Semester VI

DISCIPLINE SPECIFIC CORE COURSE – (DSC-16)
HUMAN PHYSIOLOGY

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		
Human Physiology (BCH-DSC-601)	4	2L		2P	Class XII with Science and Biology	-

Learning Objectives

The objective of the course is to provide a comprehensive study of the molecular and cellular mechanisms that govern the integrative working and regulation of the various organ systems in the human body. The course will provide a foundation of the physiological principles and the application of the same in real-life situations. It will prepare students for higher education in any field related to medical physiology.

Learning outcomes

On successful completion of the course, students will be able to:

1. Explain the homeostatic control and functioning of the human body systems
2. Discuss the regulatory mechanism regulating different organ system.
3. Describe the functioning of the different organ systems.
4. Explain the basis of various physiological diseases.
5. Perform and analyse various physiological tests that examine the function of various systems of the human body.

SYLLABUS OF DSC-16

BCH-DSC-16 : HUMAN PHYSIOLOGY
SEMESTER - VI

2.2 Course Contents
Theory (2 Credits)

Total Hours: 30

Unit I: Circulatory system **(7 Hours)**

Homeostasis: definition and control mechanisms (negative and positive feedback mechanisms). Blood Composition and Blood coagulation. Anatomy of Heart.

Heartbeat Coordination: Cardiac action potential and Pacemaker potential. Cardiac cycle. Cardiac output and its regulation. The role of blood vessels in circulation: Arteries, Veins and Blood capillaries.

Unit II: Life Processes (15 Hours)

Respiratory physiology: Ventilation and lung mechanics. Inspiration, Expiration, Lung compliance and its determinants. Transport of oxygen and carbon dioxide in blood. Regulation of respiration.

Renal physiology: Cell biology of the Bowmans' capsule. Physiology of glomerular filtration and GFR. Tubular processing of the glomerular filtrate. Urine concentration: The counter current multiplier system. Blood buffer systems.

Gastrointestinal physiology: Propulsion, motility, digestion and assimilation of food. Secretory functions of the gastrointestinal tract. Enteric nervous system. Regulation of GI tract functions. Hepatic physiology and Enterohepatic circulation.

Unit III: Introduction to muscular and neural physiology (4 Hours)

Molecular mechanisms of skeletal and smooth muscle contraction: role of troponin, tropomyosin, and calcium in contraction, excitation-contraction coupling. Overview of Central and Peripheral Nervous System and neural conduction.

Unit IV: Reproductive Physiology (4 Hours)

Sex determination and differentiation. Oogenesis, Spermatogenesis, capacitation and transport of sperm, blood-testis barrier. Fertilization, Implantation and Placentation.

2.3 Practical (2 Credits)

Total Hours: 60

1. Hematology:
    a. Determination of Packed Cell Volume, Bleeding Time and Clotting Time.
    b. Preparation of blood smear and estimation of differential leucocyte count.
    c. Enumeration of Blood cells: RBC and WBC
    d. Estimation of hemoglobin and calculation of blood indices
2. Serum Proteins Electrophoresis
3. Understanding the anatomy/structure of following: Heart, GI Tract, Kidney and Nephron, Neuron, Lung and alveoli, skeletal, smooth and cardiac muscle
4. Pulmonary function tests: Understanding Lung capacities and Lung volumes using Spirometry
5. Determination of the Blood Pressure.
6. Case studies: Renal clearance, Gastrointestinal disorder, Anemia, Jaundice (any two)
7. Virtual Lab on ECG

2.4 Essential Readings:

- Widmaier, E.P., Raff, H. and Strang, K.T. (2019) Vander's Human Physiology 15th ed., McGraw Hill International Publications (New York), ISBN: 978-1259903885

- Fox, S.I. (2018) Human Physiology 15th ed., McGraw Hill International Publications, (New York) ISBN 978-1259864629

Suggested Readings:

- Guyton, A.C. and Hall, J.E., (2016) Reed Textbook of Medical Physiology 13th ed., Elseviers India Pvt. Ltd. (New Delhi). ISBN: 978-1455770052
- Sherwood, L. (2012) Introduction to Human Physiology 8th edition; Brooks/Cole, Cengage Learning. ISBN-13: 978-1133104544.
- Gerard G Totora. (2017). Principles of Physiology and Anatomy 15th Edition, Wiley. ISBN: 978-1-119-40006-6

3. Key word:

Physiology, Homeostasis, life processes, heart, neurophysiology, reproduction

DISCIPLINE SPECIFIC CORE COURSE – (DSC-17)
BASICS OF 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		
Basics of Immunology (BCH-DSC-602)	**4**	**2L**		**2P**	**Class XII with Science and Biology**	**-**

Learning Objectives

The course is designed to understand the basic concepts in Immunology. It is important to understand the structure of the cells and organs associated with the immune system to appreciate their function in fighting infections. So, the students will study their structure and the various receptors associated with them. They will be exposed to the concept of antigen antibody and the types of immune responses generated in the body. The recognition of the antigen by B and T cells and the role of Major histocompatibility complex in generation of immune response will be elaborated.

