Name of faculty: Science	**Department:** Biotechnology
Program: B.Sc. Biotechnology	**Type:** Theory + Practical
Subject: DSC-9 Molecular Biology	**Semester:** 5
Credit: 04 + 02	**Total learning hours:** 60

Course Description:
Inculcate strong fundamentals on basic and advanced molecular biology concepts. This is a vital course for the graduate students which provides enhanced knowledge on replication, transcription and translation with their regulatory aspects and also includes content imparting knowledge about protein maturation and post translational modifications.

Student Learning Outcome: After completion of this course the students will be able to understand the central dogma of molecular biology. Further the syllabus will mainly elaborate the following points

- Covers the concept of genetic codes and their features. It explains more about the transcription occurring in Bacteria, Eukaryotes and Archaea.
- Emphasizes on synthesis of proteins, how are these proteins modeled to give a correct form. It also explains further about protein maturation and how these proteins are targeted to their destination on secretion.
- Highlights about the levels of regulation involved in RNA and protein synthesis. It gives information on processes like splicing and RNA editing. It explains about the role of ubiquitylation and chaperon mediated protein folding
- Provides information about regulation of genes in viruses additionally. It talks more about global regulatory systems.

Unit-1 DNA REPLICATION (07 Hours)
1.1 General features of DNA replication
1.2 Replication in prokaryotes
1.3 Replication in eukaryotes
1.4 Termination of replication
1.5 Regulation of replication

Unit-2 DNA MUTATIONS AND REPAIR (08 Hours)
2.1 Chemical basis of mutations
2.2 Spontaneous and Induced mutations
2.3 Effect of mutations
2.4 Detection and Isolation of mutants
2.5 DNA repair

Unit–3 MOLECULAR RECOMBINATION AND GENE TRANSFER-I (07 Hours)
3.1 Introduction to recombination and recombination in eukaryotes
3.2 Horizontal gene transfer in prokaryotes
3.3 Recombination at molecular level
3.4 Transposable elements
3.5 Bacterial plasmids

Unit–4 MOLECULAR RECOMBINATION AND GENE TRANSFER-II (07 Hours)
4.1 Bacterial Conjugation
4.2 Bacterial Transformation
4.3 Transduction
4.4 Development of antibiotic resistance in bacteria
4.5 Mapping the genome

Unit–5 TRANSCRIPTION AND GENETIC CODE (08 Hours)
5.1 Transcription in Bacteria
5.2 Transcription in Eukaryotes
5.3 Transcription in Archaea
5.4 Establishment of Genetic Code
5.5 Characteristics of Genetic Code

Unit–6 TRANSLATION (08 Hours)
6.1 tRNA and amino acid activation
6.2 Ribosome Structure
6.3 Initiation of Protein Synthesis
6.4 Elongation and Termination of Protein Synthesis
6.5 Protein maturation and secretion

Unit–7 REGULATION OF GENE EXPRESSION-I (08 Hours)
7.1 Levels of Regulation
7.2 Regulation of Transcription initiation
7.3 Regulation of Transcription elongation
7.4 Regulation of Translation

Unit- 8 REGULATION OF GENE EXPRESSION-II(07 Hours)
8.1 Post-translational Regulation
8.2 Global regulatory systems
8.3 Regulation of gene expression in Eukarya and Archaea
8.4 Gene regulation in Bacteriophage λ

References & Text Books:

- Willey, J. M., Sherwood, L. M. and Woolverton, C. J. (2008). Prescott, Harley and Klein's Microbiology, 7th Edition, McGraw Hill International Edition.
- Pal, J. K. and Ghaskadbi, S. S. (2009). Fundamentals of Molecular Biology, Oxford University Press.

Practicals:

1. Extraction of bacterial plasmid by alkaline lysis method
2. Extraction and Purification of bacterial DNA using spin column method.
3. Restriction digestion of plasmid vector.

Reference and Textbooks for Practical:

- Philippa D. Darbre, Introduction to Practical Molecular Biology, Wiley–Blackwell, ISBN- 978-0471919650
- T.A Brown, Essential Molecular Biology: A Practical Approach VolumeII, Oxford University Press; 2nd edition, ISBN-978-0199636440

Name of faculty: Science	**Department:** Biotechnology
Program: B.Sc. Biotechnology	**Type:** Theory + Practical
Subject: DSC-10: Fundamentals of Immunology	**Semester:** 5
Credit: 04 + 02	**Total learning hours:** 60

Course description:

The paper imparts the fundamental aspects of the protective defence system mounted by the host against the foreign threat/invading harmful agents. It encompasses various components and approaches employed by the host defence system to provide protective state – immunity against such invading harmful agents-pathogens. It discusses the applications that are devised using these components and approaches including diagnosis, treatments, therapy, prophylaxis etc. and also elucidate the abnormalities/diseases/disorders arising on account of immune malfunctioning.

