SEMESTER-VI

B.Sc. (Hons.) Microbiology

DISCIPLINE SPECIFIC CORE COURSE – 16: PRINCIPLES OF MOLECULAR BIOLOGY-II

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-DSC601: PRINCIPLES OF MOLECULAR BIOLOGY-II	4	3	0	1	Class XII pass with Biology/ Biotechnology/ Biochemistry	Principles of Molecular Biology-I

Learning Objectives

The Learning Objectives of this course are as follows:

- The major objective of this course is for the student to gain comprehensive knowledge of the basic concepts of molecular biology.
- The student will become familiar with DNA-related cellular processes and will become aware of the central dogma of molecular biology, learning about the propagation of information through DNA replication and the unidirectional flow of information from DNA to RNA to proteins through transcription and translation.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Student will be able to explain RNA processing events including capping, polyadenylation and splicing. Can discourse on the concepts of RNA interference through siRNA and miRNA.
- Student will be able to discuss the mechanisms of translation of proteins in both prokaryotes and eukaryotes, and convey information about the inhibitors of protein synthesis.
- Student will be able to analyze and explain various mechanisms of gene regulation in prokaryotes and eukaryotes at the level of transcription and post-transcriptional

processes, as well as epigenetic mechanisms of gene regulation through chromatin modifications, the role of lncRNAs in gene regulation.

- Student will be able to demonstrate the procedure of isolation and analyze RNA by colorimetric and spectrophotometric methods, resolve proteins by electrophoresis on SDS-PAGE.

SYLLABUS OF DSC-16

UNIT – I (15 hours)

RNA processing and its applications: Difference in structure of prokaryotic and eukaryotic mRNA. Split gene theory, introns and exons. Processing of eukaryotic mRNA: capping and polyadenylation mechanisms and enzymes involved. RNA splicing: Group I and Group II introns and the mechanisms of splicing linked to them. Spliceosome machinery. Concepts of alternative splicing and trans-splicing. Processing of rRNA. RNA interference and its significance. Brief overview of siRNA and miRNAs.

UNIT – II (14 hours)

Translation in prokaryotes and eukaryotes: Translational machinery: ribosome structure in prokaryotes and eukaryotes, tRNA structure, aminoacyl tRNA synthetases and charging of tRNA. Mechanism of initiation, elongation and termination of polypeptide synthesis in prokaryotes and eukaryotes, highlighting the differences in the processes between the two groups of organisms. Mechanisms for maintaining the fidelity of translation.

UNIT – III (16 hours)

Regulation of gene expression in prokaryotes and eukaryotes: Principles of transcriptional regulation in prokaryotes: negative versus positive regulation using lac, trp and ara operons as examples. Gene regulation during sporulation in Bacillus. Yeast mating-type switching. Mechanisms of epigenetic regulation of gene expression: regulation of gene expression by DNA methylation, histone acetylation and histone methylation. Regulation of gene expression by DNA methylation in prokaryotes versus in eukaryotes. Histone methylation as both, positive as well as negative regulator of gene expression. Gene regulation by long noncoding RNAs (lncRNAs).

Practical component

UNIT 1: (15 hours)

Analysis of RNA and its applications:

RNA isolation and estimation: Total RNA isolation from yeast / bacterial cells. Colorimetric analysis of RNA with yeast tRNA as standard, using orcinol reagent or UV spectrophotometry. Northern blot analysis of processed RNA through virtual lab.

Student group research study project: use of mRNA in vaccines – case study of the COVID19 mRNA vaccines: CCMB vaccine technology/platform (based on Pfizer-

BioNTech/Moderna technology) versus Gennova vaccine technology/platform (based on HDT Bio Corp technology)
or
Student group research study project: trans-splicing in trypanosomatids.

Unit 2: (15 hours)
Analysis of proteins:
Analysis of total cell protein of bacteria by SDS-PAGE.
Student group research study project: drugs that inhibit protein translation and their mechanism of action.