Learning outcomes

On successful completion of the course, students will be able to:

1. Explain the concept of innate and adaptive immunity.
2. Describe the structure and function of cells and organs of the immune system
3. Discuss the Attributes of an immunogen, structure and the functions associated with different isotypes of antibodies
4. Explain the humoral immune response and antibody diversity.
5. Explain the Antigen presentation mechanisms and generation of cell mediated immunity

SYLLABUS OF DSC-17

BCH-DSC-17 : BASICS OF IMMUNOLOGY
SEMESTER - VI

2.2 Theory (2 Credits)

Total Hours: 30

Unit 1 : **Introduction to the Immune System:** **(8 Hours)**

Historical Perspective, Innate and Adaptive immunity and their role in generation of immune response, Primary and Secondary Immune Response, Cells and Organs of the Immune System, Hematopoiesis, Antigens, Properties of Immunogen, Haptens, Adjuvants, B Cell and T Cell

Epitopes, Structure and Effector Functions of Different Types of Antibodies, Biological Activities of Subclasses of Antibodies, Antigenic Determinants on Immunoglobulins, Immunoglobulin Superfamily, B cell receptor,

Unit 2 : **Innate Immunity:** **(6 Hours)**

Anatomical Barriers, Soluble and Membrane Bound Molecular Sensors (PRRs), Inflammation, Phagocytic cells and Innate Immunity, Toll like receptors, Activation Pathways of Complement System, Regulation and Biological Consequences of Complement Activation.

Unit 3 : **Humoral Immune Response** **(8 Hours)**

B Cell Development, Maturation & Differentiation, Clonal Selection theory, Genetic basis of Antibody Diversity, Class switching.

Unit 4 : **Cell mediated Immune Response** **(8 Hours)**

Major Histocompatibility, General Organization and Inheritance of the MHC, Antigen Presenting Cells, Processing and Presentation of Antigen by the endocytic and cytosolic pathways, Development, Maturation & Differentiation of T cells, Role of Cytotoxic T lymphocytes, T cell and B cell interactions

2.3 Practical (2 Credits)

Total Hours: 60

1. Immunodiffusion –Double immunodiffusion and Single radial immunodiffusion
2. Differential Leucocyte Count
3. Visualization of lymphoid Organs and lymphatic system (Videos)
4. Isolation of lymphocytes from blood/spleen
5. Complement mediated lysis.
6. Active and Passive agglutination reactions
7. Dot blot and ELISA

2.4 Essential readings:

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 Readings:

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. Keywords:

Immunity, innate, adaptive, antibody, MHC, Humoral and Cell mediated immune response, Processing of antigens

DISCIPLINE SPECIFIC CORE COURSE – (DSC-18)
FUNDAMENTALS 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		
Fundamentals of Recombinant DNA Technology (BCH-DSC-603)	4	2L		2P	Class XII with Science and Biology	Basic course in Molecular Biology

Learning Objectives

The objective of the course is to teach the basics of theoretical and practical aspects of recombinant DNA technology and various techniques for DNA manipulation in prokaryotes and eukaryotes.

Learning outcomes

On successful completion of the course, students will be able to:

1. Perform restriction digestion of DNA samples.
2. Prepare genomic and cDNA libraries,
3. Perform basic cloning techniques to design a recombinant protein in a bacterial system.
4. Design primers for PCR, perform DNA amplification by PCR, and understand the principles of DNA sequencing.

SYLLABUS OF DSC-18

BCH-DSC-18 : FUNDAMENTALS OF RECOMBINANT DNA TECHNOLOGY
SEMESTER - VI

2.2 Course Contents

Theory (2 Credits)

Total 30 hours

Unit 1: Principles of gene cloning (14 hours)

Restriction and modification systems, restriction endonucleases and other enzymes used in gene cloning. Cloning vectors used in *E. coli*: plasmids pBR322, pUC, pGEM3Z. Ti-plasmid, and viral vectors (λ bacteriophage, CMV and SV40), high-capacity vectors BAC and YAC. Ligation of DNA molecules. Linkers, adapters and homopolymer tailing.

Unit 2: Selection for recombinants and clone identification (5 hours)

Uptake of DNA by cells and selection of recombinants. Making cDNA and Genomic DNA libraries. Clone identification by colony hybridization.

Unit 3: Expression of cloned genes (6 hours)

Vectors for expression of foreign genes in *E. coli,* expression cassettes÷ Hybrid promoters trc, tac. Challenges in producing recombinant protein in *E. coli.* Production of recombinant protein by eukaryotic cells. Fusion tags and their role in purification of recombinant proteins.

Unit 4: Polymerase chain reaction, DNA sequencing and Site Directed Mutagenesis (5 hours)

Fundamentals of polymerase chain reaction, Types of PCR; reverse transcriptase PCR, Primer designing. DNA sequencing by Sanger's method including automated DNA sequencing, pyrosequencing. Site–directed mutagenesis (overlap extension method).

2.3 Practical (2 Credits)

Total: 60 hours

1. Isolation of plasmid DNA from *E. coli* cells.
2. Digestion of plasmid DNA with restriction enzymes.
3. Preparation of competent cells and transformation with plasmid DNA.
4. Amplification of a DNA fragment by PCR.
5. Alpha-Complementation of β−galactosidase for Blue and White selection.
6. Hyper expression of a recombinant protein (SDS PAGE).
7. Poly histidine-tagged recombinant protein and purification using Ni– affinity resin

2.4 Essential readings:

- Brown, T.A. (2016) Gene Cloning and DNA Analysis (7th ed.), Wiley-Blackwell publishing (Oxford, UK), ISBN: 978-1-4051-8173-0.
- 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.
- Glick B.R., Pasternak, J.J. and Patten, C.L., (2010) *Molecular Biotechnology:* Principles and Applications of Recombinant DNA (4th ed.), ASM Press (Washington DC), ISBN: 978-1-55581-498-4 (HC).
- Michael R Green and J. Sambrook (2014) Molecular Cloning: A laboratory manual, (4th ed.), Cold spring Harbor laboratory press (3vol.), ISBN: 978-1-936113-42-2.