Student learning outcome:

On completion of course students will be able to:

- Understand the immune system, its components and their action to provide the protective state to the host system.
- Explain the significance of functioning of innate and adaptive immune systems in eradicating pathogens or harmful agents.
- Explain how the protective immune system once developed in the host lasts for lifetime and actively works in removing the antigen efficiently at every moment of attack.
- Describe interactions of the immune components (Ag-Ab/cell) in *in vitro* and *in vivo* conditions.
- Apply these interactions for diagnostic, prognostic purposes i.e. as diagnostic techniques, vaccines, treatments and control of diseases and disorders.
- Learn about the various conditions a host may get exposed to if the host immune system does not work in a regulated controlled manner by studying immune related diseases and disorders.

Unit-1: Introduction To Immunology And Immune System: (6h)

1.1. Historical Perspective Of Immunology
1.2. Types Of Immune System
1.3. Cells Of Immune System
1.4. Organs And Tissues Of Immune System

Unit-2: Innate Immunity: (8h)

2.1 Anatomic/Physical Barriers
2.2 Chemical Barriers: (Cytokines, Antimicrobial Peptides, Complement System, Acute Phase Proteins)
2.3 Inflammatory Barrier

2.4 Phagocytic Barrier (NLR, TLR, PRRs)

Unit-3: Specific Immunity: (8h)

3.1 Features of Adaptive Immunity
3.2 MHC Complex, CDS And Recognition of Foreignness
3.3 T-cell Biology (TCRs, T Cell Activation, Types of T Cells)
3.4 B-cell Biology (BCRs, B Cell Activation)

Unit-4: Antigens and Antigen Processing: (6h)

4.1 Immunogenicity V/S Antigenicity
4.2 Factors Influencing Immunogenicity
4.3 Epitopes and Haptens
4.4 Antigen Processing and Presentation (Cytosolic Pathway, Endocytic Pathway)

Unit-5: Antibodies: (9 h)

5.1 Immunoglobulin Structure
5.2 Classes of Immunoglobulin
5.3 Antibody Mediated Effector Functions
5.4 Antibody Diversity
5.5 Clonal Selection

Unit-6: Monoclonal Antibodies And Antigen-antibody Reactions: (8h)

6.1 Monoclonal Antibodies: (Production-Hybridoma Technology, Applications of Monoclonal Antibodies)
6.2 Precipitation
6.3 Agglutination
6.4 ELISA
6.5 RIA
6.6 Immunofluorescence
6.7 Immunochromatography

Unit-7: Hypersensitivity And Autoimmune Diseases: (8 h)

7.1. Hypersensitivities
7.2. Autoimmunity (IDDM, Transplantation Rejection)
7.3. Immunodeficiency Diseases (General Features of Immunodeficiency, Primary Immunodeficiency- SCID, Secondary Immunodeficiency- HIV and AIDS)

Unit-8: Vaccines: (7 h)

8.1. Active V/S Passive Immunization
8.2. Designing Vaccines
8.3. Attenuated Vaccines
8.4. Killed Vaccines
8.5. Subunit Vaccines
8.6. Recombinant Vector Vaccines
8.7. DNA Vaccines

References:

- Janis Kuby, Kindst, Gatsby And Osborne, Kuby Immunology –, 6th Edition, W. H. Freeman Publications. ISBN-13-978-0716767640
- Ashim Chakravarty, Immunology And Immunotechnology- Oxford University Press, ISBN-13: 978-0-19-567688-4
- John P. Harley, Donald A. Klein, Microbiology- Lansing Prescott,, 10th Edition, Mcgraw Hill Publication. ISBN-13-978-1259281594
- Keith Wilson and John Walker, Principles and Techniques of Biochemistry and Molecular Biology,, 7th Edition, Cambridge University Press. ISBN-978-0521178747
- A. K Abbas, A. Lichtman, S. Pillai, Cellular and Molecular Immunology-, International Edition, ISBN: 978-1-4160-3122-2 International Edition ISBN: 978-0-8089-2358-9

Practicals:

1. To perform Differential count of blood cells.
2. To detect HIV and Hepatitis through ELISA.
3. To diagnose Salmonella infection through Widal test.
4. To perform and analyse the antigen quantitatively through Mancini's test.

