of fertilization, early development- Patterns of cleavage, germ layer formation, implantation, placentation, Formation of blastula, embryogenesis: Nieuwkoop center, Spemann-Magold organizer theory and mesodermal induction, Gastrulation, Fate maps, and neural tube formation.

UNIT 2: Molecular biology of development **No of hours: 6**

Role of differential gene expression in development, Role of cell-cell communication in development. Key signaling pathways in development: Fgf, Hedgehog, Wnt, TGFß, and Notch. Cadherins in establishing intercellular connections, Role of extracellular matrix in development Concepts of induction and competence and senescence.

UNIT 3: Study on model organisms **No. of hours: 8**

Caenorhabditis elegans: Study of cell lineage, mosaic development and organogenesis (vulva formation).
Drosophila melanogaster: Role of maternal effect genes, morphogens and zygotic genes (Gap genes to homeotic genes) in axis formation and body patterning.
Danio rerio (Zebra fish)*:* Study various early embryogenesis stages starting from the zygote - cleavage - blastula - gastrula - segmentation, pharyngula, hatching and early larval development. Study mechanisms of pigmentation and stripe
patterning in fish skin.

UNIT 4: Stem cells and their implications in treatment strategies: **No of hours: 4**

Stem cells and their types, Pluripotent cells, Induced pluripotent stem cells and their applications in human development and diseases. Ethical issues.

UNIT 5: Developmental defects and the role of teratogens: **No. of hours: 2**

Chemical, physical and biological agents which can cause developmental defects. Brief discussion of alcohol and retinoic acid as teratogenic agents.

2.3 Practical:

Credit: 2 **Total Hours: 60**

1. Study of life cycle and developmental stages of Zebrafish.
2. Live demonstration of Zebrafish embryogenesis: Microscopic visualization of early cleavages, sphere stage, shield stage, gastrulation, epiboly and somite formation.
3. Study of life cycle and developmental stages of Drosophila melanogaster
4. Study of developmental stages of chick embryo. (optional)
5. Study of life cycle and developmental stages of *C. elegans.*

Essential Readings

1. Gilbert, S.F. and Barresi, M.J.F. (2017), Developmental Biology, 11th Edition 2016. Am. J. Med. Genet., 173: 1430-1430. https://doi.org/10.1002/ajmg.a.38166.
2. Basson M. A. (2012). Signaling in cell differentiation and morphogenesis. Cold Spring Harbor perspectives in biology, 4(6), a008151. https://doi.org/10.1101/cshperspect.a008151
3. Kimmel, C.B., Ballard, W.W., Kimmel, S.R., Ullmann, B. and Schilling, T.F. (1995), Stages of embryonic development of the zebrafish. Dev. Dyn., 203: 253-310. https://doi.org/10.1002/aja.1002030302
4. Alberts, B. (2015) Molecular Biology of the Cell. 6th Edition, Garland Science, Taylor and Francis Group, New York.
5. Wolpert, L., Tickle, C., Martinez, A. A., Lawrence, P., & Locke, J. (2019). Principles of development. Oxford, United Kingdom; New York, NY: Oxford University Press, [2019]
6. Balinsky, B.L. (2008). An introduction to embryology. 5th edition. Thomson Publishers.

Suggested Readings:

1. Davies, J. (2004). Practical guide to developmental biology. BioEssays, 26, 1142.
2. Gibbs, M., A. (2003) A Practical Guide to Developmental Biology. Oxford University Press, 2003 ISBN 0199249717, 9780199249718
3. ZFIN Protocols

3. Teaching Learning Process and Assessment Methods
Facilitating the Achievement of Course Learning Outcomes**

Unit No.	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
I	Students will learn about basic concepts of developmental processes, how cell fate is determined.	Teaching will be conducted both through black board mode and power point presentation mode. Students would also learn concepts by conducting lab practicals.	Students will be given questions that are application based and require analytical skills. Quizzes will be held to gauge their conceptual understanding. Lab skills will be tested.
II	Students would learn about the role of key signaling pathways in development	Teaching will be conducted both through black board mode and power point presentation mode. Students would also learn concepts by conducting lab practicals.	Students will be given questions that are application based and require analytical skills. Quizzes will be held to gauge their conceptual understanding. Lab skills will be tested.
III	Students would learn about the role of various model systems in the study of development Biology	Teaching will be conducted both through black board mode and power point presentation mode. Students would also learn concepts by conducting lab practicals.	Students will be given questions that are application based and require analytical skills. Quizzes will be held to gauge their conceptual understanding. Lab skills will be tested.
IV	Students would learn about stem cells and their applications	Teaching will be conducted both through black board mode and power point presentation mode. Students would also learn concepts by	Students will be given questions that are application based and require analytical skills. Quizzes will be held to gauge their conceptual understanding.

		conducting lab practicals.	Lab skills will be tested.
V	Students would learn about various developmental defects and effect of teratogens	Teaching will be conducted both through black board mode and power point presentation mode. Students would also learn concepts by conducting lab practicals.	Students will be given questions that are application based and require analytical skills. Quizzes will be held to gauge their conceptual understanding. Lab skills will be tested.

4. Key words

Developmental stages, signaling pathways, model organisms, stem cells, teratogens

Semester VII

DISCIPLINE SPECIFIC ELECTIVE COURSE - (DSE-12)
PHARMACOLOGY AND TOXICOLOGY

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Pharmacology and Toxicology (BCH-DSE-12)	**4**	**2L**		**2P**	**Class XII with Science and Biology**	**-**

Learning Objectives

This is an introductory course to lay the foundation for understanding basic concepts in Pharmacology and the pharmacological basis of therapeutics. The objective of the course is to introduce students to the core principles of drug action in terms of bioavailability, pharmacokinetics, pharmacodynamics, and mechanism of action of drugs in the treatment of diseases. The course will also provide basic principles of toxicology, toxic substances and their effects on body systems.

Learning Outcomes:

At the end of the course, a student will be able to

1. Understand the basic scientific concepts and principles that serve as the foundational underpinnings of the pharmacological sciences including pharmacokinetics; pharmacodynamics; drug metabolism; and drug-drug interactions.
2. Learn an introduction to the processes by which new drugs are discovered.
3. Understand the specific pharmacology of the major drugs and drug classes currently used in medical practice including their indications, clinical use and mechanisms of action,
4. Discuss the basic principles of toxicology; the mechanisms by which excess exposure to certain drugs, toxins, chemicals, heavy metals and poisons can lead to adverse toxicological effects

SYLLABUS OF DSE-12
BCH-DSE-12: PHARMACOLOGY AND TOXICOLOGY
Semester – VII

Theory

Credits: 2 **Total Hours: 30**

Unit I: Introduction to Pharmacology **Number of hours: 5**

History and Scope of Pharmacology, Nature and source of drugs, Routes of drug administration, Drug receptors and receptor subtypes, Drug Discovery and Development, Computer Aided Drug Design

Unit II: Pharmacokinetics and Pharmacodynamics **Number of hours: 8**

Absorption, Distribution, Metabolism, and Excretion (ADME) of drugs. Bioavailability, First Pass metabolism, Biological half-life of drug and its significance, Drug-drug interactions.

Unit III: Drug Classification and their mechanism of action **Number of hours: 10**

Drugs of Inflammation*:* NSAIDs, Analgesics and Anti-inflammatory Drugs; Drugs of autonomic and central nervous system -Adrenergics: Isoprenaline, Propranolol; Dopaminergics, Dopamine, Syndopa; General Anesthetics: Halothane; Sedatives and Hypnotics: Diazepam; Cholinergics: Bethanechol, Rivastigmine ; Anticonvulsant, Drugs of Cardiovascular system*:* Anticoagulant, Blood Pressure Lowering Drugs, Lipid Lowering Drugs ;Drugs of Gastro-Intestinal tract*:* Antacid, Acid Blocker and Laxative ;Drugs of Renal functions: Diuretics ; and Anticancer Drugs.

Unit IV: Toxicology **Number of hours: 7**

Classification of toxic substances, Drugs, Toxins and Heavy metal poisoning, Xenobiotics, Mechanism of toxicity, Tolerance to toxicants, Dose-response relationship, Therapeutic Index, Bioaccumulation and Antidotes

2.3 Practical:

Credit: 2 **Total Hours: 60**

1. To study the presence of paracetamol (acetaminophen) in given sample by spectroscopic method
2. Calculation of LD50/LC50
3. Model Systems to study Dose-Response
4. Drug Binding assay to Albumin by Spectroscopic Analysis
5. Case Studies
6. Small Molecule Databases mining and Protein-ligand Docking

Essential Readings

- Tripathi, K.D. (2010). 7th Edition. Essentials of medical pharmacology. Delhi, India: Jaypee Brothers. ISBN-13:9788184480856.
- Katzung, Bertram G. , Basic &Clinical Pharmacology, 14th Edition, McGraw Hill Education, 2017
- Klaassen, C. D. and Watkins J. B. (2021), 4th Edition, Casarett & Doull's Essentials of Toxicology New York, USA: McGraw Hill.ISBN: 978-1-26-045229-7.
- Kulkarni, S.K. (2012). 4th Edition. Handbook of experimental pharmacology. Delhi, India: Vallabh Prakashan, ISBN-13: 97881857311.

3. Teaching Learning Process and Assessment Methods:
Facilitating the Achievement of Course Learning Outcomes**

Unit No.	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
I	Students will learn about the history and scope of pharmacology. They will also learn about nature, source, administration routes, and receptors of various drugs. They will learn about various drug development strategies.	Teaching will be conducted both by chalk and board and power point presentation.	Students will be assessed through assignments, class tests, group discussions and paper presentations.
II	Students will understand about the absorption, distribution, metabolism and excretion of drugs. They will also learn about bioavailability of drugs and drug-drug interactions.	Teaching will be conducted both by chalk and board and power point presentation. .	Students will be assessed through assignments, class tests, group discussions and paper presentations.
III	Students will understand about mechanism of action of various classes of drugs.	Teaching will be conducted both by chalk and board and power point presentation.	Students will be assessed through assignments, class tests, group discussions and paper presentations.
IV	Students will learn about various toxins, their mechanism, tolerance and antidotes. Students will also learn about therapeutic index and bioaccumulation of various drugs.	Teaching will be conducted both by chalk and board and power point presentation.	Students will be assessed through assignments, class tests, group discussions and paper presentations.