Suggested readings:

- Brown, T.A. (2007) Genomes (3rd ed.), Garland Science publishing, ISBN: ISBN 0 8153 4138 5.

3. Keywords

Genetic Engineering, cloning, Recombinant Protein expression and purification, Biotechnology.

DISCIPLINE SPECIFIC ELECTIVE COURSE – (DSE-4)
BIOCHEMICAL MECHANISMS AND RESPONSES IN PLANTS

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		
Biochemical Mechanisms and Responses in Plants (BCH-DSE-4)	04	02	-	02	Class XII with Science and Biology	Basic courses allied to biological sciences

Learning Objectives

The course aims to provide thorough understanding of metabolic processes in plants and the role of different biosynthetic pathways in growth and development of plants. The course will also impart basic concepts and applications of plant secondary metabolites.

Learning outcomes

On successful completion of the course students will be able to:

1. Describe the structure and function of plant cell organelles in plant metabolism.
2. Explain the various plant biochemical processes and metabolic pathways including photosynthesis, photorespiration, nitrogen fixation and assimilation and plant secondary metabolism and their biological significance.
3. Discuss the role of plant hormones in plant growth and development.
4. Evaluate the various plant responses to different abiotic and biotic stress conditions.
5. Plan and execute plant tissue culture.

SYLLABUS OF DSE-4

BCH-DSE-4 : BIOCHEMICAL MECHANISMS AND RESPONSES IN PLANTS
Semester – VI

2.2 Course Contents

Theory (Credits – 2)

Total Hours : 30

Unit I: Photosynthesis and Respiration **(8 Hours)**

Introduction to Plant cells, Cell wall, Vacuole and Tonoplast membrane, Plastids and Peroxisomes. Overview to photosynthesis and Carbon assimilation, Light reaction and photosystems, Cyclic and non-cyclic photophosphorylation, Calvin cycle and its regulation, C4 cycle and Crassulacean acid metabolism (CAM), Photorespiration. Photoinhibition. Glycolytic pathway and its alternative reactions in plants, Translocation of metabolites across mitochondrial membrane, TCA cycle, electron transport chain in plants, alternative NAD(P)H oxidative pathways.

Unit II: Nitrogen metabolism (7 Hours)

Nitrogen cycle; Biological nitrogen fixation; Structure and function of Nitrogenase complex. Nitrate assimilation: Nitrate and Nitrite reductase. Primary and secondary ammonia assimilation in plants; ammonia assimilation by glutamine synthetase-glutamine oxoglutarate aminotransferase (GS-GOGAT) pathway.

Unit III: Plant physiology and Secondary metabolites (10 Hours)

Plant vascular system; Plant hormones and their role in plant growth and development; Regulation of plant morphogenetic processes by light. Plant stress responses to abiotic and biotic stresses: Water deficit, temperature, salinity, insect manifestation. Secondary metabolites: types, structure and functions of Alkaloids, Phenolics and terpenoids.

Unit IV: Plant tissue culture (5 Hours)

Cell and tissue culture techniques, types of cultures: organ and explant culture, callus culture, cell suspension culture and protoplast culture. Plant regeneration pathways: organogenesis and somatic embryogenesis. Applications of cell and tissue culture and somaclonal variation. Germplasm storage and cryo-preservation. Brief introduction to transgenic plants.

2.3 Practical:

Credits: 2 Total Hours : 60

1. Induction of hydrolytic enzymes (proteases /amylases/lipase) in germinating wheat seeds.
2. Effect of plant hormones on plant growth (Phytochrome effects on lettuce germination/ Gibberellic acid effect on α-amylase secretion in barley seeds).
3. Extraction and assay of Urease from Jack bean.
4. Estimation of carotene/phenols/tannins in fruits and vegetables.
5. Estimation of ascorbic acid in fruits and vegetables.
6. Effect of light on chlorophyll production.
7. Separation and analysis of chloroplast proteins (Rubisco) using SDS-PAGE.
8. Plant tissue culture

2.4 Essential readings:

1. Buchann (2015). Biochemistry and Molecular Biology of plant. (2nd ed.). I K International. ISBN-10: 8188237116, ISBN- 978047 07 14218
2. Caroline Bowsher, Martin steer, Alyson Tobin (2008). Plant Biochemistry. Garland Science. ISBN 978-0-8153-4121-5.

3. Dey, P. M. and J.B. Harborne, J.B., (Editors) (1997). Plant Biochemistry. Academic Press. ISBN-10:0122146743, ISBN-13:978-0122146749. 94
4. Taiz, L. and Zeiger, E. (2010). Plant Physiology (5th ed.). Sinauer Associates Inc. ISBN-13: 978-0878938667, ISBN-10: 0878938664

3. Keywords

Plant cell, photosynthesis, respiration, nitrogen fixation and assimilation, secondary metabolism, stress biology.