Name of faculty: Science	**Department:** Chemistry
Program: B.Sc.	**Type:** Theory + Practical
Subject: SEC- 3 Instrumentation and Techniques	**Semester-** 5
Credit: 04 + 02	**Total learning hours:** 60

Learning objective:

- Completion of this course will impart working knowledge of analytical instrumentation typically employed in chemical and biochemical research laboratories to students.
- Develop their hand on skills to use the different instruments and obtain results using appropriate techniques.
- It will also provide the student with an appreciation of the relative strengths and limitations of different instrumental based analysis methods.

Course description:

This course is concerned with the theory and practice of instrumental methods for the separation, identification and quantitative analysis.

Student learning outcome:

Upon completion of this course, students will:

- Integrate a fundamental understanding of the underlying principles.
- Use key instrumental techniques for separation and analysis.
- Distinguish between qualitative and quantitative measurements and be able to effectively compare and critically select methods for analyses.

Learning methods and activities:

- Lectures
- Demonstrations
- Written assignments
- Tests
- Hands-on training

Unit-1 Introduction to instrumental methods (4 Hrs)

1.1 Classification of analytical methods
1.2 Types of instrumental techniques
1.3 Basic functions of instrumentation
1.4 Instruments for analysis
1.5 Factors affecting the choice of technique

Unit-2 Potentiometry (08 Hrs)

2.1 General principle
2.2 Reference electrode: Calomel electrode and silver/silver chloride electrode
2.3 Membrane indicator electrode
2.3.1Types of membrane
2.3.2 Glass electrode for pH measurement
2.3.3 Other ion selective electrodes

2.4 Bio-catalytic membrane electrode

Unit-3 Optical methods of analysis (10 Hrs)

3.1 Origin of spectra, interaction of radiation with matter, Beer-Lambert's law
3.2 UV-Visible Spectrometry: Basic principle, instrumentation (single and double beam instrument), application
3.3 Infrared Spectrometry: Basic principle, instrumentation (single and double beam instrument), sampling technique, application
3.4 Atomic absorption spectrometry: Basic principles of instrumentation, choice of flame and burner designs, techniques of atomization and sample introduction

Unit-4 Thermo-analytical instruments ((06 Hrs))

4.1 Theory of thermogravimetry (TG)
4.2 Basic principle of instrumentation
4.3 Techniques for quantitative estimation of Ca and Mg from mixture
4.4 Applications and limitations

Unit-5 Chromatography: I (09 Hrs)

5.1 Classification
5.2 Principle and efficiency of the technique
5.3 Paper Chromatography: Principles, procedures, developments of chromatogram - ascending, descending and radial, applications
5.4 Thin layer Chromatography (TLC): Advantages, principles, adsorbents and solvents preparation of plates development of the chromatogram, spot detection, applications

Unit-6 Chromatography: II (10 Hrs)

6.1 Gas chromatography: Principles, stationary and mobile phases, column, detectors (TCD, ECD, FID), application and limitation
6.2 HPLC: Basic principle, instrumentation, detectors, application
6.3 Ion exchange chromatography
6.4 Gel filtration chromatography

Unit-7 Electrophoresis (07 Hrs)

7.1Introduction
7.2 Types of electrophoresis
7.3 Principle
7.4 Application

Unit-8 Radiochemical instruments (06 Hrs)

8.1 Fundamentals of radiochemical methods
8.2 Measurement of alpha particles
8.3 Measurement of beta particles
8.4 Measurement of gamma radiation
8.5 Isotope dilution method: Principle and application

Reference Books:

1. Basic Concepts of Analytical Chemistry by S.M. Khopkar
2. Elementary organic spectroscopy by Y.R. Sharma
3. Instrumental Methods of Analysis by Willard, H.H
4. Principles of Instrumental Analysis by Skoog, Holler F.J. Stanley R. Crouch
5. Quantitative analytical chemistry by James S. Fritz George H. Schenk
6. Instrumental methods of Chemical analysis by Gurdeep R.Chatwal
7. Instrumental Methods of Analysis by Willard, Merritt, Dean, Settle

Laboratory work:

1. Determination of pH of soil/aerated drinks/fruit juices/shampoos/soaps
2. Verification of Lambert-Beer's law and determination of concentration of a coloured species ($CuSO_4$/$KMnO_4$/$K_2Cr_2O_7$/ Thiocyanatoiron(III))
3. Separation and identification of the monosaccharides present in the given mixture (glucose & fructose) by paper chromatography
4. Separation of green leaf pigments/o-and p-nitrophenol/ Sudan yellow and Sudan Red using TLC
5. Analysis of pre-recorded IR spectroscopic data of organic compounds.

