

B.Sc (Hons.) Biomedical Science
Discipline Specific Core (BIOMED-DSCs)
(ACBR)
SEMESTER- IV

DISCIPLINE SPECIFIC CORE COURSE -10 (BIOMED-DSC-10) IMMUNOBIOLOGY

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		
Immunobiology BIOMED-DSC-10	4	3	-	1	XII Pass with Physics, Chemistry & Biology	Basic knowledge of biology

Learning objectives

The students will learn

- The organization and functioning of the immune system and its branches- Innate and Humoral, its complex network of cells, molecules, tissues and organs
- Various Immunological techniques and their applications
- Various types of vaccine based immunotherapies

Learning outcomes

Having successfully completed this course, students shall be able to learn

- The human immune system and its components and how the immune system responds to ‘non-self’ entities.
- The principle, methodology and applications of various laboratory techniques involving antigen-antibody reaction.
- Various types of vaccine based immunotherapies will help them to think about new approaches for combating pathogens.

SYLLABUS OF BIOMED-DSC-10:

Unit I: Overview of Immune System

(05 hrs)

Historical background, general concepts of the immune system, innate and adaptive immunity, primary and secondary immune response, active and passive immunity. Haematopoiesis

Lymphoid Organs: Thymus, Bone marrow, Lymph nodes, Spleen, MALT, GALT and SALT.

Unit II: Innate Immune response

(10 hrs)

Physical and Chemical barriers.

Cells of the innate immune system: NK cells, Monocytes and Macrophages; Neutrophils, Eosinophils, Basophils, Mast cells and Dendritic cells.

Complement system: Components of the complement activation-classical, alternative and lectin pathways; biological consequence of complement activation.

Introduction to Pathogen Associated Molecular Pattern and Pattern Recognition Receptors Mechanisms of pathogen killing by macrophages and neutrophils.

Concept of inflammation.

Unit-III Antigens and their presentation in immune responses:

(06 hrs)

Antigenicity and immunogenicity, haptens. Properties (foreignness, molecular size, heterogeneity, route and dose of administration, solubility and degradability); Types of antigens.

Major Histocompatibility Complex: Genome Organization of MHC and inheritance in humans; concepts of polygeny and polymorphism with respect to MHC and its contribution in survival of host population.

Antigen presenting cells, antigen processing, loading (Bimolecular complex formation) and presentation pathways (cytosolic and endocytic).

Unit IV: Adaptive Immune Response

(10 hrs)

Cells of the adaptive immune system: T and B lymphocytes, Characteristics of adaptive immune responses.

Humoral immune response: Stages of B cell development in bone marrow, stages of B cell activation in the secondary lymphoid organs. Antibodies: structure, function and properties of the antibodies; different classes (isotypes) and subclasses. Biological activities of antibodies, concepts of antibody diversity, monoclonal and polyclonal antibodies, Hybridoma technology.

Cell mediated immune response: Major steps in T cell differentiation in thymus- thymic selection, self MHC restriction, T cell receptor complex. Phenotypic characteristics of naïve T-cells ($CD4^+$ and $CD8^+$ T-cells). Stages of activation of naïve T-cells in secondary lymphoid organs and effector functions of $CD4^+$ and $CD8^+$ T lymphocytes.

Basic introduction and properties of cytokines: IL-2, IL-4 and IFN- γ .

Concept of hypersensitivity.

Unit V: Principles of Antigen- Antibody Interactions and Techniques (09 hrs)

Basic concepts of antigen-antibody interactions (epitope-paratope), Affinity and avidity, cross reactivity, precipitation, agglutination, immunodiffusion, ELISA, ELISPOT, western blotting.

Unit VI: Vaccines (05 hrs)

Contribution of Sir Edward Jenner and Louis Pasteur in vaccine development. Major types of vaccine and their characteristics, adjuvants. National Immunization programme.