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. Karp's Cell and Molecular Biology by G. Karp, J. Iwasa and W. Marshall. 9th edition. Wiley, USA. 2019
3. Molecular Biology by D. Clark, N. Pazdernik and M. McGehee. 3rd edition. Academic Cell, USA. 2018.
4. Lewin's Genes XII by J. Krebs, E. Goldstein and S. Kilpatrick. 12th edition. Jones and BartlettLearning, USA. 2017.
5. Becker's World of the Cell by J .Hardin and G.P. Bertoni. 9th edition. Pearson, USA. 2015.
6. Principles of Genetics by D.P. Snustad and M.J. Simmons. 7th edition. Wiley and Sons, UK. 2015.
7. 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.
8. Cell and Molecular Biology by E.D.P. De Robertis and E.M.F. De Robertis. 8th edition. Lippincott Williams and Wilkins, USA. 2006.

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. An Introduction to Practical Biochemistry by D. Plummer. 3rd edition. McGraw Hill Education, India. 2017.

Suggestive readings

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

DISCIPLINE SPECIFIC CORE COURSE – 17:
ADVANCES IN 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		
MICROB-DSC602: **ADVANCES IN IMMUNOLOGY**	**4**	**3**	**0**	**1**	**Class XII pass with Biology/ Biotechnology/ Biochemistry**	**Basic concepts of Immunology**

Learning Objectives

The Learning Objectives of this course are as follows:

- The main objective of this course is to provide a detailed insight to the student about crucial roles played by human immune system in generation of an optimum immune response as well as in serious conditions arising by immune dysfunction such as infections, hypersensitivity, immunodeficiency and autoimmunity.
- Also the importance of immune system in cases of cancer and organ transplant. The course further enhances the student's understanding of how various immunodiagnostics and other advances in immunology have changed the face of modern medicine.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Student will be able to discuss the generation of humoral and cell-mediated immune response and the killing mechanisms available within the host body.
- Student will be able to describe immunity disorders like hypersensitivity, autoimmunity and immunodeficiency.
- Student will be able to explain organ transplantation and the role of the immune system in acceptance or rejection of the grafts, and ways to manage it.
- Student will be able to describe types of cancers, the antigens and immune response involved, tumor evasion mechanisms, diagnosis and treatment.
- Student will be able to describe vaccine formulation and its types, adjuvants, and National Immunization Schedule.

SYLLABUS OF DSC-17

UNIT – I (12 hours)

Generation of Immune Response: B cell development, generation of humoral immune response, primary and secondary immune response, generation of cell-mediated immune response (TCR, Self MHC restriction, T cell activation, co-stimulatory signals), killing mechanisms by CTL and NK cells.

UNIT – II (12 hours)

Immune Dysfunction: Types of hypersensitivities with one examples each, mechanism, manifestations and detection of type I hypersensitivity; Autoimmunity: types and mechanisms (Hashimoto's thyroiditis, Goodpasture's syndrome, IDDM, Rheumatoid arthritis, Multiple sclerosis, SLE); Immunodeficiency: Animal models (nude and SCID mice), disorders (SCID, DiGeorge syndrome, Chediak- Higashi syndrome, LAD, CGD).

UNIT – III (8 hours)

Transplantation Immunology: Types of grafts (autograft, isograft, allograft & xenograft), HLA typing, immunologic basis of graft rejection (sensitization & effector stages), role of T cells in graft rejection, GVHD, clinical manifestations of graft rejection (hyperacute, acute and chronic rejection), immunosuppressive therapies (general and specific), immunoprivileged sites

UNIT – IV (8 hours)

Cancer Immunology: Immune surveillance, types of cancers, malignant transformation of cells, tumor antigens (TATA and TSTA), immune response to cancer, tumor evasion, immunodiagnosis and cancer immunotherapy

UNIT – V (5 hours)

Vaccines: Active immunization, designing vaccines, boosters, types of vaccines: live attenuated, toxoid, conjugate/ multivalent, subunit, peptide, recombinant (vector based), DNA and RNA vaccines, use of adjuvants, National Immunization Schedule (NIS).

Practical component

UNIT 1: (20 hours)

Immunological techniques based on antigen - antibody interactions: Principles, working methods and applications of the following immunological techniques: ELISPOT, western blotting, immunofluorescence, flow cytometry, immunoelectron microscopy. Performance of SDS-PAGE to separate the different types of immunoglobulins. Detection of Type I hypersensitivity by RIST and RAST. MLR and Microcytotoxicity tests for HLA typing using pictures.

Unit 2: (12 hours)

Student group research studies:

Student group research project I: Experimental Systems in Immunology: Primary lymphoid cell culture systems. Animal models: Nude mouse, SCID mouse, SPF (Specific Pathogen Free) colony mice, dirty mice.