Name of faculty: Science	**Department:** Microbiology
Program: B.Sc.	**Type:** Theory
Subject: DSE-5 Haematology and Blood Banking	**Semester:**5
Credit: 02	**Total learning hours:** 30

Course description:
This is an advanced course in Hematology and Blood Banking for B.Sc students. This course is designed to highlight the important principles and concepts of haematological and blood banking and thereby emphasising on theoretical as well as practical knowledge in preparation, handling and testing of various diagnostic criteria related to it.

Student learning outcome:

- Students will be benefited by understanding the basic concepts of various routes of blood collection, mechanism of blood coagulation and various types of anticoagulant used in vitro
- Students will be conceptualized about Haemoglobin, various types of anemia, and clinical diagnosis related to blood coagulation.
- Students will acquire the understanding about blood banking by learning ABO and Rh typing, various compatibility tests and significance in blood transfusion

Unit-1: Introduction to Haematology (Duration: 4 Hrs)

1.1 Composition of Blood
1.2 Collection of Blood in Laboratory
1.3 Anticoagulants

Unit-2: Haematological Analysis (Duration: 5 Hrs)
2.1 Estimation of Haemolglobin (Cyanmethaemoglobin method)
2.2 Total Count of WBCs and RBCs
2.3 Determination of Erythrocyte Sedimentation Rate (ESR)
2.4 Differential count of Leucocytes

Unit-3: Haematological Disorders and Hemostasis (Duration: 5 Hrs)
3.1 Anaemia
3.2 Introduction to Haemostasis and Coagulation
3.3 Laboratory Investigations of Bleeding Disorders
3.3.1 Bleeding time Determination: Ivy method
3.3.2 Whole Blood Clotting time : Lee White method

Unit-4: Immunohaematology (Duration: 4 Hrs)
4.1 Principles of Immunohaematology
4.2 Blood Group Genetics
4.3 ABO Blood and Rh Group System

Unit-5: Introduction to Blood Banking (Duration: 2 Hrs)
5;1 Clinical significance of Blood transfusion
5.2 Collection and Processing of Blood for Transfusion
5.3 Storage of Blood

Unit-6: Blood components and Compatibility tests (Duration: 4 Hrs)
6.1 Preparation and Use of Blood Components
6.2 Compatibility Testing
6.3 Major and Minor Cross Matching

Unit-7: Blood transfusion and Other Compatibility tests (Duration: 3 Hrs)
7.1 Antihuman Globulin Test
7.2 Hemolytic Disease of Newborn (HDN)

Unit-8: Transfusion Reactions and complications (Duration: 3 Hrs)
8.1 Transfusion therapy
8.2 Apheresis/Hemapheresis
8.3 Automation in Haematology

Reference Book:

- Mukharjee K. L. (1988), Medical Laboratory Technology, Vol I, Tata McGraw Hill Publishing. ISBN: 0-07-463260- 4
- Ochei J. and Kolhatkar A. (2000), Medical Laboratory Science – Theory and Practice, Tata McGraw Hill Publishing. ISBN: 0-07-463223
- SR Mehdi, (2013), Essentials of Blood Banking, 2nd Edition, Jaypee Brothers Medical publishers (p) ltd: ISBN: 978-93-80704-52-4
- Geoff Daniels et al, (2013), Essential Guide to Blood Groups, Third Edition, John Wiley & Sons, Ltd., ISBN:9781118688922
- Barbara A Brown (1988), Haematology: Principles and Procedures, Lea & Febiger. ISBN: 9780812111255

Further Reading:

- Denise M Hermening (2005), Modern Blood Banking and Transfusion Practices, 6th Edi., Library of Congress Cataloging-in-Publication Data. ISBN: 9780803626829
- Praful Godkar and Darshan Godkar (2014*),* Textbook of Medical Laboratory Technology (Set of 2 Volumes)*,* Bhalani Publishing House. ISBN: 9789381496190