DISCIPLINE SPECIFIC ELECTIVE COURSE – (DSE-5)
NUTRITIONAL BIOCHEMISTRY

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		
Nutritional Biochemistry (BCH-DSE-5)	04	02	-	02	Class XII with Science and Biology	Basic courses allied to biological sciences

Learning Objectives

This course provides students with knowledge and understanding of the characteristics, function, metabolism and deficiency of macro and micronutrients in the human body. It involves integrated learning between the areas of Biochemistry and Nutrition.

Learning outcomes

On successful completion of the course students will be able to:

1. Critically analyse and evaluate concepts in nutritional biochemistry that are important for an understanding of human nutrition.
2. Demonstrate the relationship between nutrition and health.
3. Discuss the macro and micronutrients and their nutritional deficiencies.
4. Describe techniques used in the assessment of nutritional status and nutritional disorders.
5. Explain drug nutrient interactions.

SYLLABUS OF DSE-5

BCH-DSE-5 : NUTRITIONAL BIOCHEMISTRY
Semester – VI

2.2 Course Contents
Theory (Credits – 2)

Total Hours: 30

Unit I: Introduction to Nutrition and Energy Metabolism (4 Hours)

Defining nutrition, role of nutrients. Unit of energy, Food energy, SDA. Energy expenditure and its components, Energy Balance, Recommended Nutrient Intakes (RNI) and Recommended Dietary Allowances for different age groups.

Unit II: Macronutrients **(10 Hours)**

Food sources of carbohydrates, functions of carbohydrates, RDA, Factors affecting bioavailability, Glycemic index and glycemic load. Dietary fiber and the role of fibre in health. Role of Gut microbiome in maintaining health. Role of prebiotics and probiotics in nutritive health.

Essential Fatty Acids; Functions of EFA, AI, excess and deficiency of EFA, factors affecting bioavailability. Dietary implications of ratios of n6 and n3, MUFA, PUFA and SFA, Cholesterol in the body.

Functions of proteins in the body. RDA for different age groups. Essential and Nonessential amino acids. Complete and incomplete protein, Amino Acid Interactions: Antagonism, Toxicity, Imbalance, Amino acid complementation and Supplementation in foods. Protein quality determinants NPU, Biological Value, PDCAAS, Nitrogen balance. PEM: Marasmus and Kwashiorkor.

Unit III: Fat and water soluble Vitamins **(9 Hours)**

Vitamin A, D, E, K and dietary sources, RDA, Role of Vitamin A in Visual cycle and overview of other functions. Role of Vitamin K in Gamma carboxylation (blood clotting). Role of Vitamin E as an antioxidant. Role of Vitamin D in maintenance of bone physiology and overview of other functions. Vitamin C- Dietary sources, RDA, role in collagen synthesis. The B Complex vitamins- Dietary sources, RDA. Functions and role in metabolism, Role of Vitamin B12 and Folate in Haematopoiesis and Neurology. Biochemical basis for deficiency symptoms, Hypervitaminosis.

Unit IV: Minerals **(7 Hours)**

Minerals: Dietary Sources, RDA. Sodium, Potassium, Calcium, Iron, Chloride, Copper and Phosphorus- Function, metabolism, Excretion, Deficiency, Toxicity, Trace Elements Iodine, Fluoride, Mg, Zn, Se, Chromium, Molybdenum: Function, Metabolism, deficiency, Toxicity and Sources.

2.3 Practical:

Credits: 2 **Total Hours: 60**

1. Anthropometric identifications for nutrition related diseases, BMR calculation
2. Determination of oxidative stress: TBARS in serum, antioxidant enzymes in hemolysate/plant sources.
3. Estimation of A/E vitamin in serum.
4. Estimation of minerals in drugs/food/serum.
5. Determination of nutritive value of foods.
6. Understanding fortification and supplementation
7. Presentation and discussion on Food as medicine.
8. Group discussion on Nutrient-nutrient and drug-nutrient interactions
9. Case studies on nutritional disorders.

2.4 Essential Readings:

1. Coombs Jr. G. F., (2008). *The vitamins, Fundamental aspects in Nutrition and Health.* Elsevier's Publications. ISBN-13- 978-0-12- 183493-7.
2. Mahan, L.K., Strings, S.E., Raymond, J. (2012) *Krause's Food and Nutrition Care process.* Elsevier's Publications. ISBN: 978-1-4377-2233-8.
3. Rosalind Gibson (2005). *Principles of Nutritional Assessment.* Oxford University Press. ISBN: 9780195171693
4. Tom Brody (1999). *Nutritional Biochemistry* (2nd Ed). Harcourt Braces. ISBN:9814033251, 978981403325.
5. Malik, D., Narayanasamy, N., Vavilala, P., Takur, J., Sinha, N., (2022). Textbook of Nutritional Biochemistry. Springer Singapore, ISBN978-981-19-4149-8.

Suggested reading:

1. Devlin, T. M., (2011). *Textbook of Biochemistry with Clinical Correlations.* John Wiley & Sons, Inc. (New York), ISBN: 978-0-4710-28173-4.

3. Keywords

Nutrition, macronutrients, micronutrients, energy balance, nutrient deficiency

DISCIPLINE SPECIFIC ELECTIVE COURSE – (DSE-7)
MOLECULAR BASIS OF NON-COMMUNICABLE HUMAN 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 Non-communicable Human Diseases (BCH-DSE-7)	04	02	-	02	Class XII with Science and Biology	Course in human physiology

Learning Objectives

Non-communicable diseases are a diverse group of chronic diseases that are not transferred between individuals. NCDs have long-term health consequences and often create a need for long-term treatment and care. This course is aimed at providing the learner with an understanding of the multiple aetiological factors that lead to NCDs. It will also discuss the molecular and biochemical basis of the symptoms of major NCDs like Cardiovascular disease, Cancer, lifestyle disorders, chronic renal and lung disease. Apart from the major NCDs some other NCDs will also be taught. The practicals will address the diagnostics of some of these NCDs. The course will not only help students get an insight into some aspects of molecular medicine but will also give them some background if they wish to pursue a post-graduation in molecular medicine or any other relevant field.

