

Syllabus

B. Voc.

(BIOMEDICAL SCIENCES)



**Department of Vocational Studies and Skill
Development**

**Central University of Haryana
Mahendergarh, Haryana**

STRUCTURE OF B.VOC. (BIOMEDICAL SCIENCES) PROGRAMME:

Module Code	Name of Course	Credits (T+P)	Marks
YEAR – 1, SEMESTER – I			
GENERAL EDUCATION COMPONENT			
BMS-101	Human Physiology	4 (4+0)	100
BMS-102	Basic Organic Chemistry	4 (4+0)	100
BMS-103	English Communication	2 (2+0)	50
BMS-104	Practical	2 (0+2)	50
	TOTAL	12	300
SKILL COMPONENT			
<u>Specific job roles defined by SSCs as per guidelines of NSQF</u>		18	
YEAR – 1, SEMESTER – II			
GENERAL EDUCATION COMPONENT			
BMS-201	Pharmaceutical Physical Chemistry	4 (4+0)	100
BMS-202	Environmental Science	4 (4+0)	100
BMS-203	Biomolecules	2 (2+0)	50
BMS-204	Practical	2 (0+2)	50
		12	300
SKILL COMPONENT			
<u>Specific job roles defined by SSCs as per guidelines of NSQF</u>		18	-----
YEAR – 2, SEMESTER – III			
GENERAL EDUCATION COMPONENT			
BMS-301	Metabolism of Biomolecules	4 (4+0)	100
BMS-302	Microbiology	4 (4+0)	100
BMS-303	Reactions in Organic Chemistry	2 (2+0)	50
BMS-304	Practical	2 (0+2)	50
	TOTAL	12	300
SKILL COMPONENT			
<u>Specific job roles defined by SSCs as per guidelines of NSQF</u>		18	-----
YEAR – 2, SEMESTER – IV			
GENERAL EDUCATION COMPONENT			
BMS-401	Cell Biology	4	100

		(4+0)	
BMS-402	Pharmacology	4 (4+0)	100
BMS-403	Enzymology	2 (2+0)	50
BMS-404	Practical	2 (0+2)	50
	TOTAL	12	300
SKILL COMPONENT			
<u>Specific job roles defined by SSCs as per guidelines of NSOF</u>		-----	-----
TOTAL		18	
YEAR – 3, SEMESTER – V			
GENERAL EDUCATION COMPONENT			
BMS-501	Medical Genetics	4 (4+0)	100
BMS-502	Molecular Biology	3 (3+0)	75
BMS-503	Medical Biotechnology	3 (3+0)	75
BMS-504	Practical	2 (0+2)	50
	TOTAL	12	300
SKILL COMPONENT			
<u>Specific job roles defined by SSCs as per guidelines of NSOF</u>		18	-----
YEAR – 3, SEMESTER – VI			
GENERAL EDUCATION COMPONENT			
BMS-601	Immunology	4 (4+0)	100
BMS-602	Applied organic chemistry	4 (4+0)	100
BMS-603	Medicinal Chemistry	2 (2+0)	50
BMS-604	Practical	2 (0+2)	50
	TOTAL	12	300
SKILL COMPONENT			
<u>Specific job roles defined by SSCs as per guidelines of NSOF</u>		18	-----

BMS-101: Human Physiology

Credits: 4

Unit 1: The tissue level of organization

(5h)

Types of tissues, Embryonic origin of tissues, Tissue membranes, Classification of epithelial tissue, Connective tissue, Muscle tissue and nervous tissue.

Disorders: Tissue injury and Aging, Cancer

UNIT 2: Blood

(10h)

Overview of blood, Characteristics of blood, Blood plasma, Shape and structure of erythrocytes and haemoglobin, Life cycle of erythrocytes. Disorders of erythrocytes, Structure and function of Leukocytes and platelets, Disorder of platelets. Hemostasis. Disorders of clotting.

Unit 3: Bone tissue and skeletal system

(8h)

Functions of Skeletal System, Bone classification, Bone structure, Bone cells and tissues, Bone formation and development.

Disorders: Bone fractures

Exercise, Nutrition, Hormones and bone tissues, Calcium homeostasis

Unit 4: Gastrointestinal and Hepatic system

(7h)

Overview of digestive system, Digestive system processes and regulation in the mouth, pharynx, oesophagus, Stomach, small and large intestine.

Accessory organs in digestion: Liver, pancreas and gall bladder.

Chemical digestion and absorption.

UNIT 5: The nervous system and nervous tissue

(9h)

Basic structure and function of the nervous system, The central and peripheral nervous system, Functional division of nervous system, Nervous tissue, parts of neurons, types of neurons, Functions of nervous tissue, Action potential, Communication between neurons, Synapse, Neurotransmitters

Unit 6: Renal Physiology

(6h)

Physical Characteristics of urine, gross anatomy of urine transport, Microscopic anatomy of kidney,

Physiology of urine formation, Endocrine regulation of urine function

UNIT 7: The Endocrine system

(10h)

Neural and endocrine signalling, Hormones, Types of hormones, Pathways of hormone action, Regulation of hormone secretion.

Function and regulation of the hormones secreted by following glands: Pituitary and hypothalamus, Thyroid, Parathyroid, Adrenal, Endocrine Pancreas, Gonadal and placental hormones.

Organs with secondary endocrine functions.

Unit 8: Fluid electrolytes and acid-base balance

(5h)

Body fluids and fluid compartments, Composition of body fluids, Fluid movement between compartments, Water balance, electrolyte balance, Acid-base balance, buffer systems in the body, disorders of acid-base balance in the body.