Practical (30 hrs)

(Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Virtual demonstration of lymphoid organs and phagocytosis.
2. To perform immuno-diffusion by Ouchterlony method.
3. To perform Immuno-diffusion by Mancini method.
4. To perform Lateral Flow assay/ Immunochromatography.
5. To perform Complement fixation assay.
6. To perform direct (blood group) agglutination assay.
7. To perform indirect (Widal test) agglutination assay.
8. To perform sandwich dot ELISA

Essential readings:

- Delves, P.J. Martin, S.J. Burton, D.R. and Roitt, I. M. (2017). 13th Edition. *Roitt's Essential Immunology*. New Jersey, USA: Wiley-Blackwell Science. ISBN: 13: 978- 1118415771.
- Punt, J. Stranford, S. Jones, P. and Owen, J. (2019). 8th Edition. *Kuby Immunology*. New York, USA: W.H. Freeman and Company. ISBN- 13: 978-1464189784.

Suggestive readings:

- Kindt T. J., Osborne B. A. , Goldsby R. A. (2007). 6th Edition *Kuby Immunology*. New York, USA: W.H. Freeman and Company. ISBN-13: 978-1429202114 ISBN-10: 1429202114.

- Willey, J. Sherwood, L and Woolverton, C.J. (2016). 10th Edition. *Prescott's Microbiology*. New York, USA: McGraw-Hill Education. ISBN-13: 978-1259281594.
- Hay, F.C. and Westwood, O.M.R. (2002). 4th Edition. *Practical Immunology*. New Jersey, USA: Blackwell Science. ISBN: 9780865429611.

DISCIPLINE SPECIFIC CORE COURSE –11 (BIOMED-DSC-11) MOLECULAR 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
		Lecture	Tutorial	Practical/Practice		
Molecular Biology BIOMED-DSC-11	4	3	-	1	XIIth Pass with Physics, Chemistry & Biology	Basic knowledge of biology

Learning objectives

- The objective of the course is to offer detailed and comprehensive knowledge about the mechanisms of DNA replication, repair, transcription and translation in prokaryotes and eukaryotes so that students can apply this knowledge in enhancing their analytical and research problem solving skills.
- As the course progresses, students would comprehend the basic mechanism of DNA replication in prokaryotes and eukaryotes along with associated discerning features.
- Students would also understand the mechanism of introduction of mutations and how these are repaired inside the cell.
- Students would be able to understand that, molecular biology as a field started with an in-depth research and studies on prokaryotes and only recently our understanding of life processes in eukaryotes have increased considerable.

Learning outcomes

- This course focuses on the molecular processes involving biomolecules and provides students with a range of theoretical knowledge and associated practical skills.

- Students would comprehend biological processes such as Replication, Transcription and Translation. While studying the unit on Replication, students would also appreciate how various kinds of errors can be introduced and if not removed may manifest themselves as mutations.
- The course would help them understand established repair mechanisms to take care of these mutations. Hand-in-hand and related practical knowledge would help students build their foundation for future courses like Medical Biotechnology and Genome Organization and Function.
- Students would appreciate the recent advances in molecular biology that have led to the completion of genomic projects that are changing the face of modern biology, especially in areas of medicine, agriculture and biotechnology. Research in this field has also helped in understanding the molecular basis of illnesses and use of genetic manipulation in biotechnology to make valuable products including blood clotting factors, insulin and vaccines.

SYLLABUS OF BIOMED-DSC-11

Unit-I: The Replication of DNA in Prokaryotes and Eukaryotes

(14 hrs)

An introduction to chemistry of DNA synthesis. Enzyme and proteins involved in DNA replication—helicase, topoisomerases, DNA polymerases, DNA ligase, primase, RNaseH, telomerase, sliding clamp, sliding clamp loader and SSBs. Mechanism of action of DNA polymerase, DNA transactions during replication—bidirectional replication, semi-conservative, discontinuous. Mechanics at the DNA replication fork: RNA priming, initiation and termination of DNA replication (comparing prokaryotes with eukaryotes), regulation of bacterial DNA replication, replicating the 5' end of linear chromosome, replication coupled to chromatin synthesis in eukaryotes. Various models of DNA replication including Trombone model, D-loop (mitochondrial), Theta mode of replication, Rolling circle model, replication of linear ds-DNA.