Learning outcomes

On successful completion of the course students will be able to:

1. Discuss the relationship between lifestyle and noncommunicable diseases.
2. Analyze the various molecular and biochemical interactions that contribute to the cause of NCDs.
3. Explain the networking between different endogenous and exogenous factors that contribute to NCDs burden.
4. Describe specific biomarkers that can be used to diagnose a disease or Disorder.
5. Perform tests of various diagnostic parameters that are used to identify NCDs.
6. Discuss the disease burden in today's urban society and also understand the wide spectrum of symptom diversity that occurs in such diseases through case studies.

SYLLABUS OF DSC-7

BCH-DSC-7 : MOLECULAR BASIS OF NON-COMMUNICABLE HUMAN DISEASES

Semester – VI

2.2 Course Contents

Theory (Credits – 2)

Total Hours : 30

Unit 1: Multifactorial complex disorders (10 Hours)

Understanding the definition of multifactorial diseases. Polygenic diseases and the relationship of environmental factors and genetic makeup in the onset of diseases: Polycystic ovarian syndrome, COPD, ARDS, Emphysema, Chronic and acute renal failure, Glomerulonephritis; Cancer: Molecular basis for neoplastic growth, metastasis, and cancer pathology; Cancer immunity; Molecular approaches to cancer treatment: Cervical cancer and preventive vaccine, Biomarkers for early detection of cancer- breast, prostrate, hepatic.

Unit 2: Metabolic and Lifestyle disorders (10 Hours)

Obesity and eating disorders like Anorexia nervosa and Bulimia. Diabetes mellitus, Metabolic syndrome and the relationship with hypertension, hypothyroidism and stress. Cardiovascular disorders and Atherosclerosis-defining the broad spectrum of ailments that fall in this category, understanding the factors that contribute to the syndrome, stages of disorder and the management of the condition. Irritable bowel syndrome- biochemistry behind the disorder and the influence of diet, stress and environment on the condition.

Unit 3: Diseases due to misfolded proteins (5 Hours)

Introduction to protein folding and proteasome removal of misfolded proteins; Etiology and molecular basis for Alzheimer's, Prion diseases, Huntington's Chorea, Sickle cell Anemia, Thalassemia.

Unit 4: Monogenic diseases (5 Hours)

Inborn errors in metabolism: PKU, Alkaptonuria, Maple syrup urine disease; Receptor and transport defects: Cystic fibrosis, Long QT syndrome, familial hypercholesterolemia, and clotting disorders (Hemophilia and Deep vein Thrombosis).

2.3 Practicals

Credits: 2 **Total Hours: 60**

1. Assessment of Obesity and metabolic syndrome
2. Estimation of glycosylated haemoglobin
3. Permanent slides for different types of cancer
4. Diagnosis of Thalassemia / Sickle cell Anemia
5. D dimer test / CRP tests
6. Serum LDH isozymes as a diagnostic tool

7. TropT as a cardiac marker
8. Biomarkers used in cancer diagnosis (virtual)
9. Case Studies on NCDs
10. Role of vaccination in adults to prevent NCDs with age: Group discussion.

2.4 Essential readings:

1. Textbook of Biochemistry with Clinical Correlations (2011) Devlin, T.M. John Wiley & Sons, Inc. (New York), ISBN: 978-0-4710-28173-4.
2. Introduction to Human Physiology (2012) 8th edition; Lauralee Sherwood. Brooks/Cole, Cengage Learning. ISBN-13: 978-1133104544 ISBN-10: 1133104541
3. The World of the cell, 7th edition (2009). Lewis J. Kleinsmith, Jeff Hardin, Gr Wayne M. Becker. ISBN-13: 978-0805393934 ISBN-10: 0805393935.
4. The Cell: A Molecular Approach (2009) 5th ed., Cooper, G.M. and Hausman, R.E., ASM Press & Sunderland (Washington DC), Sinauer Associates, MA, ISBN:978-0-87893-300-6

Suggested readings:

1. Genetics (2012) 6th ed., Snustad, D.P. and Simmons, M.J., John Wiley & Sons. (Singapore), ISBN: 978-1-118-09242-2.
2. Guyton, A.C. and Hall, J.E., (2016) Reed Textbook of Medical Physiology 13th ed., Elseviers India Pvt. Ltd. (New Delhi). ISBN: 978-1455770052

3. Key words:

Non-communicable disease, Lifestyle disorders, cancer, Monogenic disease, Multifactoral disease, Misfolded proteins.

DISCIPLINE SPECIFIC ELECTIVE COURSE – (DSE-8)
RESEARCH METHODOLOGY

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		
Research Methodology (BCH-DSE-8)	04	02	-	02	Class XII with Science and Biology	-

Learning Objectives

The main objective of this paper is to provide students with a general introduction to the methodological foundations and tools used in research for an understanding of the ways to identify problems, develop hypotheses and research questions and design research projects. The course will expose students to the range of designs used in research in laboratory, field experiments, surveys and content analysis. It will also provide an introduction to the concept of controls, statistical tools and computer applications used in research. In addition, the course will impart knowledge of scientific writing, oral presentation and the various associated ethical issues.