(Assessment tasks enlisted here are indicative in nature)**

Keywords:
Pharmacology, Drug Discovery, Pharmacokinetics, Pharmacodynamics, ADME, Classes of Drug, Mechanism of action, Toxicity.

Semester VII

DISCIPLINE SPECIFIC ELECTIVE COURSE - (DSE-13)
MOLECULAR DIAGNOSTICS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Molecular Diagnostics (BCH-DSE-13)	**4**	**2L**		**2P**	**Class XII with Science and Biology**	**-**

Learning Objectives

The course is designed to enable the students to provide an understanding for students about the significance and scope of molecular diagnostics. The course aims to provide information about protein and DNA/ RNA based molecular diagnostic methods for various genetic, infectious and lifestyle associated diseases. It would expose students to specific disease markers aiding diagnosis. This course would also highlight the advantages and disadvantages of using molecular-based methods compared to conventional methods in disease diagnosis.

Learning Outcomes

On successful completion of the course, a student will:

- By finishing this module, the students will have clarity about the molecular diagnostic methods, their significance and goals.
- Students will get an idea about the Quality assurance and safety procedures that need to be followed in the molecular diagnostic lab.
- The students will be able to understand the application of proteomic, DNA and / RNA based molecular diagnostic methods in various diseases including, cancers, infectious diseases, cardiovascular diseases, and genetic diseases.
- The students would learn about various disease markers.

SYLLABUS OF DSE-13

BCH-DSE-13: MOLECULAR DIAGNOSTICS

Semester – VII

Theory

Credits: 2 **Total Hours: 30**

Unit 1: Introduction to Molecular Diagnostics **No. of hours: 4**

History of diagnostics, Age of molecular diagnostics, Significance, Scope, Rise of diagnostic industry in Indian and global scenario. Ethical issues related to molecular diagnostics. Personal safety and laboratory safety. GLP for handling highly infectious disease samples and documentation.

Unit 2: Protein based molecular diagnostics: **No. of hours: 10**

FDA definition of disease markers, Role of markers in Disease diagnosis. Approaches and methods in the identification of disease markers, predictive and diagnostic value.
Molecular diagnosis of Cancer/ Tumour, Inflammation, cardiovascular diseases (myocardial infarction, hypertension, thrombosis/ clotting defects), cytoskeletal disorders, and diabetes by specific markers.
Applications of molecular diagnostics. Major Histocompatibility Complex (MHC), HLA typing. Role of Molecular diagnostics in bone marrow transplantation and organ transplantation

Unit 3: DNA/ RNA based molecular diagnostics: **No. of hours: 10**

PCR, RT-PCR, relative-quantitative PCR, multiplex PCR, SNP chromosomal microarrays, RFLP based genetic tests for following disorders: Thalassemia, Sickle Cell anaemia, Fragile-X syndrome, Alzheimer's disease.
Molecular diagnosis of various infectious diseases / vector borne: Dengue, Chikungunya, Ebola and Influenza (H1N1), Corona and HIV.
Whole genome sequencing for diagnosis of drug resistance in bacterial pathogens.

Unit 4: Molecular diagnostics of chromosomal disorders: **No. of hours: 06**

Chromosomes, Human disorders, and Cytogenetic analysis. Molecular karyotyping/cytogenetics techniques involving Fluorescence in situ hybridization (FISH)-based technology, Array-comparative genomic hybridization and next generation sequencing technologies (NGS). Prenatal diagnosis. Molecular diagnosis for early detection of cerebral palsy, Down's syndrome.

2.3 Practical:

Credit: 2 **Total Hours: 60**

1. Karyotyping of normal and abnormal human chromosome sets
2. Estimation of C-reactive protein
3. Genotyping of candidate genes for diseases by RFLP
4. Detection of DNA damage by comet assay
5. Troponin T test (Cardiac troponin I (cTnI)) test
6. Haemoglobin A1c (HbA1c) Test for Diabetes
7. D- Dimer test for blood clotting disorder
8. Case studies

Essential Readings:

1. George Patrinos Wilhelm Ansorge Phillip B. Danielson (2016). Molecular Diagnostics (3rd Edition) Elsevier Publishing Group. ISBN: 9780128029718
2. Nader Rifai A. Rita Horvath Carl T. Wittwer Jason Park (2018). Principles and Applications of Molecular Diagnostics. Elsevier Publishing Group. ISBN: 9780128160619
3. Wayne W. Grody and Frederick L. Kiechle (2010). Molecular Diagnostics Techniques and Applications for the Clinical Laboratory. Elsevier Publishing Group. ISBN: 9780123694287
4. Jim Huggett and Justin O'Grady (2014). Molecular Diagnostics – Current Research and Application. Caister Academic Press. ISBN: 978-1-908230-41-6
5. William B. Coleman and Gregory J. Tsongalis (2005). Molecular Diagnostics for the Clinical Laboratorian. Springerlink. ISBN: 978-1-59259-928-8

3. Teaching Learning Process and Assessment Methods

Facilitating the Achievement of Course Learning Outcomes**

Unit No.	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
I	Students would learn about GLP followed in Molecular diagnostics lab.	Teaching will be conducted both through black board mode and power point presentation mode. Students would also learn concepts by conducting lab practicals.	Students will be given questions that are application based and require analytical skills. Quizzes will be held to gauge their conceptual understanding. Lab skills will be tested.

II	Students would learn about various protein markers in disease diagnosis.	Teaching will be conducted both through black board mode and power point presentation mode. Students would also learn concepts by conducting lab practicals.	Students will be given questions that are application based and require analytical skills. Quizzes will be held to gauge their conceptual understanding. Lab skills will be tested.
III	Students would learn about various DNA / RNA based diagnostic methods.	Teaching will be conducted both through black board mode and power point presentation mode. Students would also learn concepts by conducting lab practicals.	Students will be given questions that are application based and require analytical skills. Quizzes will be held to gauge their conceptual understanding. Lab skills will be tested
IV	Students would learn about diagnosis of various chromosomal disorders,	Teaching will be conducted both through black board mode and power point presentation mode. Students would also learn concepts by conducting lab practicals.	Students will be given questions that are application based and require analytical skills. Quizzes will be held to gauge their conceptual understanding. Lab skills will be tested

(Assessment tasks enlisted here are indicative in nature)**

Keywords:

Molecular diagnostics, protein disease markers, DNA / RNA based diagnosis, chromosomal disorders

Semester VII

DISCIPLINE SPECIFIC ELECTIVE COURSE - (DSE-14)
BIOTECHNOLOGY

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Biotechnology (BCH-DSE-14)	4	2L		2P	Class XII with Science and Biology	-

Learning Objectives

The objective of the course is to expose students to the basic principles and applications of biotechnology. It will also teach them the basics of animal and plant tissue culture and various methods of gene transfer for the generation of transgenics. The course will also provide an understanding of the applications of biotechnology in medicine, forensics, archaeology and agriculture.

Learning Outcomes

The students after completing this course will be able to:

- Understand animal and plant tissue culture along with their applications
- Gain knowledge about methods of gene transfer in biotechnology
- Appreciate the use of biotechnology in medicine
- Gain insight into other industrial applications of biotechnology
- Become aware of the impact of biotechnology on agriculture

SYLLABUS OF DSE-14
BCH-DSE-14: BIOTECHNOLOGY
Semester – VII

Theory
Credits: 2 **Total Hours: 30**

Unit I: Methods in animal and plant biotechnology **Total No. 10**

Introduction to cell and tissue culture.
Overview of Reproductive Animal Biotechnology and livestock improvements: artificial insemination, embryo transfer, in-vitro fertilization, somatic cell nuclear transfer (Dolly the sheep). Methods of gene transfer: viral mediated gene transfer, direct gene transfer using PEG, micro injection, electroporation, microprojectile (biolistics) method, liposome mediated DNA delivery. Fermentation technology and upscaling to industrial production

Unit II: Medical Biotechnology **Total No. 07**

Production of recombinant pharmaceuticals: insulin, factor VIII, human growth hormones, erythropoietin. Recombinant Vaccines. Pharming—recombinant protein from live animals and plants. Gene therapy: Gene therapy for inherited diseases and cancer with suitable examples. The ethical issues related to gene therapy.

Unit III: Agricultural Biotechnology **Total No. 08**

The gene addition approach to plant genetic engineering: plants that make their own insecticides, Herbicide resistant crops. Gene subtraction: Antisense RNA and the engineering of fruit ripening in tomato, other examples of the use of antisense RNA in plant genetic engineering. Overview of plants as biofactories: plant-based vaccines, plantibodies and biopharmaceuticals. Safety and ethical concerns of genetically modified plants.

Unit IV: Other Industrial Applications of Biotechnology **Total Hrs 05**

Preparation of fermented food products and beverages. Single cell proteins. Treatment of wastewater (Municipal treatment plant) and sewage. Bioremediation and biodegradation. Production of recombinant enzymes for use in industries.

2.3 Practical:

Credit: 2 **Total Hours: 60**

1. Plant tissue culture
2. Restriction Fragment Length Polymorphism (RFLP) of genetically modified plants.
3. Extraction of DNA from buccal swab.
4. Presentation of research papers.
5. Virtual lab for bioreactors
6. Educational trip to industrial plants/fermentation units

7. Case studies of the use of DNA profiling for kinship analysis
8. Designing of antisense RNA against polygalacturonase (*in silico*)
9. Group discussion on Archaeogenetics—using DNA to study human prehistory

Essential Readings

- Brown, T. A. (2016) Gene Cloning and DNA Analysis: An Introduction, (7th ed.). Wiley-Blackwell Publishing (Oxford, UK); ISBN: 978-1-119-07256-0
- Glick, B.R., Pasternak, J.J., Patten, C. L. (2010) Molecular Biotechnology: Principles and Applications of Recombinant DNA (4th ed.). ASM Press (Washington DC); ISBN: 978-1-55581-498-4.
- Primrose, S.B., and Twyman, (2006) Principles of Gene Manipulation and Genomics (7th ed.), R. M. Blackwell Publishing (Oxford, UK) ISBN:13: 978-1-4051-3544-3.
- Buchann (2015). Biochemistry and Molecular Biology of plants. (2nd ed.). I K International. ISBN-10: 8188237116, ISBN- 978047 07 14218
- Willey, J., Sherwood, L., Woolverton, C. (2017). Prescott's Microbiology (10th ed.). McGraw Hill international. ISBN 13: 9781259657573.