Unit 1: Organic intermediates: (10h)

Reactive Intermediates -Carbocations: Generation, structure, stability and reactivity; Carbanions: Generation, structure, stability and reactivity; Free Radicals: Generation, structure, stability and reactivity; Concept of Electrophile and Nucleophile, inductive effect, mesomeric effect

Unit 2: Chemistry of Organic Compounds (Part-1): (20h)

Preparation, Properties and Reactions of Organic Compounds: Hydrocarbons (Alkanes, cycloalkanes, alkenes, alkynes and dienes,); Haloalkanes and Haloarenes; Alcohols, Phenols

Unit 3: Chemistry of Organic Compounds (Part-2): (20h)

Preparation, Properties and Reactions of Organic Compounds: aromatic and aliphatic Aldehydes, Ketones; Carboxylic acids and Esters; aliphatic and aromatic amines

Unit 4: Chemistry of aromatic compounds and Polynuclear Hydrocarbons: (10h)

Aromatic Compounds: Preparation, properties, structure and reactions of benzene, Huckel's rule of aromaticity, aromaticity of heterocyclic compounds, cations, anions and annulenes; **Structure and medicinal uses of polynuclear hydrocarbons:** Naphthalene, Phenanthrene, Anthracene, Diphenylmethane, Triphenylmethane

UNIT – I**06 Hours**

Communication Skills: Introduction, Definition, The Importance of Communication, The Communication Process – Source, Message, Encoding, Channel, Decoding, Receiver, Feedback, Context.

Barriers to communication: Physiological Barriers, Physical Barriers, Cultural Barriers, Language Barriers, Gender Barriers, Interpersonal Barriers, Psychological Barriers, Emotional barriers

Perspectives in Communication: Introduction, Visual Perception, Language, Other Factors affecting our perspective – Past Experiences, Prejudices, Feelings, Environment.

UNIT – II**06 Hours**

Elements of Communication: Introduction, Face to Face Communication – Tone of Voice, Body Language (Non-verbal communication), Verbal Communication, Physical Communication.

Communication Styles: Introduction, The Communication Styles Matrix with example For each – Direct Communication Style, Spirited Communication Style, Systematic Communication Style, Considerate Communication Style

UNIT – III**07 Hours**

Basic Listening Skills: Introduction, Self-Awareness, Active Listening, Becoming an Active Listener, Listening in Difficult Situations

Effective Written Communication: Introduction, When and When Not to Use Written Communication – Complexity of the Topic, Amount of Discussion' Required, Shades of Meaning, Formal Communication

Writing effectively: Subject Lines, Put the Main Point First, Know Your Audience, Organization of the Message,

UNIT – IV**11 Hours**

Interview Skills: Purpose of an interview, Do's and Dont's of an interview

Giving Presentations: Dealing with Fears, Planning your Presentation, Structuring Your Presentation, Delivering Your Presentation, Techniques of Delivery

Group Discussion: Introduction, Communication skills in group discussion, Do's and Dont's of group discussion

Correspondence: Personal, official and Business, Report writing, Drafting an email, Writing of C.V.

BMS-104: Practical**Credits: 2**

1. Estimation of haemoglobin
2. Determination of bleeding time and clotting time of blood.
3. Determination of total erythrocyte count.
4. Determination of total leukocyte count.
5. To perform differential leukocyte count of blood.
6. Blood Pressure recordings in humans.
7. Determination of blood group
8. Preparation of volumetric solutions and estimation of acidic or basic contents
9. Functional group test: Amines, carboxylic acids, aldehydes, and ketones
10. Functional group test: Aromatic and halogenated hydrocarbons and phenols.
11. Preparation of Soap.

Unit 1: Kinetics of Drug Stability:

Rate and Rate Equation Order and molecularity, first- Order and pseudo first order reactions, Second-order reactions, Zero-order reactions, Half-life, Shelf life and the Factors affecting the Rate of Reactions

Unit 2: Catalysis:

Catalysis: Classification and Applications: Catalysis and Types of Catalysis, Theory and applications of Homogenous and Heterogenous catalysis; **Mechanisms of Catalysis:** Acid- Base Catalysis, Enzyme Catalysis, Biocatalysis Phase, Transfer Catalysis, Transition Metal Catalysis and Organo catalysis

Unit 3: Disperse System:

Colloidal: Size, Shape and types of colloidal systems, Optical Properties, Kinetic Properties, Electrical Properties, Stability of colloidal systems, Sensitization and protective colloidal Action, Solubilisation, Pharmaceutical Applications of colloids; **Gels and Emulsions:** Gels and its types, Emulsions, Types of emulsions, Preparation of Emulsion; **Suspensions:** Classification and Properties, Formulations and Application

Unit 4: Complexation:

Complexes: Classification, Preparation, Properties and Applications: Classification of complexes, Methods of preparation and analysis of complexes, applications of complexes; **Chelates and Metalloproteins:** Chelate, Metalloporphyrin

Unit 1: Introduction to Environmental Science

Multidisciplinary nature of Environmental Studies. Definition, scope and importance, need for public awareness

Unit 2: Natural Resources

Renewable and non-renewable resources: Land resources: Land as a resource, land degradation, soil erosion and desertification. Forest resources: Use and over-exploitation, deforestation, case studies. Water resources: Use and over-utilization of surface and ground water

Unit 3: Ecosystems

Concept of an ecosystem. Structure and function of an ecosystem. Energy flow in the ecosystem. Food chains, food webs and ecological pyramids.

Unit 4: Bio-diversity and its Conservation

Definition: genetic, species and ecosystem diversity. Biogeographical classification of India. Hot-spots of biodiversity. Threats to biodiversity, Endangered and endemic species of India. Conservation of biodiversity.

Unit 5: Environmental Pollution

Definition, Causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Nuclear hazards.

Unit 6: Environment policies & laws

Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and Control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Issues involved in enforcement of environmental legislation. Public awareness.

Unit 7: Human Population and Environment

Human population growth, Impacts on environment, human health and welfare. Environment Movements: Chipko, silent valley, Bishnois of Rajasthan.

Unit 8: Field Work

Visit to a local polluted site: Urban/Rural/Industrial/Agricultural.

Unit 1: Carbohydrate**(8h)**

Definition, classification, structure and functions of Carbohydrates

Monosaccharides- Glucose, Fructose, Galactose, Mannose, Stereoisomeres, epimers, Ring structure and anomers, mutarotation.