Student group research project II: short-term and long-term immune response to COVID-19 vaccines: case study of Covaxin.

Essential/recommended readings

Theory:

1. Immunology: A short course by R. Coico. 8th edition. Wiley- BlackwellScientific Publication, UK. 2021
2. Cellular and Molecular Immunology by A.K. Abbas, A.H. Lichtman and S. Pillai. 10th edition.Elsevier, USA. 2021.
3. Kuby Immunology by J. Punt, S. Stranford, P. Jones and J. Owen. 8 th edition.
4. W.H. Freemanand Company, USA. 2018.
5. Roitt's Essential Immunology by P. Delves, S. Martin, D. Burton and I.M. Roitt. 13th edition.Wiley- Blackwell Scientific Publication, UK. 2017.
6. Janeway's Immunobiology by K. Murphy and C. Weaver. 9th edition. Garland Science Publishers, USA. 2016.
7. Basic and Clinical Immunology by M. Peakman and D. Vergani. 2nd edition. ChurchillLivingstone, UK. 2009.
8. Immunology by C. Richard and S. Geoffrey. 6th edition. Wiley- Blackwell Scientific Publication, UK. 2009.

Practicals:

1. A Handbook of Practical and Clinical Immunology Volumes I & 2 by G. P. Talwar and S.K. Gupta. 2nd edition. CBS Publishers, India. 2017.
2. Practical Immunology, A Laboratory Manual by S. Balakrishnan, K. Karthik and S. Duraisamy. Lambert Academic Publishing, India. 2017.
3. Microbiology: A Laboratory Manual by J. Cappuccino and C.T. Welsh. 11th edition. Pearson Education, USA. 2016.
4. Laboratory Manual on Immunology and Molecular Biology by D. Dwivedi and V. Singh. Lambert Academic Publishing, India. 2013.
5. Practical Immunology by F.C. Hay, M.R. Olwyn and M.R. Westwood. 4th edition. Wiley Blackwell Publishing. 2002.

Suggestive readings

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

DISCIPLINE SPECIFIC CORE COURSE –18: INDUSTRIAL MICROBIOLOGY

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-DSC603: INDUSTRIAL MICROBIOLOGY	4	3	0	1	Class XII pass with Biology/ Biotechnology/ Biochemistry	None

Learning Objectives

The Learning Objectives of this course are as follows:

- The major objective of this course is to give students an overview of the applications of fermentation processes in industry.
- The students will gain in-depth knowledge of different types of fermentation processes, fermenter designs and operations. They will become aware of large scale culturing methods of microorganisms for production of bioactives of industrial importance.
- Students will also gain an insight into steroid biotransformation and enzyme immobilization

Learning outcomes

The Learning Outcomes of this course are as follows:

- Student will be able to describe important developments in industrial microbiology and explain different types of fermentation processes.
- Student will be able to discuss the design, operations and applications of different types of fermenters and the measurement and control of fermentation parameters.
- Student will be able to demonstrate use of various methods to isolate, screen, preserve and maintain industrially important microbial strains, the different types of media used in fermentation processes.
- Student will be able to demonstrate use of various techniques for the recovery and purification of industrial products produced by microorganisms.
- Student will be able to explain the principles of large-scale microbial production and recovery of industrial products.
- Student will be able to demonstrate microbiological transformations of steroids and use the methods of enzyme immobilization to exploit their advantages and applications in the industry.

SYLLABUS OF DSC-18

UNIT – I (7 hours)

Development of industrial microbiology: Important developments in industrial microbiology and contribution of following scientists: Louis Pasteur, Carl Wilhelm Scheele, Casimir Funk, Alexander Fleming, Selman A. Waksman, Howard W Florey and Ernst B Chain. Types of fermentation processes: aerobic and anaerobic fermentations, solid-state and liquid-state (stationary and submerged) fermentations, batch, fed-batch and continuous fermentations

UNIT – II (10 hours)

Bioreactors and analysis of fermentation parameters: Parts of a typical fermenter. Types of bioreactors and their applications: Laboratory, pilot-scale and production fermenters, continuously stirred tank reactor, air-lift fermenter. Measurement and control of parameters: pH, temperature, dissolved oxygen, foaming and aeration.