Suggested Readings

- Freshney, R. I. (2010). Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications. Wiley-Blackwell, 6th Edition.
- Roberta H. Smith. (2013) Plant Tissue Culture: *Techniques and Experiments*. 3rd edition. Academic Press. ISBN: 978-0-12-415920-4
- Adrian Slater, Nigel Scott and Mark Fowler. (2003) Plant Biotechnology: The genetic manipulation of plants, 1st Edition, Oxford University Press
- Verma, A. S. and Singh, A. (2014). Animal Biotechnology. Academic Press, Elsevier, USA

3. Teaching Learning Process and Assessment Methods

Facilitating the Achievement of Course Learning Outcomes**

Unit No.	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
I	Students will be introduced to animal cell and tissue culture. They will gain insight into methods of livestock improvements. They will also understand different methods of gene transfer in animal and plant biotechnology, fermentation technology and upscaling.	Teaching will be conducted both through black board mode and power point presentation mode. Discussions will be conducted on various recent methodologies in biotechnology.	Students will be given questions that are application based and require analytical skills. Quizzes will be held to gauge their conceptual understanding.

II	Students will be introduced to various applications of biotechnology in medicine. Students shall gain insight into gene therapy, pharming, recombinant vaccines and pharmaceuticals.	Classical chalk and board teaching, oral discussions and powerpoint presentations whenever needed.	Students shall make power-point presentations on latest advances in biotechnology. Open book tests will be held to promote self-learning. Practical related oral questions will be asked.
III	Understand the applications of biotechnology in agriculture. Gain knowledge about the insecticides, Herbicide resistant crops. Understand about Antisense RNA and the engineering of fruit ripening in tomato. They shall learn about plants as biofactories and genetically modified plants	Teaching will be conducted both through black board mode and power point presentation mode. Practical knowledge used field visits shall be imparted.	Regular class question-answer sessions. Students will be asked to prepare PowerPoint presentations Internal assessment tests will be conducted. Discussions using case studies will be conducted.
IV	Students shall be introduced to various methods of preparation of fermented food products and beverages. They shall gain knowledge about Single cell proteins, Treatment of wastewater Bioremediation, biodegradation and recombinant enzymes.	Teaching will be conducted through black board and power point presentation. Useful video clips will be shown for better clarity.	Regular oral evaluation will be done. Internal assessment tests will be conducted

(Assessment tasks enlisted here are indicative in nature)**

Keywords

Biotechnology, gene transfer, livestock improvements, animal and plant tissue culture, gene therapy, recombinant vaccine, pharming, genetically modified plants, fermentation, bioremediation

Semester VIII

DISCIPLINE SPECIFIC CORE COURSE - (DSC-20)

ADVANCED IMMUNOLOGY

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Advanced Immunology (BCH-DSC-20)	**4**	**2L**		**2P**	**Class XII with Science and Biology**	**-**

Learning Objectives

This course covers advanced topics in immunology for students who already have a basic knowledge of immunology. The course is designed to understand the mechanisms in humoral and cell mediated immune responses during altered host conditions either due to changes in self or upon infection. Thus, central topics are allergy, autoimmunity, transplantation and immunodeficiency disorders.

Learning Outcomes

At the end of the course the students should be able to

- understand and explain the basis of immunological tolerance, autoimmunity, and transplantation
- understand the principles governing vaccination and the mechanisms of protection against infectious diseases
- understand and explain the basis of allergy and allergic diseases
- understand regulation of immune response and use of monoclonal antibodies as therapeutics

SYLLABUS OF DSC-20

BCH-DSC-20 : ADVANCED IMMUNOLOGY

Semester – VIII

2.2. Theory

Credits: 2 **Total Hours: 30**

Unit 1- Tolerance & Autoimmunity **5 Hours**

Tolerance, B cell tolerance and T cell tolerance, Central and Peripheral Tolerance, Organ specific and systemic autoimmune diseases; mechanisms for the induction of autoimmunity and treatment

Unit II -Hypersensitivity & Immunodeficiency Disorders **10 Hours**

Hypersensitivity, Gell and Coombs classification; representative examples of type I, II, III and IV Hypersensitivity, Allergy, Hypersensitive reactions against innocuous antigens, and potentially harmful antigens.

Immunodeficiency primary (humoral and cell mediated) and secondary immunodeficiency, treatment.

Unit III -Transplantation immunology & **Vaccines** **8 Hours**

Typing of tissues; characteristics of graft rejection; major and minor histocompatibility antigens; alloreactivity of T cells; Graft Vs host disease (GVHD), Xenotransplantation and privileged sites, Immunosuppressive drugs, Vaccines: types of vaccines-live attenuated, inactivated organisms, toxoids, subunit vaccines, DNA vaccines and recombinant vector vaccines; Active and Passive Immunization; requirements for an effective vaccine and recommended childhood vaccination schedules in India.

Unit IV- Immunoregulation and Immunotherapy **7 Hours**

Regulatory T cells**,** Immunoregulation Regulation by Cytokines, Hypothalamus-Pituitary Immune Axis, Hybridoma Technology for Production of Monoclonal Antibodies, Chimeric and humanized Monoclonal Antibodies, Therapeutic Applications of Monoclonal Antibodies.

2.3 PRACTICALS

Credit: 2 **Total Hours: 60**

1. Immuno-electrophoresis
2. Active and Passive agglutination
3. Isolation of lymphocytes from blood/spleen
4. Cytotoxic Assay
5. Phagocytic activity of Macrophages
6. Hybridoma Production (video)

2.4 Essential Reading

1. Kuby Immunology (2007) 6th ed., Kindt, T.L., Goldsby, R.A. and Osborne, B.A, W. H. Freeman and Company (New York), ISBN:13: 978-0-7167-8590-3/ ISBN: 10:0-7617-8590-0
2. Immunology: A Short Course (2009)6th ed., Coico, R. And Sunshine, G., John Wiley & Sons, Inc (New Jersey), ISBN: 978-0-470-08158-7.

Suggested Textbooks:

1. Janeway's Immunobiology (2012) 8th ed., Murphy, K., Mowar, A., and Weaver, C.T., Garland Science (London & New York), ISBN: 978-0-8153-4243-4
2. Cellular and Molecular Immunology (2021), 10th edition, Abbas, A.K., Lichtman, A.H., Shiv Pillai, Elsevier, ISBN: 9780323757485

3. Teaching Learning Process and Assessment Methods

Unit No.	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
I	Students will understand the concepts of tolerance and induction of autoimmunity that leads to autoimmune disorders	Teaching will be conducted both through Traditional chalk talk mode, presentations and case studies	Students will be asked questions related to the topic and class discussion will be held
2	Students will learn about various types of hypersensitivity and immunodeficiency disorders	Teaching will be conducted both through Traditional chalk talk mode, presentations and case studies	Assignment will be given and class discussion will be held
3	Students will learn about the immunological basis of transplantation and learn about vaccines	Teaching will be conducted both through Traditional chalk talk mode, presentations and case studies	Quiz and classroom discussions will be held
4	Students will understand regulation of immune responses and immunotherapy	Teaching will be conducted both through Traditional chalk talk mode, presentations and case studies	Mid semester test will be held and assignments will be given

4. Keywords

Tolerance, Autoimmunity, Hypersensitivity, Immunodeficiency, Transplantation, Vaccines, Immunoregulation, Immunotherapy

Semester VIII

DISCIPLINE SPECIFIC ELECTIVE COURSE - (DSE-9)

MOLECULAR BASIS OF INFECTIOUS DISEASES

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Molecular Basis of Infectious Diseases (BCH-DSE-9)	**4**	**2L**		**2P**	**Class XII with Science and Biology**	**-**

Learning Objectives

The course aims to provide knowledge about various microbial infectious agents that cause diseases in humans, the concepts of treatment and the biochemical basis of mechanism of action and drug resistance for various antimicrobial agents. The course will also provide an outline of the various strategies that are employed for preventing infectious diseases and the role of vaccination in eradication of diseases. It will cover the concept of emergence and re-emergence of diseases and its impact worldwide. The course will also summarize the significance of hygiene, sanitation, drugs and vaccination in prevention and eradication of infectious diseases.

Learning Outcomes

1. Upon completion of this course, a student will:
2. Understand various classes of pathogens and their mode of action and transmission.
3. Be exposed to the molecular basis of treatment, diagnosis and vaccine design strategies for all the diseases listed.
4. Gain insight into host immune responses that ensue subsequent to infection.
5. Learn the details of diseases such as tuberculosis, AIDS and malaria which are highly prevalent in the Indian subcontinent.

SYLLABUS OF DSE-9
BCH-DSE-9: MOLECULR BASIS OF INFECTIOUS DISEASES
Semester – VIII

Theory
Credits: 2 **Total Hours: 30**

Unit I: Introduction to Infectious diseases **No. of Hours: 4**

Basic understanding of infection cycle, nosocomial infections, emerging and re-emerging infections, pathogenic agents of biological warfare, Source, reservoir and transmission of pathogens, reproduction number, LD50, Sanitation and Biosafety levels.

Unit II: Diseases caused by Bacteria **No. of. Hours: 10**

Classification of bacterial pathogens based on structure and nutritional requirements. Study of tuberculosis: History, causative agent, infection and pathogenicity, diagnostics, prevention/precautions, therapeutics and vaccines, drug resistance. Other diseases – Typhoid, Diphtheria, Tetanus, Cholera, Plague.

Unit III: Diseases caused by Virus **No. of. Hours: 10**

Unit Overview of structure, viral virulence factors and host pathogen interactions; detailed study of AIDS (including opportunistic infections) and Influenza: history, causative agent, pathogenesis, diagnostics, drugs, prevention/precautions; overview of other viral diseases including Hepatitis A/B/E, Dengue, Polio, Rabies, SARS.