Disaccharides- Maltose, lactose, Sucrose, Trehalose,

Polysaccharides- Concept of homopolysaccharide and heteropolysaccharide, chemical nature of starch, glycogen, cellulose, bacterial cell wall polysaccharides and agar. Biological importance of Proteoglycans, Glycoproteins, and Glycolipids

Unit 2: Lipids**(6h)**

Definition and classification of lipids. Classification of fatty acids, physio-chemical properties of fatty acids, Structure and function of cholesterol, phosphoglycerides, sphingolipids, glycosphingolipids and Eicosanoids.

Unit 3: Protein**(9h)**

Definition and classification of amino acids based on chemical nature and nutritional (essential and nonessential) requirement, Zwitterions, pKa, pI, titration of amino acids, peptide bonds.

Structure of protein-Primary, secondary, tertiary and Quaternary structure

Protein stability, Bonds and interaction stabilizing the protein structure, protein folding, Denaturation and Renaturation.

Unit 4: Nucleic acids**(7h)**

Importance of nucleic acids in living system, general composition of nucleic acids, the purine and pyrimidine bases. Structure of nucleosides and nucleotide, deoxynucleotides, cyclic nucleotides.

Watson and crick model of DNA, Different types of DNA and RNA, Denaturation and renaturation of DNA

Suggested Textbooks

1. Nelson, D.L. and Cox, M.M.(2009). Lehninger`s Principles of Biochemistry, W.H. Freeman and Company, New York.
2. Price, N.C. and Stevens, L.(1996). Fundamentals of Enzymology, Oxford University Press Inc. N.Y.

BMS-204 Practical**Credits: 2**

1. Determination of the effect of temperature on the rate of reaction.
2. Determination of the effect of Concentration on the rate of reaction.
3. Determination of the effect of catalyst on the rate of reaction.
4. Estimation of Mg or Ca ions by EDTA titration
5. Synthesis of a coordination compound metal acetyl acetonate
6. Qualitative tests for Carbohydrates
7. Qualitative tests for Proteins
8. Acrolein test for glycerol
9. Determination of saponification value of fats and oil.
10. Determination of Iodine number of a fat sample.

BMS-301: Metabolism of Biomolecules

Credits: 4

Unit 1: Carbohydrate Metabolism

(15h)

Glycolysis, Entry of galactose, Mannose and fructose into glycolytic pathway.

Anaerobic fate of pyruvate: ethanol and lactic acid fermentation,

Gluconeogenesis, Hexose Monophosphate Pathway, Coordinate Regulation of glycolysis and gluconeogenesis, futile cycle

Glycogen metabolism: Synthesis and breakdown of glycogen and its coordinate regulation.

Aerobic fate of pyruvate, Pyruvate dehydrogenase complex enzyme and TCA cycle, Amphibolic nature, Anaplerotic reactions, Regulation of TCA cycle, Glyoxylate cycle

Electron transport chain and Oxidative phosphorylation: Component and sequence of electron, Proton motive force, Chemiosmotic theory of ATP synthesis, Role of uncouplers and thermogenesis.

Disorders associated with defects in carbohydrate metabolism: Lactose intolerance, fructose intolerance, Glycogen storage disorders.

Unit 2: Lipid Metabolism

(15h)

Transport of fatty acids to mitochondria, β -Oxidation of even chain saturated fatty acid. β -Oxidation of odd chain saturated fatty acid, Omega and Alpha oxidation of fatty acids

Bioenergetics for complete oxidation of fatty acid to acetyl CoA and CO₂, Coordinate regulation of fatty acid synthesis and breakdown, Ketone bodies synthesis and degradation (Ketosis). Relationship of ketone bodies production with Diabetes mellitus and starvation

Disorders associated with defects in Lipid metabolism:

Tay sach's disease, Gaucher disease

Unit 3: Amino acids metabolism

(15h)

General reaction of amino acid degradation – Transamination, deamination and decarboxylation. ketogenic and glucogenic amino acids, Urea cycle and its significance, Link between Urea cycle and Citric acid cycle. Regulation of Urea cycle, Catabolic pathway of phenylalanine and tyrosine.

Disorders associated with defects in protein and amino acid metabolism:

Disorder associated with deficiency of Urea cycle enzymes and their treatment, Maple syrup urine disease, Phenylketonuria.

Unit 4: Metabolism of Nucleic acid (DNA)

(15h)

Brief outline of *denovo* synthesis of purine and pyrimidine nucleotides, Regulation of synthesis of purine and pyrimidine nucleotides by feedback mechanism, Allosteric regulation of asparate transcarbamoylase by CTP and ATP, Salvage pathway for DNA synthesis, Chemotherapeutic agents targeting nucleotide biosynthetic pathways.

Disorders associated with defects in nucleotide metabolism- Gout, Lesch-Nyhan Syndrome, ADA.

Suggested Textbooks

1. Nelson, D.L. and Cox, M.M. (2005); Lehninger Principles of Biochemistry, fourth edition, W.H.Freeman and company, N.Y. USA
2. Voet, D. and Voet, J.G.(2004). Biochemistry, John Wiley and Sons. INC

BMS- 302: Microbiology

Credits: 4

Unit 1: History and Scope of Microbiology

(7h)

Members of the Microbial World: Prokaryotes, Eukaryotes, Biological entities

Discovery of Microorganisms: Development of Microscopes and Culture-Based Methods

Conflict over Spontaneous Generation: Contributions of Francesco Redi, John Needham, Lazzaro Spallanzani, Theodore Schwann, Theodor von Dusch, Louis Pasteur, John Tyndall

Microorganisms and Disease: Contributions of Louis Pasteur, Joseph Lister, Robert Koch

Unit 2: Prokaryotic Cell Structure and Function

(8h)

An Overview of Prokaryotic Cell Structure: Shape, Arrangement, and Size

Bacterial Cell Wall and Plasma Membrane: Overview of Bacterial Cell Wall Structure, Peptidoglycan Structure, Gram-Positive Cell Walls, Gram-Negative Cell Walls, Fluid Mosaic Model of Plasma Membrane Structure