Unit-II: The Mutability and Repair of DNA

(6 hrs)

Replication Errors (transitions, transversion and thymine dimer), DNA Damage (deamination, depurination and dimerization). DNA repair: Direct repair, Mismatch repair, Excision Repair, Photo reactivation, Recombination Repair, SOS response.

Unit-III: Information Transfer—I: Mechanism of Transcription.

(8 hrs)

Basic transcription apparatus. Transcription in Prokaryotes: Initiation, elongation and termination of transcription, Promoter sequences and concept of abortive initiation. Transcription in Eukaryotes: Types of RNA polymerases, RNA polymerase II, Promoters, TBP and other transcription factors. Transcription by RNA polymerase I and III. Inhibitors of transcription- rifampicin and- amanitin.

Unit-IV: Post-Transcriptional Modifications

(8 hrs)

Split Genes, Concept of introns and exons, RNA splicing pathways: Spliceosomes and Self splicing introns (Group I and Group II introns), Ribozymes, Variants of splicing: alternative splicing, exon shuffling and RNA editing, Mutually exclusive splicing (example Drosophila Dscam gene), Mechanism determining the sex of Drosophila.

Unit-V: Information Transfer-II: Mechanism of Translation

(9 hrs)

Features of genetic code and exceptions in some systems. Types of RNA: Messenger RNA, Ribosomal RNA and Transfer RNA, Ribosomal structure, Charging of tRNA, Amino-acyl tRNA synthetases, Proteins and factors involved in translation. Process of translation: Initiation, elongation and termination (Prokaryotes and Eukaryotes), Fidelity of translation, Translation-Coupled removal of defective mRNA. Inhibitors of protein synthesis–tetracyclins, aminoglycosides, chloramphenicol and aminoglycosides.

Practical

(30 hrs)

(Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Calculations and preparation of various stock and working solutions of Molecular Biology experiments (Number 2 to 9).
2. Isolation of genomic DNA from bacterial cells.
3. Isolation of genomic DNA from blood/tissue.
4. Fractionation of DNA by agarose gel electrophoresis.
5. To determine the lambda max for DNA and protein.
6. Quantify and analyze the purity of DNA using spectrophotometer (estimating at 260 nm, 280 nm and 320 nm).
7. Quantitative estimation of salmon sperm/calf thymus DNA using colorimetric assay using Diphenylamine reagent.
8. In vitro gene amplification method of Polymerase Chain Reaction (PCR): Primer designing and setting up of the reaction.

9. Analysis of the PCR products.

Essential readings:

- Karp, G. (2020). 9th Edition. *Cell and molecular biology: Concepts and experiments*. New Jersey, USA: Wiley Publishers, ISBN-13: 978-1119598244
- Cox, M. M. Doudna J. A. and Donnell, M. O. (2015). 2nd Edition. *Molecular biology: Principles and practice*. London, UK: W H Freeman & Co Publishers, ISBN-13: 978-1464126147
- Watson, J. D. Baker T. A. Bell, S. P. Gann, A. Levine, M. and Losick, R. (2013). 7th Edition. *Molecular Biology of the Gene*. New York, USA: Cold Spring Harbor Laboratory Press, ISBN-13: 978-0-321-76243-6.
- Green, M.R. and Sambrook, J. (2012). 4th Edition. *Molecular cloning: A laboratory manual*, New York, USA: Cold Spring Harbor Laboratory Press, ISBN-13:978-1936113422.
- Hardin, J. Bertoni, G.P. Kleinsmith, L.J. and Becker, W.M. (2008). 7th Edition. *The world of the cell*. San Francisco, USA: Benjamin Cummings Publishers, ISBN-13:978-0805393934.

Suggestive Readings

- Kornberg, A. (2005). 2nd Edition. *DNA replication*. California, USA: University Science Books, ISBN-13: 978-1891389443.

DISCIPLINE SPECIFIC CORE COURSE -12 (BIOMED-DSC-12) PHARMACOLOGY**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 BIOMED-DSC-12	4	3	-	1	XII Pass with Physics, Chem & Biology	Basic knowledge in Functioning of human body.