Unit IV: Fungal and Parasitic Infections **No. of. Hours: 6**

Detailed study of Malaria: history, causative agents, vectors, life cycle, Host parasite interactions, diagnostics, drugs, vaccine development, prevention/precautions. Other diseases including Kala Azar, Amoebiasis, Giardiasis. Fungal diseases such as Candidiasis: general disease characteristics, medical importance, pathogenesis, diagnosis and treatment, antifungal drugs, prevention/precautions.

2.3 Practical:

Credit: 2 **Total Hours: 60**

1. Permanent slides of pathogens: *Mycobacterium tuberculosis*, *Leishmania*, *Plasmodium falciparum*
2. Gram staining
3. Acid fast staining of non-pathogenic *Mycobacterium smegmatis*
4. WIDAL test as a diagnostic test for Typhoid
5. MIC determination using Kirby Bauer / Alamar Blue assay
6. PCR as a diagnostic tool/dry lab.
7. Case studies on SARS, Rabies, Dengue, Polio and Plague
8. Case studies on Malaria, Amoebiasis and Giardiasis
9. Research presentation on current trends in infectious diseases

Essential readings:

1. Jawetz, Melnick & Adelbergs (27th ed.), *Medical Microbiology.* McGraw Hill Education. ISBN-10: 0071790314; ISBN-13: 978-007179031.
2. Kenneth J. Ryan, C., George Ray (2010), *Sherris Medical Microbiology: An introduction to infectious diseases*. McGraw-Hill. ISBN-13: 978-0071604024 ISBN-10: 0071604022
3. Prescott, Harley, Wiley, J.M., Sherwood, L.M., Woolverton, C.J. Klien's (2008). Microbiology (7th ed.). Mc Graw Hill International Edition (New York) ISBN: 978-007-126727
4. Pier, Lyczak and Wetzler, *Immunology, infection and immunity. ASM Press.* Print ISBN:9781119739555 |Online ISBN:9781683672111 |DOI:10.1128/9781555816148

3. Teaching Learning Process and Assessment Methods

Facilitating the Achievement of Course Learning Outcomes**

Unit No.	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
I	Students will develop an understanding of important terminologies used in infectious diseases, transmission of pathogens and will gain insight into host immune responses that ensue following infection. They will understand the importance of biosafety equipment for people who work on infectious disease-causing pathogen.	Traditional chalk and board teaching aided with Power Point presentations. Videos for Biosafety levels will be shared.	Regular question answer sessions, MCQs and unit-test for internal assessment.
II	Students will learn classification of bacteria and study various bacterial virulence factors. They will learn the pathophysiology of Mycobacterium tuberculosis and study ways to prevent and treat Tuberculosis. They will also learn about various bacterial diseases (Typhoid, Diphtheria, Tetanus Cholera, Plague) their molecular mechanisms and intervention strategies	Traditional chalk and board teaching aided with Power Point presentations. Animations and video tutorials will be used to teach pathogen-host interactions.	Group discussion, Quiz will be conducted, and students will be asked to deliver Power Point presentations on the assigned topics
III	Students will learn about virus structure and viral virulence factors.	Classroom teaching from research papers, chalk and board method of teaching	Group discussion, Quiz will be conducted, and

	They will understand the pathophysiology of the HIV, Influenza and study ways to diagnose and prevent disease. The students will also learn about secondary infections that can happen with AIDS. Students will learn about other various viral diseases (Hepatitis, Rabies, Dengue, Polio and SARS) their molecular mechanisms, diagnosis and intervention strategies. An introduction to Coronavirus will also be done.	and use of powerpoint presentation. Audio visual to demonstrate the viral infection, transmission and pathogenesis.	students will be asked to deliver Power Point presentations on the assigned topics
IV	Students will learn about various parasitic diseases, host parasite interaction, their molecular mechanisms of infection, diagnosis and intervention strategies. Students will also learn about fungal diseases (Candidiasis), molecular mechanisms, diagnosis and intervention strategies	Classroom teaching from research papers, chalk and board method of teaching and use of powerpoint presentation.	Group discussion, Quiz will be conducted, and students will be asked to deliver Power Point presentations on the assigned topics

(Assessment tasks enlisted here are indicative in nature)**

Keywords

Infection, Pathogen, Immune response, Diagnosis, Vaccines, Diseases

Semester VIII

DISCIPLINE SPECIFIC ELECTIVE COURSE - (DSE-10)

NEUROBIOLOGY

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Neurobiology (BCH-DSE-10)	4	2L		2P	Class XII with Science and Biology	-

Learning Objectives

The course neurobiology being offered aims to provide the students with an understanding of the cellular and molecular mechanisms operating in the human brain. Students will learn the electrical and signaling pathways that operate in the neurons. The objective of this course is also to enable students to comprehend the transduction of external signals and the integration of this information into higher level brain functioning.

Learning outcome

- Students would be introduced to neuroscience and Cellular neurophysiology
- Students would understand the anatomical layout of the nervous system relevant to physiological functions.
- Students would be able to appreciate the excitable properties of neurons and the function of synapses and explore neural circuits along with important neurotransmitters.
- Students will gain understanding of cellular and molecular mechanisms governing neural development, plasticity, and the establishment of memory.
- They would also comprehend the nature and causes of learning disabilities and neurodegenerative diseases

SYLLABUS OF DSE-10
BCH-DSE-10: NEUROBIOLOGY
Semester – VIII

Theory
Credits: 2 **Total Hours: 30**

UNIT 1: Introduction and Anatomy of nervous system **No of classes 5**

Understanding structural hierarchy in the nervous system. Cells of the nervous system: classification; Neuroglia and their function; Neuron and structure; Structure of nerve; Neural growth; Blood Brain Barrier; Formation and composition of cerebrospinal fluid; Introduction to neuroanatomy: Neural meninges, Brain stem, cerebellum, limbic system and cerebral cortex; Spinal cord.

UNIT 2: Neurochemistry **No. of classes 10**

Neuron as an excitable cell: resting membrane potential, ion channels, generation of action potential, graded and spike potentials, patch clamp technique; the Synapse: electrical and chemical synapse, Synaptic neurotransmitter release, synaptic plasticity; Neurotransmitter: Structural and molecular mechanisms of acetylcholine, catecholamines, serotonin, glutamate, glycine, histamine , GABA, neuropeptides like PYY, enkephalins, endorphins, substance P, orexin and anorexic peptides; Neurotransmitter receptors: metabotropic and ionotropic; saltatory conduction and axonal transport.

UNIT 3: Neurophysiology **No. of classes 7**

The concept of neural circuits and neuronal pools. Introduction to sensory perception, sensory receptor types and somatosensory pathway; Perception of touch and pain; Perception of chemical senses: taste and smell; Autonomic nervous system: sympathetic and parasympathetic; Somatic nervous system: reflex arc and neuromuscular junction.

UNIT 4: Neural processes and Neurodegenerative diseases **No. of classes 8**

Circadian rhythm, EEG and sleep; Memory: Types. memory loss, LTP and learning, learning disabilities, aphasias, Emotional and motivational conditioning in neural responses; Neurodegenerative disorders- Parkinson's disorder; Neurochemical basis of drug abuse.

2.3 Practical:

Credit: 2 **Total Hours: 60**

1. To make a temporary mount of a neuron.
2. Virtual laboratory on patch clamp.
3. Acetylcholinesterase assay in different brain areas.
4. Assay of a neurotransmitter (catecholamines)
5. Study of sensation of touch smell and taste, understanding desensitization and adaptation.
6. Reflex arc through knee jerk assay
7. Understanding EEG and case studies on sleep, epilepsy and mood disorders.
8. Drosophila/ zebrafish behavioral experiment.
9. Case studies on learning disabilities, neurodegenerative disease, autism spectrum disorders and schizophrenia.

10. Field trip to see EEG and fMRI.

Suggested reading:

1. Medical Neurobiology (2011) 1st ed., Peggy Mason, Oxford University press, ISBN-13: 978-0195339970.
2. Principles of Neural Science (2000) 4th ed., Eric R Kandel, James H Schwartz & Thomas M Jessell, McGraw Hill (USA), ISBN: 0-07-112000-9.
3. Clinical Neuroanatomy and Neuroscience (2012) 6th ed., M J Turlough Fitzgerald, Gregory Gruener & Estomih Mtui, Elsevier, ISBN: 978-0-7020-4042-9. Bijlani, Guyton

3. Teaching Learning Process and Assessment Methods

Facilitating the Achievement of Course Learning Outcomes**

Unit No.	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
I	The students will be able to learn the anatomy and physiological roles of cells of the nervous system. They would gain the knowledge about the importance of cerebrospinal fluid and Blood Brain Barrier	Teaching will be conducted both through black board mode and power point presentation mode Students would also learn concepts by conducting lab practicals.	Students will be assessed through the assignment and tests Lab skills will be tested
II	Students would be able to understand the concept of nerve action potential, its generation and importance. They will also learn about the role of synapse and the importance of chemicals in neural signaling.	Teaching will be conducted both through black board mode and power point presentation mode Students would also learn concepts by conducting lab practicals.	Students will be assessed through the assignment and tests. MCQs will also be given to assess the understanding of few concepts Lab skills will be tested
III	Students will learn about the concept of neuronal circuits and neuronal pools. They will also learn about the different perceptions including pain, touch, smell and taste	Teaching will be conducted both through black board mode and power point presentation mode Videos to demonstrate various perceptions will be shown to students to understand the theoretical concept Students would also learn concepts by conducting lab practicals. Field visit	Students will be assessed through the assignment and tests. MCQs will also be given to assess the understanding of few concepts Lab skills will be tested Data obtained from experiments like maze testa and sensory perception tests and other related topics can be

		will help them get an experiential training in the method used in reading brain function like fMRI and EEG. analysis of such data with discussions will help them understand concepts better.	presented and discussions conducted.
IV	The students will learn about various neural processes including memory and learning. They will also get to know about the physiology of some of the common neurodegenerative disorders	Teaching will be conducted both through black board mode, power point presentation mode as well as by demonstrating the experiment. Students would also learn concepts by conducting lab practicals.	Students will be assessed through the assignment and tests case studies discussions will make them understand the neurophysiological aspects of neurodegenerative and other neurological diseases better.