Cytoplasmic Matrix & Nucleoid: Inclusion Bodies, Ribosomes, Plasmids, Nucleoid

Components External to the Cell Wall: Capsules, Pilli, and Flagella

Unit 3: Introduction and General Characteristics of Viruses

(4h)

Structure of Viruses: Virion Size, General Structural Properties, Helical Capsids, Icosahedral Capsids, Viruses with Capsids of Complex Symmetry, Viral Envelopes and Enzymes, Viral Genomes

Bacteriophages: General Characteristics, Lytic Cycle, And Lysogenic Cycles

Unit 4: Pathogenicity of Microorganisms

(8h)

Host-Parasite Relationships: Parasite, Host, Pathogen, and Virulence

Pathogenesis of Viral Diseases: Maintaining a Reservoir, Contact Entry and Primary Replication, Release from Host Cells, Viral Spread and Cell Tropism, Virus-Host Interactions, Virus Shedding

Pathogenesis of Bacterial Diseases: Maintaining a Reservoir, Transport to the Host, Attachment and Colonization, Invasion of Host Tissues, Growth and Multiplication, Leaving the Host.

Bacterial toxins: Exotoxins, Endotoxins

Unit 5: Human Diseases Caused by Bacteria

(8h)

Bacterial Pneumonia, Tuberculosis, Staphylococcal food poisoning, Gonorrhea (etiology, clinical symptoms, virulence factors involved, detection and prevention)

Unit 6: Human Diseases Caused by Viruses and Protozoans

(10h)

Life cycle and clinical symptoms of;

Respiratory Syndromes: Coronaviruses and Human Respiratory Syncytial virus

Acquired Immuno Deficiency Syndrome (AIDS): HIV Virus

Influenza (Flu): Influenza virus A, Influenza virus B

Arboviruses: Dengue and chikungunya

Protozoal Infections: Malaria, Leishmania, Amoebiasis

Unit 7: Chemotherapy and Antiviral Drugs

(5h)

Development of Chemotherapy: Contributions of Paul Ehrlich, Alexander Fleming, Howard Florey, Ernst Chain, Norman Heatley, Selman Waksman

General Characteristics of Antimicrobial Drugs: Selective Toxicity, Therapeutic Index, Range of Effectiveness

Determining the Level of Antimicrobial Activity: Dilution Susceptibility Tests, Disk Diffusion Tests, Etest

Antiviral Drugs: General characteristics and mode of action of common antiviral drugs

Unit 8: Antibacterial Drugs and Drug Resistance

(10h)

Antibacterial Drugs: Inhibitors of Cell Wall Synthesis, Protein Synthesis Inhibitors, Metabolic Antagonists, Nucleic Acid Synthesis Inhibitors, Factors Influencing Antimicrobial Drug Effectiveness

Drug Resistance: Mechanisms of Drug Resistance, Origin and Transmission of Drug Resistance, Overcoming Drug Resistance

BOOKS RECOMMENDED

Prescott's Microbiology, 10th Edition, Willey, Sherwood, Woolverton

Unit 1: Organic reactions and their mechanisms (Part-1):

Overview of different types of Organic Reaction, **Addition Reactions:** Electrophilic Addition, Nucleophilic Addition, Free Radical Addition, Concerted Addition; **Substitution Reactions:** Nucleophilic Substitution Reactions, Electrophilic substitution Reaction, Free Radical Substitution Reaction; **Elimination Reactions:** Introduction, E1 Mechanism, E2 Mechanism, E1CB Mechanism, Alpha Elimination reactions

Unit 2: Organic reactions and their mechanisms (Part-2):

Free Radical Reactions: Generation, Structure and Stability of Free Radicals, Reactions and Applications of Free radical reactions, persistent radicals; **Pericyclic Reactions:** Pericyclic reactions and its types, Cyclo Addition Reaction, Electrocyclic Reaction, Sigmatropic Rearrangement Reactions; **Photochemical Reactions:** Photophysical Processes, Jablonskii Diagram, Photochemical reactions

Unit 3: Chemistry of heterocyclic compound:

Nomenclature, Classification, Synthesis, Properties, Reactions and Medicinal Uses of Heterocyclic Compounds: Furan, Thiophene, Pyrrole, Pyridine, Quinoline, Indole; **Structure of heterocyclic Compounds:** Pyrazole, Imidazole, Oxazole, Thiazole, Purine, Pyrimidine, acridine, Azepines; **Heterocyclic Compounds in Drugs:** Identification of Heterocyclic core in Drug molecules

Unit 4: Organic Name Reactions:

Synthetic Applications of Organic Name reactions: Aldol reaction, Cannizzaro reaction, Diels-Alder reaction, Grignard reaction, Michael addition, Mannich reaction, Reformatsky Reaction, Wittig Reaction, Baeyer-Villiger Oxidation, Claisen Schmidt reaction, Dieckmann condensation, Knoevenagel condensation, Mitsunobu reaction, Suzuki coupling, Stille coupling, Sonogashira coupling, Beckman rearrangement

BMS-304: PRACTICAL

Credits: 2

1. Gram's staining
2. Antibiotic Susceptibility Testing by Agar Disk Diffusion Method
3. Study of Antibiotic Resistance in Bacteria
4. Study of Normal Microflora of the Throat and Skin
5. Identification of staphylococcus pathogens
6. Identification of *Mycobacterium tuberculosis*
7. Drawing structures, reactions, mechanism and properties using chem-draw software.
8. Dibenzal acetone from benzaldehyde by Claisen Schmidt reaction
9. Preparation of umbelliferone by Pechhman reaction
10. Estimation of blood sugar
11. Testing of Liver Function Test (Bilirubin, SGOT, SGPT, Alkaline Phosphatase, Albumin, Globulin, Total Protein)
12. Estimation of urea
13. Estimation of cholesterol

BMS-401: Cell Biology

Credits: 4

Unit 1: Introduction to cell Biology

(5h)

Structure, Size and Classification.