Learning outcomes

On successful completion of the course students will be able to:

1. Describe the importance of research in knowledge generation.
2. Explain the research process
3. Evaluate the importance of the major quantitative and qualitative research methods
4. Construct an effective research proposal
5. Examine the importance of research ethics
6. Record and analyse data using computer software
7. Prepare a Scientific presentation and article.

SYLLABUS OF DSE-8

BCH-DSE-8 : RESEARCH METHODOLOGY
Semester – VI

2.2 Course Contents

Theory (Credits – 2)

Total Hours: 30

Unit I: Introduction to Research (4 Hours)

Objectives and characteristics of research; significance of research, types of research methods-qualitative and quantitative; basic and applied; descriptive and analytical; various phases of research-problem identification, generation of hypothesis, experimental design, results and discussion. Writing a research proposal-schematic presentation.

Unit II: Basic principles of research design (8 Hours)

Review of literature using appropriate sources – reviews, patents, research papers, books and e-resources; Significance of controls in research, Types of research designs – exploratory, descriptive, experimental, survey and case study.

Unit III: Statistical tools and Report writing (12 Hours)

Data collection, analysis and graphical presentation; Sample – types and characteristics; Basic Statistical Tools - Measures of central tendency, Arithmetic mean, Median, Mode, Standard deviation, Co-efficient of variation (Discrete serious and continuous serious), Correlation, Regression, Multiple Regression, hypothesis testing, P-value, data analysis and interpretation; Report writing, format of publications and presentations-oral and poster.

Unit IV: Scientific conduct and ethics in Research (6 Hours)

Biosafety and Ethics - compliance and concerns; Plagiarism-Software tools and Creative Commons; Introduction to Intellectual Property Rights; Citation and acknowledgement, Impact factor, h-index, Indian and international funding agencies.

2.3 Practical:

Credits: 2 **Total Hours: 60**

1. Citation formats and citation generator
2. Plagiarism tools
3. Design of a research survey on a specific problem
4. Writing a concept note / research proposal
5. Writing of a mini-review paper
6. Systematic review, meta data analysis and presentation
7. Poster/oral presentations

2.4 Essential readings:

1. Cresswell, J. (2009) *Research Design: Qualitative and quantitative Approaches* Thousand Oaks CA, (3rd ed.), Sage Publications
2. Kothari, C.R. (2004) *Research Methodology: Methods and Techniques* (2nd ed.), New Age International Publishers.
3. Kumar, R. (2011) *Research Methodology: A Step-by-Step Guide for Beginners* (5th ed.), SAGE publisher
4. Walliman, N. (2017*) Research Methods: The Basics,* **(**2nd ed.), London; New York: Routledge
5. *WHO (2001) Health Research Methodology – A Guide for Training in Research Methods.*

3. Keywords

Research methodology; Patents; Plagiarism; Ethics; Biosafety; Report writing

GENERIC ELECTIVE COURSE - (GE-7)
CELLULAR COMMUNICATIONS

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		
Cellular Communications (BCH-GE-7)	04	02	-	02	Class XII with Science and Biology	Basic course in Cell Biology

Learning Objectives

- Explain the concept of Cell-cell communication.
- Describe the various types of receptors, signal transduction pathways, second messengers and effector molecules.
- To understand how signalling pathways, regulate cell motility, metabolism, growth, organogenesis, and cell death.
- Discuss the crosstalk between signal transduction pathways crosstalk and are auto-regulated.
- To know about various diseases associated with cellular communication pathway defects.

Learning outcomes

On successful completion of the course, students will be able to:

1. Describe various types of cell - cell communication.
2. Discuss the various types of receptors and signal transduction pathways in bacteria, plants and animal system.
3. Explain the importance of various signalling pathways in the regulation of metabolism, growth, organogenesis and cell death.
4. Discuss the cellular communication defects that lead to various types of diseases including cancers.

SYLLABUS OF GE-7

BCH-GE-7 : CELLULAR COMMUNICATIONS
SEMESTER - VI

2.2 Course Contents

Theory (Credit 2)

Total Hours : 30

Unit: 1 Introduction to cell- cell communication. (2 Hours)

Chemical signalling - endocrine, paracrine, autocrine, intracrine and neuroendocrine mechanisms. Cognate signalling.

Unit: 2 Receptors and Signal transduction pathways (16 Hours)

Hormone receptors - extracellular and intracellular. Receptor - hormone binding, Scatchard analysis. G-Protein-coupled Receptors: Heterotrimeric G proteins, Second messengers: cAMP, cGMP, Lipid-derived Second Messengers (IP3, DAG) NO, Calcium Signalling. Effector systems - adenylyl cyclase, guanylyl cyclase, PDE, PLC. Protein kinases (PKA, PKB, PKC, PKG).

Enzyme linked receptors: Receptor Tyrosine Kinases: EGF, insulin and erythropoietin. Ras - MAP kinase cascade, and JAK - STAT pathway.
Ion-channel linked receptors; Neurotransmitter receptors (Acetylcholine receptor). Nerve transmission.

Intracellular receptors: Cytoplasmic and nuclear receptors. Steroid hormone, thyroid hormone receptors. Gene regulation.