(Assessment tasks enlisted here are indicative in nature)**

Keywords

Brain anatomy, cerebrospinal fluid, neurochemistry, saltatory conduction, sensory perception, reflex reactions, sleep, memory and learning, mood and neurological disorders.

Semester VIII

DISCIPLINE SPECIFIC ELECTIVE COURSE - (DSE-11)

DEVELOPMENTAL BIOLOGY

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Developmental Biology (BCH-DSE-11)	4	2L		2P	Class XII with Science and Biology	-

Learning Objectives

The objective of this course is to provide basic knowledge of the development processes, different molecular and cellular mechanisms which are involved in animal development. This course would also highlight the importance of different animal models in the study of developmental processes. The course would also give knowledge about the concept of stem cells, totipotency.

Learning Outcomes

On successful completion of the course, students will:

- Students will acquire knowledge about basic concepts of developmental processes, fertilization, germ layer formation and patterning of body plan.
- Students will gain detailed insight into the molecular events of embryogenesis, importance of various model systems and their applications in understanding human development and associated defects.
- Students will learn about Stem cells, their roles in development and significance in development of regenerative medicines, current applications and advancement in stem cell research.

SYLLABUS OF DSE-11
BCH-DSE-11: DEVELOPMENTAL BIOLOGY
Semester – VIII

Theory
Credits: 2 **Total Hours: 30**

UNIT 1: Introduction to Developmental Biology **No of hours: 10**

History, Evolutionary embryology and Basic concepts of developmental biology, Overview of fertilization, early development- Patterns of cleavage, germ layer formation, implantation, placentation, Formation of blastula, embryogenesis: Nieuwkoop center, Spemann-Magold organizer theory and mesodermal induction, Gastrulation, Fate maps, and neural tube formation.

UNIT 2: Molecular biology of development **No of hours: 6**

Role of differential gene expression in development, Role of cell-cell communication in development. Key signaling pathways in development: Fgf, Hedgehog, Wnt, TGFß, and Notch. Cadherins in establishing intercellular connections, Role of extracellular matrix in development Concepts of induction and competence and senescence.

UNIT 3: Study on model organisms **No. of hours: 8**

Caenorhabditis elegans: Study of cell lineage, mosaic development and organogenesis (vulva formation).
Drosophila melanogaster: Role of maternal effect genes, morphogens and zygotic genes (Gap genes to homeotic genes) in axis formation and body patterning.
Danio rerio (Zebra fish)*:* Study various early embryogenesis stages starting from the zygote - cleavage - blastula - gastrula - segmentation, pharyngula, hatching and early larval development. Study mechanisms of pigmentation and stripe
patterning in fish skin.

UNIT 4: Stem cells and their implications in treatment strategies: **No of hours: 4**

Stem cells and their types, Pluripotent cells, Induced pluripotent stem cells and their applications in human development and diseases. Ethical issues.

UNIT 5: Developmental defects and the role of teratogens: **No. of hours: 2**

Chemical, physical and biological agents which can cause developmental defects. Brief discussion of alcohol and retinoic acid as teratogenic agents.

2.3 Practical:
Credit: 2 **Total Hours: 60**

1. Study of life cycle and developmental stages of Zebrafish.
2. Live demonstration of Zebrafish embryogenesis: Microscopic visualization of early cleavages, sphere stage, shield stage, gastrulation, epiboly and somite formation.
3. Study of life cycle and developmental stages of Drosophila melanogaster

4. Study of developmental stages of chick embryo. (optional)
5. Study of life cycle and developmental stages of *C. elegans.*

Essential Readings

1. Gilbert, S.F. and Barresi, M.J.F. (2017), Developmental Biology, 11th Edition 2016. Am. J. Med. Genet., 173: 1430-1430. https://doi.org/10.1002/ajmg.a.38166.
2. Basson M. A. (2012). Signaling in cell differentiation and morphogenesis. Cold Spring Harbor perspectives in biology, 4(6), a008151. https://doi.org/10.1101/cshperspect.a008151
3. Kimmel, C.B., Ballard, W.W., Kimmel, S.R., Ullmann, B. and Schilling, T.F. (1995), Stages of embryonic development of the zebrafish. Dev. Dyn., 203: 253-310. https://doi.org/10.1002/aja.1002030302
4. Alberts, B. (2015) Molecular Biology of the Cell. 6th Edition, Garland Science, Taylor and Francis Group, New York.
5. Wolpert, L., Tickle, C., Martinez, A. A., Lawrence, P., & Locke, J. (2019). Principles of development. Oxford, United Kingdom; New York, NY: Oxford University Press, [2019]
6. Balinsky, B.L. (2008). An introduction to embryology. 5th edition. Thomson Publishers.

Suggested Readings:

1. Davies, J. (2004). Practical guide to developmental biology. BioEssays, 26, 1142.
2. Gibbs, M., A. (2003) A Practical Guide to Developmental Biology. Oxford University Press, 2003 ISBN 0199249717, 9780199249718
3. ZFIN Protocols

3. Teaching Learning Process and Assessment Methods
Facilitating the Achievement of Course Learning Outcomes**

Unit No.	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
I	Students will learn about basic concepts of developmental processes, how cell fate is determined.	Teaching will be conducted both through black board mode and power point presentation mode. Students would also learn concepts by conducting lab practicals.	Students will be given questions that are application based and require analytical skills. Quizzes will be held to gauge their conceptual understanding. Lab skills will be tested.
II	Students would learn about the role of key signaling pathways in development	Teaching will be conducted both through black board mode and	Students will be given questions that are application based and require analytical

		power point presentation mode. Students would also learn concepts by conducting lab practicals.	skills. Quizzes will be held to gauge their conceptual understanding. Lab skills will be tested.
III	Students would learn about the role of various model systems in the study of development Biology	Teaching will be conducted both through black board mode and power point presentation mode. Students would also learn concepts by conducting lab practicals.	Students will be given questions that are application based and require analytical skills. Quizzes will be held to gauge their conceptual understanding. Lab skills will be tested.
IV	Students would learn about stem cells and their applications	Teaching will be conducted both through black board mode and power point presentation mode. Students would also learn concepts by conducting lab practicals.	Students will be given questions that are application based and require analytical skills. Quizzes will be held to gauge their conceptual understanding. Lab skills will be tested.
V	Students would learn about various developmental defects and effect of teratogens.	Teaching will be conducted both through black board mode and power point presentation mode. Students would also learn concepts by conducting lab practicals.	Students will be given questions that are application based and require analytical skills. Quizzes will be held to gauge their conceptual understanding. Lab skills will be tested.

4. Key words

Developmental stages, signaling pathways, model organisms, stem cells, teratogens

Semester VIII

DISCIPLINE SPECIFIC ELECTIVE COURSE - (DSE-12)

PHARMACOLOGY AND TOXICOLOGY

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Pharmacology and Toxicology (BCH-DSE-12)	**4**	**2L**		**2P**	**Class XII with Science and Biology**	**-**

Learning Objectives

This is an introductory course to lay the foundation for understanding basic concepts in Pharmacology and the pharmacological basis of therapeutics. The objective of the course is to introduce students to the core principles of drug action in terms of bioavailability, pharmacokinetics, pharmacodynamics, and mechanism of action of drugs in the treatment of diseases. The course will also provide basic principles of toxicology, toxic substances and their effects on body systems.

Learning Outcomes:

At the end of the course, a student will be able to

1. Understand the basic scientific concepts and principles that serve as the foundational underpinnings of the pharmacological sciences including pharmacokinetics; pharmacodynamics; drug metabolism; and drug-drug interactions.
2. Learn an introduction to the processes by which new drugs are discovered.
3. Understand the specific pharmacology of the major drugs and drug classes currently used in medical practice including their indications, clinical use and mechanisms of action,
4. Discuss the basic principles of toxicology; the mechanisms by which excess exposure to certain drugs, toxins, chemicals, heavy metals and poisons can lead to adverse toxicological effects

SYLLABUS OF DSE-12
BCH-DSE-12: PHARMACOLOGY AND TOXICOLOGY
Semester – VIII

Theory
Credits: 2 **Total Hours: 30**

Unit I: Introduction to Pharmacology **Number of hours: 5**

History and Scope of Pharmacology, Nature and source of drugs, Routes of drug administration, Drug receptors and receptor subtypes, Drug Discovery and Development, Computer Aided Drug Design

Unit II: Pharmacokinetics and Pharmacodynamics **Number of hours: 8**

Absorption, Distribution, Metabolism, and Excretion (ADME) of drugs. Bioavailability, First Pass metabolism, Biological half-life of drug and its significance, Drug-drug interactions.

Unit III: Drug Classification and their mechanism of action **Number of hours: 10**

Drugs of Inflammation*:* NSAIDs, Analgesics and Anti-inflammatory Drugs; Drugs of autonomic and central nervous system -Adrenergics: Isoprenaline, Propranolol; Dopaminergics, Dopamine, Syndopa; General Anesthetics: Halothane; Sedatives and Hypnotics: Diazepam; Cholinergics: Bethanechol, Rivastigmine ; Anticonvulsant, Drugs of Cardiovascular system*:* Anticoagulant, Blood Pressure Lowering Drugs, Lipid Lowering Drugs ;Drugs of Gastro-Intestinal tract*:* Antacid, Acid Blocker and Laxative ;Drugs of Renal functions: Diuretics ; and Anticancer Drugs.