Unit 2: Nucleus, Protein Sorting and Transport

(10h)

Nuclear Envelope - Structure of Nuclear Pore Complex, Nuclear Lamina, Transport across Nuclear Envelope, Chromatin: Molecular Organization, Nucleolus.

Endoplasmic reticulum, Golgi Apparatus, Mechanism of Vesicular Transport, Lysosomes.

Unit 3. Mitochondria and Peroxisomes

(7h)

Structural Organization, Function, Marker Enzymes, Mitochondrial Biogenesis, Protein Import in Mitochondria, Semiautonomous Nature of Mitochondrial DNA, Peroxisomes' Assembly

Unit 4. Plasma Membrane, Extracellular Matrix and Cell Interactions

(8h)

Structure; Transport of Small Molecules, Endocytosis, Extracellular Matrix and Cell Matrix Interactions; Cell-Cell Interactions.

Unit 5: Cell Signaling

(8h)

Signaling Molecules and their Receptors; Functions of Cell Surface Receptors; Intracellular Signal Transduction Pathway (GPCR, RTKs); Signaling Networks.

Unit 6. Cytoskeleton and Cell Movement

(7h)

Structure and Organization of Actin Filaments; Actin, Myosin and Cell Movement; Intermediate Filaments; Microtubules.

Unit 7. Cell Cycle

(8h)

Eukaryotic Cell Cycle, Regulation of Cell Cycle Progression, Events of Mitotic Phase, Meiosis and Fertilization.

Unit 8. Cell Death and Cell Renewal

(7h)

Programmed Cell Death (Extrinsic and Intrinsic Pathways, Necrosis and Autophagy, Stem Cells and Maintenance of Adult Tissues, Embryonic Stem Cells.

BMS-402: Pharmacology

Credits: 4

Unit 1: Introduction to pharmacology (5h)

Basic concepts in pharmacology, Drug nomenclature, Drug Compendia, Concept of Essential medicines, Routes of drug administration.

Unit 2: Pharmacokinetics (10h)

Transport across Biological membranes: Passive diffusion, filtration and specialized transport. Principle of absorption, bioavailability, bioequivalence, distribution, Plasma protein binding, metabolism, excretion, kinetics of elimination

Unit 3: Pharmacodynamics (7h)

Principles of drug action, Dose-response relationship, Drug potency and efficacy, Therapeutic index.

Unit 4: Pharmacotherapy and clinical pharmacology (8h)

Drug dosage, factors modifying drug action, pharmacogenomics, rational uses of medicines, Expiry date of pharmaceuticals.

Clinical studies: Clinical trails, Cohort studies and case control studies.

Unit 5: Autonomic Nervous System and drugs (8h)

Mechanism in autonomic nervous system and cholinergic transmission.

Cholinoreceptors: Muscarinic receptors and Nicotinic receptors, Muscarinic and nicotinic actions.

Cholinergic drugs: Cholinergic agonists (Pilocarpine), Anticholinesterases (physostigmine), Anticholinergic drugs (Atropine)

Unit 6: Adrenergic System and drugs (7h)

Adrenergic transmission, Adrenergic drugs (Noradrenaline, Adrenaline, Salbutamol) Antiadrenergic drugs (Atenolol)

Unit 7: Antimicrobial and anticancer drugs (8h)

General consideration, Antibacterial (tetracyclines, penicillins), antiviral (acyclovir, Zidovudine), Classification of anticancer drugs (Methotrexate, Imatinib).

Unit 8: NSAIDs and diuretic drugs (7h)

Pharmacological actions and pharmacokinetics of Aspirin. Thiazide diuretics

Reference Book:

1. Pharmacology by K.D. Tripathi, 6th Edition

Unit 1: Enzymes**(15h)**

Introduction to enzymes, Apoenzyme, Holoenzyme, Role of coenzymes and prosthetic groups and vitamins as coenzymes precursors, Metal-activated and Metallo-enzymes.

Classification and nomenclature of enzymes with example, Activation energy and Transition state theory, Binding energy, Proximity and Orientation effect, Strain and distortion theory.

Unit of enzyme activity – definition of IU, Katal, enzyme activity, Specific activity

Effect of pH, temperature, substrate concentration and metal ions on the activity of enzyme. Specificity of enzymes (concept of active site)

Theories of enzyme catalysis – Lock and key model, Induced fit theory.

Unit 2: Enzyme kinetics and regulation**(15h)**

Relationship between initial velocity and substrate concentration,

Enzyme kinetics: Michaelis – Menten equation, Briggs and Haldane theory (rapid equilibrium and steady state theory), Lineweaver – Burk (L-B) plot, Determination of V_{max} & K_m from L-B plot and their significance, Significance of K_{cat} and specificity constant.

Reversible enzyme inhibition– Competitive, Non-competitive and Uncompetitive.

Suicide inhibitor, Transition state analogues, Catalytic antibodies, Isozymes and Ribozymes.

Allosteric enzyme, Allosteric regulation with ATPase as an example, Covalent modification- glycogen phosphorylase, Zymogen activation by proteolytic cleavage with example of chymotrypsin and trypsin.

Suggested Textbooks

1. Nelson, D.L. and Cox, M.M.(2009). Lehninger's Principles of Biochemistry, W.H. Freeman and Company, New York.
2. Price, N.C. and Stevens, L.(1996). Fundamentals of Enzymology, Oxford University Press Inc. N.Y.

BMS-404: PRACTICAL**Credits: 2**

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

1. Preparation of metaphase chromosome
2. Study of Barr Body in human cheek epithelial cells
3. Demonstration of osmosis in egg
4. To study the stages of Mitosis and Meiosis from permanent slides
5. To prepare stained temporary mounts of onion peels
6. Study of cell division in onion root tip
7. Titration curve of Glycine.
8. Determination of alkaline phosphatase activity from germinating seeds.
9. To determine temperature optima for alkaline phosphatase
10. To examine effect of pH on activity of alkaline phosphatase
11. To study the effect of substrate concentration on activity of alkaline phosphatase and determination of K_m and V_{max} of the reaction.
12. Preparation of casein from milk and determination of its isoelectric point.