Integrin receptors. Integrin signalling. Cell matrix communication Receptor Regulation. Cross talk.

Unit 3: Photoreceptors and signal transduction in plants (4 Hours)

Phytochromes, cryptochromes and phototropins signalling.

Unit 4: Cell death signalling (4 Hours)

Apoptosis, Autophagy

Unit 5: Bacterial signalling (4 Hours)

Quorum sensing, autoinducers, chemotaxis.

2.3 Practical

Credit: 2 **Total Hours : 60**

6. Yeast response to mating pherohormones .
7. Study of Chemotaxis response in Tetrahymena/ paramecium/ dictostylium
8. Study change in heart rate (sympathetic response) on exposure to caffeine (cAMP mediated) in zebrafish larvae.
9. Chemotaxis/ motility assay in microbes.
10. Effect of plant hormones on plant growth or photomorphogenesis in response to light. (Phytochrome effects on lettuce germination/ Gibberellic acid effect on α-amylase secretion in barley seeds)

Essential readings:

1. Lodish, U. H. (2016) Molecular Cell Biology. W.H. Freeman, 2016.
2. Nelson, D. L., & Cox, M. M. (2021). Lehninger principles of biochemistry (8th ed.). W.H. Freeman. ISBN:9781319230906
3. Lim, W., Mayer, B., & Pawson, T. (2015). Cell signaling: principles and mechanisms. New York: Garland Science, Taylor & Francis Group.
4. Kocher, S. L., and Gujral, S. K. (2020). Plant Physiology Theory and Application. Cambridge University Press DOI: https://doi.org/10.1017/9781108486392.018
5. Demuth, D., & Lamont, R. (Eds.). (2006). Bacterial Cell-to-Cell Communication: Role in Virulence and Pathogenesis (Advances in Molecular and Cellular Microbiology). Cambridge: Cambridge University Press. doi:10.1017/CBO9780511541506

Suggested readings:

1. ZFIN protocols
2. Harris UM. A., McGee, S. A., and Batzi J. M. (2018). Uncooking Yeast: Cells Signalling a Rise to Inquiry. Tested Studies for Laboratory Teaching. Proceedings of the Association for Biology Laboratory Education. 38 (9) 1-48
4. Plant physiology and biotechnology laboratory manual. Compiled by: David Law, Lada Malek and JoAnne Henderson. 2006. https://old.amu.ac.in/emp/studym/99997510.pdf

3. Keywords

Chemical signaling, Receptors, signal transduction, GPCRs, RTKs, Photoreceptors, cell death signaling, bacterial signalling

GENERIC ELECTIVES COURSE - (GE-8)
BIOCHEMICAL CORRELATION OF 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		
BIOCHEMICAL CORRELATION OF DISEASES (BCH-GE-8)	**04**	**02**	**-**	**02**	**Class XII with Science and Biology**	**XIIth pass with biology**

Learning Objectives

The course aims to provide students with knowledge and understanding of the spectrum of human diseases. It will introduce the concept of a well-balanced diet, healthy lifestyle, the biochemical mechanism of diseases, treatment strategies, mechanism of action of drugs and drug resistance against various antimicrobials. The course also aims to outline the various strategies that could be employed for prevention of infectious and non-infectious diseases.

Learning outcomes

On successful completion of the course students will be able to:

1. Discuss the importance of a balanced diet, regular exercises and healthy lifestyle in leading a disease-free life.
2. Explain the functioning of the immune system and endocrine system and the basis of various autoimmune and hormonal disorders.
3. Correlate the genetic mutation and metabolic disorders.
4. Discuss the molecular mechanism of microbial pathogenicity, drug resistance and implications in public health management.

SYLLABUS OF GE-8

BCH-GE-8 : BIOCHEMICAL CORRELATION OF DISEASES
SEMESTER - VI

2.2 Course Contents

Theory (Credit 2)

Total Hours: 30

Unit I: Inherited Metabolic diseases and Hormonal disorders (9 Hours)

Introduction to inherited Metabolic diseases. Alkaptonuria, Phenylketonuria; Glycogen storage diseases (Von Gierke disease, Cori disease); Lipid storage diseases: Gaucher's disease; SCID. Overview of the endocrine disorders: Cushing's disease, Diabetes insipidus.

Unit II: Nutritional deficiency and lifestyle-based diseases (7 Hours)

Concept of nutrition and balanced diet; Protein-energy malnutrition: Kwashiorkor and Marasmus; Vitamin deficiency diseases: Beri-Beri, Scurvy, Pellagra, Nutritional deficiency Anemia, Night blindness, Rickets. Lifestyle-based diseases: Atherosclerosis, Diabetes Mellitus-II.

Unit III: Autoimmune diseases (6 Hours)

Concepts in immune recognition-self and non-self-discrimination, organ specific autoimmune diseases- Hashimoto's thyroiditis, Graves' disease, Myasthenia Gravis, Diabetes Melitus-I, Systemic diseases: Systemic lupus erythematosus (SLE), Rheumatoid arthritis.

Unit IV: Infectious diseases (8 Hours)

Classification of infectious diseases; Role of sanitation, drugs and vaccines in prevention, transmission and treatment of infectious diseases. Diseases caused by viruses: Polio, Influenza, HIV and COVID. Diseases caused by bacteria: Tetanus, Tuberculosis. Protozoan infections: Malaria; Parasitic infections: Kala Azar.