Unit IV: Toxicology **Number of hours: 7**

Classification of toxic substances, Drugs, Toxins and Heavy metal poisoning, Xenobiotics, Mechanism of toxicity, Tolerance to toxicants, Dose-response relationship, Therapeutic Index, Bioaccumulation and Antidotes

2.3 Practical:
Credit: 2 **Total Hours: 60**

1. To study the presence of paracetamol (acetaminophen) in given sample by spectroscopic method
2. Calculation of LD50/LC50
3. Model Systems to study Dose-Response
4. Drug Binding assay to Albumin by Spectroscopic Analysis
5. Case Studies
6. Small Molecule Databases mining and Protein-ligand Docking

Essential Readings

- Tripathi, K.D. (2010). 7th Edition. Essentials of medical pharmacology. Delhi, India: Jaypee Brothers. ISBN-13:9788184480856.
- Katzung, Bertram G. , Basic &Clinical Pharmacology, 14th Edition, McGraw Hill Education, 2017

- Klaassen, C. D. and Watkins J. B. (2021), 4th Edition, Casarett & Doull's Essentials of Toxicology New York, USA: McGraw Hill.ISBN: 978-1-26-045229-7.
- Kulkarni, S.K. (2012). 4th Edition. Handbook of experimental pharmacology. Delhi, India: Vallabh Prakashan, ISBN-13: 97881857311.

3. Teaching Learning Process and Assessment Methods:
Facilitating the Achievement of Course Learning Outcomes**

Unit No.	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
I	Students will learn about the history and scope of pharmacology. They will also learn about nature, source, administration routes, and receptors of various drugs. They will learn about various drug development strategies.	Teaching will be conducted both by chalk and board and power point presentation.	Students will be assessed through assignments, class tests, group discussions and paper presentations.
II	Students will understand about the absorption, distribution, metabolism and excretion of drugs. They will also learn about bioavailability of drugs and drug-drug interactions.	Teaching will be conducted both by chalk and board and power point presentation. .	Students will be assessed through assignments, class tests, group discussions and paper presentations.
III	Students will understand about mechanism of action of various classes of drugs.	Teaching will be conducted both by chalk and board and power point presentation.	Students will be assessed through assignments, class tests, group discussions and paper presentations.
IV	Students will learn about various toxins, their mechanism, tolerance and antidotes. Students will also learn about therapeutic index and bioaccumulation of various drugs.	Teaching will be conducted both by chalk and board and power point presentation.	Students will be assessed through assignments, class tests, group discussions and paper presentations.

(Assessment tasks enlisted here are indicative in nature)**

Keywords:

Pharmacology, Drug Discovery, Pharmacokinetics, Pharmacodynamics, ADME, Classes of Drug, Mechanism of action, Toxicity.

Semester VIII

DISCIPLINE SPECIFIC ELECTIVE COURSE - (DSE-13)

MOLECULAR DIAGNOSTICS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Molecular Diagnostics (BCH-DSE-13)	**4**	**2L**		**2P**	**Class XII with Science and Biology**	**-**

Learning Objectives

The course is designed to enable the students to provide an understanding for students about the significance and scope of molecular diagnostics. The course aims to provide information about protein and DNA/ RNA based molecular diagnostic methods for various genetic, infectious and lifestyle associated diseases. It would expose students to specific disease markers aiding diagnosis. This course would also highlight the advantages and disadvantages of using molecular-based methods compared to conventional methods in disease diagnosis.

Learning Outcomes

On successful completion of the course, a student will:

- By finishing this module, the students will have clarity about the molecular diagnostic methods, their significance and goals.
- Students will get an idea about the Quality assurance and safety procedures that need to be followed in the molecular diagnostic lab.
- The students will be able to understand the application of proteomic, DNA and / RNA based molecular diagnostic methods in various diseases including, cancers, infectious diseases, cardiovascular diseases, and genetic diseases.
- The students would learn about various disease markers.

SYLLABUS OF DSE-13
BCH-DSE-13: MOLECULAR DIAGNOSTICS
Semester – VIII

Theory
Credits: 2 **Total Hours: 30**

Unit 1: Introduction to Molecular Diagnostics **No. of hours: 4**

History of diagnostics, Age of molecular diagnostics, Significance, Scope, Rise of diagnostic industry in Indian and global scenario. Ethical issues related to molecular diagnostics. Personal safety and laboratory safety. GLP for handling highly infectious disease samples and documentation.

Unit 2: Protein based molecular diagnostics: **No. of hours: 10**

FDA definition of disease markers, Role of markers in Disease diagnosis. Approaches and methods in the identification of disease markers, predictive and diagnostic value.
Molecular diagnosis of Cancer/ Tumour, Inflammation, cardiovascular diseases (myocardial infarction, hypertension, thrombosis/ clotting defects), cytoskeletal disorders, and diabetes by specific markers.
Applications of molecular diagnostics. Major Histocompatibility Complex (MHC), HLA typing. Role of Molecular diagnostics in bone marrow transplantation and organ transplantation

Unit 3: DNA/ RNA based molecular diagnosis: **No. of hours: 10**

PCR, RT-PCR, relative-quantitative PCR, multiplex PCR, SNP chromosomal microarrays, RFLP based genetic tests for following disorders: Thalassemia, Sickle Cell anaemia, Fragile-X syndrome, Alzheimer's disease.
Molecular diagnosis of various infectious diseases / vector borne: Dengue, Chikungunya, Ebola and Influenza (H1N1), Corona and HIV.
Whole genome sequencing for diagnosis of drug resistance in bacterial pathogens.

Unit 4: Molecular diagnostics of chromosomal disorders: **No. of hours: 06**

Chromosomes, Human disorders, and Cytogenetic analysis. Molecular karyotyping/cytogenetics techniques involving Fluorescence in situ hybridization (FISH)-based technology, Array-comparative genomic hybridization and next generation sequencing technologies (NGS). Prenatal diagnosis. Molecular diagnosis for early detection of cerebral palsy, Down's syndrome.

2.3 Practical:

Credit: 2 **Total Hours: 60**

1. Karyotyping of normal and abnormal human chromosome sets
2. Estimation of C-reactive protein
3. Genotyping of candidate genes for diseases by RFLP
4. Detection of DNA damage by comet assay
5. Troponin T test (Cardiac troponin I (cTnI)) test

6. Haemoglobin A1c (HbA1c) Test for Diabetes
7. D- Dimer test for blood clotting disorder
8. Case studies

Essential Readings:

1. George Patrinos Wilhelm Ansorge Phillip B. Danielson (2016). Molecular Diagnostics (3rd Edition) Elsevier Publishing Group. ISBN: 9780128029718
2. Nader Rifai A. Rita Horvath Carl T. Wittwer Jason Park (2018). Principles and Applications of Molecular Diagnostics. Elsevier Publishing Group. ISBN: 9780128160619
3. Wayne W. Grody and Frederick L. Kiechle (2010). Molecular Diagnostics Techniques and Applications for the Clinical Laboratory. Elsevier Publishing Group. ISBN: 9780123694287
4. Jim Huggett and Justin O'Grady (2014). Molecular Diagnostics – Current Research and Application. Caister Academic Press. ISBN: 978-1-908230-41-6
5. William B. Coleman and Gregory J. Tsongalis (2005). Molecular Diagnostics for the Clinical Laboratorian. Springerlink. ISBN: 978-1-59259-928-8

3. Teaching Learning Process and Assessment Methods

Facilitating the Achievement of Course Learning Outcomes**

Unit No.	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
I	Students would learn about GLP followed in Molecular diagnostics lab.	Teaching will be conducted both through black board mode and power point presentation mode. Students would also learn concepts by conducting lab practicals.	Students will be given questions that are application based and require analytical skills. Quizzes will be held to gauge their conceptual understanding. Lab skills will be tested.
II	Students would learn about various protein markers in disease diagnosis.	Teaching will be conducted both through black board mode and power point presentation mode. Students would also learn concepts by conducting lab practicals.	Students will be given questions that are application based and require analytical skills. Quizzes will be held to gauge their conceptual understanding. Lab skills will be tested.

III	Students would learn about various DNA / RNA based diagnostic methods.	Teaching will be conducted both through black board mode and power point presentation mode. Students would also learn concepts by conducting lab practicals.	Students will be given questions that are application based and require analytical skills. Quizzes will be held to gauge their conceptual understanding. Lab skills will be tested
IV	Students would learn about diagnosis of various chromosomal disorders,	Teaching will be conducted both through black board mode and power point presentation mode. Students would also learn concepts by conducting lab practicals.	Students will be given questions that are application based and require analytical skills. Quizzes will be held to gauge their conceptual understanding. Lab skills will be tested

(Assessment tasks enlisted here are indicative in nature)**

Keywords:

Molecular diagnostics, protein disease markers, DNA / RNA based diagnosis, chromosomal disorders

Semester VIII

DISCIPLINE SPECIFIC ELECTIVE COURSE - (DSE-14)

BIOTECHNOLOGY

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Biotechnology (BCH-DSE-14)	4	2L		2P	Class XII with Science and Biology	-

Learning Objectives

The objective of the course is to expose students to the basic principles and applications of biotechnology. It will also teach them the basics of animal and plant tissue culture and various methods of gene transfer for the generation of transgenics. The course will also provide an understanding of the applications of biotechnology in medicine, forensics, archaeology and agriculture.

Learning Outcomes

The students after completing this course will be able to:

- Understand animal and plant tissue culture along with their applications
- Gain knowledge about methods of gene transfer in biotechnology
- Appreciate the use of biotechnology in medicine
- Gain insight into other industrial applications of biotechnology
- Become aware of the impact of biotechnology on agriculture

SYLLABUS OF DSE-14
BCH-DSE-14: BIOTECHNOLOGY
Semester – VIII

Theory
Credits: 2 **Total Hours: 30**

Unit I: Methods in animal and plant biotechnology **Total No. 10**

Introduction to cell and tissue culture.
Overview of Reproductive Animal Biotechnology and livestock improvements: artificial insemination, embryo transfer, in-vitro fertilization, somatic cell nuclear transfer (Dolly the sheep). Methods of gene transfer: viral mediated gene transfer, direct gene transfer using PEG, micro injection, electroporation, microprojectile (biolistics) method, liposome mediated DNA delivery. Fermentation technology and upscaling to industrial production

Unit II: Medical Biotechnology **Total No. 07**

Production of recombinant pharmaceuticals: insulin, factor VIII, human growth hormones, erythropoietin. Recombinant Vaccines. Pharming—recombinant protein from live animals and plants. Gene therapy: Gene therapy for inherited diseases and cancer with suitable examples. The ethical issues related to gene therapy.