Learning objective

- This course is concerned with the study of drugs and how they can be used in the treatment of various diseases.
- The students will be able to learn about various formulations and administration of drugs in the body. The course provides basic mechanisms by which various drugs modify/affect physiology of the body leading to the treatment of various diseases.
- Students will also get an insight into making choice and functioning of drugs given to treat microbial infections, and various diseases due to imbalance of hormones in the body.

Learning outcomes

- Students will be familiarized with the naming and formulation of drugs; routes of drug administration and conditions under which one route is preferred over another in patients; various macromolecular targets (receptors, enzymes, etc.) of drugs in the body.
- They will also learn basic mechanisms of absorption, transport, excretion of drugs and effects of metabolism on drug action; basics of quantification of half-life, bio-availability and elimination of drugs in the body and factors affecting them; an insight into measurement of response, efficacy and potency of drug, and factors affecting action of the drugs.
- Students will also be imparted knowledge of the classification, mechanism of action, uses and contraindication of various classes of drugs. Assessment of the choice of antimicrobial drugs; problems arising from indiscriminate/inadequate use of antimicrobial drugs. Use of hormones and

hormone antagonists as drugs in endocrine system related disorders; hormone replacement therapy and its application.

SYLLABUS OF BIOMED-DSC-12

Unit-I: Introduction to pharmacology (07 hrs)

Nomenclature of drugs, various dosage forms of drugs (solid, liquid, semi-solid and inhalation forms) routes of drug administration, their advantages and disadvantages, various macromolecular targets of drugs (membrane receptor, transporters, enzymes, channels etc.).

Unit-II: Pharmacokinetics and pharmacodynamics (09 hrs)

Drug absorption, distribution, metabolism, and excretion, bio-availability, excretion and kinetics of elimination, biological half-life of drug and its significance, drug-drug interactions.

Unit-III: Mechanism of action of different classes of drugs (18 hrs)

General aspects; classification and mechanism of action of following classes of drugs along with side effects and contraindication of the drugs mentioned against each class should also be covered.

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| (a) General Anesthetics: | Halothane |
| (b) Sedatives and Hypnotics: | Diazepam |
| (c) Cholinergics: | Bethanechol, Rivastigmine |
| (d) Skeletal Muscle Relaxants: | Succinylcholine |
| (e) Adrenergics: | Isoprenaline, Propranolol |
| (f) Dopaminergics: | L-Dopa, Carbidopa |
| (g) Diuretics: | Furosemide |
| (h) Analgesics and Antipyretics: | Aspirin, Celecoxib |

Unit-IV: Chemotherapy of microbial disease (05 hrs)

General aspects of anti-microbial therapy, Antibacterial (Quinolones: Ciprofloxacin).

Unit-V: Hormones and hormone antagonists (06 hrs)

Brief introduction to hormones; insulin and oral hypoglycemic agent (tolbutamide, metformin), HRT, estrogen and progestins (progesterone, hydroxylprogesterone caproate).

Practical (30 hrs)

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Handling of laboratory animals.
2. Routes of drug administration (Oral, I.M.)
3. To study the presence of acetaminophen in given sample.
4. To study the stages of general anesthesia.
5. To determine partition coefficient of general anesthetics.
6. Effect of analgesic (Tail-flick test).
7. Anti-anxiety effect of Valium (Plus maze test).
8. Fixing of organ bath and kymograph.
9. To record CRC of acetylcholine using guinea pig ileum/ rat intestine.
10. Determination of dose ratio.
11. Study of competitive antagonism using acetylcholine and atropine.

Essential reading

- Kulkarni, S.K. (2014). 4th Edition, Reprint. *Handbook of Experimental Pharmacology*, Vallabh Prakashan, India, ISBN-13: 978-8185731766.
- Tripathi, K.D. (2018). 8th Edition. *Essentials of Medical Pharmacology*. Jaypee Brothers, India, ISBN-13: .9352704996-978

Suggestive readings

- Ritter, J.M., Flower, R., Henderson, G., *et al.* (2019). 9th Edition (International). *Rang and Dale's Pharmacology*. Relx India Pvt. Ltd, ISBN-13: 978-0702074479.
- **Katzung, B. G.**, (2021) Basic and Clinical Pharmacology, 15th Edition, McGraw-Hill Education, ISBN: 978-1260452310