Unit I Introduction to Medical Genetics (5h)

Importance of medical genetics, History of Genetics, Types of genetic diseases, Clinical impact of genetic disease

Unit II Autosomal dominant and recessive disorders (8h)

Basic concept of formal genetics: Mendel's contributions, concept of phenotype, Basic pedigree structure

Auosomal dominant inheritance: Characteristics of autosomal dominant inheritance, reoccurrence risks

Autosomal recessive inheritance: Characteristics of autosomal recessive inheritance, reoccurrence risks.

Factors affecting expression of disease causing genes: New mutation, germline mosaicism, reduced penetrance, age dependent penetrance, variable expression, locus heterogeneity, pleiotropy

Unit III Sex-linked and Non-traditional modes of inheritance (6h)

Sex linked inheritance: X-linked recessive inheritance, X-linked dominant inheritance, Y-linked inheritance, Sex linked and sex influenced traits, mitochondrial inheritance.

Genomic imprinting: Prader-Willi and Angle man syndrome, Fragile X syndrome

Unit IV Genetic Variation (10h)

Mutation: Type of mutation, molecular consequences of mutation, clinical consequence of mutation (Hemoglobin disorders: Sickle cell disease & Thalassemia), Causes of mutation, DNA repair, Mutation rates.

Detection and measurement of genetic variation: genetic variation in ABO blood group and Rh system. Detecting variation by protein electrophoresis, brief mention of techniques for detecting variation at the DNA level.

Genetic variation in populations: Basic concept of probability, Gene and genotypic frequencies, The Hardy-Weinberg principle, Causes of genetic variation

Unit V Clinical cytogenetics (7h)

Cytogenetic technology and nomenclature: Chromosome banding, Fluorescence in situ hybridization comparative genomic hybridization.

Abnormalities of chromosome number: Polyploidy, Autosomal Aneuploidy (Trisomy 21, 18, 13); Sex chromosome aneuploidy (Turner syndrome, Klinefelter syndrome)

Abnormalities of Chromosome structure: Translocations, deletions, duplication, inversions.

Unit VI Disease-Gene identification (9h)

Gene mapping: Linkage analysis, LOD Scores, Linkage analysis and Human gene map.

Physical Mapping and cloning: Chromosome morphology, Dosage mapping using deletions and duplications, Functional versus non-functional DNA, Computer analysis of DNA sequence, Test for gene expression.

Gene mapping by association: Genome wide association studies, Examples of well-known mendelian disease causing genes.

Unit VII Biochemical Genetics (6h)

Prevalence of metabolic disease, inheritance of metabolic defects.

Defects of metabolic processes: Defects of Carbohydrate metabolism (Glucose), Unclear Defects of amino acid metabolism (Phenylalanine), Defects of Lipid metabolism (Cholesterol)

Unit VIII Cancer genetics, Genetic Testing and Precision medicine (9h)

Causes of Cancer, Cancer genes, Inherited cancer gene versus somatically altered genes, Tumor suppressor genes, Oncogenes, Identification of inherited cancer causing genes

Prenatal diagnosis of genetic disorders and congenital defects: Amniocentesis, Chorionic Villus Sampling

Impact of genomics: Pharmacogenetics, Individualized drug therapy, Diagnosing and monitoring common disease

BOOKS RECOMMENDED

1) Medical Genetics, 5th Edition, Jorde, Carey, Bamshad

Unit 1: Introduction to molecular biology (10h)

Composition and structure of DNA, gene and genome; Introns and exons

Key experiments establishing the Central Dogma

Chromatin structure: Euchromatin, Heterochromatin, Constitutive and Facultative heterochromatin.

Regulation of Chromatin Structure and Nucleosome Assembly

Organization of Chromosomes

Unit 2. DNA Replication (10h)

General principles: Bidirectional replication, Semiconservative, Semi-discontinuous, RNA priming,

Various models of DNA replication: Rolling circle, D-loop (mitochondrial), Θ (theta) mode of replication, replication of linear ds-DNA, replicating the 5' end of linear chromosome.

Enzyme involved in DNA replication – DNA polymerases, DNA ligase, Primase, Telomerase and other accessory proteins.

Replication errors, DNA damage, DNA repair.

Unit 3. Mechanism of Transcription (7 hours)

RNA Polymerase, Transcription unit,

Mechanism of Transcription in Prokaryotes and Eukaryotes

Unit 4. Transcription Regulation in Prokaryotes (3 hours)

Principles of transcriptional regulation, regulation at initiation with examples from lac and trp Operons.

Regulatory RNAs: Riboswitches, RNA interference, miRNA, siRNA, Regulatory RNA and X-inactivation

Unit 5. RNA Modifications (10 Hours)

Removal of Introns, Spliceosome machinery, splicing pathways, alternative splicing, exon shuffling, RNA editing, and mRNA transport.

Unit 6. Translation (Prokaryotes and Eukaryotes) (5 hours)

Steps in protein synthesis: Ribosome structure and assembly, charging of tRNA, aminoacyl tRNA synthetases, Proteins involved in initiation, elongation and termination of polypeptides.

Fidelity of translation. Inhibitors of protein synthesis. **Regulation of translation:** Translation-dependent regulation of mRNA, Protein stability.

Unit 1: Foundations of DNA Technology (9h)

Tools of Genetic Engineering: Organisms as models, Microbial recombination, Restriction Enzymes, Plasmids.

Recombinant DNA experiments: Safety issues.

Unit 2: Methods of DNA Technology (9h)

Biochemistry of gene expression: Obtaining the gene, selecting the vector, selecting the host cell, expressing the gene, collecting the gene product

Gene Libraries: Establishing a library, screening the gene library, cDNA Library.