Unit III: Agricultural Biotechnology **Total No. 08**

The gene addition approach to plant genetic engineering: plants that make their own insecticides, Herbicide resistant crops. Gene subtraction: Antisense RNA and the engineering of fruit ripening in tomato, other examples of the use of antisense RNA in plant genetic engineering. Overview of plants as biofactories: plant-based vaccines, plantibodies and biopharmaceuticals. Safety and ethical concerns of genetically modified plants.

Unit IV: Other Industrial Applications of Biotechnology **Total Hrs 05**

Preparation of fermented food products and beverages. Single cell proteins. Treatment of wastewater (Municipal treatment plant) and sewage. Bioremediation and biodegradation. Production of recombinant enzymes for use in industries.

2.3 Practical:

Credit: 2 **Total Hours: 60**

1. Plant tissue culture
2. Restriction Fragment Length Polymorphism (RFLP) profiling of genetically modified plants.
3. Extraction of DNA from buccal swab.
4. Presentation of research papers.
5. Virtual lab for bioreactors
6. Educational trip to industrial plants/fermentation units
7. Case studies of the use of DNA profiling for kinship analysis
8. Designing of antisense RNA against polygalacturonase (*in silico*)
9. Group discussion on Archaeogenetics—using DNA to study human prehistory

Essential Readings

- Brown, T. A. (2016) Gene Cloning and DNA Analysis: An Introduction, (7th ed.). Wiley-Blackwell Publishing (Oxford, UK); ISBN: 978-1-119-07256-0
- Glick, B.R., Pasternak, J.J., Patten, C. L. (2010) Molecular Biotechnology: Principles and Applications of Recombinant DNA (4th ed.). ASM Press (Washington DC); ISBN: 978-1-55581-498-4.
- Primrose, S.B., and Twyman, (2006) Principles of Gene Manipulation and Genomics (7th ed.), R. M. Blackwell Publishing (Oxford, UK) ISBN:13: 978-1-4051-3544-3.
- Buchann (2015). Biochemistry and Molecular Biology of plants. (2nd ed.). I K International. ISBN-10: 8188237116, ISBN- 978047 07 14218
- Willey, J., Sherwood, L., Woolverton, C. (2017). Prescott's Microbiology (10th ed.). McGraw Hill international. ISBN 13: 9781259657573.

Suggested Readings

- Freshney, R. I. (2010). Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications. Wiley-Blackwell, 6th Edition.
- Roberta H. Smith. (2013) Plant Tissue Culture: *Techniques and Experiments*. 3rd edition. Academic Press. ISBN: 978-0-12-415920-4
- Adrian Slater, Nigel Scott and Mark Fowler. (2003) Plant Biotechnology: The genetic manipulation of plants, 1st Edition, Oxford University Press
- Verma, A. S. and Singh, A. (2014). Animal Biotechnology. Academic Press, Elsevier, USA

3. Teaching Learning Process and Assessment Methods

Facilitating the Achievement of Course Learning Outcomes**

Unit No.	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
I	Students will be introduced to the animal cell and tissue culture. They will gain insight into various methods of livestock improvements. They will also understand about different methods of gene transfer in animal and plant biotechnology. They will gain insight into fermentation technology and upscaling.	Teaching will be conducted both through black board mode and power point presentation mode. Discussions will be conducted on various recent methodologies in biotechnology.	Students will be given questions that are application based and require analytical skills. Quizzes will be held to gauge their conceptual understanding.

II	Students will be introduced to various applications of biotechnology in medicine. Students shall gain insight into gene therapy, pharming, recombinant vaccines and pharmaceuticals.	Classical chalk and board teaching, oral discussions and powerpoint presentations whenever needed.	Students shall be asked to make power-point presentations on latest advances in applications of biotechnology in medicine. Open book tests will be held to promote self-learning. Practical related oral questions will be asked.
III	Understand the applications of biotechnology in agriculture. Gain knowledge about the insecticides, Herbicide resistant crops. Understand about Antisense RNA and the engineering of fruit ripening in tomato, They shall learn about plants as biofactories and genetically modified plants	Teaching will be conducted both through black board mode and power point presentation mode. Practical knowledge used field visits shall be imparted.	Regular class question-answer sessions. Students will be asked to prepare PowerPoint presentations Internal assessment tests will be conducted. Discussions using case studies will be conducted.
IV	Students shall be introduced to various methods of preparation of fermented food products and beverages. They shall gain knowledge about Single cell proteins, Treatment of wastewater Bioremediation, biodegradation and recombinant enzymes.	Teaching will be conducted through black board and power point presentation. Useful video clips will be shown for better clarity.	Regular oral evaluation will be done. Internal assessment tests will be conducted

(Assessment tasks enlisted here are indicative in nature)**

Keywords

Biotechnology, gene transfer, livestock improvements, animal and plant tissue culture, gene therapy, recombinant vaccine, pharming, genetically modified plants, fermentation, bioremediation

Annexure-2

INDEX
Department of Microbiology
B.Sc.(H) Microbiology Program
Semester- VII and VIII

Discipline Centric Elective Courses (DSEs) available to students which have been already approved in AC and in EC and notified vide University notification dated 15-June-2023

Discipline Centric Elective Courses (DSEs):					
	Code	**Title**	**L**	**T**	**P**
	MICROB-DSE1	Eukaryotic Microbes: Biology and Biotechnology	2	0	2
	MICROB-DSE2	Applications of Statistics in Biology	2	0	2
	MICROB-DSE3	Microbial Quality Control in Food and Pharmaceutical Industries	2	0	2
	MICROB-DSE4	Biotechniques and Instrumentation	2	0	2
	MICROB-DSE5	Plant-Pathogen Interactions	2	0	2
	MICROB-DSE6	Biosafety and Intellectual Property Rights	2	0	2
	MICROB-DSE7	Applications of Microbes in Bioremediation and Petroleum Industry	2	0	2
	MICROB-DSE8	Scientific Writing and Communication	2	0	2
	MICROB-DSE9	Agricultural Microbiology	2	0	2
	MICROB-DSE10	Principles of Genetics	2	0	2
	MICROB-DSE11	Microbial Biotechnology	2	0	2
	MICROB-DSE12	Research Methodology	2	0	2
	MICROB-DSE12	Research Methodology	2	0	2
	MICROB-DSE13	Applications of Informatics in Biology	2	0	2
	MICROB-DSE14	Advances in Microbiology	2	0	2
	MICROB-DSE15	Microbiome in Health and disease	2	0	2
	MICROB-DSE16	Microbial Diagnosis and Public Health Management	2	0	2

Generic Elective Courses (GEs) available to students which have already been approved in AC and in EC and notified vide University notification dated 14-Mar-2023

Generic Electives Courses (GEs):				
Code	**Title**	**L**	**T**	**P**
MICROB-GE1	Introduction and Scope of Microbiology	2	0	2
MICROB-GE2	Microbes in Health and Hygiene	2	0	2
MICROB-GE3	Food Fermentation and Preservation Techniques	2	0	2
MICROB-GE4	Microbial Quality Control and Testing	2	0	2
MICROB-GE5	Microbes in Animal Health	2	0	2
MICROB-GE6	Microbes in Environmental Management	2	0	2
MICROB-GE7	Microbes in Infectious Diseases	2	0	2
MICROB-GE8	Applications of Microbes in Biotechnology	2	0	2
MICROB-GE9	Fundamentals of Agricultural Microbiology	2	0	2
MICROB-GE10	Microbial Products in Therapeutics	2	0	2

B.Sc. (Hons.) Microbiology

DISCIPLINE SPECIFIC CORE COURSE – 19: MICROBIAL GENETICS AND GENOMICS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
MICROB-DSC701: MICROBIAL GENETICS AND GENOMICS	4	3	0	1	Class XII pass with Biology/ Biotechnology/ Biochemistry	NA

Learning Objectives

The Learning Objectives of this course are as follows:

- The major objective of this course is to introduce the students to acquire a clear understanding of the genetic make-up of microorganisms, the organization of microbial genomes and their structure-function analysis, as well as the maintenance of genome integrity through various repair mechanisms.
- The students will gain insights into how microorganisms evolve by horizontal transfer of genetic material, thus also leading to greater biodiversity.
- They will recognize the importance of microorganisms as model systems in exploring the structure, function, and regulation of genes.
- They will learn to design basic experiments in microbial genetics relating phenotypes with the genotypes through the use of mutants.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Student will be able to describe the organization of bacterial, viral, eukaryotic and organelle genomes, and discuss the methodology employed in studying structural and functional genomics.
- Student will be able to recall various natural plasmids, their functions and their significance.

- Student will be able to evaluate the importance of stem cells and their associated technologies and applications.
- Student will be able to describe the fundamentals of different types of transposons and mechanisms of transposition.
- Student will be able to discuss the various mechanisms of natural gene transfer in bacteria and fungi and solve problems in genetic analysis particularly related to genetic mapping and strain construction..
- Student will be able to describe the importance of mutations and the repair mechanisms that operate in cells to maintain genome integrity, and use the microbial test for detecting the carcinogenic/mutagenic potential of chemicals.
- Student will be able to discuss the alternate life styles of phage lambda, the potential of the CRISPR-Cas bacterial defense mechanism and the applications of the CRISPR-Cas system in making gene knockouts

SYLLABUS OF DSC-19

UNIT – I (10 hours)

The organization and structure of genomes and extrachromosomal elements: Genome sizes and gene densities. Genome organization in bacteria (*E. coli*) and eukaryotic microorganisms (*Saccharomyces cerevisiae*, *Neurospora*). Introduction to methods in genomics: structural and functional genomics and analysis. Plasmids: circular and linear (with examples). Host range: broad and narrow (with examples). Properties and importance of: R Plasmids, F plasmids, colicinogenic plasmids, degradative plasmids, yeast 2µ plasmid. Plasmid replication mechanisms: theta (unidirectional and bidirectional) and rolling circle. Plasmid partitioning, Plasmid amplification, Plasmid incompatibility, regulation of plasmid copy number, plasmid curing.