2.3 Practical:

Credits: 2 **Total Hours : 60**

8. Anthropometric measurements: BMI, Waist/Hip Ratio, Mid Arm Muscle Area (MAMA), Mid Arm Area (MAA).
9. Measurement of Blood pressure
10. Determination of blood Lipid Profile: Triglyceride, Cholesterol
11. Glucose tolerance test
12. Widal test
13. Permanent slides of malarial parasites/Leishmania
14. Case studies related to autoimmune diseases, life-style disorders and hormonal imbalance

2.4 Essential readings:

5. Berg, J.M., Tymoczko, J.L., Gatto, G.J., Stryer, L. (2019). Biochemistry (9th ed.). W.H Freeman and Company (New York). ISBN-13:9781319114671
6. Coico, R. (2021). Immunology: A Short Course (8th ed.). John Wiley & Sons, Inc (New Jersey). ISBN: 9781119551577.
7. Devlin, T. M., (2011). Textbook of Biochemistry with Clinical Correlations. John Wiley & Sons, Inc. (New York). ISBN: 978-0-4710-28173-4.
8. Willey, J., Sandman, K., Wood, D. (2019). Prescott's Microbiology (11th ed.). McGraw Hill International Edition (New York) ISBN: 9781260211887.

Suggested readings:

4. Sherwood, L. (2012). Introduction to Human Physiology (8th ed.). Brooks/Cole, Cengage Learning. ISBN-13: 978-1133104544 ISBN-10: 1133104541.
5. Hadley, M.E., Levine, J.E. (2007). Endocrinology (6th ed.). New Delhi, Pearson Education, Inc. ISBN: 978-81-317-2610-5.
6. Malik, D., Narayanasamy, N., Vavilala, P., Takur, J., Sinha, N., (2022). Textbook of Nutritional Biochemistry. Springer Singapore, ISBN978-981-19-4149-8.

3. Keywords

Lifestyle and metabolic disorders, nutritional deficiency, hormonal disorder, autoimmunity and infectious diseases.

GENERIC ELECTIVES COURSE - (GE-11)
TOOLS OF GENETIC ENGINEERING

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		
Tools for Genetic Engineering (BCH-GE-11)	04	02	-	02	Class XII with Science and Biology	Basic course in Molecular Biology

Learning Objectives

The objective of the course is to teach:

- Basics of theoretical and practical aspects of recombinant DNA technology.
- Various techniques for DNA manipulation in prokaryotes and eukaryotes.

Learning outcomes

On successful completion of the course, students will be able to:

1. Grow bacterial culture and obtain single isolated colonies
2. Estimate the concentration of DNA by UV spectroscopy
3. Extract plasmid DNA from recombinant *E. coli*
4. Perform restriction digestion and evaluate the end products by agarose gel electrophoresis
5. Perform Polymerase chain reaction and amplify a DNA fragment
6. Explain the various methods for expression of recombinant genes in *E.coli*
7. Perform gene cloning

SYLLABUS OF GE-11

BCH-GE-11 : TOOLS FOR GENETIC ENGINEERING
SEMESTER - VI

2.2 Course Contents

Theory (Credit 2)

Total Hours: 30

UNIT I: Introduction to recombinant DNA technology **(5 Hours)**

Overview of gene cloning. Restriction and Modification systems, Restriction endonucleases, DNA modifying enzymes (DNA polymerase I, Taq polymerase, DNAse I, DNA Ligase).

UNIT II: Cloning vectors for prokaryotes and eukaryotes (6 Hours)

Salient features of vectors (pBR322, pUC8, Lambda bacteriophage, Ti plasmid) used in cloning.

UNIT III: **Introduction of DNA into cells and selection of recombinants (9 Hours)**

Ligation of DNA molecules: linker, adapters, homopolymer tailing. Introduction of DNA into bacterial cells, selection of transformed cells, insertional inactivation. Identification of recombinant phages. cDNA and Genomic DNA libraries. Clone identification by colony and plaque hybridization.

UNIT IV: Basics of Polymerase Chain Reaction and DNA sequencing (5 Hours)

Fundamentals of polymerase chain reaction, designing primers for PCR. DNA sequencing by chain-termination method, pyrosequencing.

UNIT V: Expression of cloned genes (5 Hours)

Vectors for expression of foreign genes in *E. coli,* expression cassettes. Hybrid promoters trc, tac, λpL and T7 promoter-based expression–vectors. Challenges in producing recombinant protein in *E. coli.* Fusion tags (poly-histidine, GST) and their role in purification of recombinant proteins.

2.3 Practicals

Credits : 2 **Total Hours: 60**

1. Growing a culture of *E.coli* and obtaining isolated colonies by streak-plate method.
2. DNA estimation by UV spectrophotometry.
3. Isolation of plasmid DNA from *E. coli.*
4. Restriction digestion of plasmid DNA and agarose gel electrophoresis.
5. Amplification of a DNA fragment by PCR (demonstration)

2.4 Essential Readings

1. Gene Cloning and DNA Analysis (2016) 7th ed., Brown, T.A., Wiley Blackwell Publishing (Oxford, UK), ISBN: 978-1-119-07256-0.
2. Molecular Biotechnology: Principles and Applications of Recombinant DNA (2010) 4th ed., Glick B.R., Pasternak, J.J. and Patten, C.L., ASM Press (Washington DC), ISBN: 978-1-55581-498-4 (HC).

3. Key Words

Genetic Engineering, Recombinant Proteins, PCR, DNA Sequencing