Unit 3: Pharmaceutical products of DNA Technology (7h)

Introduction:

Human protein replacements: Insulin, Human Growth hormone, Factor VIII.

Human Therapies: Tissue plasminogen Activator, Interferon, Antisense molecules, other innovative pharmaceuticals.

Vaccines: Hepatitis B, AIDS, traditional vaccines, DNA Vaccines.

Unit IV: DNA Analysis and Diagnosis (8h)

Methods of DNA Analysis: DNA Probes, PCR, DNA CHIP, RFLP Analysis.

Diagnosing infectious disease: AIDS, Tuberculosis, Human Papilloma virus and other disease.

Identifying genetic disease: Cystic fibrosis, Duchenne's muscular dystrophy, Huntington's disease, fragile X syndrome, Retinoblastoma, Alzheimers's disease, ALS, diabetes, Cancer, obesity, parkinson's disease.

Gene Banking

DNA Matching techniques: DNA finger printing

Unit V: Gene Therapy (6h)

Introduction, Somatic cell therapy, Vectors in Gene Therapy

Gene replacement therapy: Retroviral Vectors, Adenoviral vectors, Adeno-associated viral vectors, lentiviral vectors, Challenges in viral gene therapy, nonviral vectors.

Gene-blocking therapies: Antisense therapy, Ribozyme therapy, RNA interference

Unit VI: Transgenic Animals (6h)

Techniques of Placing DNA in mammalian cells: Microinjection

Custom made animals: Human mouse, oncomouse, Alzheimers mouse, knockout mouse.

Transgenic products: Use of animals as bioreactors, Human hemoglobins from pigs,

Lactoferrin, Pharm animals, vegetable vaccines, Examples of transgenic animals, improving animals for the production of transgenic products.

BMS-504: PRACTICAL

Credits: 2

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

1. Preparation of various stock solutions required for Molecular Biology Laboratory.
2. Isolation of genomic DNA from blood/ tissue.
3. Agarose gel electrophoresis for separation of DNA fragments.
4. Determination of absorption maxima of nucleic acids
5. Isolation of plasmid DNA from E. coli.
6. Transformation of E. coli cells with plasmid DNA.
7. Digestion of plasmid DNA with restriction enzymes.
8. Demonstration of Polymerase Chain Reaction (PCR) technique.
9. Karyotyping
10. Hardy-Weinberg Genetic equilibrium: Study of gene & genotype frequencies. (PTC Tasters & nontasters)
11. To test for colour blindness using Ishihara charts and calculation of allele frequencies.
12. Blood group typing using haemagglutination tests and calculation of allele frequencies.

BMS-601: Immunology

Credits: 4

Unit 1 Introduction to immunology

(5h)

Concept of Innate and Adaptive immunity; Contributions of following scientists to the development of field of immunology - Edward Jenner, Karl Landsteiner, Robert Koch, Paul Ehrlich, Elie Metchnikoff.

Unit 2 Immune Cells and Organs

(10h)

Structure, Functions and Properties of: Immune Cells – Stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell, Dendritic cell; and Immune Organs – Bone Marrow, Thymus, Lymph Node, Spleen, GALT, MALT, SALT

Unit 3 Antigens

(6h)

Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity); Haptens; Epitopes (T & B cell epitopes); T-dependent and T-independent antigens; Adjuvants

Unit 4 Antibodies

(9h)

Structure, Types, Functions and Properties of antibodies; Antigenic determinants on antibodies (Isotypic, allotypic, idiotypic); VDJ rearrangements; Monoclonal and Chimeric antibodies

Unit 5 Major Histocompatibility Complex

(9h)

Organization of MHC locus (Mice & Human); Structure and Functions of MHC I & II molecules; Antigen processing and presentation (Cytosolic and Endocytic pathways)

Unit 6 Complement System

(6h)

Components of the Complement system; Activation pathways (Classical, Alternative and Lectin pathways); Biological consequences of complement Activation

Unit 7 Generation of Immune Response

(8h)

Primary and Secondary Immune Response; Generation of Humoral Immune Response (Plasma and Memory cells); Generation of Cell Mediated Immune Response (Self MHC restriction, T cell activation, Co- stimulatory signals); Killing Mechanisms by CTL and NK cells, Introduction to tolerance

Unit 8 Immunological Disorders and Tumor Immunity

(7h)

Types of Autoimmunity and Hypersensitivity with examples; Immunodeficiencies - Animal models (Nude and SCID mice), SCID, DiGeorge syndrome, Chediak- Higashi syndrome, Leukocyte adhesion deficiency, CGD; Types of tumors, tumor Antigens, causes and therapy for cancers.

BMS-602: Applied organic chemistry**Credits: 4****Unit 1: Basics of Green Chemistry****(15h)**

Introduction and Green Chemistry, Goals and Principles of Green chemistry, Designing a Chemical synthesis, Prevention of waste or by-products, Atom Economy, Prevention/minimization of hazardous/toxic products, Green Solvents, Solvent less Processes, Immobilized solvents and ionic liquids, Examples of green synthesis/reactions, Microwave assisted reaction, Ultrasound assisted reactions; **Green Synthesis:** Ibuprofen, Paracetamol, Aspirin, limitations and obstacles in the pursuit of the goals of green chemistry

Unit 2: Stereochemistry (15)

Chirality; Molecules with one chiral centre: Enantiomers, R-S system of configurational nomenclature; Fischer projection; **Effect of chiral molecules on polarized light:** Optical activity and specific rotation, Enantiomeric excess, Racemic mixture; **Molecules with more than one chiral centre:** Diastereomers, Meso compounds; Physical properties of enantiomers and diastereomers, separation of stereoisomers and chiral synthesis

Nomenclature of geometrical isomers: Cis-Trans Nomenclature, EZ Nomenclature, Syn-Anti system; **Conformations and conformational analysis:** Cyclohexane and its derivatives, Ethane and n-butane, Bayer strain Theory and orbital picture of angle