UNIT – II (13 hours)

Bacteriophage genetics and Transposable elements: Genome organization of MS2, T4 and lambda phages. Regulation of lytic- lysogeny switch in lambda phage.
Bacterial transposons: insertion elements, composite and non-composite transposons. Mechanism of transposition: Replicative and non-replicative transposition. Mu transposon. Eukaryotic transposable elements: yeast (Ty retrotransposon), Drosophila (Copia elements and P elements in hybrid dysgenesis), Maize (Ac/Ds and Spm/dSpm). Applications of transposons.

UNIT – III (10 hours)

Genetic transfer mechanisms: Horizontal gene transfer in bacteria and its significance, Bacterial transformation: competence and mechanism. Bacterial conjugation: Hfr and F' strains, conjugation mechanism, use of interrupted mating technique for gene mapping. Bacterial transduction: generalized and specialized transduction, gene mapping by recombination and co-transduction of markers.

Integrons as agents of bacterial evolution. Fungi: Homologous recombination, evidence of horizontal gene transfer in fungi.

UNIT – IV (12 hours)

Mutations and DNA repair: Types of mutations: spontaneous and induced. Physical, chemical and biological mutagens. Base substitutions, frameshifts, deletions, insertions, duplications, inversions, silent mutations, missense mutations, nonsense mutations, conditional and lethal mutations. Loss- and gain-of-function mutants. Reversion and suppression: true revertants, intra- and inter-genic suppression. Mutator genes. Uses of mutations. Ames Test. Repair mechanisms: photoreactivation, recombination-dependent repair, SOS repair, mismatch repair, excision repair, NHEJ repair. Site directed mutagenesis.

Practical component

UNIT 1: (20 hours)

Mutations and mutagenesis: Preparation of master and replica plates. Study of the effect of mutagens on bacteria: effect of ethidium bromide-induced mutagenesis (chemical mutagenesis) on bacterial growth and survival – analysis by plating of serial dilution followed by cfu counts. Effect of UV irradiation (physical mutagenesis) on bacterial growth and survival – analysis by preparation of survival curve. Ames Test by virtual lab and / or demonstration.

Unit 2: (10 hours)

Methods of genetic transfer: Group experiment: transfer of genetic material between bacteria by conjugation. Transformation of plasmid DNA. Bacterial transduction by virtual lab.

Essential/recommended readings

Theory:

1. Lewin's Essential Genes by J. Krebs, E. Goldstein and S. Kilpatrick. 4th edition. Jones andBartlett Publishers, USA. 2020.
2. Snyder and Champness Molecular Genetics of Bacteria by T.M. Henkin and J.E. Peters. 5th edition. ASM Press. 2020.
3. Concepts of Genetics by W.S. Klug, M.R. Cummings, C. Spencer and M. Palladino. 11thedition. Pearson Education, USA. 2018.
4. Genetics: A Conceptual Approach, by B.A. Pierce. 7th edition. W.H. Freeman and Co, UK. 2019.
5. Principle of Genetics by D.P. Snustad and M.J. Simmons. 7th edition. John Wiley and Sons,UK. 2015.
6. Molecular Biology of the Gene by J.D. Watson, T.A. Baker, S.P. Bell, A. Gann, M. Levine and R. Losick. 7th edition. Pearson Education, USA. 2014.

7. iGenetics- A Molecular Approach by P.J. Russell. 3rd edition. Benjamin Cummings, USA.2009.

8. Microbial Genetics by S. Maloy, J. Cronan and D. Friefelder. 2nd edition. Jones and Barlett, USA. 2004.

Practicals:

1. Molecular Cloning: A Laboratory Manual by M. Green and J. Sambrook Volumes 1-3. 4th edition. Cold Spring Harbor Laboratory Press, USA. 2012.

2. Benson's Microbiological Applications, Laboratory Manual in General Microbiology by A. Brown and H. Smith. 15th edition. McGraw-Hill Education, USA. 2022.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE –20:
PRINCIPLES OF RECOMBINANT DNA TECHNOLOGY

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
MICROB-DSC801: **PRINCIPLES OF RECOMBINANT DNA TECHNOLOGY**	**4**	**3**	**0**	**1**	**Class XII pass with Biology/ Biotechnology/ Biochemistry**	

Learning Objectives

The Learning Objectives of this course are as follows:

- The main objective of this course is to enable students to develop a clear comprehension of the concepts of recombinant DNA technology and identify its potential.
- Students will get acquainted with the major tools used to manipulate DNA, and will become familiar with various methods and applications of cloning. They will be brought abreast with recent high throughput technologies and gain knowledge of recombinant products of agricultural and human importance.
- Students will be able to design a suitable strategy towards developing a genetically modified organism.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Student will be able to describe and perform simple DNA cloning and use DNA restriction and DNA modifying enzymes.
- Student will be able to discuss the use of cloning and expression vectors.
- Student will be able to explain various gene delivery methods and basic as well as high throughput methods of DNA, RNA and protein analysis
- Student will be able to elaborate on DNA amplification and DNA sequencing methods.

- Student will be able to evaluate the applications of recombinant DNA techniques in the areas of agriculture and pharmaceutical.

SYLLABUS OF DSC-20

UNIT – I (6 hours)

Concept of gene cloning and enzymes used in recombinant DNA technology: Introduction to genetic engineering. Restriction endonucleases (RE), its types and nomenclature. Role of Type II enzymes in gene cloning: generation of cohesive and blunt ends, frequency of recognition sequences in a DNA molecule, star activity, isoschizomers and neoschizomers, partial and double digestion. DNA modifying enzymes: DNA polymerase I, Klenow fragment, alkaline phosphatase, T4 polynucleotide kinase, terminal deoxynucleotidyl transferase, DNA ligase.

UNIT – II (9 hours)

Cloning vectors and expression systems: Cloning vectors: nomenclature and properties. Plasmid vectors: pBR, pUC and pGEM series. Phage vectors: lambda (insertion and replacement) vectors, M13-based vectors. Phagemids, cosmids, artificial chromosomes. Conversion of blunt-ended DNA into DNA with cohesive ends via linkers, adaptors, and homopolymer tailing. Screening and selection of recombinants: insertional inactivation (including alpha complementation and inactivation of drug resistance cassette), use of suicide genes for counter-selection of non-recombinants. Expression vectors and its components: strong promoters (prokaryotic and eukaryotic), reporter genes, and gene fusions. Expression systems in *S. cerevisiae* (YIp, YEp, YRp and YCp vectors), *Pichia pastoris*, baculovirus-based expression vectors, mammalian SV40 based expression vectors

UNIT – III (10 hours)

Introduction of DNA into living cells and analysis of DNA, RNA and proteins: Physical methods of introduction of DNA into cells: microinjection, electroporation, biolistic particle delivery. Chemical methods: Calcium chloride-based method, liposome-mediated delivery. Biological Methods: viral-mediated delivery, Agrobacterium - mediated gene transfer. DNA and RNA analysis by agarose gel electrophoresis, Southern Blotting and Northern Blotting. Protein analysis by SDS-PAGE and western blotting. Probes labelling by random priming and nick translation. Techniques to identify interaction of DNA with proteins: Gel Retardation Assay and DNA Footprinting. Transcriptome analysis by Microarrays. Phage display.

UNIT – IV (20 hours)

Amplification and Sequencing of DNA, and Applications of recombinant DNA technology: PCR: Basic Reaction, primer designing, RT-PCR, Real-Time PCR. Applications of PCR. DNA Sequencing: by Sanger's Method. Automated DNA sequencing. Primer walking. Hierarchical versus whole genome shotgun sequencing. Human Genome Project. Introduction to Next Generation Sequencing (NGS) method: Illumina platform. Genomic and cDNA libraries: Construction and uses of genomic and cDNA libraries, their screening

by colony hybridization, colony PCR, immunoscreening and bioactivity assays.
Recombinant Products of human therapeutic value: Insulin, recombinant vaccines. Gene therapy: Somatic and germline, strategies, applications, and current status. Gene cloning in agriculture: Bt cotton, antisense RNA technology (FlavrSavr tomato). Safety concerns with GM crops. Applications in forensics: DNA fingerprinting by RFLP.

Practical component

UNIT 1: (15 hours)

Analysis of DNA fragments by agarose gel electrophoresis: Determination of molecular weight of given DNA against a standard DNA molecular weight ladder by resolution on agarose gel electrophoresis followed by graphical analysis of the migration patterns. Restriction digestion analysis of given plasmid DNA: comparison of RFLP patterns between vector and gene clone (vector plus insert) by analysis on agarose gel electrophoresis. Ligation of Lambda HindIII fragments: comparative analysis of DNA before and after ligation by analysis on agarose gel electrophoresis.
Cloning of GFP gene in bacteria OR cloning of gene into suitable vector followed by selection using alpha-complementation.

Unit 2: (15 hours)

DNA sequencing and DNA amplification: Introduction to DNA sequencing by Sanger's method using virtual lab and videos: traditional as well as automated methods. Interpretation of sequencing results: reading a sequence off a traditional autoradiogram as well as current sequencing electropherogram. Introduction to PCR: designing primers for amplification of a fragment of genomic DNA. Group experiment: amplification of bacterial rDNA using 16S rDNA primers- performance of PCR and analysis of results by agarose gel electrophoresis.

Essential/recommended readings

Theory:

1. Molecular Biotechnology: Principles and Applications of Recombinant DNA by B.R. Glickand C.L. Patten. 6th edition. ASM Press, USA. 2022.
2. Gene Cloning and DNA Analysis: An introduction by T. A. Brown. 8th edition. Wiley-Blackwell Publishing, UK. 2020.
3. Prescott's Microbiology by J. M. Willey, K. Sandman and D. Wood. 11th edition. McGrawHill Higher Education, USA. 2019.
4. Principles of Gene Manipulation and Genomics by S.B. Primrose and R.M. Twyman. 8th Edition. Blackwell Publishing, UK. 2016.
5. Biotechnology by D.P. Clark, N.J. Pazdernik. 2nd edition. Academic Press, USA. 2015.

Practicals:

1. Gene Cloning and DNA Analysis: An introduction by T. A. Brown. 8th edition. Wiley-Blackwell Publishing, UK. 2020.

2. Molecular Cloning: A Laboratory Manual by M. Green and J. Sambrook Volumes 1-3. 4th edition. Cold Spring Harbor Laboratory Press, USA. 2012.

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