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Name of faculty: Science	**Department:** Chemistry
Program: B.Sc.	**Type:** Theory
Subject: DSE-5-Bioinformatics and Chemoinformatics	**Semester-**5
Credit: 02	**Total learning hours:** 30
Course description: The objectives of this course are to provide students with the theory and practical experience of the use of common Bioinformatics tools which facilitate investigation of molecular biology and evolution-related concepts. This course for chemistry, biochemistry and bioinformatics students introduces the small-molecule-ligand-oriented in silico physical chemistry aspects of rational drug design. Topics include Introduction to subject, information regarding basic database and application of cheminformatics.	
Student learning outcome: ● Able to gain basic idea of Computer and Bioinformatics ● Able to understand what is Database and how it is managed? ● Can gain knowledge of NCBI and other Bioinformatics concepts. ● Able to understand aim of Bioinformatics, its scope and use for biotechnology research ● Able to Describe the principles of cheminformatics ● Able investigate chemicals and materials that are not practical for laboratory analysis ● Able to practise computer assisted structure elucidations	

Unit-1 Introduction to Computer & Bioinformatics (04 Hrs)

1.1 MS-WORD, EXCEL, Microsoft PowerPoint, Adobe Photoshop
1.2 Introduction & History of Bioinformatics
1.3 Area and Scope of Bioinformatics
1.4 Biological databases, Primary & Secondary Database, DNA and Protein Structure \ and sequence Database, Metabolic Pathway Database

Unit-2 Bioinformatics Tools (04 Hrs)

2.1 Sequence alignment: Pairwise alignment techniques Global alignment, Local Alignment
2.2 Pairwise alignment techniques- continued, Significance of alignment- Z-score, P-score, E-value
2.3 Different types of BLAST and FASTA
2**.4** Multiple sequence Alignment-Dynamic Programing Sequence alignment, ClUSTAL W, HMM

UNIT-3 Bioinformatics Software & Program (04 Hrs)

3.1 Concept of dendrograms and its interpretation, Phylogenetic analysis -Maximum Parsimony and UPGMA methods
3.2 Phylogenetic trees: Rooted and unrooted trees
3.3 Phylogeny programs: PHYLIP, PAUP, MEGA.
3.4 3D structure viewers (Rasmol, SPDBv, Chime, Cn3D, PyMol)

Unit-4 Organization of Bioinformatics in India (03 Hrs)

4.1 BTIS
4**.2** Protein structure prediction server, Conformational epitope prediction server

4.3 Genomics and Proteomics server
4.4 Indian IT Companies involved in Bioinformatics Initiatives

Unit: 5 Introduction to Cheminformatics **(04 Hrs)**

5.1 History and evolution of cheminformatics
5.2 Use of cheminformatics
5.3 Prospects of cheminformatics
5.4 Molecular modelling and structure elucidation

Unit: 6 Chemical Databases **(04 Hrs)**

6.1 CHEMDB
6.2 KEGG LIGAND
6.3 CSD
6.4 CAS REGISTRY
6.5 BIOMETA DB
6.6 National Cancer Institute Database(NCI), PubChem, chEMBL, DrugBank, etc.

Unit-7 Molecular Drawing and Interactive Visualization **(03 Hrs)**

7.1 ChemDraw
7.2 MarvinSketch
7.3 ORTEP
7.4 Chimera

Unit-8 Application of Cheminformatics **(04 Hrs)**

8.1 Prediction of properties of compounds
8.2 Linear Free Energy Relations;
8.3 Quantitative Structure-Property Relations
8.4 Model Building
8.5 Structure-Spectra correlations

Reference books:

1. Bioinformatics: Sequence and genome analysis, Mount, D. W., 2001, Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
2. Introduction to bioinformatics, Attwood TK, Parry-Smith DJ. Essex, 1999, GB: Pearson Education
3. Bioinformatics: Principles and Applications, Ghosh Z. and Bibekanand M., 2008, Oxford University Press
4. An introduction to Chemoinformatics, Andrew R. Leach & Valerie, J. Gillet, 2007, Springer: The Netherlands.
5. Chemoinformatics: A text-book, Gasteiger, J. & Engel, T., 2003, Wiley-VCH.
6. QSAR & Molecular Modeling, Gupta, S. P., 2011, New Delhi: Anamaya Pub.
7. Molecular Modelling for Beginners, Alan Hinchliffe, 2003, John-Wiley