UNIT – III (7 hours)

Selection of industrially important microbial strains: Sources of industrially important microorganisms, their isolation and screening (primary and secondary). Preservation and maintenance of stock and working cultures. Crude and synthetic fermentation media, inoculum and production media. Crude media components: molasses, corn-steep liquor, sulphite- waste liquor, whey, yeast extract. , peptone and tryptone.

UNIT – IV (4 hours)

Recovery methods for fermentation products: Physiochemical and biological methods for cell disruption, centrifugation, batch filtration, precipitation, solvent-solvent extraction spray drying and lyophilization.

UNIT – V (17 hours)

Upstream and downstream processing of microbial products, steroid biotransformation and enzyme immobilization: Citric acid, ethanol, glutamic acid, Vitamin B12, Wine (white, rose & red), beer, antibiotics (penicillin,streptomycin) and enzymes (amylase, protease, lipase and glucose oxidase). Microbiological transformation of steroids and its applications. Methods of enzyme immobilization: cross linking, entrapment, adsorption and covalent bonding. Advantages and applications of immobilized enzymes: glucose isomerase and penicillin acylase

Practical component

UNIT 1: (18 hours)

Aerobic fermentation processes: Microbial production of enzymes (amylases/lipase/protease) by liquid-state static /submerged fermentation and its detection by plate-assay method using an agar-based medium. Estimation of enzyme activity spectrophotometrically. Production of amino acids (glutamic acid /lysine) using a suitable bacterial culture, its detection by paper chromatography and its

colorimetric estimation using buffered ninhydrin reagent. Microbial production of citric acid by solid-state /liquid state fermentation using Aspergillus niger, its detection by chromatographic techniques and its quantitative estimation by titration.

Unit 2: (12 hours)

Anaerobic fermentation processes: Ethanol production by submerged fermentation using Saccharomyces cerevisiae, its detection by qualitative tests and its estimation spectrophotometrically using a suitable reagent.

A visit to any educational institute/industry to understand different types of fermenters/ bioreactors: laboratory-scale, pilot-scale and production fermenter, and their components (spargers, baffles, impellers etc

Essential/recommended readings

Theory:

1. Industrial Microbiology by A.H. Patel. 2nd edition. Laxmi publication Pvt Ltd/Trinity Press. 2022.
2. Industrial Microbiology by L.E. Casida. 2nd edition. New Age International publisher. 2019.
3. Modern Industrial Microbiology and Biotechnology by N. Okafor and B.C. Okeke. 2nd edition. CRC press, UK. 2018.
4. Crueger's Biotechnology: A Textbook of Industrial Microbiology by W. Crueger,

A. Crueger and K.R.Aneja. 3rd edition. Medtech Publisher, India. 2017.

5. Biotechnology Industrial Microbiology. A textbook by W.Clarke. CBS Publishers, India.2016.
6. Industrial Microbiology by K.L. Benson. CBS Publishers & Distributors. 2016.
7. Principles of Fermentation Technology by P.F. Stanbury, A.Whitaker and S.J. Hall. 3rd edition. Elsevier Science Ltd, Netherlands. 2016.
8. Microbial technology. Vol I- Microbial processes and Vol II -Fermentation technology edited by H.J. Peppler and D. Perlman. 2nd edition. Academic Press, USA. 2009.
9. Industrial Microbiology: An Introduction by M.J. Waites, N.L. Morgan, J.S . Rockey and G.Higton. Wiley –Blackwell. 2001.
10. Microbial Biotechnology: Fundamentals of Applied Microbiology by A.N. Glazer and H.Nikaido. 1st edition. W.H. Freeman and Company, UK.1995.

Practicals:

1. Microbiology: A Laboratory Manual by J. Cappuccino and C.T. Welsh. 12th edition. Pearson Education, USA. 2020.
2. Laboratory manual of Microbiology and Biotechnology by K.R. Aneja. 2nd edition. Scientific International Pvt. Ltd., Delhi. 2018.
3. Manual of Industrial Microbiology and Biotechnology edited by R.H. Baltz, A.L. Demain, and J.E. Davies. 3rd edition. American Society for Microbiology. 2010.
4. Microbial technology. Vol I- Microbial processes and Vol II -Fermentation technologyedited by H.J. Peppler and D. Perlman. 2nd edition. Academic Press, USA. 2009.

Suggestive readings

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