Unit 3: Chemistry of natural products**(15h)**

Occurrence, extraction and properties of Alkaloids: Connine, Nicotine, Atropine, Therapeutically Important alkaloids; **Terpenes :** Isoprene Rule, Classification, Isolation, Properties, Geraniol, Pinene, Camphor, **steroids**, Cholesterol, and Classification of Antibiotics

Unit 4: Reagents and Their Application**(15h)**

Synthetic Reagents: NBS, Diazomethane, **Amide Coupling Reagents:** DCC, **Oxidizing Reagents:** Peracids, Dess-martin Periodinane, OsO₄, KMnO₄, PCC, PDC, Peroxides; **Reducing Agents:** LAH, DIBAL, NaBH₄, **Borane Reagents and Hydrogenation Reactions:** Homogenous Catalysis, Heterogenous Catalysis, **Role of protection/ deprotection in organic synthesis:** Protection for Hydroxyl group, Protection of 1,2- and 1,3- diols, Protection for the carbonyl group, Protection for the carboxyl group, Protection for the amino group and amino acids. Solid phase peptide synthesis

BMS-603: Medicinal Chemistry

Credits: 2

Unit 1: Principles of drug discovery

(10h)

Drug discovered without rational design: Discovery of penicillin & Librium, drug discovered through metabolic studies.

Modern rational drug design: Target based drug design, overview of drug targets

Drug development: Preclinical development, Clinical development

Unit 2: Lead discovery

(5h)

Basic concept of lead, Sources of Lead compounds, Endogenous ligands, Screening of compounds, desirable properties of compounds for screening.

Unit 3: Lead modification

(10h)

Identification of pharmacophore, Functional Group Modification, Structure–Activity Relationships, Structure Modifications to Increase Potency, Therapeutic Index, and ADME Properties, Structure Modifications to Increase Oral Bioavailability and Membrane Permeability, Computational Methods in Lead Modification.

Unit 4: Proteins and nucleic acids as drug targets

(5h)

Drug receptor interactions: general principles, important forces involved in drug receptor complex Role of confirmation in affinity, Types of drug receptors, Design of agonist and antagonists, Concept of partial antagonism, desensitization, tolerance and dependence.

Classes of DNA interactive drugs: Reversible DNA binders, Groove binders (netropsin), DNA intercalators (amsacrine), DNA alkylators (Mechlorethamine, Carmustine).

BMS-604: Practical**Credit: 2**

- 1) To detect antigen-antibody complex by ring-precipitin test.
- 2) To detect antigen-antibody complexes by single diffusion method (Ouchterlony)
- 3) To detect antigen-antibody complexes by double diffusion method (Mancini)
- 4) To perform immunoelectrophoresis
- 5) To detect ABO blood group type.
- 6) Introduction and preparation of stereo models: Methane, Ethane, Ethylene, Acetylene, Cis/Trans alkene, substituted cyclohexane
- 7) Preparation of nylon 66 and urea formaldehyde resin
- 8) Separation of solid binary mixture of organic compounds- neutral and acidic
- 9) Thin-Layer Chromatography of Chlorophyll a and b from Spinach
- 10) Synthesis of phenytoin and aspirin
- 11) Preparation of biodiesel
- 12) Extraction of caffeine from Tea leaves and studies its absorption properties.
- 13) Determination of partition coefficient in octanol water system.

Skill Education Component

Semester I

Skill Qualification pack

Sector Skill Council: Life Sciences Sector Skill Development Council

Job Role: Machine-Life Sciences

NSQF Level: 4

Qualification pack Code: LFS/Q0207

National Occupation Standards

1. LFS/N0213: Prepare machines and accessories for the manufacturing process
2. LFS/N0214: Perform manufacturing operations
3. LFS/N0103: Ensure cleanliness in the work area
4. LFS/N0102: carry out reporting and documentation
5. LFS/N0215: Carry out broad level quality checks before, in process and post manufacturing
6. LFS/N0101: Maintain a healthy, safe and secure working environment in the life sciences facility

Semester II

Skill Qualification pack

Sector Skill Council: Life Sciences Sector Skill Development Council

Job Role: Quality Control Chemist

NSQF Level: 5

Qualification pack Code: LFS/Q1301

National Occupation Standards

1. LFS/N0301 Perform routine analysis in lab while ensuring compliance with Good Manufacturing Practices (GMP) and Good Laboratory Practices (GLP)
2. LFS/N0101 Maintain a healthy, safe and secure working environment in the life sciences facility
3. LFS/N0302 Coordinate with Supervisors and colleagues within and outside the department
4. LFS/N0103 To ensure cleanliness in the work area
5. LFS/N0314 To carry out reporting and documentation to meet quality standards

Semester III & IV
Skill Qualification pack

Sector Skill Council: Life Sciences Sector Skill Development Council

Job Role: Licensing Manager-Life Sciences

NSQF Level: 6

Qualification pack Code: LFS/Q0609

National Occupation Standards

- 1 LFS/N0622: Regulatory compliance and exchange of information for licensing activities
- 2 LFS/N0613: Provide analytical support for supply chain management
- 3 LFS/N0623: Manage, coordinate and interact with people to effectively control licensing operations
- 4 LFS/N0102: Carry out reporting and documentation

Semester V & VI
Skill Qualification pack

Sector Skill Council: Life Sciences Sector Skill Development Council

Job Role: EHS Manager-Life Sciences

NSQF Level: 7

Qualification pack Code: LFS/Q0214

National Occupation Standards

1. LFS/N0230: Develop, implement and direct a comprehensive environment, health and safety program for the Company
2. LFS/N0231: Prepare and provide training on Environmental, Health and Safety Standards
3. LFS/N0232: Manage and co-ordinate EHS team
4. LFS/N0233: Carry out reporting and documentation as per EHS standards
5. LFS/N0234: Supervise effective working of manufacturing process according to EHS standards and identifying and resolving any issues arising during the process
6. LFS/N0101: Maintain a healthy, safe and secure working environment in the life sciences facilit

